Book of Abstracts

sb13 munich

Implementing Sustainability – Barriers and Chances

Sustainable Building Conference
Munich April 24-26, 2013

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Table of Content

4. Methodologies and Tools for Planning, Operation & Deconstruction Processes of Buildings

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Foreword

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For almost twenty years now, the implementation of the principles of a sustainable development in the construction and real estate industries has been and is still being discussed. During that time an integrative understanding of sustainability has been worked out and transferred into European standards. Numerous sustainability evaluation systems have been developed. Additionally, data, methods and support have been made available. This is, among other things, the result of an extensive scientific exchange which found its expression in numerous conferences such as the series on “Sustainable Building”. The representatives of planning-, construction- and real estate practice have contributed by the development and implementation of new technologies and products, the realization of new building or modernization projects as well as the integration of the sustainability aspects of instruments and decision-making procedures. This process has also been strongly supported by the exchange of experiences.

The SB13 Munich offers the possibility to continue the exchange of experiences in this field. In many contributions there will be analyses and discussions of whether and, if so, which obstacles still exist and have to be overcome in the field of sustainable planning, construction and maintenance. At the same time, possible opportunities for product manufacturers, planning engineers and the construction and real estate industries will be highlighted. The role of public administration will be particularly addressed here.

Contributions dealing with the role of public administration and current developments in the fields of standardization and legislation can be found in **Topic 1**, which is supplemented by references to sponsorship opportunities and results of the assessment of economic advantages. **Topic 2** focuses on themes of the sustainable development of quarters, residential estates and cities. Here a new field of activity with a high potential is evolving. **Topics 3 and 4** are closely connected. Here contributions dealing with the application of the principles of a sustainable development of new building and modernization projects are summarized. Consequences for the planning process are discussed as well as the methods and aids for supporting it. Special attention is paid here to current developments in life-cycle analysis and sustainability assessment. In addition, the question of the extent to which sustainability themes can be integrated into education and further training will be investigated.

A precondition for the realization of sustainable building projects is the availability of suitable products and methods. The contributions summarized in **Topic 5** present appropriate solutions and refer to the importance of the provision of relevant product information in the form of EPD's. In the book of abstracts you will find a short summary of the contributions provided for a speech or a poster. They feature an overview of current topics and trends in the field of "sustainable construction" with the focus on Europe/Germany, also including, however, valuable contributions from other parts of the world. Together they form the basis for discussions at the SB13 Munich conference and serve to prepare the SB14 World Conference.

Prof. Dr.-Ing. Gerd Hauser
Prof. Dr.-Ing. habil. Thomas Lützkendorf
Prof. Dr.-Ing. Natalie Eßig

Foreword BMVBS

Sustainable building from the perspective of the Federal Government

“Only fell as many trees as can grow back.” This pithy saying from the field of forestry is an accurate description of the strategy we are pursuing in many areas today, 300 years later, and which has become known as sustainable action.

As early as 2002, the Federal Government adopted a national sustainable development strategy that includes all relevant sectors of society and is underpinned by measurable targets. Since then, this strategy has constantly been reviewed and evolved. The construction and property industries play a major role in all this because one third of the total energy and resource consumption in Germany can be attributed to the construction and operation of buildings.

As the Federal Ministry of Transport, Building and Urban Development, we make a crucial contribution towards ensuring more sustainability in the construction sector. Sustainable construction must be perceived as a holistic approach. It begins with the design and construction of a building and continues through its use and management right up to its eventual demolition. This all-embracing perception will ensure a sustained improvement in quality throughout the life cycle of a building.

Moreover, the Federal Government, as the largest public sector client in Germany, plays an important pace-setting role and sets an example of good practice with its own projects. This is true of the quality and value for money of structures as well as their functionality, safety or accessibility. We also want to ensure that the buildings are constructed and operated in such a way that their climate change impact and energy consumption are minimized. Against the background of demographic trends, they must be permanently and flexibly fit for everyday use.

The Sustainable Construction Guide is an important governance tool. Together with the Sustainable Construction Assessment System, they have been binding for the construction of new office and administrative buildings since 3 March 2011. This system allows for the first time the description and final assessment of a building’s environmental impact and its overall contribution to sustainable development, based on scientific, mostly quantitative methods. In the meantime, this approach has been complemented by standards which were developed for the existing building stock, for instruction buildings, laboratories and outdoor facilities.

Implementing the principles of sustainability requires commitment, reliable partners and an intensive transfer of knowledge. For many years now, the Sustainable Building Conference has been providing an excellent platform for this purpose. Germany is honoured to be this year’s host. I wish all participants many new insights and lots of interesting discussions and hope that this event will have the desired lasting success.

Yours sincerely,

Ministerialdirektor Günther Hoffmann
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Foreword Deutsche Bundesstiftung Umwelt (DBU)

Sabine Djahanschah , Dipl. Ing. (Architect)

Head of the "Architecture and Building" division

Philosophy of sponsoring of the "Architecture and Building" division

The Deutsche Bundesstiftung Umwelt (DBU) sponsors environmental innovations, taking small and medium-sized businesses into special consideration. Due to its profound environmental impact and structure, which is characterised by small and medium-sized enterprises, the construction industry is of central importance to our sponsoring activities.

In the field of "Architecture and Building", the DBU supports model-based, environmental innovations. Within an urban planning context, buildings with specific usages require individual solutions, meaning that the main focus is on the development of an optimised planning methodology. In integral planning processes, interdisciplinary teams (composed of architects and specialist consultants) develop exemplary solutions for sustainable optimisation.

Since the decisive factors for achieving high building quality are determined in the early planning phases, the investment in people brings especially good results. The specified requirements from an urban planning and functional perspective, as well as those regarding design quality, construction and materials, HVAC, construction physics, fire protection, outdoor facilities, ecology and economy, are detailed and linked. This leads to an optimised result that can be calculated in monetary terms over the life cycle of a building. In order to realise the concepts optimised through the consideration of variants during the implementation phase, quality assurance measures are needed during tendering, the award of contracts and the construction process. Furthermore, a two-year evaluation period is instrumental in optimising the process technology and operation, incorporating user needs and securely achieving and documenting the desired energy values and comfort levels.

These additional expenditures during the planning process, as well as their quality assurance, evaluation and documentation, can be partly funded by the DBU. They do not necessarily engender higher added costs during construction, but on the contrary, lead to better quality for the same amount of money. Through the documentation and sharing of this entire process, property developers, construction consultants and users may be inspired to follow in the same footsteps. Against this backdrop, the future-oriented development of educational establishments has been a main focus of the "Architecture and Building" division. In many ways, schools are extremely important for our future: the children shaped in and by schools today will be the decision-makers of tomorrow. In addition to ambitious pedagogical concepts and encouraging teachers and parents, the spatial environment of the building contributes in no small way to the future viability of a school.

Furthermore, in the field of "Monument and Energy", a further focal point was the development of innovative renovation concepts within the context of the preservation of architecturally valuable buildings. The goal of these endeavours is to find solutions and approaches that are transmissible to the rather larger group of historical structures that are worth preserving, but for which no practicable solutions for sustainable development have been found, and that do justice to the artistic integrity of these structures.

Oil and gas are no longer the only dwindling resources, due in part to global construction demands. Rare stones and earths are leading to price increases and make it clear that other resources are also finite. Added to are degradation processes of raw materials, as well as production, transport and disposal processes of construction materials that are detrimental to the environment.

Until now, a primary focus in green building research has been the lowering of energy consumption levels during use thanks to insulation and efficient HVAC systems, as well as the use of renewable energies. These energy consumption levels, however, are being so far reduced (for instance through the use of Passivhaus concepts) that in relation to these, the environmental impact linked to the choice of construction materials and products is much higher. In order to have a defining impact on the ecological assessment of a building, the large components in particular (i.e. the primary structure) must be made from renewable raw materials. These considerations naturally lead to the use of timber, which, through diverse developments and product innovations, now also lends itself to interesting building solutions in a vast number of larger construction projects. By increasing the use of timber, renewable raw materials are substituted for non-renewable raw materials, significantly reducing the carbon footprint of the construction industry. Here, too, the DBU plans relevant funding in the future.

In addition to planning processes and the monitoring and documentation of model projects, the development of eco-friendly construction components, resources and methods is of great importance. In this context, planning aids have been developed that help construction consultants optimise sustainable solutions. Among these are instruments for calculating variants in life cycle costs and integrating information on eco balance sheets and hazardous materials into the planning process, as well as instruments and methodical approaches for efficient evaluation and quality assurance.

The key to success in the creative development of future-oriented solutions within the framework of the DBU renovation work and new construction model projects proved to be the integral planning processes in teams of different experts. In this way, the DBU is engaged in the methodical development of a planning culture that takes into account the challenges of sustainable thinking and can be measured against exemplary models of future-oriented building culture.

A number of projects have recently shown that investments in paid thinking are the central motor in bringing about new developments. Generally, money is not the thing that is lacking in the search for good solutions, but rather people who can think outside of the box and can use their flexibility, creativity and courage to find new ways towards credible solutions. We look forward to working together with these leading thinkers on specific projects and getting the ball rolling on the road towards a sustainable building culture. With this in mind, we hope this session will also contribute towards the interconnection, discussion and sharing of new concepts.

1. Political Frameworks for a Sustainable Built Environment

Investigation on the Differences between LEED, BREEAM and Open House Assessment Systems by Means of two Hungarian Case Studies

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Extended Abstract

Within the framework of the Open House project, two case studies were assessed in accordance with the Open House criteria system. The two projects investigated were: Corvin I Offices, an existing building located in Budapest and Nordic Light Offices project, which is currently in the construction planning phase, located in the Hungarian capital alike.

The Corvin I Offices building is a multitenant office building. The owner of the building decided to carry out sustainable assessments after completion. The building was evaluated with LEED and BREEAM-In-Use systems where a BREEAM in Use rating was achieved in 2011 with the following results:

BREEAM in Use, Part 1 - Good
BREEAM in Use, Part 2 – Pass

The Nordic Light Offices (NLO) building project is also a multitenant office development. Sustainability aspects played a key role during the whole planning procedure. Parallel to the design a zero energy study was carried out which analyzed how to minimize energy consumption with high user comfort and resource efficiency as well. The NLO project is currently undergoing LEED C&S certification and has already received a precertification of LEED GOLD level.

This paper shows the most significant differences between LEED and BREEAM, which are the most commonly used green building rating systems in Hungary, and the new Open House methodology by means of the above mentioned two case studies. These differences were analysed in light of the Hungarian construction industry and current office building development practices.

The comparison of the new OPEN HOUSE methodology and LEED, BREEAM systems shows that sustainability approaches of the systems are similar. Current investigation shows, that the main difference between the rating systems is that the emphasis is laid on different objectives. In case of LEED and BREEAM, great emphasis is given on the building performance in operation (commissioning, recycling waste, energy efficiency, comfort,, building user guide etc.) and the construction phase (waste management, considerate constructors, IAQ management, etc.). In the OPEN HOUSE system, sustainability is addressed in a broader scale during the whole life cycle of the building: from the beginning of the site selection process to the demolition of the building. During the whole life cycle, environmental and cost-related issues are to be assessed, as well.

Outgoing from this experience, there is a good chance that the final OPEN HOUSE methodology will gain ground in Hungary in the future. It has a flexible scoring and weighting system, an open and transparent concept and a whole life cycle approach of sustainable issues. In addition, the standards and regulations referenced in the methodology are commonly used in Europe. Consequently, the implementation is much easier in case of a central European country, as well.

Furthermore, OPEN HOUSE has the potential to move forward the Hungarian green building market because it is a free, open source assessment tool. Hungary Green Building Council has already attempted to incorporate the use of green building rating tools into the Hungarian regulations. Nevertheless, the process has not been successful so far because the position of local policymakers on this issue is that the rating systems cannot be prescribed until the assessment itself is so expensive. Therefore, the open source OPEN HOUSE system could be a solution for this complex situation.

Ecological Aspects of Building Materials within BNB (Assessment System for Sustainable Construction for Federal Buildings)

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Summary

This paper explains how building materials and products are factored into Sustainable Building for Federal Buildings, a binding assessment system introduced in Germany. Apart from the technical characteristics, particularly the impact on the global environment (e.g., global warming potential) plays a key role. These indicators are determined by meana a life cycle assessment at building level. The use of materials and products in a building designed as sustainable is also determined by environmental and health-relevant aspects (e.g., interior emissions, risk potential for soil, water and air). Using the ÖKOBAU.DAT database (basic data for life cycle assessment) and the WECOBIS internet platform (comprehensive information on environmental and health aspects of building products), the federal government provides helpful aids for selecting materials according to ecological criteria.

Keywords: sustainable construction, building materials, ecological aspects

Extended Abstract

There are numerous political initiatives - at global, European and national levels - that formulate political objectives in connection with sustainability, such as energy efficiency, resource efficiency and reduction of greenhouse gases. Various political programmes deal with different individual aspects of sustainability. Frequently, the topics relevant to construction are linked to requirements with respect to building materials and building products.

For example, the National Sustainability Strategy defines specific tasks and objectives for sustainable development in Germany. As part of corresponding action programmes, specific objectives were adopted, such as halving of CO_2 emissions by the federal government by 2020 (compared to 1990 levels) or preparing an energy renovation schedule for all existing federal buildings. The National Sustainability Strategy is of special importance for federal construction projects: aligning federal buildings with the requirements of the Assessment System for Sustainable Building (BNB) was decided and implemented in a binding fashion as part of the action programme.

In applying the BNB, many of the sustainability aspects mentioned in the various political initiatives are taken into account by means of the comprehensive sustainability criteria, such as the deconstructability of buildings, recyclability of building products, global environmental effects with the global warming potential at their core, environmental and health-relevant effects on soil, water and air, indoor air quality and other aspects.

This paper deals with the role played by building materials/products in BNB. In the context of sustainable development, there are frequent calls for naming so-called ecological or sustainable building products. As the sustainability of a building under the BNB principles is ensured by taking into account all sustainability criteria in relation to Ecological, Economic, Socio-Cultural, Technical and Process Quality, building products are not assessed as individual products, but looked at within the context of the entire building.

Building products have to meet a wide range of requirements in terms of technical aspects (e.g., stability, fire protection, durability) as well as environmental and health-relevant aspects (e.g., risks to the environment, risks to users during processing or while building is used) and economic aspects (costs). The assessment of whether building products in a building are used in a sustainable manner, therefore, depends on the context of the building in question and, thus, on different sustainability criteria. Essentially, the properties of building prod- ucts play a role in all areas of sustainability: Ecological Quality (life cycle analysis, environment, material), Economic Quality (life cycle costs), Socio-Cultural Quality (e.g., indoor air quality), Tech- nical Quality and Process Quality. Consequently, building materials are assessed for the purposes of BNB indirectly and proportionately by way of different criteria profiles - generally taking into ac- count the life cycle over the chosen time period of 50 years.

Particularly with respect to Ecological Quality, that is, when considering the impact on the global and local environment, building materials form an essential part of the overall assessment. The effects on the global and local environment play a vital role (global warming, ozone depletion, photochemical ozone creation, acidification and eutrophication potential), which are determined by life cycle analysis. In addition, the risk potential for the environmental resources of ground water, surface water, soil, outside air and indoor air is analysed.

As part of the Assessment System for Sustainable Building, the federal government provides important aids for choosing suitable building products, which are presented in this paper. ÖKOBAU.DAT supplies basic data for life cycle assessment at building level. In addition, the WECOBIS internet platform provides key information on environmental and health-relevant aspects of building products.

BUILDING UP Research & Innovation Roadmap Addressing RTD Priorities for Improving Energy

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Summary

The article presents the major outcome of the European research project BUILDING UP "Multi-stakeholder, cross-sectorial, collaborative long term Research & Innovation Roadmap to overcome technological and non-technological barriers towards more energy-efficient buildings & districts" (http://www.buildingup-e2b.eu/).

Keywords: construction, energy efficiency, buildings, barriers

1. Introduction

The BUILDING UP project aimed to create an effective coordination of European Technology Platforms (ETP) and major initiatives whose Strategic Research Agendas and activities address energy efficiency in the built environment considering research on nanotechnology, materials and processes.
In this framework, the overall objectives of the Building Up Industrial and Research Roadmap are as follows:
- to outline and detail cross-sectorial research and innovation targets up to 2020 and beyond related to nanotechnology, materials and processes, in order to improve the energy efficiency in built environment,
- to obtain such goal through a cross-ETP Roadmapping activity, involving the Building Up network and large public consultations and debates.

2. Roadmap overview

Whilst it is based on a long term vision (up to 2050), the Building Up Roadmap [1] focuses its main targets in the short-medium term (up to 2020), with some suggested actions for longer terms (beyond 2020). In this framework, the Building Up Roadmap includes:

8 Cross-Platform (CP) collaboration areas in research and innovation in the NMP (Nano-technologies, Materials, Products) field, i.e. areas considered of interest by several ETPs involved in the roadmapping, with high impact for the energy efficiency in the built environment. These are:

CP1. Performance Based Approach for building components, including sustainable design, Life Cycle Analysis;
CP2. Multi-materials and composites;
CP3. Healthy and comfortable indoor environment (including air quality, ventilation, lighting, acoustics);
CP4. Electricity generation and storage materials and systems;
CP5. Thermal generation and storage materials and systems;
CP6. Advanced thermal insulation construction materials for new buildings and existing buildings;
CP7. Building materials recyclability and re-use of components;
CP8. Renewable resource-based products.

A set of **cross-cutting targets** with considerations on broad non technological issues.

The **overall social, environmental and economic impact**, adding specific examples on **target markets** and **expected benefits** of the proposed actions for each cross-platform areas.

The background for developing the roadmap was a broad review of foresight studies and other relevant sources (EU-funded work and reports, research agendas from ETPs, and other national and multinational initiatives), which takes into consideration climate change, resource scarcity and demographic change as global changes that will affect the building sector.

3. Conclusions

Building Up roadmap is well aligned with the E2BA “2020 Research & Innovation Roadmap” which aims at driving the creation of an innovative high-tech energy efficiency industry where the entire value chain will produce advanced systems, solutions and high value services for intelligent and sustainable buildings. This vision meets the 2020 targets with the overarching goal to support both Climate and Energy policies set at European level for the full decarbonisation by 2050 of the European economy [2]. This requires preparing new market conditions where building owners are ready to invest into an affordable built environment having lower energy demand and lower GHG emission footprints over their whole life cycle, while improving optimal indoor air-quality and comfort.

The roadmap was released in October 2012. Regarding the expected impact, BUILDING UP project promotes the European knowledge in the built environment and increases the industrial competiveness of the construction sector and the inter-connected sectors.

4. References

[1] CIOFFI M., DI GENARO F., ZINETTI S. (lead authors), BAX L., BOUJABEUR S., BOURDEAU L., DANKL C., FANGRAT J., HERRMANN E., OAKEY J., SCALIA M., ELNVERT J., “Cross-ETP Research and Innovation Roadmap for the Energy Efficiency in Building”, Steinbeis-Edition, Stuttgart, 2012, ISBN 978-3-94335637-3, pp. 27-35.

[2] European Commission, Brussels, XXX COM(2011) 885/2, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, “Energy Roadmap 2050”, http://ec.europa.eu/energy/energy2020/roadmap/doc/com_2011_8852_en.pdf (2011).

WWW.WECOBIS.DE – Web Based Information System for Health and Environmental Aspects of Building Products

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Extended Abstract

WECOBIS is a web-based information system in German language which offers key information on building products and materials with a focus on health and environmental aspects. The web page serves as a central platform with continuative links to all major primary and secondary sources and information portals.

Keywords: Building material; data base; environmental and health aspects

Fig. 1: Image – Web based information system for health and environmental aspects of building products – www.wecobis.de.

Introduction

In the context of sustainable construction as well as in correlation with European and national development of regulations, health and environmental issues of building materials gain increasing importance. Since there is a wide range of different legislative rules, assessment systems, declaration types as well as plenty of software programs or planning tools to support planners, it becomes rather difficult to filter the mass of information properly.

For this reason the webportal WECOBIS offers comprehensive information with focus on health and environment which is independent from manufacturers. Herewith WECOBIS serves as a central platform with links to all major primary and secondary sources and information portals. The Federal Ministry of Transport, Building and Urban Development (BMVBS) provides the information system in cooperation with the Bavarian Chamber of Architects (ByAK). The division II 6 – Construction and Environment – in the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) is consigned to administrate and supervise the management and operation of WECOBIS.

Health and Environmental Aspects of building products

Health aspects can come into account during any lifecycle phase. WECOBIS x-rays building products in several time spans such as short- and long-term use and also addresses health risks caused by damage due to fire or water. The editors worked out very specific features of product categories important for the safety of workers, users and any other person.
With regard to environmental aspects WECOBIS adresses reason and effect on local or global biospheres, which can be either local systems such as vegetation or fauna or global systems like water cycles or the climate for example.
WECOBIS devises typical qualities or risks of each product category and names individual alternatives, in order to sensitize planners for how to support a vital closed loop of resources at the same time as treating the natural habitat with care.

Structure and content

The information in WECOBIS is independent from manufacturers and it is well structured into the category “lifecycle” (Lebenszyklus) and “functional information” (Fachinformationen). Within the vast amount of information, the simple structure enables users to find and evaluate product data very easy. Currently, building information for approximately 160 building product categories and 30 basic material categories is available.

Building Product

- Wallcladding
- Flooring
- Insulation
- Seals
- Timber and derived timber products
- Adhesives
- Solid Construction Materials
- Mortar and Screed
- Surface Treatment Materials
- Glazing

Basic Construction Materials

- Binder
- Aggregate
- Plastic
- Metal

Further development

In January 2013 WECOBIS 2.0 was presented to the public at the international trade fair BAU 2013 in Munich as a revised version. The redesigning of the webpage and the restructuring of the data sheets were important steps towards improving user-friendliness. Several upcoming projects were announced, which will continue the modification of the information system. Gaps in data sheets will be closed and several product sheets will be added step by step. Tabs like “tendering” (Ausschreibungshilfen) will be filled with advice on how to consider equivalent aspects in tender documents, BNB relevant contents are in development and will be added soon, too.
The main intention of the ongoing development is strenthening the features of WECOBIS. This aims to further improve the user-friedliness as well as to integrate its essential content in planning and construction processes and therefore in everyday life.

Towards Improved Uptake of Smart Sustainable Building Implementation

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Summary

As people spend a significant amount of their lifetime in buildings, buildings therefore have a great impact on occupant health, productivity and culture. By consuming natural resources and producing CO_2 emissions, commercial buildings have a significant negative impact on the environment. This impact can be reduced by adopting Smart Sustainable Building (SSB) practices. In addition to the accepted ecological and social benefits, SSB can also have a positive economic impact due to lower life cycle costs and better building durability. To profit from SSB benefits, the Australian Government recently started to stimulate the SSB market, which as a result has grown strongly in the last few years. This research is conducted to analyse and compare the Australian and German SSB adoption process for commercial buildings. Key drivers and barriers for the SSB market are identified from literature and through interviews with key stakeholders in the Australian and German construction industries. The findings suggest that the Australian and German SSB markets are driven by the same factors. However, the Australian SSB market still needs to overcome some relevant market entry barriers. In order to achieve further market penetration, external "push and pull" methods are required. Based on the identified drivers and barriers, nine conceptual initiatives to encourage on-going growth of the Australian SSB market are developed. These strategies can contribute to more extensive use of smart technologies and sustainable design in Australian commercial buildings, which can ultimately reduce GHG emissions and the use of new resources whilst providing healthy, safe and comfortable working environments.

Keywords: Intelligent building; smart sustainable building; smart technology; market acceptance; sustainable construction.

1. Introduction

Today, sustainable development is gaining more attention in society due to current environmental issues, such as energy costs and climate change. Especially the building sector has a high influence on sustainable development, as for instance, it accounts for approximately 40% of the global energy demand and greenhouse gas (GHG) emissions, which are expected to negatively impact on-going climate change. One of the proposed solutions within this area is the adoption of SSB practices, because SSBs help to reduce the environmental impacts, such as energy and resource consumption and therefore GHG emissions as well. Besides environmental benefits,

SSBs also provide financial benefits, such as reduced operating costs and social benefits, encompassing increased occupant productivity together with healthy indoor air and lighting quality.
In Australia the SSB market is still a niche. This paper aims to identify the reason for this in form of market key drivers and barriers and to develop respective strategies to overcome the barriers via analysing the SSB market through literature review and expert interviews by focussing on commercial buildings.

2. Research Findings

Based on literature review of the history of SSBs and respective current developments as well as on interviews with experts of the Australian and German SSB market, key drivers and barriers for the SSB market are identified and respective strategies to overcome the barriers are developed.
The analysis shows that the Australian and German SSB market seem to be driven by the same factors, but the market development stages differ between both countries. The German SSB market can be seen at the beginning of the maturity phase and has the potential to be more mature, as many criteria of SSBs are embedded in strict building regulations with a long tradition. Nevertheless, the German SSB market still depends on strong governmental support, such as the mentioned regulations as well as financial incentives. In Australia SSB practices have been adopted, but still more regulations and financial incentives are needed to grow and to reach the mature phase. Hence the Australian market seems to be currently at the end of the niche market phase and needs to overcome some relevant market entry barriers.
In analysing the barriers different complexity levels of the barriers are identified, which can be divided into two main areas, governmental-based and market-based barriers. A likewise distinction is made for the initiatives, which should be implemented to overcome the barriers, by distinguishing between external “push and pull” methods. Within this context nine conceptual initiatives are developed to encourage on-going growth of the Australian SSB market by partly following respective developments in Germany. These nine initiatives, on the one hand encompass “governmental initiatives”, such as to force the immediate implementation of the Carbon Pollution Reduction Scheme (CPRS), which aims to raise taxes on coal-fired energy generation and to promote renewable energy production, the continuous enhancement of the Commercial Building Disclosure (CBD) and respective compulsory requirements, which armies all large commercial buildings to have a Building Energy Efficiency Certificate, and a heat act to obligate building owners to adopt renewable energies in their buildings. On the other hand it includes “focus initiatives”, which aim to increase public awareness through quantitative case studies of SSBs and their benefits through associations, such as the API, and the adaption of existing building certification systems with respect the importance of technological aspects. Furthermore, the creation of SSB related know-how should be supported through respective guidelines especially for small and medium sized enterprises and through knowledge sharing among the involved stakeholders by developing a project knowledge value chain. Finally initiatives, which address the high up-front cost issue directly, such as the Green Lease Schedule (GLS), need to be increased and/or extended to the commercial building sector.

3. Conclusion

The identified strategies can contribute to more extensive use of smart technologies and sustainable design in Australian commercial buildings, which can ultimately reduce GHG emissions and the use of new resources whilst providing healthy, safe and comfortable working environments. Nevertheless, the findings of this research are limited to perceived SSB barriers and drivers on the part of construction industry experts. A comparison between perceived and actual barriers and drivers is proposed as a topic for future research. Further, this research does not focus on existing buildings, which is also a current challenge for development of both the Australian and German SSB market. For a more precise analysis, a central database for buildings might need to be developed in order to facilitate future research in the German and Australian building sector. This would enable analysis of the market size, growth and facilitate the development of accurate practical measures.

Barriers and Chances for Sustainability by Fire Protection

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KEYWORDS : Sustainability, fire protection, safety in case of fire, CPR, basic requirements, EU Member States, resource efficiency, energy efficiency, fires on facades, EPS

Sustainability is one of the major tasks on all agendas in respect of the future of our planet. Accordingly various projects and programs on European and national level have the clear target to provide products and product data, which allow to improve the sustainability of buildings.

For the construction sector the regulators from the EU member countries have designed the so called Construction Products Regulation CPR which will become mandatory in all Member States on 01. July 2013. The structure of this CPR is based on seven "basic requirements for construction works". With reference to sustainability a basic requirement No. 7 has been appended : "Sustainable use of natural resources".

This structure stands for a holistic approach which is taking seven fundamental criteria for the construction sector into consideration. These seven basic requirements each contribute to the design and safety of buildings in the future. "Safety in case of fire" is as well a basic requirement as "Sustainability".

One "administrative" barrier of fire protection for sustainability lies in the federal structure of the European Union. It is still - and will remain so in the future - in the authority and responsibility of the single Member States MS to set up national rules and regulations to grant the national understanding of safety in case of fire. In a consequence it is up to every MS to define levels and thresholds for the various applications and intended use for the construction products.
The result of this federal character of the EU proves different levels of classifications of safety in case of fire in different MS. So what may be accepted in one country must not be installed in other MS.

Further more there are not only "administrative" barriers in EU, but as well "technical barriers". The current technical state of the art would without doubts permit to develop materials and products with excellent fire protection qualities. Some simple examples like intumescent coatings on timber or steel, flame retardants in all kind of insulating products, binders in loose fill cellulose or mineral wool fibres prove very clear that these listed products would on one hand improve the fire protection qualities of systems with referring components.
On the other hand such components bare in most cases so many dangerous substances that the use of them would lead to health risks for building users.

In the opposite case it would be - of course - most desirable to use components of regrowing "green" materials like sheep wool or flax as inner core of insulating boards e.g. for facades or fire doors. However - these "green" materials unfortunately burn like hell in case of fire. With the unacceptable effect to tremendously increase the risk of fire hazards in every kind of buildings where such components are installed.

It is evident that the risk in case of fire generates unacceptable barriers for such "green" materials under fire protection aspects.

As emphasized above the overall consideration of basic requirements makes sense for the assessment of chances of sustainable materials without dangerous substances under aspects of safety in case of fire.

One of numerous examples deliver the current discussions of insulation for energy and resources efficiency in external ventilated façades (**E**xternal **T**hermal **I**nsulation **C**omposite **S**ystems ETICS).
Just by pure cost calculation it is evident that systems for the insulation of facades with EPS-based boards are without doubts constructions of lower costs in a rate of approximately 30 %.
In practical use - however - such systems prove risks in case of fire as well as problems under environmental aspects (two basic requirements).

Under fire protection aspects EPS-based boards are classified in EUROCLASS E, means : normally flamable.
Accordingly fires on facades with EPS-based insulation boards have shown in the last 3 years some extended spread of flames over large areas of ventilated facades.

Alternating materials like mineral wool prove identic insulating effects, evident sustainable qualities AND are classified in EUROCLASS A, means : non flamable. It is evident that such non flamable materials bear lower risks in an extended way than normally flamable products.

The experiences with and investigations in fire hazards have pointed out that sustainable products with qualities which contribute to more safety in case of fire have higher chances in future even if they show higher prices than alternating (combustible) materials. This gives some hope for the future even under economical aspects.

Integration of Sustainability Aspects into Property Valuation Practice in Germany


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Summary

This paper is concerned with recent developments in the area of sustainability and property valuation and comments on existing guidelines and requirements for property professionals on how to deal with sustainability issues in everyday practice. The paper investigates the extent to which valuation professionals in Germany have adopted existing guidelines as well as the extent to which they have actually amended their practices in response to such guidance.

Keywords: property valuation, real estate appraisal, sustainability, sustainable development

1. Introduction

Recent empirical research has shown that within some sub-markets and in some countries property pricing is increasingly distinguishing between buildings that exhibit different sustainability-related building features and associated physical or operational performance. There is recognition that buildings which are not resource efficient, low carbon in terms of operation and location and which are not equipped to flex to changing occupier needs will not be future proofed in market value terms.

As a consequence, several professional bodies and valuation standard setting organisations (notably the Royal Institution of Chartered Surveyors, RICS) now not only advise valuers to consider the extent to which sustainability may impact on value when conducting valuations but also encourage valuers to expand their basic data collection procedures to include a record of any sustainability features, even if they do not currently have an impact on value. However, this type of sustainability-related advice and recommendations for valuers are as yet not mandatory requirements enforced by professional organisations but are of informative character only. It is therefore likely to assume that most valuers would hesitate to modify their practices as well as to extend their data collection procedures as this could be seen as an unpaid extra-work. But without improved data availability and increased transparency in the market for measuring and comparing sustainability in buildings, good comparable evidence is unlikely to be available on a wider basis.

In order to investigate the aforementioned assumption, this paper will – based on a survey among members of RICS Germany - discuss the extent to which practicing valuers are aware of existing sustainability-related valuation guidance (notably VIP13 of the RICS) as well as the extent to which valuers have actually amended their practices in response to such guidance.

2. Results

It is argued that the valuation profession is undergoing a tremendous change. The sustainable development discourse highlights both the often qualitative nature of the valuation exercise and, as a result, the importance of transparency of the valuation process. In addition, market participants increased awareness for sustainability issues imposes new requirements, duties but also business opportunities to the profession. Clients increasingly want being informed about the sustainability-related performance aspects of property asset and the likely value implications. The survey results presented in this paper show that there is a surprisingly high willingness among RICS members in Germany to give attention to and to engage with the issue of sustainability.

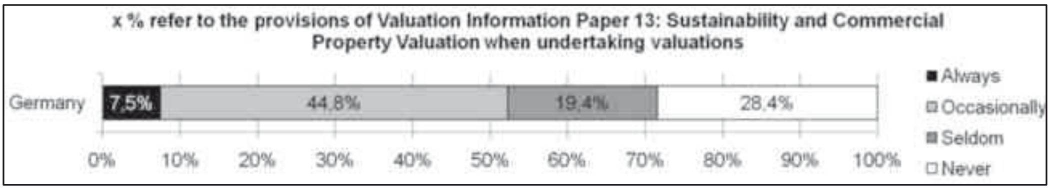

Fig. 1: Uptake of VIP13 in Germany

In addition, the survey highlights both those sustainability issues that are usually taken into account by valuers during the data collection process, and identifies those aspects on which information/data is usually not-available. Interestingly, important information and data on the sustainability characteristics of buildings are being collected by (some) individual professionals even if this information and data do not always feed into the actual valuation.
The survey also reveals the valuers' perception of those sustainability aspects that impact through to a property's value and explains which valuation parameters are being used in order to factor in different sustainability issues into the valuation process.

3. Conclusion and outlook

Even if (some) individual professionals are highly motivated and engaged there is a need for collective and coordinated action to improve the empirical data base. In Germany, the task of collecting, analysing and publishing comparable sales data is carried out by the so-called valuation expert bodies (Gutachterausschüsse). They need to find effective ways to link sales information with information on the properties' sustainability credentials (e.g. through the increased usage of information contained in energy performance certificate, sustainability assessments or even building passports).
Regarding the survey results it has to be noted that the survey participants may well represent the engaged and committed forefront among German valuers and not the majority of the profession (it is reasonable to assume that most valuers who are not committed to the issues of sustainability will not participate in a survey on sustainability and valuation). As a consequence, the question arises how to engage with the majority of valuers since these may still be reluctant to include sustainability considerations in their daily work. First, professional bodies should extend their efforts to further develop and offer respective training and educational courses for practitioners (and aspiring valuers). And second, valuation standard setting bodies should update their existing standards to include mandatory valuation guidance on this topic. In Germany, it would be desirable if the German valuation standard setters would pay further attention to the issue of sustainability (like this is currently being done by the UK-based RICS) whenever the German valuation order and respective guidelines are to be revised or updated.

Governing Carbon Efficiency - The International Regime of Standards in Wooden Construction

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Summary

One feature of globalisation is increasing spread of international standards. In general, standards define benchmarks and rules for production. They can stem from a variety of sources ranging from NGOs to industries and governments. This article focuses on standard setting by international standards development organisations. We explore into the global regimes that govern standards for wooden products that are used in construction. Construction is one of the biggest producers of green house gas emissions and since recently wood is being promoted as a means for carbon storage. We focus on the norms that internationally are most dominant in intending to regulate sustainability and carbon efficiency for the use of wood in construction. Standardisation in this newly emerging field is still under development. The article aims at drawing a comprehensive picture of the institutionalised rules and processes that up to now are globally most influential. In conclusion the process is best described as a "regulation of self-regulation" that takes place under the institutional umbrella of the two most influential private actors CEN and ISO.

Keywords: Standardisation, Governance, CEN, ISO, Wooden Construction, Carbon Efficiency

1. Introduction

Worldwide, there is growing recognition of the potential for substituting fossil-fuel based materials such as concrete or steel with wooden-based materials. This is seen as a means for reducing many environmental damages and impacts that can be achieved with the simple strategy of changes in product use. The main argument in the debate is that the use of wood instead of cement, steel and the many other non-renewable and non-sustainable materials results firstly in less greenhouse gas (GHG) emissions and secondly in the support of national and international strategies for mitigation of climate change. Thus, forests and wooden products have the potential for effective climate protection, an argument which has already been established in 1996 (IPPC 1996, 6).[i] Since the Kyoto-protocol from 1997 at the latest, both forests and wooden products can be considered to be amongst key elements of the global carbon cycle in attempts for mitigation. The present paper will concentrate on one aspect in this field, namely building with wood. Buildings and housing are of crucial importance for humanity not the least due to the amounts and functions for living, working and human existence, urban and rural the like.
We will examine the way the issue has been tackled by politics, more precisely we will shed light on the regulative measures that touch upon wooden products in building and construction. Whilst

recently there has emerged a bundle of literature that exemplifies the regulation of European telecommunications (Abbot and Snydal 2008, 355-6), pharmaceutical certifications (Gehring et al. 2008, 239-40.) and foodstuffs (Gehring et al. 2008, 246-8) and also toys (Gehring/Kerler 2008), product and technical standards generally tend to be relatively neglected in scholarly literature (see Nadvi 2008, 326). By this is meant that up to now, scholarly interest has focused more on standards in food technology and social and labour standards as protective measures that regard health, safety and/or human rights (Nadvi, 2008).

This paper explores on the way that carbon efficiency in wooden construction is regulated by standards. We want to map the kind of “regime” the related regulations constitute. How is the system of standardisation within crucial environmental issues built-up? Who are the ones that foremost decide and thus “rule” in this field? By this the article will contribute theoretically and empirically to further assessments of global creations of standards. We are interested in the norms that regulate the use of wooden products in light of carbon efficiency.

Therefore we will firstly sketch on the links between carbon efficiency, forests, wooden products and construction. We will secondly examine and describe in detail the internationally most important regulations for wooden products in construction. These touch upon sustainability, environmental friendliness and product boundaries. Finally, we will discuss the specific challenges for this field in regards to standard production. We will also provide an outlook on the kind of private public regime our findings do imply.

Which is the Task of the Historic Built Environment within the Development of a Smart City?

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Summary

The European energy policy set the objective of reduction of 20% of energy demand and CO_2 emission by 2020 and the building sector is at the centre of European interest. In fact the new initiative Smart City supports cities towards a 40% reduction of greenhouse gases emissions by 2020 through pioneering measures for buildings, energy grids and transportation.
To which extents historic urban areas are included in these targets?
The paper analyses several energy retrofit actions undertaken by European cities, to define a system of cultural values and local policies useful to public administrations for managing an acceptable adaptation of heritage architecture to new sustainability requirements of Smart Cities.

Keywords: Smart City, heritage architecture, S.E.A.P., cultural value, energy retrofit strategy.

1. Introduction

Among the five targets of Europe 2020 growth strategy, the “Climate change and energy sustainability” issue poses three main objectives: reducing by 20% the greenhouse gas emissions registered in 1990, turning the 20% of fossil energy use into renewable energy, increasing the energy efficiency by 20%. After the adoption, in 2008, of the EU Climate and Energy Package, the European Commission launched the “Covenant of Mayors movement”. Signatory mayors have to submit a Sustainable Energy Action Plan (S.E.A.P.) that declares the actions undertaken by their city to go over 20-20-20 strategy targets. The new European initiative Smart City is then promoted by European Community to support pioneer European cities that intend to demonstrate the feasibility of reaching a 40% reduction of greenhouse gas emissions through sustainable production, distribution and use of energy.

This paper analyses the role of historic areas of cities within the transition towards the objectives of the initiative Smart City.

2. Results

The actions aimed at increasing energy performances of the built environment developed within the S.E.A.P. of Dublin (IE), Paris (FR) and Turin (IT) are analysed to understand which are typical approaches, efficiency targets and specific solutions established for historic areas (if present). Where the historic building stock represents a large part of urban areas, as in the City of Paris, S.E.A.P. consider specific actions for integrating tailored retrofit measures; where more recent urban areas of the town represent a major issue for the total energy demand, such as the case of Dublin and Turin, retrofit measures are not applied on heritage architecture. However the transition to the concept of Smart City will need to face the issue of energy efficiency of historic urban areas in order to guarantee a comparable energy performance to the whole city.

To design renovation projects on the built environment able to take into account the quality of the urban architecture is fundamental a definition of “ complex values” that have to be preserved. On one hand international charts for heritage conservation state that saving resources and reducing pollution is considered part of the sustainable attitude of projects. On the other hand renovation and conservation principles can be considered coherent with the sustainability theory to the extent that contribute to the environmental, economic and social improvement of the heritage areas of towns.

The results achieved by the Program for the urban renovation of the Morro da Sé district of the city of Porto (PT, 2008-2012), the Energy Heritage project and Renewable Heritage project, developed in Edinburg Old town, (Scotland, UK, 2007-2009) and the partial ones of Geothermal Communities project in Montieri demo-site (Tuscany, IT, 2010-2015) represent a state of the art about the potential of retrofit interventions on historic urban areas, as well as feasible strategies of intervention.

3. Conclusions

A specific plan for heritage areas within the overall Smart City action is the tool identified as successful to take into account the complexity of cultural values, technical limits and efficiency requirements together with “smart” interventions on the historic built environment. The potential for reducing energy demand of buildings, integration of efficient energy grids and renewable energy systems must be evaluated for each category of building and public space that characterises historic areas. The local authority should organise specific clusters of experts for the development of the plan, able to communicate and share strategic decisions with the other areas of interest of the Smart City strategy. In fact, since actions for buildings, transportation and energy grids cross in the central areas of towns, here these actions have to respect a common system of values.

The Impact of Procurement Processes on the Sustainability of School Buildings

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Keywords: public procurement, sustainability, low carbon energy systems, school buildings

Introduction

Sustainable development is a term which has grown out of the need to integrate two potentially conflicting priorities, that of development, particularly for economic and social good, and the protection of the natural environment. The UK Labour Government from 1997–2010 showed its commitment to improving sustainability through a raft of policy statements and publications, and with the introduction of increasingly stringent building regulations.

The Labour Government also had a strongly stated commitment to education. This led to the introduction of major new state school building programmes, including the Academies programme from 2000, and Building Schools for the Future (BSF) from 2003. The original aim for the new schools was to improve social and economic equality in areas of deprivation, but in 2004 the focus shifted. In a speech to industry, Prime Minister Tony Blair called for the new school buildings to be '*models of sustainable development*', and a visible demonstration of the Government's aspirations.

Over the same period there was a drive to increase productivity and reduce inefficiencies in the UK construction industry, which had led to the development of new procurement processes claiming to promote collaborative working through partnerships, framework agreements and early contractor involvement, and to encourage stakeholder participation in decisions. The need for an effective and rapid method of procurement for the new school buildings was clear, and two new procurement models were introduced which co-existed with the existing routes.

This paper describes some of the impacts of these overlapping policies and aims, through four case studies of secondary state school building projects, each procured through a different route. The paper hypothesised that the new schools, procured through the BSF and Academies programmes with their stronger focus on stakeholder involvement and on developing integrated design and construction teams, would result in more sustainable schools.

Results

Sustainability is a contested and value-laden term, so the first step was an analysis of Government initiatives and publications for sustainable schools to identify their interpretations. This identified particular Government aspirations for the new schools as: achieving high BREEAM rating as an indication of environmental impact; installing low carbon energy technologies leading to a reduction in operational carbon emissions; the inclusion of stakeholders in design decisions; and ensuring accessibility throughout school buildings for disabled pupils. Consideration of embodied carbon was specifically *excluded* by the Government, but identified as a concern of the construction sector, and so was also included in the study.

The case studies demonstrate that the procurement processes had a clear impact on these aspects, but not necessarily that which was intended. For the BSF and Academies projects the main design phase takes place during the bidding stage, imposing a confidentiality clause which resulted in considerable restriction of stakeholder engagement during this crucial stage of design decisions. Furthermore a tool specifically introduced to facilitate stakeholder dialogue had the opposite effect of limiting discussion and frustrating the users. The limitations of the consultation process, as well as the calculation of funding at feasibility stage before some major design decisions had been taken, had the result that disabled access remained unresolved at one school where it had been a key aspiration.

The new procurement processes had been intended to produce integrated design and construction teams, and more effective relationships between these delivery teams and the clients. Within the academy project this did work well, but mainly because the client and contractor had a pre-existing healthy working relationship from a previous project, independent of the current framework agreement. However the local framework agreement used at another school appeared to have resulted in an unhealthy imbalance of power, with the result that the services engineer was persuaded to rewrite her design advice to match the client's choice of low carbon technology. BREEAM Very Good was achieved by the BSF procured school, and Excellent by the Academy. However Very Good was also achieved, even though not a requirement, at the school which was procured through a traditional route with separate design and construction teams, late contractor involvement and no continuing relationship with the (inexperienced) client.

The Government's focus on the use of low carbon technologies as a panacea to reducing carbon emissions also appears to have back-fired, with three of the four schools likely to have higher operational emissions than if they had installed standard gas boilers. In two of these cases the choice was made by the client based on cost. In another case the team was pushed towards the choice of biomass by a spreadsheet tool possibly responding to hidden bias in the tool's design.

Conclusions

This paper concludes that while the Labour Government's aspirations for sustainable schools were worthy, they were not supported by the new methods of procurement. In particular:

- The long period of confidentiality during design development runs contradictory to the need for stakeholder involvement.
- Effective relationships between the client, contractor and design team can have positive benefits for the project; however these were not shown to result from either the new procurement processes, nor the existing framework agreements.
- The BSF process resulted in fragmentation between the design stages, and had harmful effects on the time, cost and satisfactory outcome of the project

The effects of procurement on sustainability are therefore complex and poorly understood.

Energy Efficient Historic Stone Houses – A Case Study Highlighting Possibilities and Risks

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Summary

The objective of this research is to investigate the possibilities of facilitating a sustainable management approach in a category of traditional stone houses considering both the cultural values that these buildings represent and societal goals of energy efficiency. The paper is based on a type of stone houses on the island of Gotland in the Baltic Sea. The main result of this research is in method development where the parameters are both quantitative (energy use etc) and qualitative (heritage values of the historic buildings).

The proposed method for this case study includes the following steps:

1. Defining the character of the building type/category
2. Energy calculation and measurements
3. Evaluation of interventions
4. Determining energy saving potential

To define and assess cultural heritage values is a crucial step for an integrated analysis of consequences and potential of energy savings in historic buildings. To achieve this, the character and the values of the buildings need to be defined. The selection of the buildings was done in three steps and on three levels. The first step was to define the category of buildings. The category was selected by studying and analyzing data from inventories of the traditional buildings on Gotland. From the category of stone buildings, which consists of 3000 buildings, 20 buildings were selected for further surveys and measurements. One building was finally selected to be representative for the building stock. By doing this we can interpret the results on a general level.

Calculations, measurements and evaluation of interventions were conducted to determine the present performance and energy saving potential of the selected buildings. Measurements of the indoor climate, air tightness and air exchange rate were conducted. The condition of the structures has been surveyed and documented.

Common energy saving interventions were assessed on a scale; low, medium and high risk/impact with respect to durability, indoor environment and impact on character. These solutions were then grouped together in packages using the same scale.

The studies category of buildings has a very high energy consumption compared to the modern building stock but considerable energy savings can be made. The European goals of energy savings (20%) as well as the Swedish long term goals (50%) can easily be achieved with interventions of low visual and physical impact. However, national regulations applicable at major renovations on energy use (55 kWh/m^2) and U-value (0,4 W/m^2K) cannot be reached in these houses without major effect on heritage values.

Keywords: Energy efficiency; Sustainable management; Cultural heritage; Building conservation; Historic stone houses

Influence of Sustainable Building Attributes On Customer Satisfaction

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Summary

The original function of a building is to meet the needs (core processes) of the user. From the investor's point of view, property value retention and appreciation are the most important incentives for sustainable real estate development. In this paper, the influence of sustainable building attributes on customer satisfaction is determined in an empirical investigation.

Keywords: Sustainability, Energy Efficiency, Building Attributes, Requirements of User, Needs of User, Customer Satisfaction, Kano-Model, Economic Benefit, Windfall Gain

Methodology

The data collection is accomplished by a user opinion survey. Therefore, the Quality Management Theory of Kano, which indicates the impact of consumer goods attributes on satisfaction, is adapted and applied on the asset invested (buildings). The survey studies different sustainable building characteristics. As users of buildings in general do not work with technical requirements these are expressed as building attributes for non-professionals. Some of the attributes can be measured or calculated monetarily, like less energy consumption and some are non-monetary attributes, like e.g. comfort. The influence of 'energy efficient attributes' on the value can be calculated (while planning) or measured (during operation) directly and monetarily. Building attributes whose influence on the value can only be calculated or measured indirectly are called 'sustainable attributes'.

Results

As a result of the research, the sustainable building attributes are classified into the categories '*must-be'* (minimum requirements), '*one-dimensional'*, '*attractive*', '*indifferent*' and '*reverse*'. The analysis revealed 18 *must-be* requirements and 19 *attractive* requirements out of a total of 45 evaluated building attributes. Thus the risk of a developer to contrast negatively against competitors by not fulfilling *must-be* requirements is about the same as the opportunity to contrast positively by fulfilling *attractive* requirements. All building attribute out of the group 'environmental and ecological engineering' are *attractive* requirements allowing competitors to differentiate themselves from others. Every building attribute from the group 'controllability of comfort' is a *must-be* requirement leading to the proposition to carefully offer controllability of ventilation, heating, cooling, sunscreen, glair protection, windows, illumination and sound exposure for office users. This comes to be an important aspect in particular since new technologies allow a high degree of automation in the operation of office buildings.

Conclusion

Contrary to an assessment system for sustainable building, e.g. BMVBS or other assessment systems like LEED or DGNB, which formulate technical demands for energy efficient and sustainable buildings, this evaluation points out some market-based incentives for a sustainable development. In the survey additional questions were asked concerning personal data of the sample and in particular the readiness to pay for specific building attributes. Extending the scope the continued research currently focuses on correlation of satisfaction and readiness to pay.

Policies to Overcome the Barriers for Implementing CO2 Reduction in the Built Environment of Neighbourhoods in Europe

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Summary

One of the main sustainability challenges is climate change caused by the emission of CO_2 that have their origin in the built environment due to heating, hot water, electric light and the use of other electric devices. Although this is widely known there is no reduction of CO_2 emissions in this area so far. Since 2005, The EU Project CONCERTO has been implementing CO_2 reduction measures in neighbourhoods in 58 sites all over Europe. These examples have so far shown that cities and communities can cut their CO_2 emissions at acceptable costs. Through implementation of renewable energy sources, innovative technologies and an integrated approach, analysis of the projects provide useful insights into the main barriers, why there are not more cities and communities use the existing potential to reduce their energy consumption, CO_2 emissions and energy costs, as well as insights into the policy options to overcome these barriers. First results of these experiences are presented here.

Keywords: policy for CO_2 reduction; energy efficiency, renewable energy, neighbourhoods; Europe; barriers for CO_2 reduction; retrofit

1. Introduction

One of the main sustainability challenges is climate change caused by the emission of CO_2 that have their origin in the built environment due to heating, hot water, electric light and the use of other electric devices. Although this is widely known there is no reduction of CO_2 emissions in this area so far. The CONCERTO initiative demonstrates in 23 countries in 58 sites how this challenge can be met with today's knowledge and technology. Thus it plays an important role in implementing the objectives of the EPBD and in leading Europe towards a breakthrough in energy use. With sites in 23 countries and involving a wide variety of solutions regarding energy efficiency in buildings, any stakeholder in the building sector can find a model that matches his/her own challenge.
The project CONCERTO Premium is tasked with the technical and strategic analyses of all CONCERTO projects on behalf of the European Commission. CONCERTO Premium will highlight the challenges and opportunities of optimising a whole community. Until today, low energy buildings are more expensive than standard building practice. Their market acceptance thus is not as high as it needs to be to reach energy and climate targets for 2020. The same applies to EU targets relating to renewable energy sources (RES). The following highlights those aspects of value for cities, politician, investors and builders to develop an integrated approach for city planning and city development in targeting low energy buildings and the use of RES.

2. Results

The following will present some preliminary results of questionnaires filled and interviews given by representatives of the different CONCERTO sites. Some of the results are:

- CONCERTO provides numerous examples of using ESCOS in order to organise energy supply. However there are also examples of the sensitivities of ESCO-models and that, as in the case of the CONCERTO projects in Lambeth, ESCOs are not considered to be a safe option.
- It is furthermore obvious that ESCOs can have teething problems and that they are sensitive against changes from the original project plan, especially if expected customers fail to materialize. A thorough risk analysis and a staged approach have to be considered.
- From point of view of projects there is generally a heavy dependency on subsidies in order to meet the substantial additional up-front costs of buildings with better energy performance and renewable energy installations.
- From point of view of the EC (and potentially other national funding providers, too) it can be observed that a comparatively small percentage of funding can leverage a large amount of funding from other sources. This means that considerable economic activities (local trade of goods and services in the construction sector) can be stimulated.
- CONCERTO projects considered the shareholder structure of ESCOs and other delivery vehicles as important for ascertaining sustainability. No examples for Property Assessed Clean Energy (PACE) financing, or on-bill financing could be found, though the notion was prominent in discussions surrounding the Irish Project SERVE
- The refurbishment of the existing building stock, in particular, requires specialized knowledge and skills on the part of planners, architects, installers, craftsmen and construction workers which is often lacking. Another general problem besides lack of knowledge on the part of professionals is quality control and check of compliance of actual construction with plans. Building control inspectors at municipal level are common throughout Europe, but notoriously understaffed and sometimes under-skilled. Thus, new strategies of quality assurance must be found.
- Installing new technologies requires a lot of expert knowledge and a good organization. Therefore it is necessary to involve all relevant stakeholders during the whole process and to be part of a network, not only on a regional level but also with experts with experience from other projects.
- Beside a reduction of energy consumption and CO_2-emissions in most cases a large range of additional positive effects have been attributed to the participation in the CONCERTO project, emphasizing the value of such projects as drivers for a wider sustainable development agenda.
- Greater quality of life due to improvements to the indoor and outdoor environment undertaken as part of CONCERTO projects has been reported in some questionnaires.
- Measures to raise general energy awareness were considered as particularly important. To this end the Irish projects made particularly good use of energy performance certificates. However, there other projects did not seem to recognise their potential to the same degree.
- CONCERTO Projects have influenced and improved policy making at local regional and in some few examples also at national level. The CONCERTO experience provides a strong evidence base across many EU countries that such projects can act as successful drivers for good policy making in the area of energy efficiency and sustainable energy solutions in the built environment.

3. Conclusion

The presented examples show that there are many measures which can help to drive the energy efficiency in buildings and the use of RES. The right funding and business models are key. Policy developments happening in the wake of climate change mitigation projects at neighbourhood scale have been observed.

Economic Viability in Thermal Retrofit Policies: What can we learn from ten years of experience in Germany?

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Summary

Germany aims to reduce CO2 emissions by 80% by 2050 compared to 1990 levels and has merged this target with mandatory Energy Saving Regulations for thermal renovation of existing homes: The policy uses the criterion of 'economic viability', whereby renovations must pay back through the space and water heating fuel savings they produce. This paper discusses the extent to which economically viable thermal renovations can contribute to the 80% goal. It suggests that the actual savings, based on measured consumption, are likely to be around 25%. Further, average measured consumption is estimated to be around 149 kWh/m^{2}a nationally, and this would have to be reduced to around 30 kWh/m^{2}a to meet the 80% policy goal. This may be beyond the limits of economically viable renovation technology. The paper suggests that policymakers should consider de-coupling the criterion of economic viability from the 80% goal, emphasise other reasons for renovating to economically viable levels, and consider a more systematic approach to facilitate household behaviour change.

Keywords: heating energy consumption, energy policy, building regulations, thermal retrofit, prebound effect

1. Introduction

Germany has a policy of reducing GHG emissions by 80% by 2050 compared with 1990 levels and this goal also applies to energy consumed by Germany's housing stock. German thermal renovation standards are given in the *Energieinsparverordnung* (energy saving regulations – 'EnEV'). Whenever 20% or more of any feature of a building (such as a wall or roof) was being repaired or renewed, that entire feature had to be thermally renovated to the same standard as a new build, if it is 'wirtschaftlich' (economically viable). Two questions can be raised as to whether it is feasible to renovate existing buildings so as to achieve reductions in heating energy of 80%: is it economically viable, as claimed by German government ministries and agencies; and what is likely to be the *actual* energy consumption before and after the renovation? Based on the analysis of German databases that are named in the each section, this paper summarises some findings of our longer research project on the assessment of Germany's retrofit policy that was funded by Cambridge Humanities Research Grant Scheme (CHRG) in 2011-2012.

2. Economically viable energy saving potential

In Germany, thermal renovation subsidies are administered by the Housing Ministry and given through the German Development Bank *(Kreditanstalt für Wiederaufbauung* – KfW), and only to projects that are designed to do better than the EnEV standards for comprehensive renovations. A conclusion that can be drawn from the annual KfW monitoring reports is that if these subsidised projects, that attempted to go beyond the regulation level, in reality achieved less than 33% energy

saving, the savings achieved with ‘economically viable’ building regulation standards, without subsidies, are likely to be less.
Data used by studies by Schröder et al. (2011), Michelsen and Müller-Michelsen (2010), Walberg et al (2011) suggests that the average economically viable (as defined in the EnEV) heating energy reduction through thermal renovation in Germany is likely to be around 25%, depending on age and size of building.
Further, there is a discrepancy, in percentage savings pre- and post-renovation, between calculated and actual performance: around 33% for calculated cases, and around 25% for measured. A possible answer is offered in our previous study of comparisons between measured and calculated domestic heating energy consumption in Germany. Firstly, measured consumption is, on average, 30% below calculated consumption in these studies. Secondly, the higher the calculated consumption, the larger the percentage gap between this and the actual, measured consumption (‘prebound effect’, which is the opposite of the ‘rebound effect’ when a dwelling consumes *more* energy than its calculated consumption). This may be one reason the actual savings of thermal retrofits in Germany are less than those calculated.
Our study of the German statistical sources suggests that national average heating energy consumption is approximately 149 kWh/m^{2}a, with the average for smaller buildings around 172 kWh/m^{2}a; for medium-sized around 145 kWh/m^{2}a; and for large apartment blocks around 130 kWh/m^{2}a. The average measured consumption of 149 kWh/m^{2}a would have to be reduced to around 30 kWh/m^{2}a to meet the 80% policy goal. This may be beyond the limits of economically viable renovation technology.

3. Conclusions and policy recommendations

Four findings emerge from the above analysis. Firstly, using theoretical, calculated energy consumption figures, based on the physical characteristics of buildings only, does not give an accurate picture of the energy savings (and thus ‘economic viability’) being achieved through thermal renovation. The German Energy Agency now admits that that savings of approximately 26% are, on average, being achieved with thermal retrofits.
Secondly, the current heating fuel consumption in the German housing sector is in reality lower than assumed in policies, and therefore the energy savings potential is also less. All the estimates of current heating fuel consumption examined in this paper put it well below the German Energy Agency’s official figure of 225 kWh/m^{2}a.
Thirdly, the German government may need to revisit the legal definition of ‘economic viability’ in the Energy Saving Law, to take account of what economic viability actually means for homeowners.
Fourthly, it is highly unlikely that economically viable thermal retrofits will bring us anywhere near to achieving the climate goal of 80% reductions by 2050. Policymakers may need to uncouple the issue of the 80% reduction goal from that of economically viable energy savings.

Cultural Heritage and Sustainability: Innovation, Lessons Learnt and Behaviour

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Summary

Key words: cultural heritage; historic buildings; museums, new and old technologies; environmental footprint; behaviour; generic vs. specific approach

1. Introduction

Cultural heritage and sustainability could and should be mentioned together as at least historic cultural heritage has a limited environmental footprint because of its long lifetime and its often locally obtained materials. With regards to energy efficiency, cultural heritage has a more varied performance. But today major challenges such as climate change and re-use are to be met with by both historic heritage and new cultural patrimony and their stakeholders. Development and implementation of suitable new technologies, or revitalizing old ones, should both be done. But, perhaps more important, the heritage field should leave its comfort zone to attain a sustainability in the long term.

2. Results

In this paper two types of cultural heritage will be discussed via some examples: historic buildings and art. Other kinds of heritage, like archeology, historic landscapes and archives also merit attention, but they are excluded because of the length of this paper.

This paper focuses on two approaches towards sustainability by heritage stakeholders: a generic and a specific approach.

The first approach is characterized by the adoption of generic solutions which are often a part of mainstream societal common practice. Or, to put it in different words, this approach is non-dependant on the stakeholder.
Two examples:

Everyone wants to cut down on energy expenses and common solutions like sensor induced lighting and pellet heaters can be used by both owners of historic buildings or museums and by all users of any buildings.
All restaurateurs are inclined to cater their restaurants in an environment-friendly way, in which museum restaurants or country seats basically do not differ from for instance department stores or government institutions.

However valuable this approach is, it does not address the effort one might expect the heritage stakeholders should also make. This effort, this second approach, is characterized by the adoption of heritage-specific solutions. These force the stakeholders to leave their comfort zone. A comfort zone which is maintained by notions like: ‘heritage is sustainable in itself’; and: ‘artists are in an intrinsic way professionally detached from societal challenges’.
Some examples:
Residents of historic buildings can resolve to all kinds of solutions to minimize energy costs which might cause damage to their listed building, both esthetically as well as regarding building physics. They could also accept a less comfortable way of life which includes putting on a warm jersey instead of having a fully heated house like their neighbours in a newly built dwelling, or closing shutters every night to keep in the warmth.
Government officials responsible for historic buildings could accommodate heritage owners by giving leave to install photovoltaic solar panels in their possibly historic gardens. In this way, more owners wanting to contribute to sustainability aims will be able to meet their ambitions, although this might result in a (reversible) loss of heritage values.
Museums could decide to have less temporary exhibitions with loans being flown in from all over the world and instead focus more on varying exhibitions from their own collections or from collections from their own region or country. And when an exhibition is hosted with loans from all continents, transport by ship will decrease significantly the energy consumption. Thus, the global footprint of temporary exhibitions can be reduced substantially.
Museums and built heritage professionals could try to adopt virtual means to enhance the experience of heritage by serious gaming or rendering. This will mean to abstain from costly and often environment-unfriendly reconstructions and switch towards virtual simulations. This approach can have results for all kinds of heritage, like paintings, sculpture, buildings and also archeological sites.
Contemporary artists might still be inclined to create in a workshop which can practically and literally be considered as a hermitage. But should both they and their clientele not also take notice of the wish for sustainability which is accepted by the rest of our society?

3. Conclusion

To conclude: there are all kinds of actions. Innovation in materials and devices which also includes adopting solutions developed for new buildings. Making use of lessons learnt by adopting solutions invented by earlier users. And a new behaviour which leads to a new mindset and the acceptation by the heritage community of the vision: adopting generic solutions alone will not do.

2. Sustainable Urban and Regional Planning

Market Barriers for Energy Efficient City Systems in Five European +Countries

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Summary

The aim of this study was to identify the main market barriers which prevent energy efficiency improvements in cities and communities. The results reveal that despite the differences of the economic, cultural, social and political environments of the studied countries, some main market barriers seem to exist in all countries. The most significant identified barriers were educational/information-related barriers, cost-oriented thinking and bureaucratic/ regulatory barriers. The findings of this study suggest that some strategies could be implemented in all the studied countries: the government bodies should provide incentives for energy efficient refurbishment in forms of financial instruments, policies and subsidies; more supportive regulations and legal framework are needed, and social awareness could be raised by introducing educational programmes at different levels encompassing all stakeholders.

Keywords: Market barriers; energy efficient city systems; low-energy construction; financial instruments; regulations; social barriers

1. Introduction

The objective of this study was to identify the main market barriers which prevent energy efficiency improvements in cities and communities. The scope of the study reaches beyond single building solutions. Instead, the focus is on utilising energy potentials on district, city and regional scales to support long-term strategic developments and to move towards sustainable energy efficient city systems.

The study encompassed five European countries; Finland, Norway, Spain, the Netherlands and Germany, and the data was collected by questionnaires, interviews and workshops involving experts in leading research and technology organizations in respective countries.

2. Results

The list below summarises and reveals the order of importance of different barriers existing in the market for energy efficient city systems:

1. *Education/information*
- Lack of demand for innovation; insufficient education; dispersity of information and services; lack of new services; inability of partners to innovate; “not in my backyard”-attitude

2. *Cost oriented thinking*
- High initial investment; focus on cost reduction; the costs are not allocated on fair basis/pollution is too economical; infrastructure costs; energy efficiency does not add value; focus on risk minimization favours old technologies; unwillingness to see/appreciate long term savings
3. *Bureaucracy & regulations*
- Bureaucracy and complicated forms; local energy production is not supported; dispersity and scattered nature of decision making not leading to overall optimum; maintenance is not regulated
4. *Funding*
- High level of private ownership; lack of funds; lack of funds for refurbishment
5. *Trust*
- Possibility of technical disappointments; acting parties could be left out of the process or not involved enough; lack of trust hampers dissemination
6. *Other*
- Mandatory district heating connection; emission factor of district heating does not depend on the way it has been produced; ambitions can be too broad/vague; historic value; too many changes of plans cause delays; energy price is low; control of regulations not implemented

3. Conclusion and acknowledgements

According to our study, despite the differences of the economic, cultural, social and political environments of the studied countries, some main market barriers seem to exist in all countries. The most significant identified barriers were educational/information-related barriers, cost-oriented thinking and bureaucratic/regulatory barriers, scattered information, insufficient financial incentives and low consumer awareness and demand. The study suggests that there is a strong need to provide country-specific solutions for overcoming the market barriers. However, it seems that some strategies could be implemented in all the studied countries: for example the government bodies should provide incentives for energy efficient refurbishment in forms of financial instruments, policies and subsidies, more supportive regulations and legal framework are needed, and social awareness could be raised by introducing educational programmes at different levels encompassing all stakeholders.

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Sustainable Urban Development Considerations at the Scale of the City-Quarter: The Usefulness of Future Alternatives for Interdisciplinary Research

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Abstract

Nuremberg West (NW) is one of 17 declared urban renewal areas in the City of Nuremberg, Germany. Once the birthplace of Germany's first railroad between Nuremberg and Fürth, NW features today an oversupply of abandoned industrial space, which is coupled with low demand. The municipality of Nuremberg commissioned Munich University of Technology (TUM) with a research project titled "Stadtlabor Nuernberger Weststadt" with the purpose of analyzing and identifying the possibilities of intervention in NW under the guiding principle of sustainable urban development. This paper presents one of the approaches that were developed for this project.

Sustainable urban development considerations at the scale of the city quarter provide substantial challenges. When applying this flexible concept onto the redevelopment of a city-quarter, it emerged that questions of spatial scale, time horizon and dialogue between the various disciplines involved in this project are quite of a challenge. A multi-scalar perspective is needed, one that extends system boundaries beyond the immediate boundaries of a delineated area of intervention. In addition, the view to the future should be one, which breaks free from the short-term approach where almost all handles/levers to intervene are fixed and rigid. Simultaneously, this view to the future should not become too hazy. Last but not least, the challenge is to find ways for internalizing within the research process mechanisms with which proposals of individual disciplines are continuously weighed against their holistic contributive value rather than their insular value towards one particular thematic perspective.

These challenges highlight the need for a common platform for exchange in order to organize the debate, identify inconsistencies and synthesize the analyses into a coherent narrative. The Chair for Spatial and Territorial Development devised an approach for tackling these challenges by proposing evidence-based, possible future alternatives for the transformation of Nuremberg West. These future alternatives are innovative, creative, politically unrestrained and impact oriented transformation possibilities for NW, set intentionally at the year 2050. They are not impulsive, spontaneous or provocative visions; nor are they projections of definite future developments.

These future alternatives became a framing and guiding narrative to internalize and anchor the debate in-between the various disciplines.

Each of these proposals has been detailed in terms of the potential roles of NW within the metropolitan urban hierarchy and the associated functionality of the space of NW. In addition, we elaborated on the nature of spatial transformation and the process of transformation that are necessary for such an alternative future to take place. The themes of, economy, housing, space, transport and energy provided the organizational structure through which we continuously sieved our investigation, in order to further detail these future alternatives. We term the first proposal “NW is sustained through managed care”, the second, “NW transforms into a hub for the Knowledge Economy”, the third, “NW transforms into the birthplace for the Subsistence Economy”. This paper presents this approach; it describes three future alternatives that were developed for NW and illustrates in particular the usefulness of this approach for the interplay of interdisciplinary considerations of spatial transformations and the development of energy demand.

Life-Cycle Assessment of Induced Impacts in the Built Environment

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Summary

Life-cycle assessment has proven crucial in determining the direct and indirect quantitative environmental impacts from the building sector. Academic research on life-cycle assessment tends to focus on individual buildings, and particularly on embodied (e.g. materials) and operational (e.g. heating, electricity) impacts. This approach however treats the building as an isolated object, omitting its relationship with the surrounding urban context. Other research expands environmental assessment to the city level, and life-cycle assessment is increasingly being used for this analysis. The results of city-wide analyses are useful for overall planning purposes, but the majority of construction in North America and Europe is within existing cities rather than the construction of entirely new cities or major infrastructure projects. Therefore a new methodology is needed to expand the use of life-cycle assessment for individual buildings within existing cities to capture the induced impacts resulting from the interactions of the building and the surrounding urban context (Fig. 1).

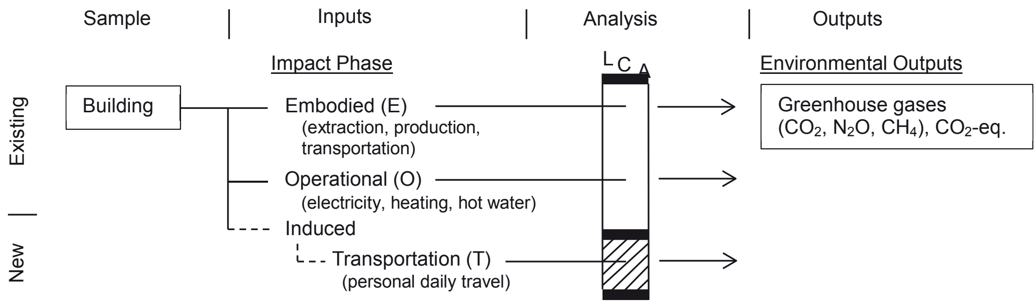

Fig. 1: The research methodology expands upon embodied and operational impact phases to include the induced impact phase of transportation. The three impact phases are then evaluated using life-cycle assessment for greenhouse gas emissions.

The original research presents for the first time the outline of a new life-cycle assessment methodology focusing on the interactions between an individual building and its urban surroundings. The methodology is then evaluated using a case study for Germany. Total greenhouse gas emissions are calculated for all impact phases – embodied (i.e., materials), operational (i.e., heating, hot water, electricity), transportation (i.e., personal automobiles and public transportation), and end-of-life (i.e., materials). A life-span of 60 years is used for all phases of the case study. The cumulative greenhouse gas emissions are presented in Figure 2.

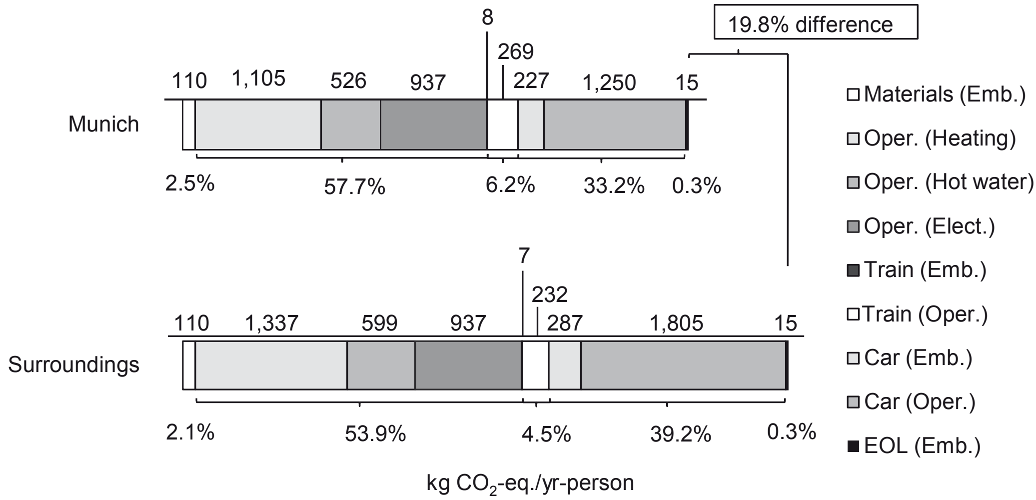

Fig. 2: Average greenhouse gas emissions (kg CO_2-eq./yr-person) for Munich and the surrounding area result from materials (2.3%), operation (55.7%), train transportation (5.3%), car transportation (36.5%), and end-of-life (0.3%) – for data see the detailed report.

Greenhouse emissions are dominated by the operational impacts (56%) followed by the transportation impacts (42%) and finally from the embodied impacts including the end-of-life phase (3%) (Fig. 2). Transportation impacts (42%) are thus of crucial importance in analyzing the inclusive greenhouse gas emissions of the building in question. The findings also show a 20% variance between the greenhouse gas emissions for the city of Munich and the surrounding area using Munich as the reference value. This difference is due to varying travel patterns (i.e., more personal automobile use in the surroundings) and higher operational (i.e., heating and hot water) impacts in the surrounding area. Comparing the environmental impacts from the induced, embodied, and operational impacts illustrates the importance of including induced impacts in meeting environmental goals. Expanding the use of life-cycle assessment to capture induced impacts – impacts resulting from the interaction of the building and its urban context – provides a means of quantifying all environmental outputs in the built environment. Finally the research presents recommendations to mitigate environmental impacts from the building sector, and outlines future areas for additional research.

Keywords: Buildings, built environment, life-cycle assessment, induced impacts, greenhouse gas

Infill Development land-use Potentials and Strategies in German Municipalities – First Survey Results

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Abstract

A main objective of the German government is to reduce the land use rate from the current figure of around 90 ha per day to 30 ha by 2020. To achieve this goal, the infill development of towns and rural municipalities should be encouraged. Residential and non-residential developments should preferably be realized within existing settlement bodies, primarily on brownfields and vacant sites. A large number of towns and rural municipalities are already striving to achieve such targets. However, currently there is a lack of sufficient and reliable basic data on the size of infill development land-use potentials. Therefore the Federal Ministry of Transport, Building and Urban Development (BMVBS) and the Federal Institute of Building, Urban Affairs and Spatial Development (BBSR) have commissioned the Leibniz Institute of Ecological Urban and Regional Development in Dresden (IOER) to conduct a survey on these development potentials for Germany. The project's title is "Implementation of Measures to Reduce the Rate of Land Use – Infill Development Potentials". The IOER's project partner is "Projektgruppe Stadt und Entwicklung Ferber, Graumann und Partner" in Leipzig.

The primary goal of the project is to design and carry out a national, regionally differentiated survey of brownfield sites and settlement land that has the potential for infill development. A further aim is to investigate how a permanent national monitoring system of infill development potentials could be designed and set up, incorporating the latest data and techniques. To this end various methods to calculate infill development were to be used to complement and evaluate one another. The paper focuses on a survey carried out German towns and rural municipalities. This survey was conducted by a standardized online questionnaire addressing a representative sample (disproportionately layered selection) of around 12 % of all German towns and rural municipalities (population = 11,255). The field phase ran from June to October 2012. A total of 450 municipalities have completed the questionnaire. Although data is currently still being evaluated, some initial results can be presented as a workshop report in this paper.

More than 90 % of participants were able to name some estimation of the size of their infill development potentials.

About 75 % of the participating large towns have reported that they already carry out regular surveys of infill development potentials, while only about 30 % of small towns and rural municipalities collect such data.

Analyzing the Errors of Heat Consumption Estimations at High Spatial Resolution

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The analysis of heat consumption is one of the key issues of local and regional energy concepts as they concentrate on the sectors households and crafts, trades and services where most of the demanded energy is used for room heating and warm water. Measured heat consumption data for thousands of buildings is often not available. However, the estimation of heat consumption for single buildings or a high spatial resolution respectively implies high estimation errors. But the high spatial resolution is desired as the transport of heating energy means high losses and investment costs. Heat consumption furthermore does not only depend on the energetic quality of the building but also on individual aspects as user behaviour. It can, therefore, not be estimated precisely based on building parameters.

This report scopes the comparison of heat consumption estimations for detached and semidetached buildings with actual measured heat consumptions, which are generally not available. Based on a building database for a city with about 40,000 buildings, a subset of 17,489 detached and semidetached buildings is chosen. The estimation error is the difference between the estimated and measured consumption. It is distinguished into a statistical error of estimation, caused by the variances of measured consumption, and a systematic error of estimation, due to excessive or undervalued estimators.

For every building in the subset, the building parameters year of construction, volume, surface, inhabitants and gas consumption are familiar. They were gathered from different sources and automatically matched with other. Based on the inhabitants, warm water consumption is deducted from the gas consumption to calculate room heat consumption. Varying combinations of the known building parameters are used to classify buildings into building types. These building types and average measured consumption values or values from the literature are used to create different estimation scenarios, which are compared on basis of the resulting estimation error. To simulate different precise spatial resolutions for the estimation, buildings are combined into groups. The group sizes vary between single buildings and the whole subset of 17,489 buildings. For every group size and for every scenario 10,000 groups of buildings are randomly chosen to analyse the distribution of the resulting estimation error.

The results show, that by calibrating estimators and increasing group size, estimation errors of spatially disaggregated heat consumption estimations of detached and semidetached buildings can be reduced significantly. Figure 1 displays the estimation error with a confidence of 95 %. Due to the high variance of measured heat consumption of single buildings, estimation errors for single buildings are as high as the estimations itself but decrease to about 50 % for groups of only five buildings. An increasing group size corresponds to a reduction of the spatial resolution. This also reduces the difference of the estimation error between scenarios using no building parameters or all known building parameters for the estimation. Furthermore the overall estimation error can be reduced by the calibration of estimators from literature with aggregated data. The reduction of the error increases with growing group size.

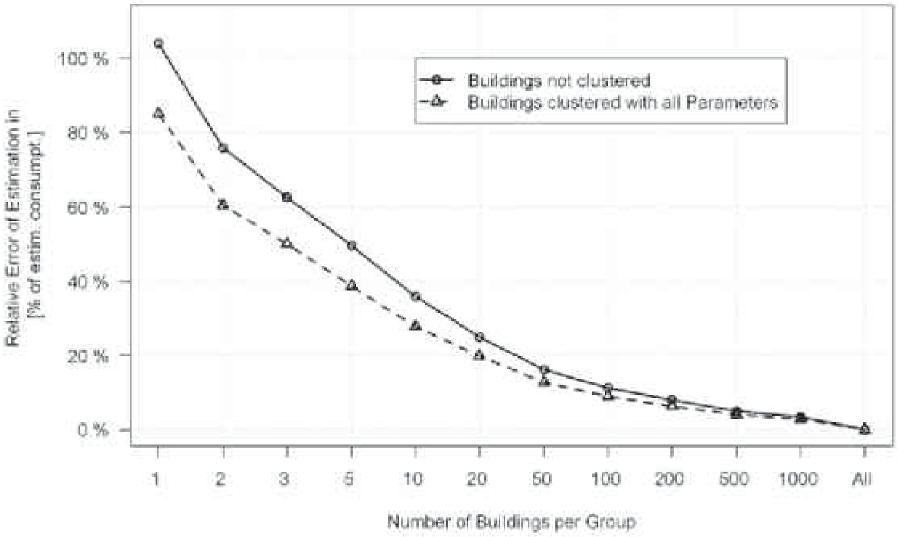

Figure 1: Estimation error as a fraction of the estimated heat consumption per group of buildings for different group sizes and a scenario with no building data used for the estimation and a scenario with all building data used

It can be summarised that based on individual user behaviour and other individual building characteristics a high spatial resolution and a high accuracy of heat consumption estimations are concurrent objectives. If the spatial resolution is adapted to the investigation objectives and as low as possible, the accuracy of estimation can be increased while at the same time the effort for gathering data can be decreased. Furthermore, the results of spatial disaggregated heat consumption estimation can easily be verified with single tests. In that case, estimation results with high accuracy will have a greater acceptance in public although they have a lower spatial resolution.

A Roadmap for the Future Energy Infrastructure in Salzburg Approaches to Optimize an Urban Energy System

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Extended abstract

The energy infrastructure of a city is rather long living. Investment decisions are therefore done under major uncertainties. Energy models help to understand future developments and can be used as rational basis for investment decisions. In this paper a roadmap for the energy, especially the heat supply, for the city of Salzburg is presented. The paper gives a detailed description of the analysis done to develop the roadmap for Salzburg.

A rather detailed building database formed the basis of the analysis. The thermal standard of the present building stock and the potential of refurbishment measures was calculated for around 60 building types and applied to the building database. We defined types regarding age, size and major utilization of the buildings. The calculation was proven to be more realistic in comparison with measured heat demand data.

Based on these data the future heat demand was inferred with the help of optimisation model. The model could choose between various refurbishment options. Different heat price developments were assumed. All buildings in an area of 250*250 m² were summed up to keep the complexity in the model moderate. The model gives the development of the heat demand in dependence of the heat prices.

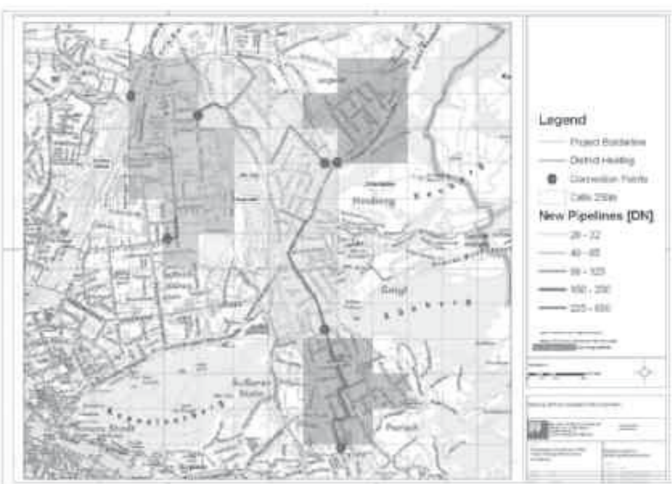

Fig. 1: District heating expansion in the districts Gnigl, Schallmoos and Esch according to a strategy following a financial support of 30% of investment costs

An even more detailed description was used to find the structure of possible future district heating networks. Based on the geographical resolved heat demand development areas of sufficient high demand were identified and judged by technical as well as strategic considerations. A special model was developed to find the optimal district heating network for these areas. The model is also based on an optimisation process which maximizes the revenue of the district heating operating company.

We assumed that such pipe structures only can be placed in urban street segments. For small areas additional trace options were included by GIS. Revenues depend on the heat price and the amount of sold heat from nearby buildings assigned to this segments. The costs are the sum of the annualised investment costs for the pipe structures in the segments, variable costs of the district heating system and the heat costs. Costs for house connections were included.

The freedom of the model was to decide which street segments were covered by district heating pipes and at which diameter. A set of constraints needed to be fulfilled: the heat flowing out of a segment could not exceed the heat flowing in a segment subtracted by the heat demand of the segment and the calculated heat losses of the segment. The heat flowing in a knot of pipes had to be zero. The model displayed georeferenced pipe structures (see Figure 1) as well as parameter like investment costs, heat input, heat loss and pipe diameters of every area. For certain areas the result of the optimization was to build completely no district heating network because investment costs are very high in general.

After all a heat supply model which was based on the heat demand model results determines the optimal share of heating technologies in all regions of the city as well as the district heating expansion. Global boundary conditions are CO_2-emission limits, certain lower limits for renewable energies and air quality standards.

Towards a Sustainable Youth Housing in Egypt

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Summary

This paper is a call for new visions in the housing policies and strategies in Egypt. One of the governmental interventions at the end of the 20th century was a new public housing scheme in new urban communities (Mubarak Youth Housing). The aim of this intervention was to offer affordable housing to the youth and young married couples. The government, however, did not provide enough significant programmes or support to achieve its goals. This scheme was stopped short and was unable to find a path toward progress and success. The following vision targets the young, low to moderate income families. This paper attempts to outline policies and strategies of this vision in a balanced process by approaching the three pillars of sustainability. In this new housing community model, the social aspect is to be considered just as highly and is to be tackled with the same level of importance as the economic and environmental pillars. Hence, it is emphasised that environmental problems are inherently social problems.

Keywords: Housing problems in Egypt; new settlement and satellite cities; housing communities; sustainable youth housing strategies; social cohesion and solidarity.

Introduction

Egypt is considered among the most popular countries in the Middle East, and as the cultural and economic centre of the Arab World. Cairo is distinguished by its old history and the cumulative urban heritage from many different eras. In addition, Cairo itself is the economic, cultural, and administrative capital of Egypt with a population of more than 17 million inhabitants, among whom approximately 20-25 % are youth. This figure confirms the role of Egypt as the leader for sustainable urban development. Housing communities in the historic, traditionally Islamic cities had once shown cooperative housing systems as early as the 7th century. These systems would be revitalised as the nucleus of the contemporary housing community centre in the 21th century.

Discussion

The universal need for sustainable development calls for comprehensive solutions in the global south to confront global environmental and ecological problems; yet it does not call for uniform solutions. Nevertheless, German experience in different contexts can present significant and well-known examples of housing cooperatives with contemporary visions. Some of the best examples will be briefly reviewed to show the interest of the social aspects in integrated strategies.
Housing problems in Egypt are the results of economic and political problems, but also of massive social problems. This research intends to define the current planning situation, the housing policies, and the housing problems, all of which have been reviewed, analysed, and discussed. A variety of local learning experiences are highlighted from different aspects to recognise the various

challenges, as well as the potential in the socio-cultural, urban, economic, and environmental characters in the traditional urban cities as well as other previous experiences in the last centuries. Through these intensive studies, this paper outlines lacking aspects in the process and key issues for sustainable housing communities. These important key issues, which were missing from state policies, are: Defining the social structure to form both a cohesive society and solidarity within it; defining the housing organisation during and after establishing the community in order to control and sustain its success; creating a flexible capacity and adaptable regulations for the building process; and finally, placing the decision making process inside the community-structure.

Outcomes and Final remarks

The process and strategies for developing Youth Housing Communities are suggested at the end of this paper using a holistic approach toward social, economic, and environmentally friendly housing communities. The selected target groups are young families with low to moderate income levels. Because the youth represents the largest percentage of Egypt's population, these groups are considered as being important social resources.

This research defines a well-organised process and integrates ideas by using the best, local practical examples without neglecting the needs of modern urban and architectural designs. Planners have traditionally placed considerable emphasis on the 'efficient use of land', while ecologists and environmental sustainability experts have attempted to use efficient renewable energy technologies. Consequently, the urban, social, and organisational configurations and structures in this new vision are determined to provide a thorough scheme for this community. This paper ends with recommendations of how to best utilise local resources, among them population and land. It is to pave the road, as a further step, for the best application of renewable energy techniques, e.g., solar panels, photo voltaic cells on roofs and wind turbines. Finally, this paper highlights from one side the regulations and the organisations as the main obstacles in the previous housing policies in Egypt. From the other side, it gives an approach for developing passive communities, which would efficiently use minimum resources and would consequently produce affordable housing with flexible regulations. In addition, these communities could be further developed to be plus-energy housing communities.

The District Energy Concept Adviser: A Software Tool from IEA ECBCS Annex 51 to support Urban Decision Makers in planning District Energy Supply Schemes

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Summary

Within the framework of the German research initiative EnEff:Stadt (launched by the German Federal Ministry for Economy and Technology), Fraunhofer Institute for Building Physics IBP has developed a computer programme which supports actors in the field of urban planning during the first stages of planning energy-efficient district concepts. This programme was developed in collaboration with international partners from IEA ECBCS Annex 51 "Energy Efficient Communities" and comprises a set of individual supporting tools.

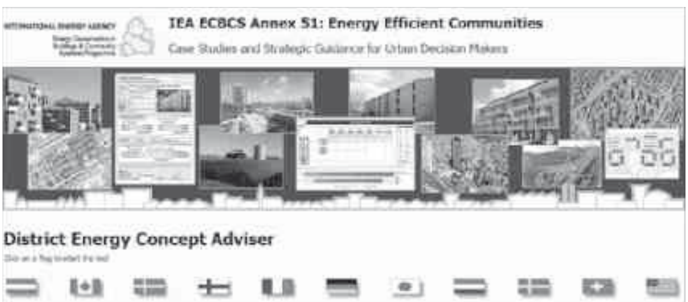

Fig. 1: Start page of the District Energy Concept Adviser

Keywords: Energy Efficient Communities; Software Tools, Energy Saving Potentials, Central Supply, Decentral Supply, Neighborhood, Performance Rating, Case Studies

1. Introduction

The very heart of the programme is a tool for the energy assessment of districts, which uses archetypes and other pre-set configurations to allow for a quick data input mapping all the buildings in the district. Thus it enables the user to identify the energy saving potential of various strategies in the areas of building construction, technical building systems, and centralized supply systems. In addition to the main part, i.e. the numerical assessment of the energy needs of a designed or an existing district, international examples of energy-saving and eco-friendly districts are presented in a structured form; besides, strategies and technologies for minimizing the district energy consumption are described. A performance rating tool enables the user to compare energy consumption data to the national average of similar districts.

2. Results

The District Energy Concept Adviser offers different tool sections adapted to the users' need:

- With the help of the **Performance Rating** tool the user can compare the energy use of a certain district with the national average of a similar district
- The **Case Studies of Energy Efficient Districts** have been provided by the national representatives in the IEA ECBCS Annex 51. Studying the 19 included exemplary case studies of energy efficiently new built or renovated quarters will give inspirations for own projects but will also inform on lessons learned.
- Various **Strategies and Technologies** can contribute to energy efficiency in quarters. This tool section gives a short overview on applicable measures and includes many links for further information, mostly to specific IEA annexes and tasks that deal in detail with certain technologies.
- The **Energy Assessment of Districts** enables the user to calculate the energy performance of various energy concepts on the demand and the supply side. The supply can be central like for example a local district heating system or decentral with boilers or heat pumps but also in combinations of both. Results are presented as delivered energy, primary energy and CO2 emissions.
- In the section **Basic** a list of international and national reports dealing with energy efficient quarters can be downloaded.
- Information on various detailed planning instruments for buildings and supply strategies can be found in the part **Detailed Planning**.
- The participating organisations of the IEA Annex 51 have been listed in the last section **Contact**.

3. How to get the Tool

The international version of the District Energy Concept Adviser (in English) is available as a free download from spring 2013 (visit http://www.annex51.org/). A German language version will be issued shortly afterwards. Other national translated versions will include Austrian (German language but Austrian boundary conditions) and French.

Partial System Simulation for Long-term Sustainable Urban Development

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Keywords: Systems Engineering; Systems Modelling; Urban Planning; Long-Term Urban Development Strategies

The impacts of global change affect cities and urban agglomerations in an increasing manner. Economic, social, technological and ecological changes, such as climate change or the latest transformative changes regarding the energy policy in Germany (“Energiewende”) impose significant challenges, which influence the conversion of existing neighbourhoods and communities. In this context, the interdisciplinary research project ‘City Lab Nuremberg West’ at the ‘Technische Universität München’ dealt with these challenges in order to establish long-term strategies for the development of a liveable and sustainable future for this urban district, which has approx. 15.000 inhabitants. Based on the analysis and the study of global trends, three alternative visions (hypotheses) for a plausible future were developed, which were aimed at the coming decades until the year 2050. Especially with regard to the development of key projects, sites and locations, long-term strategies are crucial, as the short-term realisation of supposedly appropriate projects on specific locations might prohibit the future viability of sustainable projects in these locations.

Cities are dynamically evolving structures and are constantly in transition due to continuous changes in many areas, such as population, functional requirements and economic conditions. Furthermore, global and local trends influence the development of a city. Due to the constant changes within the city over time, and the three different development paths, time-based simulations became necessary. Therefore, this paper proposes a method of systems modelling and partial simulation that is adapted to the specific situation of long-term urban development. The purpose of the time-based simulation consists in gaining information about the interaction of the sectors and disciplines and to learn about the time-related development of district in a long-term perspective. This includes information about the planned and expected effects in terms of their strength and timing but also the identification of unexpected side effects.

The method described in section two starts from the modelling of the system structure by expert examinations, as it is proposed by Vester. The next step is the selection of partial scenarios for simulation. This paper puts a focus on an adapted method for the partial system simulation, which differs from the method proposed by Vester. The adapted method allows different types of interdependencies and the linkage of the system scales and interdependencies to real values. Based on the adapted method, a partial simulation for Nuremberg Weststadt is implemented, which is described in section three. Selected results from the simulation runs serve to illustrate in section four, which information partial simulation delivers for long-term urban planning.

The paper shows that systems analysis, modelling and simulation are important tools to support the development of strategies to sustainable and liveable urban structures. The interpretation of the results from the simulation for Nuremberg Weststadt shows what kind of information from a partial system simulation can result. It is first information on the intensity and timing of processes taking place. Changing either a variable controlling the system, as they are known by the analysis before, helps to understand how to direct the quartier to a sustainable and liveable quartier. Interpretation and reasoning of further consequences in other variables second shows strategies for this development and adds a risk assessment. Caused by such conclusion, further modelling might be required, e.g., for determining the influence of the bad or good condition of the quartier on the behaviour of investors. This illustrates that the application of system simulation is an interactive process of modelling systemic information, running simulation, interpretation and conclusions.

In summary, it shows that partial system model and the interpretation by the experts lead to the identification of strategies, of potentials and of risks in the different development paths (hypotheses). Especially, the overall systemic effect of actions, the intensity of the reactions and the time it takes that they have effect – which before is only guessable – become objectively testable by the partial system simulation. Therefore, the main benefit of the method is the support by documented and comprehensible results of systemic effects.

FIEMSER – An Innovative Controller for Residential Buildings

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Extended Abstract

FIEMSER stands for **F**riendly **I**ntelligent **E**nergy **M**anagement **S**ystems in **R**esidential buildings. The FIEMSER project is funded by the European Union in the 7th framework program. The target is the development of a new innovative control concept for energy production, -storage and -consumption inside residential buildings and local grids. The project is executed by a consortium of four scientific and four industrial partners across the European Union. The basic objective of the FIEMSER project is to design, develop and evaluate a prototype of a new, innovative controller for residential buildings. In addition to the functionalities of common building automation systems FIEMSER has several capabilities that will enable further reductions of the energy consumption. The FIEMSER system targets dwellings, apartments and complete housing blocks. A reduction of the energy consumption with the CO_2 equivalent of 30 % is targeted within this research project. These ambitious goals shall be reached by providing additional intelligence to the building control. The basic idea behind all mechanisms of the FIEMSER system is to shift as much energy consumption as possible to timeframes where these loads can be covered by local and renewable generated energy. This applies for thermal energy as well as for electrical energy. FIEMSER tracks the following principles:

- Use right away the just generated renewable energy.
- Store the odd energy in local storages.
- Use local stored energy if current renewable production is too small.
- Reduce the buildings energy consumption by adapting to the user.

Consequently FIEMSER assumes that there are renewable energy sources within the control range of the building that FIEMSER manages. When no or not sufficient renewable energy sources are available to the FIEMSER controlled living space FIEMSER will use other indicators to shift the energy consumption. This can either be a forecasted renewable energy production at a nearby facility or future energy prices, e.g. provided by a smart meter. A further capability of FIEMSER is to control the storage capacities for electrical and thermal energy at the residential building as well as inside local grids (apartment houses / neighbourhood grids). The concept of producing and using as much (renewable) energy as possible on-site decreases the balance load on the national energy grid. Aside the support of the energy exchange inside local grids is part of the FIEMSER philosophy. The most efficient energy is energy that is not consumed at all. Therefore the buildings behaviour will be optimized taking into account the occupants' comfort settings, their timetables and their usual behaviour. To ensure that the user never feels overpowered by the system it is always possible to override the system's decisions.

For its optimisation process the FIEMSER system requires detailed forecasts of the next day's energy demand. Systematically the building's energy demand is grouped into three groups:

1. Energy demand for keeping the indoor climate at the required comfort levels.
2. Energy demand of house hold devices controlled by the user that have to become active at once when activated (e.g. TV, room's lighting).
3. Energy demand of devices with relocatable timeframes (e.g. a heat pump or a dish washer).

The forecast of the next day's demand is compared with the forecast of the next day's generation of renewable energy sources. These forecasts of demand and generation are based on model information of the building, characteristics of the energy generators and on weather forecasts acquired from web services. A reliable forecast of the user-dependent household devices is very important for a functional FIEMSER system. The demand of the user-dependent household devices is predicted by user schedules of occupancy and then corrected by experience-values learned from the system's energy-meters. The results of this comparison between the predictions and the real situation over the day are used to adapt the user schedules by means of a self-learning algorithm.

The completely developed system and its potential for reduction of the energy consumption will be evaluated in two different facilities at two different locations. The system will be installed in three rooms of Tecnalia's KUBIK test facility in Bilbao, Spain and in the two-room attic spaces of one of the Twin Houses of the Fraunhofer Institute for Building Physics IBP at Holzkirchen, Germany. The attic space of the second Twin House is identical to the attic of the first Twin House except the FIEMSER system. This enables the project consortium to perform a direct comparison between a common and the FIEMSER system under well controlled in situ conditions.

Site Development for the 2000-Watt-Society

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Summary

Switzerland is increasingly following the path towards the 2000 Watt Society. This includes a continuous reduction of primary energy consumption from 6,500 watts today, to an average global energy consumption of 2,000 watts per capita (1,500 watts renewable and 500 watts non-renewable energy) and a cut in Global Warming Potential from 8.7 tons to 1 ton CO_2-equivalents in the next 100 to 150 years. This concept is derived from a global view and applied on a European, national, cantonal and communal level. Furthermore, a publication in Switzerland presents the target value of 2000 Watt per Person, year and square meter heated floor area of a building with different types of construction. The main focus of this publication is on the methodology developed and applied to a calculation tool for assessing future development sites regarding the target values. The tool supports the improvement of projects regarding the planned constructions, the energy supply and the related mobility. Based on the guideline and the calculation tool, a new label “2000-Watt-Site Development” has been introduced and already successfully applied on one development site in Switzerland in 2012.

Keywords: 2000, Watt, Sustainable, Building, Construction, Development, Site, Primary, Energy, Switzerland

1. Introduction

Ten years ago, the vision of a "2000 Watt Society" was developed at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. It calls for a continuous reduction of primary energy consumption from 6,500 watts today to an average global energy consumption of 2,000 watts per capita (1,500 watts renewable and 500 watts non-renewable energy) and a cut of Global Warming Potential from 8.7 tons to 1 ton in the next 100 to 150 years.

2. From a Global Perspective to a Single Building

2.1 Global – European –National / State (Cantonal) - Communal

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) sets binding obligations on industrialised countries to reduce emissions of greenhouse gases by 5.2% from the emissions from 1990. At the 2012 Doha climate change talks, it was agreed to a second commitment period to 2020.

The European Union (EU) already agreed an integrated strategy in the area of energy and climate protection in December 2008 to reduce its CO_2 emissions by 20 percent (compared to 1990) by 2020.

In 2012, the Swiss Federal Council agreed on a new energy policy in which energy efficiency and renewable energy are to support a sustainable energy system based on the 2000 Watt Society.

This new national energy policy has been adopted by several states (or Cantons). Some cities (e.g. Zurich) have successfully introduced an “Energy City” label.

A small community in the Swiss Alps (S-chanf) with mostly heritage-protected buildings has developed a concept for achieving the 2000 watt goals in future. It proved to be possible thanks to a large future source of renewable energy from a new sewage treatment plant.

2.2 Building and Development Site

The methodological foundations for the implementation of the 2000 Watt Society in the construction sector have been set out in a publication of the Swiss Society of Engineers and Architects called “Energy Path of Efficiency“. As part of a further development of this instrument, a calculation method for the three building categories living, office and schools was published.

On a development site scale (e.g. former industrial area), a research project funded by the Swiss Federal Office of Energy and the Office for Building Construction of the city of Zurich has developed a methodology and tool to calculate the energy efficiency of areas to be developed.. The simple tool supports investors and planners in calculating the total energy consumption and greenhouse gas emissions on the basis of the preliminary design stage with a limited amount of information: retrofit or new construction, planned mix of use (e.g. living, restaurant, etc.), floor area, etc. The underlying default values can be adapted on the basis of the full planning stage. The results of a project are put in relation to target values which are derived from the 2000 Watt Society goals and presented in a way to easily gather insight, where the project could be improved in terms of energy efficiency.

A new development site (Zwicky Areal) located north-east of Zürich on a former industrial site where the company Zwicky produced sewing thread and weaving yarn until 1993. The cooperative building association Kraftwerk 1 is planning a mix of apartments and commercial premises. The site is well connected to the public transport, the heating demand will be covered by a heat pump using warm wastewater from the nearby sewage plant and the electricity demand will partly be covered by onsite photovoltaic. From the studied indicators for the development of the Zwicky Areal, global warming potential is the most difficult to achieve. It shows that the guidance value for operation and mobility can be met very well, whereas not for the construction itself. This is the reason why the overall target value just can’t be met.

3. Conclusion

The quantitative assessment of measurable indicators like primary energy and other environmental impacts in building, development sites or neighborhood labels will play a more important role in future. The published guideline “Site development for the 2000-Watt-Society”, together with the calculation tool, is a good basis for this assessment. The approach of the 2000-Watt-Society is only feasible in the context of a comprehensive sustainability when the economic and social dimensions are included. This has partly already been implemented in the new Swiss certificate “2000-Watt-Site-Development” which has been released by the supporting association of “Energiestadt” in 2012.

Refurbishment of a Historical City Centre with a Quarter Based Approach – A part of the Project „100% EE WOLFHAGEN“

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Summary

With a quarter based approach, including refurbishment strategies and the heat supply, the participants of the project will search for realizable solutions by involving the owners, the local government, the consultants, the planners and the service providers. Enclosed in the superior aim of the whole project, to start a transforming process in relation to energy efficiency, energy supply and safeguarding the future in Wolfhagen, the focus of the working package is the historical building stock in the city centre. Communication and information are important parts of the whole process in relation to the conditions in this rural area.

Keywords: quarter based; energy refurbishment; thermal heat supply; historical city centre; rural area; transforming process; participation

1. Introduction

Nearly 26% of the German inhabitants live in small municipalities, another 18% in small towns [1]. Such a small one is the north hessian township Wolfhagen with 14.000 inhabitants. During the next five years a research project will take place there which is sponsored from the German Ministry of Education and Research in the frame of the program „Energy efficient City“. Important tasks are the protection of the historical city centre for the future with a main focus on the energy efficiency and sustainability of timber framed buildings as well as the inclusion of the interests and possibilities of the owners.

Enclosed in the superior aim of the whole project, to start a transforming process in relation to energy efficiency, energy supply and safeguarding the future in Wolfhagen, the focus of the working package is the historical building stock in the city centre. The objective is clearly designed to municipal structures in rural areas and differs significantly in the orientation from the boundary conditions of (big) urban structures.

The investigation of energy related aspects regarding the building and also the supply options are only one part of a broader analytical framework. The superior aim is it to change the building stock in the historical city centre into an attractive and modern living and working location. Urban, architectural, design and functional aspects must also be part of the consideration, to achieve with this approach to strengthen and secure the future of integrated urban locations with a good supply situation (“city of short ways”).

Based on this point of view the issue of energy efficiency in the historical stock will be connected with the development of new services and operator models to use synergetic effects. These points are combined with the aspects of modular power generation and supply, as well as concepts of urban development and revitalization in the city centre of Wolfhagen.

2. Methodology

From the existing 250 historical timber framework buildings of the inner city five to ten buildings will be identified in a moderated process, which can be viewed and evaluated as an ensemble. Taking into account of the urban planning aspects, structural and plant specific properties of the timber framework buildings are recorded in a detailed inspection. The accompanying communication process is vital to inform the citizens from the beginning and to accompany during project continuously. So it is necessary that the owner get all information to understand the objective of the project. The communication process face to face starts with the inspection of the buildings. The owner shall be informed in advance of the inspection with pre information and in the further course of the process continuously.

Based on the data and information of the inspection a precise building ensemble will be identified. A concept and feasibility study will be developed for this quarter in a moderated process. Experts have to be involved. In the following process energetic, technical, organizational, legal and financial issues will be reviewed based on the feasibility study. The feasibility study is then used later in the project as a basis for an implementation concept and a precise planning. An energetic refurbishment concept and an approach for the energy supply will be developed. In regarding to the overall project objectives the using of renewable energy have to take into account in particular.

3. Conclusion

A transformation process will be initiated that should lead to a change of thinking and acting in Wolfhagen. This visionary approach is not reachable until the end of the project but the points have to be made until then in this direction. It is impossible without the active inclusion of the citizens, municipal representatives, planners, consultants, artisans and financiers. For this reason, the communication process and the dissemination of knowledge have to carry in a matched, sensitively and consistently way in addition to the scientific, technical and structural studies. Especially in rural areas, the personal and direct address is an important element to move players to participate.

A Framework for the Evaluation of Urban Heat Island Mitigation Measures

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Summary

In the last few years, the general awareness concerning the urban heat island (UHI) phenomenon has been steadily rising. Likewise, a deeper understanding is emerging concerning UHI's far-reaching implications for microclimate, energy use, and human requirements pertaining to health and comfort. In this context, in many cities around the world adaptation and mitigation measures are being conceived – and, in a number of instances implemented – that are expected to address the negative impacts of UHI phenomena. Such measures generally require a considerable level of effort and investments. Hence, their effectiveness should be assessed and evaluated a priori and systematically.

As a contribution to the present efforts in this direction, this paper presents results of an on-going research project which investigates the urban heat island phenomena in the Central European area. The proposed methodology can be seen as a contribution to the UHI issue in terms of reducing the negative effects of this phenomenon. Moreover, the present paper introduces a systematic framework for the evaluation of urban heat island mitigation measures.

The aforementioned UHI project involves the consideration of potential pilot actions toward mitigation of the urban heat island effect. A spatial domain associated with the area in which such a pilot action is envisioned, could be defined in terms of an U2O. These well-defined segments may share characteristic features in view of geometry, massing, or other aspects of the physical structure. In order to predict, estimate, and verify the effect of urban heat island mitigation actions on reduction of urban heat island intensity, we need to express such actions in terms of changes that they introduce in an U2O. We thus need a structured approach to systematically capture the essential geometric and physical features of an U2O. Once U2Os and their respective variables are defined, potential mitigation measures may be expressed in terms of respective changes to the variable attributes. Once the specifics of an envisioned mitigation measure are determined (specifically, in terms of implied changes in the U2O variables), their impact can be estimated based on appropriate calculation tools and modelling methods.

Given its complexity, we are providing the summary of the proposed framework by listing the steps that will provide us meaningful results:

i) Definition of "Urban Units of Observation" (U2O): These are properly bounded areas within an urban setting selected as the target and beneficiary of candidate UHI mitigation measures.

ii) Description of the status quo of U2O in terms of a structured set of geometric and physical properties. The first set includes variables such as built volume ratio, urban envelope factor, etc. The second set captures information on surface albedo, admittance, etc.

iii) Specification of the existing UHI effect intensity in terms of a set of pertinent variables (e.g., the difference between urban and rural temperatures).

iv) Specification of the candidate mitigation measures in terms of projected changes to the geometric and/or physical properties captured in step *ii* above.

v) Predictive assessment of the effect of mitigation measures using empirically-based and/or numeric micro-climatic models.

vi) Expression of the mitigation measures' impact in term of predicted changes in UHI effect intensity variables mentioned under step *iii* above.

vii) Overall evaluation of the mitigation measures' effectiveness on the basis of modelling results together with their estimated financial and logistic ramifications.

Keywords: Urban heat islands; mitigation and adaptation; modelling, evaluation

UrbanReNet – Local Regenerative Microgrids in Urban Space

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1. Summary

In consideration of the resolved reversion in energy policy in Germany and the prospective necessity for sustainable energy supply concepts in general, the research project UrbanReNet focuses on the examination of urban structures regarding their potentials for local energy production, energy storage and the basic possibilities of linking these structures to make use of synergetic effects. Apart from the thorough evaluation of urban structures the project team is currently working on a software tool which enables the user to upload existing urban structures for the purpose of analysis and to simulate proposed network scenarios.

Keywords: network, energy, city

2. Extended abstract

UrbanReNet is an interdisciplinary research project which was launched in September 2009 at the Energy Efficient Building Design Unit, Department of Architecture at the Technical University of Darmstadt. The project is grant-aided by the „Federal Ministry for Economics and Technologies“ and has reached the second work phase in September 2012 with an intended duration of another two years of research. Altogether the project team is made up of 6 persons, of which 5 have degrees as architects and one as a mathematician. Substantially the project focuses on two main topics: to fully examine the potentials of local energy production and local energy storage of existing urban und suburban structures and furthermore to determine the basic possibilities of linking these structures on an urban scale. The results of these two main research modules merge in the development of a software tool for the evaluation of city excerpts.

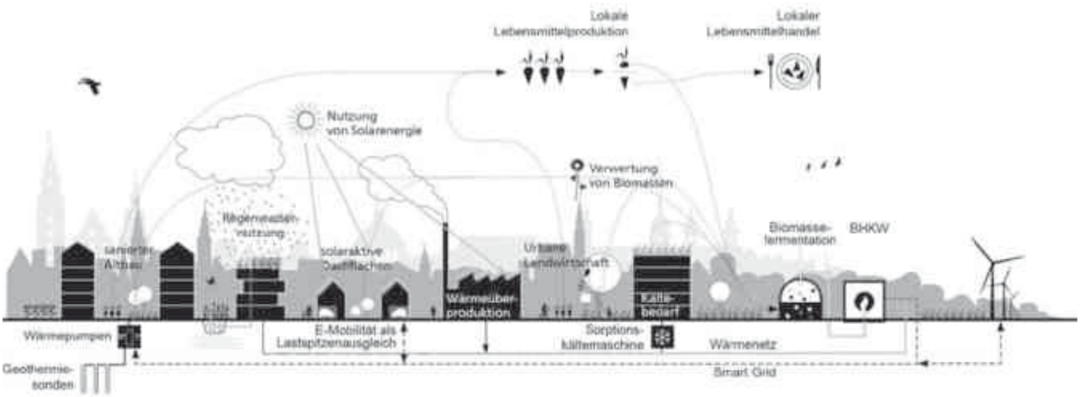

Figure 1 *city as network*

One of the most essential steps in the course of the project was to comprehend the city as a multiplication of distinctive structural elements rather than interpreting it as a dense gathering of single houses. It was necessary to sub classify on a larger scale and define the typical repeating urban structures. These urban structures are labeled as the so called “energetic city elements” (abbreviated: EST) of which 13 were defined altogether. Each one is characterized by a specific structure, density, use and a catalogue of energetic potentials as well as energetic requirements. To specify these attributes we have concluded a fairly intense and long lasting phase of analysis on existing urban structures in Germany and have collected a great deal of basic data for each energetic city element defined. Especially the energetic properties in form of potentials and demands are of particular interest regarding the main emphasis of the project. The software tool currently in progress is able to qualitatively and quantitatively evaluate and display these properties of any uploaded city structure. Furthermore the user has the option to interact by defining specific parameters like the building class or level of renovation. In perspective the software application can not only act as static tool for energy balance but can also simulate proposed networked scenarios by applying dynamic modeling techniques. Especially with this function at hand we will be able to contribute to the development of innovative and sustainable concepts for city planning and urban redevelopment.

Sustainable Urban Development – Report on Research for Practice

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Summary

The paper reports on results of the project Climate protection concept for the City of Riedstadt funded by Germany's federal climate protection initiative. Key aspects are the holistic consideration of town parts wrt. energy demand and production of renewable energy. Two scenarios carbon reduction with different assumptions on renovation rate and proliferation of renewable energies were investigated using a space- time-energy model. Riedstadts carbon emission targets can only be achieved by the more ambitious scenario.

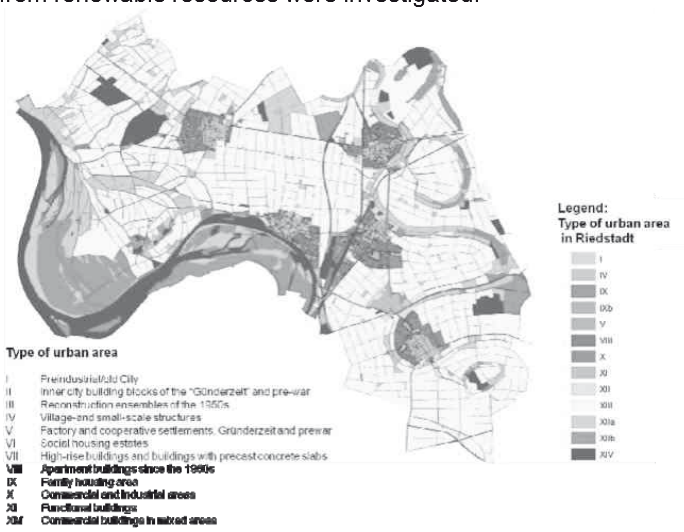
Keywords: Sustainable urban planning; regional planning; climate protection concept; existing neighbourhoods and buildings; energy area management, energy assessment

1. Climate Protection Concept for the City of Riedstadt

The city of Riedstadt is located 25 km south of Frankfurt am Main and member of the climate protection alliance in Hesse in Germany. To achieve lasting CO_2-reductions, Riedstadt wants to replace their past activities on environmental protection by a comprehensive climate protection concept. The development of such a concept is conducted in the framework of a project supported by funds of the federal ministry of environment, nature conservation, and nuclear safety. The project is mainly about developing, implementing, and accompanying a concrete strategy on climate protection. The city of Riedstadt consists of 5 geographically disjoint parts that differ in their urban structures. The methodology pays attention to that.

2. Methodology

First, the status quo wrt. energy consumption, carbon emissions and energy production from renewable resources was determined. This made use of so called building topologies. Using the approach of energetically homogeneous areas (EHAs) [4]/[6], energy consumption was contrasted with the potential of producing renewable energies. Two scenarios (base and excellence) with differences in the development of energy demand and energy production from renewable resources were investigated.



Energetically Homogenous Areas (EHA) of Riedstadt [4]: [1]/[2], Method [3]

3. Results

Within Riedstadt, housing accounts for 26% of the energy consumption, work for 36% and transportation for 38%. Of all types of energy consumption, heat demand is 47%, fuels are 36% and electricity 17%. 90% of the energy is supplied by means of fossils and only 10% from renewable resources. Of those later ones, only 3% are produced within Riedstadt, but 7% are imported. In the excellence scenario, assuming a renovation rate for 3% per year and a sizable exploitation of renewable energies, the energy demand may be reduced by 42% and midterm and long term climate protection goals may be achieved.

Achievable carbon reduction und targets of the Klima-Bündnis

$CO_{2\text{-Equ}}$/c.a according LCA								
	1990	**2010/ 12**	**2030: taget based on 1990**			**2050: 10%-reduction every 5 years**		
			Klima-Bündnis	Base-Scenario	Excellence-Scenario	Klima-Bündnis	Base-Scenario	Excellence-Scenario
Riedstadt $_{LCA}$	8,70	7,96	**4,35**	6,47	4,3	3,4	5,12	2,79
Target achieved?	-	-	-	no	yes	-	no	yes

LCA: Life Cycle Assessment, Equ: Equivalents, c.a: Citizen and year, results from 22.11.12, [4]

4. References

[1] Ecofys, RWTH-Aachen & FH-Köln (2004) Leitbilder und Potenziale eines solaren Städtebaus. Köln, Aachen, Köln, Ecofys GmbH Köln, RWTH Aachen, FH Köln, 257

[2] EVERDING, D., Ed. Solarer Städtebau: Vom Pilotprojekt zum planerischen Leitbild, 2007, Stuttgart, W. Kohlhammer.

[3] BBR/BBSR & BMVBS 2009b: Nutzung städtischer 'Freiflächen' für erneuerbare Energien (Bearbeitung: D. Genske, A. Ruff, T. Joedecke). Bonn, Berlin, Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung (BBR), Bundesministerium für Verkehr, Bau und Stadtentwicklung, S. 140, Bonn, Berlin

[4] MESSARI-BECKER L., Klimaschutz für Riedstadt, 2013, Abschlussbericht, in preperation

Developing Sustainable ‘Liveable’ Buildings, Cities and Communities for a Sub-Tropical Context: Residents’ Perspectives

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Summary

A key challenge for the 21st Century is to make our cities more liveable and foster economically sustainable, environmentally responsible, and socially inclusive communities. Design thinking, particularly a human-centred approach, offers a way to tackle this challenge. Findings from two recent Australian research projects highlight how facilitating sustainable, liveable communities in a humid sub-tropical environment requires an in-depth understanding of people’s perspectives, experiences and practices. Project 1 (‘*Research House*’) documents the reflections of a family who lived in a ‘test’ sustainable house for two years, outlining their experience and evaluations of universal design and sustainable technologies. The study family was very impressed with the natural lighting, natural ventilation, spaciousness and ease of access, which contributed significantly to their comfort and the liveability of their home. Project 2 (*‘Inner-Urban High Density Living’*) explored Brisbane residents’ opinions about high-density living, through a survey (n=636), interviews (n=24), site observations (over 300 hours) and environmental monitoring, assessing opinions on the liveability of their individual dwelling, the multi-unit host building and the surrounding neighbourhood. Nine areas, categorised into three general domains, were identified as essential for enhancing high density liveability. In terms of the dwelling, thermal comfort/ventilation, natural light, noise mitigation were important; shared space, good neighbour protocols, and support for environmentally sustainable behaviour were desired in the building/complex; and accessible/sustainable transport, amenities and services, sense of community were considered important in the surrounding neighbourhood. Combined, these findings emphasise the importance and complexity associated with designing liveable building, cities and communities, illustrating how adopting a design thinking, human-centred approach will help create sustainable communities that will meet the needs of current and future generations.

Keywords: sustainable design; experience of higher density; subtropical Australia; liveability

An Interdisciplinary Research Approach for Sustainable Urban Development

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The development of sustainable and liveable cities or urban districts is a highly complex and multi-layered task. An important prerequisite for the solution for such problems is that a technically versatile approach be delivered by an interdisciplinary team. In the research project 'Urban Lab Nuremberg West', six departments of the Technische Universität München cooperated towards the goal of a sustainable refurbishment of the district of Nuremberg West (NW) by 2050. NW had to endure a heavy economic crisis during the last 20 years. As a result, businesses closed, jobs dropped away and the population decreased. To improve this unfavourable situation and moreover to be responsive to upcoming changes, a long-term, sustainable reorientation of the district is required. There is a need for an approach that propels an adaptive rather than reactive transformation process and activates the specific characteristics of the city quarter as a valuable resource. Hence, an approach was developed allowing the collaboration across the different specialist areas of urban, regional and landscape planning, energy efficiency as well as mobility.

Due to the interdisciplinary research approach, there was great variance between objects of investigation, perceptions of problems and objectives, working methods and value systems between the project partners. We had to understand that beyond the different specialised topics, fundamental disciplinary differences exist at least at three levels: dimensions of space, spatial scales and time horizons. Our understanding of space in particular turned out to be, at the same time, a barrier and a bridge between the different disciplines. For example, the economic and social development of the city quarter can only be understood when taking into account global and regional trends and the specific competitive advantages and disadvantages of NW within a regional as well as international context. On the other hand, the specific local conditions must be taken into consideration for the energy demand. In addition to the perceptions of space, the different speeds of the transformation process have to be taken into account [1]. In an existing city quarter, the built environment can only be changed in a very slow process. On the other hand, economic and social change occurs at a much faster pace. The approach provides a structure with interfaces between these different levels of space and time, ensuring comprehension among the specialist areas and the exchange of the necessary qualitative and quantitative data.

The overarching framework of the project is the concept of sustainable development. This is generally seen as a necessary basis for reasonable long-term urban development strategies. In the case of the 'Urban Lab NW', this framework also provides a suitable background in order to find appropriate methods of interdisciplinary cooperation. A custom-made evaluation method had to be developed, because existing schemes rather aim at a specific urban design project with fixed planning phases. This was not suitable for our long-term projections with a broad range of possible development paths. Therefore, our focus was not so much an absolute state of sustainability, but rather the comparison of those possible future paths and transformation processes of the district with regard to sustainability. The chosen method expands upon the well-known three pillars of sustainability – ecological, economic and social factors. We complemented the top-down point of view of common welfare with the perspective of individual freedom. The method was based on a comprehensive, already-existing approach, which is characterised by the addition of the dimension of politics and decision-making processes, as well as an ethical framework [2], [3].

Given the complexity of the research task, the project team deliberately rejected the idea of one all-integrating method. The idea was to flexibly join the approaches of the different disciplines according to the interdependencies and interfaces. The project management had to develop a value chain of integrating methods on-the-job. The following connecting and complementing approaches were used:

- combination of the analytical results of fundamentally different approaches, like top-down and bottom-up
- identification of spatial interdependencies
- translation of global trends to the city quarter
- identification of impact chains for transformation and urban renewal, in order to conceptualise possible future development paths for NW
- sustainability evaluation as a two-fold purpose: providing the theoretical background and the objectives for the whole project, as well as supporting the interdisciplinary teamwork.

Our research approach led to the development of three different kinds of results. They had to be organised in a way to provide a long-term and adaption-orientated framework with a combination of the different levels of scale and moreover to specify decisive impulses for the transformation process. First, long-term alternative futures were developed, based on the specific position of NW in the wider spatial context of the Nuremberg Metropolitan Region and on its adaptation on global trends. Second, the influence of strategic sub-spaces and individual sites on NW as a whole was visualised. The third part of the results was represented by the tasks of the transformation process, the so-called fact sheets. As activity-orientated information, they demonstrate the possibilities to influence the current situation.

The central challenge of the project was to design a working process that allows the combination of different levels of scale and methods and the organisation of a sustainable urban transition. It was not the overarching method but rather the combination of individual methodological steps that provided the basis for the long-term view, which should enable adaptive planning. The need for learning is still high; however, the essential components were developed.

1. References

[1] Alaily-Mattar, Nadia, Alain Thierstein, and Agnes Förster (2012) Urban Transformation, Change, Opportunities. The case of Nuremberg West, Germany. In: Shi Nan and Chris Gossop (eds.), Fast Forward: City Planning in a Hyper Dynamic Age, 8/Perm: ISOCARP, 178-195.

[2] Thierstein, Alain, Wilhelm Natrup, Sabine Friedrich, Dunja Binggeli, and Carolina Grimaldi (2005) Aufbruch West? Nachhaltige Entwicklung und städtische Erneuerung am Beispiel von Zürich West. Zürcher Kantonalbank, Zürich. http://www.zkb.ch/etc/ml/repository/prospekte_und_broschueren/corporate/studien/studie_aufbruchwest_pdf.File.pdf, 19.01.2009.

[3] Thierstein, Alain, and Manfred Walser (2007) An evaluation framework of quality management of projects for regional sustainable development. In: Uwe Schubert and Eckhard Störmer (eds.), Sustainable Development in Europe. Concepts, Evaluation and Applications, Evaluating Sustainable Development, Cheltenham, UK, Northampton, MA, USA: Edward Elgar, 125-142.

Geo-Referenced Modeling of an Urban Quarter for the Assessment of Refurbishment Potentials and Energy Supply Strategies

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Keywords: Building stock; refurbishment strategies; energy transition; simulation model; energy supply; model-based optimization

Extended Abstract

The necessary rearrangements of our energy system are numerous and affect energy supply and energy demand alike. Various studies [1] show the existing extensive potential for emission reductions. The change and optimization of our energy system is a crucial challenge of the coming years, which can only be done on the basis of verified knowledge about the details inherent to the system.

The number of interdependencies and variables included illustrates the high requirements for the description of the system in simulation models, which should become increasingly detailed by zooming into the system. Depending on the purpose of the investigation, the level of detail varies strongly.

Concerning the building stock of an urban quarter, accuracy is often limited in using available statistical data for the modeling of energy demand. This data includes information about building size and building age classes. Especially site-specific information, like arrangement and alignment of the buildings, cannot be considered in this way. Geo-referenced data include this information; therefore their integration provides two important possibilities: The potential in energy efficiency of a city quarter can be assessed with respect to the special characteristics thereof, and the data resolution in time can be increased in order to deliver the demand to the optimization algorithm of the further energy supply structure.

In contrast to the residential buildings, for the non-residential buildings no data are collected by the statistics agency. Thus, the data about the existing non-residential buildings and their use had to be collected by site inspections in the quarter “Nuremberg West”. Furthermore, only rough typologies offer data about the quality of the building components and the typical issues of the building age. Therefore site-inspections provided information like the building age and the energetic quality of the components and the dimension of the building envelope. Because of the high share of conditioned space in non-residential buildings - about 50% - they had to be considered in the same way as the residential buildings.

Only once this is done, the impacts of different refurbishment strategies can be assessed and a negotiation over contributions of different strategies can begin. Particularly in respect to district heating in combination with basic fabrics from before 1948, the assessment of the impact to the energy supply is a fundamental precondition for the negotiation over the necessary extent of refurbishment.
A special characteristic of the quarter Nuremberg West is the high share of residential buildings which were built before 1948. These buildings, which predominantly have decorative facades, form the character of the quarter even though large-scale commercial space exists as well. The improvement of the thermal protection of these buildings is a technically demanding task which can only be succeeded by careful planning and construction.
In contrast to modeling the building stock of an urban quarter, a higher scale-level is used for the investigation of the electricity system. The interaction between optimization on a supra-level and local data aggregation has always been a bottleneck. But alongside with intense methodical research in the area of energy systems optimization over the past decades, drastic gains in accurate modeling of aggregated systems arose. This allows for increasing degrees of detail in the modeling of local circumstances.
This paper describes approaches in modeling to design the energy structures of an urban quarter sustainably. Therefore, the site-specific modeling of the energy demand was enhanced by the use of geo-referenced data to increase the level of detail and the resolution in time. Furthermore, the detailed data about the arrangement of the buildings was used to assess the site-specific potential in energy-efficiency regarding the careful handling of decorative façades. The higher resolution in time, which was achieved in the course of the project, provided the possibility to deliver time-dependent data for simulation and optimization of the energy supply. Thereby it is possible to optimize the energy system by the use of more site-specific information.
With regards to the energy supply the crucial question of the project was to find optimal strategies in different scenarios. To answer this question, the findings of the estimation of the energy demand were used in a linear energy systems optimization model (URBS). The model was adopted by the Institute for Energy Economics and Application Technology at the TUM in order to match all project targets. The requirements of the project are a more specific research focus on the structure of capacity built-up for thermal energy generation and the interaction with the surrounding electricity system with high shares of renewable energies.
To answer further questions about multi-level interactions in the energy system, the cooperation of the energy supply optimization side with the detailed energy demand calculation offers potential to do so, but also requires equivalent effort to develop the corresponding methodologies.

E80³ – A Plus-Energy Building Concept for Existing Buildings

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Keywords: Plus-energy; building concept; existing buildings, LCC, LCA

1. Introduction

In Austria, many of the buildings built between 1950 and 1980 are now being retrofitted or refurbished. If these refurbishments achieve a high level of energy performance, or even reach a plus-energy standard, they would represent a major step towards achievement of the European 2020 targets.

In this paper the successful refurbishment of the project "e80^3-Buildings" - *reconstruction concepts towards energy plus house standard with prefabricated active roof and facade elements, integrated home automation and network integration* - will be described in detail. This project is realized as a case study – demonstration project – in Kapfenberg (Styria/Austria) by the property developer „Gem. Wohn- u. Siedlungsgenossenschaft ennstal" in the years 2010 to 2013.

2. Case study

The case study is located in northern part of Styria, in a City called Kapfenberg. The building owner is a social housing cooperation. The projects consists of 32 residential units, 2.800 m^2 gross floor area, with total construction cost of approximately 3,5 Mio €.
One of the main purposes of the architectural concept is to actively show the installed innovative building elements in the facade and on the roof. With the integration of active elements like PV-modules and solar thermal collectors, as well as passive components, the transition towards energy generation of building should become a visible element of the energy concept for the public.

3. Conclusion und outlook

Refurbishment that is intended to result in plus-energy buildings is only possible with designs that carefully integrate energy systems (see *Fig.* 1). This specifically requires a high-quality thermal refurbishment of the building envelope with simultaneous integration of energy-producing active elements (solar thermal collectors and photovoltaic elements), as well as network integration for electricity and heat.

Concerning LCCA there are several tasks to be solved in the future - first a reduction of development and production costs of prefabricated facade modules e.g. by establishing serial production and by increasing the amount of installed active panels by a simultaneous increase of the degree of efficiency.

Fig. 1: rendering of the refurbished building (Nussmüller Architekten ZT GmbH)

4. Acknowledgements

The research project *e80^3-Buildings - "reconstruction concepts towards energy plus house standard with prefabricated active roof and facade elements, integrated home automation and network integration"* is funded by the Federal State of Styria and the program “Building of Tomorrow” of the Austrian Federal Ministry of Transport Innovation and Technology (BMVIT) via the Austrian Research Promotion Agency (FFG).

5. References

[1] Passer A, Kreiner H and Maydl P: Assessment of the environmental performance of buildings: A critical evaluation of the influence of technical building equipment on residential buildings, Int J Life Cycle Assess (2012) 17:1116–1130; DOI 10.1007/s11367-012-0435-6

[2] e80^3-Buildings - "reconstruction concepts towards energy plus house standard with prefabricated active roof and facade elements, integrated home automation and network integration", Federal Ministry of Transport, Innovation and Technology, Austria, Research Promotion Agency (FFG), http://www.hausderzukunft.at/results.html/id5836

Scientific Research Support for Construction Waste Management

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Summary

One of the most important sustainable research goals for Poland is creation of a modern management system including legal, organizational and technical solutions dedicated to the construction and demolition waste that combined with environmental tools will engage all actors in the building material cycle to share responsibility in facilitating the feasibility of reducing, recovering and recycling of C&D waste. Actual considerations and research needs for developing a successful waste management system are presented in the article.

Keywords: construction waste management, sustainable resource use, recycling

1. Introduction

The general objective of paper is to present the scientific and research framework aiming at setting rules for effective building demolition process and construction waste management for polish municipalities including environmental, social and economic optimization. For many years Poland has been facing a serious problem of waste management and disposal, with the current system failing to reduce landfilled waste. According to Polish National Waste Management Plan in 2020 it will be produced about 5 mln tones of construction and demolition waste (C&D waste) comparing to 3.6 million tons produced now (Fig.1.). According to Waste Framework Directive recycling target for non-hazardous C&D waste reducing is by weight 70% by 2020. These objectives are connected with achieving adequate levels of recycling, preparation for reuse, recovery and storage limitations. To reach the target approximately 3.5 million tones will have to be reused, recycled or recovered in properly designed management.

Through Directives, the EC requires that Poland achieves specific objectives in relation to particular types of waste. These objectives are connected with achieving adequate levels of recycling, preparation for reuse, recovery and storage limitations. Since the municipalities manage waste, their main goal is to organize a well working system to ensure they achieve these objectives. By the end of 2020, national municipalities will be required to achieve the level of recycling and preparation for reuse of municipal waste of at least 50 % by weight. Furthermore the level of recycling, preparation for re-use and other methods of recovery of non-hazardous construction and demolition waste of at least 70 %, by weight. These targets are set out in a Regulation of the Ministry of Environment for the years 2012 to 2020, with the aim of progressively reaching the 2020 goal. Reaching the level required means that hundreds of thousand tons must be reused, recycled or recovered in properly designed system. So the municipalities will need integrated and sustainable waste management system and tools for a quick implementation.

As a technical and logistic system it creates a huge subject for analysis and multidimensional process to be driven with many obstacles and engineering's challenges [1,6]. To create the environmentally sound C&D waste management system in Poland it is extremely important to base it on detailed characteristics data. It is difficult at this point to clearly assess if Poland will manage to meet the requirements of Framework Waste Directive in 2020. This is one of reasons to propose the national research program in this field. The views from national stakeholders and experts opinions were collected in 2012 via the state of the art analysis and questionnaire action. The outputs identified a number of activities that can support the effective development and practical implementation of C&D waste management system [1-6]. The state of the art research outcome shows: lack of a well-developed waste recycling market, insufficient regulations and that waste reduction does not receive sufficient attention in construction design. These matters are perceived as the main barriers. The obstacles and difficulties could be grouped into six underlying subjects including: lack of data, weak awareness and inadequate education and training, insufficient support of the authorities, economic barriers, immature market and technological barriers. From this study the research areas for necessary actions for the national research units and technical universities were proposed. The necessary activity for national research units is to give the scientific and educational support to the building end of life processes basing on practical studies of the legal, technical, and economic framework taking into consideration best practical and technological solutions. Necessary elements of the effective national waste management system are presented on figure 6.

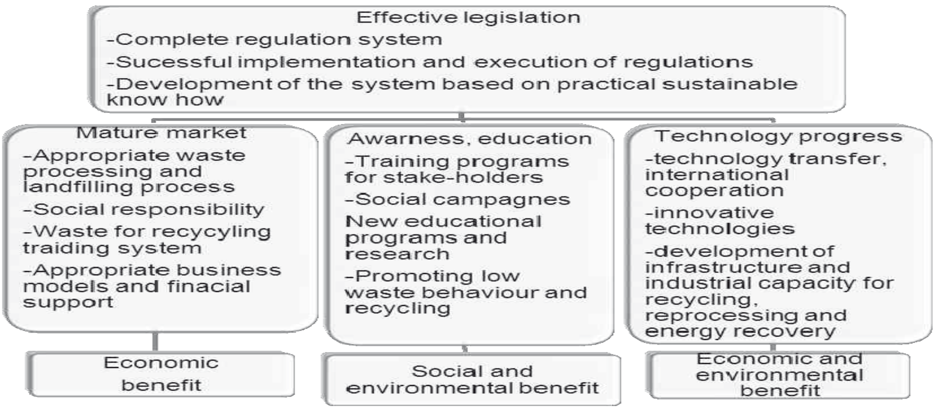

Fig. 1. Strategic elements of the effective national waste management system

2. References

[1] BERGSDAL H.I, BOHNE R., BRATTEBO H., "Dynamic Eco-Efficiency Projections for Construction and Demolition Waste Recycling Strategies at the City Level", Journal of Industrial Ecology 12(1) 2008: 52–68

[2] BANIAS G., ACHILLAS Ch., VLACHOKOSTAS "A web-based Decision Support System for the optimal management, of construction and demolition waste, Waste Management", 31 (2011) 2497–2502

[3] DE MELO A., GONCALVES A.F., MARTINS I.M., "Construction and demolition waste generation and management in Lisbon (Portugal)", Resources, Conservation and Recycling 55 (2011) 1252– 1264;

[4] HONGPING Y., ABDOL R., "A dynamic model for assessing the effects of management strategies on the reduction of construction and demolition waste", Waste Management 32 (2012) 521–531;

[5] WANG J.Y., TOURAN A., "A systems analysis tool for construction and demolition wastes management; Waste Management 24 (2004) 989–997;

[6] YUAN H., Key indicators for assessing the effectiveness of waste management in construction projects, Ecological Indicators 24 (2013) 476–484;

The Role of Local Actors in Revitalization Strategies in Shrinking Cities: Lessons from three Spanish Cases

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Abstract

Shrinkage is a current problem in many European cities. In Spain this phenomenon is mainly related cities with an industrial tradition suffering an economic and demographic crisis in the last quarter of the 20th century. While most of the Spanish cities increased their population and employment, these cities experienced a slowdown that worsened their position within the Spanish urban system. From the beginning of the eighties the three levels of Spanish administration, namely central, regional and local government, have developed different strategies to cope with this problem. However, after thirty years of public policies results are diverse: whereas some cities have reversed the shrinkage (as well as its environmental and social negative consequences) other remain declining. These results can be explained by a theoretical framework which combines the path dependence of each city and some local conditions related to revitalization strategies against urban decline (objectives, local networks, promotion of local resources, town planning).

This paper proposes study the main strategies linked to urban planning, industrial heritage recovering, local governance and quality of life conditions in three medium-size cities. The cases analyzed are located in Spain, Langreo and Avilés in Asturias (an old industrial Spanish region that suffered an adjustment process in its secondary sector in the 1970s and the 1980s of the 20th century) and Puertollano in Castilla-La Mancha (a low industrial region in which Puertollano represents the main industrial centre). The interest Langreo, Avilés and Puertollano have is due to their growing thanks to the promotion of industry to posteriorly suffer an important crisis with negative consequences in their development. However, the revitalization strategies pursued since then by both cities to face these challenges were distinct and the results have been very different local paths.

Reactivation strategies carried could be divided according to whether their aim was economic and employment promotion, seeking the creation of a competitive town; strengthening of the local system, with the aim of launching a town «with project»; promotion of innovation and entrepreneurship, or promotion of a smart city; or else improvement of life and environmental quality, in order to have a town where it was easier to live. First of all, among the strategies related to economy and employment promotion, supply of new business land was a common factor to the three cases under analysis. However, there are differences in the way in which this was brought about. Langreo exemplifies the creation of new land at a high cost (due to ground unevenness in new developments and the small area of the actions taken, which makes more expensive the projects). Puertollano, by contrast, is an example of accelerated creation of low-cost land and a too lenient business attraction policy, which is a warning against the costs of long-term investment sustainability and high resource consumption. Finally, Avilés is an example of how land creation must be followed by planning in order not to place activities of different natures, and which are sometimes hard to make compatible, side by side. In parallel, the cases have promoted new, more dynamic sectors and increased their competitive capacity. In the case of Puertollano, the renewable-energy sector, which has grown exponentially for some years, despite later deceleration, was given a boost. Another recurring issue which has arisen in Avilés, Langreo and Puertollano was serving to the largest possible extent the demands from new sectors and town trade.

As regards the strategies aimed at favouring cooperation between economic, political, and civil society agents by means of actions aimed at the improvement of urban governance, significant actions were taken to promote collective projects (grouping of municipalities for providing services, tourism community, health forum, etc.), but these projects were also greatly dependent on political circumstances to continue or go farther in their objectives. In all three cases, models related to

these premises were tried out. Involvement of new agents is still very limited, as is the continuity of the projects, which in many cases do not go beyond the first development stages or one term of office. In parallel, there are deficits in the contents of these projects, as shown both by the lack of measurement, evaluation, monitoring, and control instruments, as by some of the plans, too ambiguous or general.

Interpretation of the third group of strategies, aimed at improving economic and social innovation through the promotion of collaboration between research centres and business or business centre projects, nurseries, etc. is central in all three cases. Firstly, entrepreneurship training and business activation initiatives have been launched. Through the construction of business centres, technology centres related to the existing clusters, results have shown that the creation of infrastructures is not enough in itself, but training and research programmes must also be developed in order to see the first results, something which shows the slowness of certain change processes in long-term urban histories –paths– characterised by inertia and internal blockages, and which are highly interiorised by society.

Finally, strategies linked to improvement of urban, environmental, and quality of life conditions were really important because of the inheritance which industrialisation left to these towns – persistence of large infrastructures in urban centres, chaotic urban development and lack of services, damaged environments, and industrial ruins – was one of the main challenges which they have faced. All three cases are also characterised by implementation of urban development improvements, from façade plans to recovery of the mining-industrial structures or the creation of new green areas. Even though, fieldwork showed that some issues remained pending. Among them, the persistence of railway infrastructures in all three towns, also making the remaining industry compatible with the need for environmental improvement which has an impact on the residents' quality of life, the town image, and urban attractions.

The importance of the different local trajectories, in which the evolution of the town has conditioned later strategies and possibilities, the nature and orientation of actions, and internal evolution of the agent networks, would explain their different reactions to shrinkage.

Energy Atlas – A Strategic Tool for Urban Energy Planning

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Summary

The Objective of the Energy Atlas Berlin is the design and development of a strategic tool for transparent energy planning addressing decision makers in industry like energy suppliers and energy providers, government, administration and the public. In this paper we are showing the general approach, the functional principle of data management and processing, the means of heat demand assessment, options of multi-level aggregation hierarchies, and visualisation of results.

Keywords: Strategic tool for energy planning, virtual 3D city model, CityGML, energy efficient retrofitting, renewable energy systems, energy demand assessment, inter-domain energy analysis, integrated framework, geoinformation system

1. Introduction

The transformation of the urban infrastructure is one of the most important tasks towards sustainable, resilient urban systems. In order to initiate the transformation of urban energy systems, a general view and fundamental database about the existing infrastructure and build environment is needed. The aim of the Energy Atlas Berlin is the implementation of specific energy related data in a 3D city model such as solar energy and geothermal heat potential, energy characteristics of buildings, smart grids, traffic, and mobility patterns. This allows the assessment of different scenarios for retrofitting existing buildings and the transformation of energy infrastructure. The Energy Atlas Berlin facilitates the integration, analysis and spatial visualization of energetic and ecologically relevant information, energy requirements and consumption, energy streams and distribution, renewable energy sources and the reduction of greenhouse gas emissions. Energy Atlas Berlin is a starter project of the European Institute of Innovation and Technology (EIT) Knowledge & Innovation Community for Climate Change and Mitigation (Climate-KIC) toward resilient and low-carbon cities.

2. Technical Framework and Visualisation

The technical framework of the Energy Atlas is based on a data backbone for the storage of 3D city models conforming to the City Geography Markup Language (CityGML). CityGML is an international standard issued by the Open Geospatial Consortium (OGC) for the representation and exchange of semantic 3D city models. The structure of CityGML allows an integration of energy-related indicators on single city objects, like buildings, as well as the identification and processing of urban energy indicators on different multi-level aggregation hierarchies, e.g. administrative districts, socio-economic hierarchies and hierarchies of energy infrastructure. Each group of city objects, modelled by the *CityGML* class *CityObjectGroups*, allows for the grouping of sets of single city objects, e.g. buildings, or further groups of city objects as members. This concept provides the ability to aggregate arbitrary city objects according to user-defined criteria including the possibility of the modelling of nested grouping of arbitrary depth. Criteria for the grouping into aggregation hierarchies can be spatial, thematic, or a combination of both, e.g. grouping of all connected buildings within a specific supplier network.

The information fusion within all relevant urban structures regarding their aggregation hierarchies creates broad knowledge for energy and environmental planning which gives an integrative insight into the given energetic urban situation. Four substantial subsystems have been investigated. These systems are traffic and mobility patterns, geothermal heat potential, energy characteristics of buildings, and smart grids for power systems. The technical framework and the toolset consisting of internal or external tools for energy modelling and modes of visualisation in relation to the data backbone are shown in Fig. 1. A typical visualization of results in the 3D city model using Google Earth with information balloons for selected city objects is shown in Fig. 2.

3. Conclusion

The Atlas provides key information at a glance in matters of the potential power output, reductions in carbon dioxide emissions, and investment costs. An increasing number of cities around the world maintain 3D city models conforming to the standardized modelling language CityGML. Understanding the city as a complex energy system, Energy Atlas Berlin becomes a test bed for conceptual design of a framework concerning holistic energy planning and simulations, based on a virtual 3D city model and allows easy adoption of the same concepts in different cities.

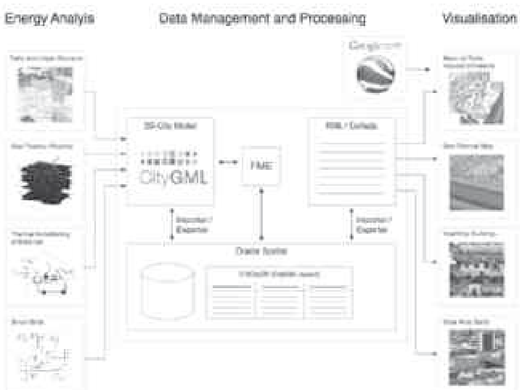

Fig. 1: Technical Framework and Toolset

Fig. 2: 3D Visualisation of the results

Municipalities as First Movers for Promoting Low Energy Buildings – Local Planning Experiences from the CLASS1 EU Concerto Project

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Summary

Improvement of the energy performance of buildings represents an important focus area in Europe, since there is a need to reduce the heat loss from building envelopes and implementing a greater share of renewable energy. One of the major policy responses from the European Commission has been to set up the Energy Performance of Building Directive in European legislation. Although this type of regulation provides an important push towards improved building standards in Europe, it has certain limitations in terms of preparing the ground for a more fundamental break with the inertia that still exists in the building sector with regards to improvement in the energy performance of buildings.

Traditional energy policy responses to lack of diffusion of technologies often rely on a too simplistic view of technology transfer, where emphasis is put on removing single 'barriers' to technology take-up (Shove 1998). It is therefore argued that policy makers often fail to recognise that technical transfer represents a contextual, localised and temporally specific process, which is often governed by non-linear processes, rather than rational and goal-oriented processes (Geels 2005). This points towards a need to reframe policy initiatives in order to take the complexity of dissemination of energy efficient technologies in practice into account; acknowledging that singular instruments are seldom sufficient to boost a wider transition in building practices, since no simple cause or driver for change exists (Elle et al. 2002; Geels 2005).

The aim of this paper is to explore the conditions that urban governments have for proactively promoting low energy buildings at the local scale. These conditions are explored by looking into the use of municipal planning systems to enforce higher energy efficiency standards as a potential form of experimentation in transition processes. In doing that urban governments are pointed out as proactive agents of change at the local level; demonstrating potential transformative power with regards to climate change processes. Through a review of five case studies of municipal initiatives to promote more energy efficient buildings from different countries in Europe, the paper provides insight into how proactive urban governments engage with and navigate within different prevailing planning and regulation frameworks to promote low energy buildings.

The study in this paper is based on the work carried out in the EU Concerto Class 1 project, where one aim has been to look into how energy efficient buildings have been deliberately promoted

among the five participating municipalities in the project (in Denmark, Italy, Estonia, Romania and France). The study is based on a case-oriented review on proactive municipal attempts to promote energy efficient buildings through their planning practices. The case-oriented approach does not aim at providing a state-of-the-art analysis of the planning and regulation systems in Europe, but at providing a more contextual understanding of the preconditions that municipalities experience, when trying to promote energy efficient settlements. The cases were strategically selected so that these represent flagships for the involved municipalities in terms of promoting energy efficient buildings.

The study shows that although important instruments exist in the planning and regulation frameworks in Europe these are not always applicable for proactive municipalities that wish to more radically promote energy efficiency in local building projects. In most of the studied cases, the building regulation represents an important instrument with a high degree of legislative power. However, in several of the case studies, the building regulation is defined at the national level, which leaves the municipalities without local influence. Another important instrument is the detailed plan, which provide a great degree of freedom for the municipalities in most of the case studies. However, in several of the cases, the detailed plan does not have any legal impact, which play down its transformative powers. In most of the cases, the municipalities applied instruments that were not directly intended for planning purposes. For example, the planners in the Danish case had to apply easements as a way for the municipality to define their own energy efficiency requirements with a legal impact. In both Estonia and Italy, municipalities already have this ability, because they have the authority to define building regulation in local building projects.

The conclusion is that the reviewed case studies demonstrate that municipalities have a strong position to operationalise strategies of energy efficient buildings, and a willing to do so. However, the municipalities lack support from prevailing planning and regulation frameworks due to lack of authority and legislative impact of the available instruments. In spite of this lack of support from the planning and regulation framework, municipalities show that they are capable of implementing energy efficient technologies in local building projects through alternative means. This illustrates that the current planning and regulation framework fails to encompass the variety of strategies for promoting energy efficiency that municipalities have at their disposal. Municipalities fill out a number of different roles, where they are able to promote energy efficient technologies in different ways, e.g. being planning authority, property owner, developer or approving authority. Each of these local processes provides different conditions – and possibilities – to promote energy efficiency in the built environment, and in each case different instruments may be combined in order to fulfil the targets.

Keywords: Local planning, building regulation, energy efficiency, experiment, innovation

Green Infrastructure – Demands, Opportunities and Constraints of Green Space Development for Future Urban Development

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Summary

The impacts of climate change, the growing perception of public health and wellbeing in relation to demographic change, the discussion about environmental justice and the increased relevance of environmental aspects for competitive cities and urban regions mean important challenges for urban development. Green infrastructure in terms of the manifold elements of urban vegetation, green spaces, and urban ecosystems provides diverse benefits and services to meet these challenges.

Are these growing demands for urban green infrastructure accompanied with appropriate or even new planning approaches at different scales of implementation? It will be shown, (1) that there is a differentiated debate about urban form and the role green spaces have in there and (2) that various planning approaches are made to strengthen urban green infrastructure within urban development. The results presented here are based on a ground-financed project “Green City Lab”, investigating urban strategies focusing on green infrastructure according to a theoretical framework and case studies. Additionally some findings from the project REGKLAM are involved (Development of an integrated regional programme for climate change adaptation in the region of Dresden, funded as part of the KLIMZUG initiative by the German Federal Ministry of Education and Research).

The discussion on sustainable urban form, often focused on compact cities will be reflected in the light of shrinking cities, redevelopment opportunities of brownfields and upcoming approaches to understand green spaces as a strategic and guiding principle of urban development. Against the background of some notes to the theoretical discussion regarding the role of green spaces and green infrastructure in the current debate on urban form the contribution will discuss innovative approaches to implement green infrastructure on different scales. Starting with urban concepts guided by green space, new types of urban green spaces as urban forests and urban agriculture will be presented according to their opportunities, but also constraints as part of a sustainable urban development.

Keywords:

climate change, urban form, urban biodiversity, green space planning, green space types

1. Introduction

Benefits as for example the regulation of micro- and bioclimate to tackle heatwaves, the support in dealing with storm water and flooding, and the provision of areas for active and passive recreation as part of healthy lifestyles make green infrastructure a crucial element of sustainable urban development. Green infrastructure planning is an evolving field of action within urban development. The opportunities to protect and implement green infrastructure within the manifold, sometimes also competing, demands of urban development as well as the strategies and planning approaches integrating green space demands vary in different urban contexts.

2. Urban form and green spaces – theoretical background and current trends

The opportunities to implement both a green infrastructure strategy and to provide green infrastructure elements are dependent on the spatial framework of each city. Besides topographic and historical structures urban form is influenced by overall concepts, reacting to particular drivers of land use changes. Approaches to apply urban structures, which are more focused on green and open spaces, have a strong history within the debate on urban form. Two trends are obvious: On the one hand there is a vital claim but also critical discussion on the sustainability of the compact city. On the other a number of theoretical, but also practical approaches are emerging, which assign importance to urban green infrastructure, both to benefit urban life and to design urban structures. In view of the currently evolving challenges in urban development, new dynamics can be seen within this debate to a certain extent.

3. Conclusions

In anticipation of successful answers to upcoming challenges, green spaces provide various solutions and benefits. These increasing and differentiated demands of green space development leads both to new approaches at overall strategic levels and at smaller scales. There is evidence for growing interests and integration of green infrastructure issues into urban concepts and planning processes. The expectations as well as opportunities for green space development seem as high as never before. But there are various challenges for the implementation of the goals.

Efficient green infrastructure has to be implemented at all scales of the urban area. The establishment of a green network at the regional and city scale requires strategic concepts and legal bindings to protect and expand the urban-regional green spaces system. Despite opposite frameworks due to growth and shrinkage, the answers to the demands of green infrastructure implementation show similarities. The idea of a sort of fragmented urban area combined with a green space network meets different challenges both of urban and green space development. The demand to be compact as well as green seems to be addressed and actually solved by urban concepts. Additionally the whole variety of green space types has to be considered to build a multifunctional, efficient, attractive and flexible green space inventory. Besides, new ways according to responsibilities and funding have to be applied. By strengthening the awareness of synergies and benefits, political and economic support may be enhanced.

Transition of Energy Systems in Small and Medium Sized Communities

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Extended Summary

Communities play an important role in the planning, management and realisation of long-term energy transition processes. The transition of energy systems towards more sustainable and secure energy supply solutions has to be solved on local and regional level. Next to the challenges we face in large agglomeration areas the potentials of the countless small and medium sized communities have to be used to achieve the overall targets. In the highly urbanized countries of central Europe the majority of inhabitants live in towns and communities smaller than 100,000 inhabitants.

The communal stakeholders are an important link between political ambitions and the practical needs of local economy and residents. The paper follows the hypothesis that only if these stakeholders realise the chances of an increased use of local energy resources and efficiency potentials a broad energy transition will become feasible. The necessary steps from creating a political vision towards renewable and sustainable energy supply to the implementation of effective measures for a long-term system change are not a defined agenda and can be approached from different angles. Being mostly laymen in energy issues, there is support and strategic development needed to support and enable ambitious projects in this sector.

There are numerous interesting projects and case studies worldwide that address different aspects of energy efficiency and renewable energies. The scales of the projects range from several buildings or single renewable energy plants over integrative settlement or quarter projects all the way to large scale interregional energy cooperation. From the large number of innovative projects, three examples shall be described here in a little more detail to draw some conclusions for the specific demands and challenges found in small and medium sized community settings compared to larger cities: these are the community of Tilburg in the Netherlands, the island of Samsø in Denmark and the community of Wolfhagen in Germany. The selected examples show various similarities. First of all they have approximately the same spatial dimension but very different numbers of inhabitants. This leads to different demands and challenges for the implementation of energy transition processes.

In all three case studies it becomes clear that technology is only one aspect when talking about transition processes in small and medium sized communities and cities. The energy potentials in renewable energies can usually be identified by structural and statistical analysis. The same applies with some approximations for the demand side and efficiency measures. Since energy efficiency and energy production is not a traditional core task in urban planning and development and has little tradition in planning theory and methodology, the question of whether after the strategic plan-making an implementation and a vital transition process will follow, cannot be projected solely from energy potential analysis.

In all cases, small and large communities, personal initiative and interest play an important role at the beginning to trigger the process. A specific characteristic of the small and medium sized communities of Samsø and Wolfhagen is the very direct and personal contact between the project participants and community administration and the local population. People know each other, distances are short and informal. This bears both potential and risk: if the project initiators loose the trust and support of the local population, this usually means the end of the project. There is no way to enforce local energy projects against the will of the local population. The question ‘What’s in it for me?’ has to be answered directly and in an understandable and face-to-face manner. Residents of small and medium sized rural communities tend to show rather conservative behaviour. Risky and highly innovative projects are more likely to find supporters in a city context.

Consequently in small and medium sized communities, the addressed goals and targets in public communication have to be much more on ‘How shall our village develop in the future?’ rather than on Climate Change and CO_2-reduction, which as a rather academic and moral motivation, as well matches the interests of urban citizens. The experiences in the case studies show well-working examples and outstanding project success. The implementation of energy transition strategies demands a structured and targeted anchor in administrative structures and continuous man-power in the process. While in larger cities, as the example of Tilburg shows, the implementation of a continuous coordination office can profit from a larger number of potential users, contributions from industry and trade, the success in small and medium sized community founds to a large extent on the short and uncomplicated communication between public and administrative actors. Open communication platforms, future labs and participatory workshops enable locals to become part and identify with the targets and find their personal financial or social benefit.

To support a long-term transition process, the strategy must be anchored as permanent task in the administrative structures and political development agendas. This way a continuous discussion process can be kept lively and productive.

Demand Side Management in Non-Residential Buildings

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Summary

Smart Buildings are able to adjust the current electric consumption to the fluctuating power production of renewable energies. Siemens Building Technologies and the Technische Universität München are developing innovative systems to introduce demand side management in non-residential buildings. An existing office building was modelled with a dynamic thermal simulation to analyse the load management potential in buildings' heating, ventilation, and air conditioning (HVAC) systems. Based on the thermal behaviour predicted by this building model, economic optimisation software was developed to better match changing electricity prices of fluctuating energy production.

Keywords: Demand Side Management; Smart Building; Smart Grid; Innovative control strategies; Renewable power supply;

1. Introduction

The increasing share of fluctuating electricity production from renewable energies can result in temporary negative residual loads. This is forcing a paradigm shift to turn the current consumption-based power supply concept into a more intelligent power supply network. An important feature of these emerging Smart Grids is their ability to adjust the demand side to better match the instantaneous power production. Siemens Building Technologies and the Technische Universität München (department of building climatology and building services, Prof. Dr.-Ing. Dr. h.c. Gerhard Hausladen, together with the department of energy economy and application technology, Prof. Dr. rer. nat. Thomas Hamacher) are developing innovative systems to introduce demand side management (DSM) in non-residential buildings.

2. Thermal building simulation

The basic requirement for analysing load management potential without compromising human comfort is to predict the thermal behaviour of the chosen building. For this study a modern Siemens office building was modelled in a dynamic thermal simulation with TRNSYS17.

The simulated heat demand was validated with measured energy data from heat meters for the years 2011 and 2012. The total energy demand of the simulation model is 9.6% less than the measured values from the last two years. With a time step resolution of less than 5 minutes and the validation at hand the TRNSYS model is suitable for analysing the DSM potential in the examined office building.

3. Optimisation of HVAC Schedules

The next step to managing the demand side is to calculate an optimised schedule for electric load. The simulated HVAC system can be controlled via interface to LabVIEW and can shift peak loads and large electricity consumers to times with low energy prices. The algorithm that was developed takes into consideration the predicted power price development as well as the local weather forecast. It further ensures that all thermal comfort requirements are met. In a second step, the optimisation algorithm is extended to include adaptive building models that are capable of learning the thermal behaviour of the building with the help of neuronal networks.

4. Conclusion and outlook: model predictive control

The basic requirement for analysing load management potential of a certain building is to measure and predict its thermal behaviour through detailed dynamic simulations. Flexibility in building models can be achieved by using model predictive control (MPC) with optimised scheduling for the HVAC systems. Two approaches for self-adapting models (a neural network and a system of differential equations derived from building physics) were developed to be used in model predictive control to forecast the building's thermal behaviour [1].

Previous studies in the building typologies: schools, hospitals, and office and administrative buildings, have shown potential for load management strategies in non-residential buildings [2].
The Siemens Building Technologies and Technische Universität München cooperation's goal is ambitious: to use innovative control strategies for demand side management to turn buildings, new construction, and existing building stock, into intelligent Smart Grid participants.

5. References

[1] D. Attabay, S. Herzog, F. Sänger, J. Jungwirth and V. Mikulovic, „Self-Adapting Building Models and Optimized HVAC Scheduling for Demand Side Management," CIRED 2013, Stockholm, 2013.

[2] L. von Mandach, T. Rössel and J. Jungwirth, „Potential of demand side management in nonresidential buildings," CIRED, 21th international Conference on electricity distribution, 2011.

Appreciated Living: Future-Oriented and Sustainable Refurbishing of Buildings and Districts

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Summary

In our region, which consists of three larger cities, smaller towns and a countryside with a lot of small villages, a few initiatives for climate protection have been established. In cooperation, the associations for public housing refurbished some old buildings; the state of repair necessitated the modification and by implementing a number of measures energy efficiency has been achieved. In the new building sector, a few outstanding projects were built to a passive house standard and using renewable energy (including in larger buildings).
In conversion areas, mostly using private investments, the old buildings were refurbished to a standard which undercut the statutory provisions for new buildings (e.g. EnEV 2007, 2009) by more than 50% or 30%, with a focus on CO_2-neutral supplies for heating, warm water and cooling.

Keywords: conversion, district development, plus-energy building, demographic change, developing user-friendly and damage free interior insulation

1. Introduction

However, reaching the private owners of old, single-family homes or small condominium houses is still a major problem. The amortisation of renovation costs occurs too late for this group of owners . This is a result of the demographic situation. Most of the owners are over 65 years old.

On the other hand, in new development areas, including in small towns, the municipalities demand that building is to minimum passive-house standards. Most young people, who build their homes single-handedly, invest in renewable sources for heating and electricity and, of course, in a minimum consumption of energy.

But many building promoters are still selling underperforming condominium houses with cheaper flats. With larger condominium parties, there will be no chance to make improvements within the next two or three generations. The debit is subsequently simply too much for the owners.

Consulting should focus on persuading the responsible persons and the buyers of these flats to implement measures to provide for subsequent cheaper adaptations. In the building sector, particularly in the area of refurbishing old building stocks, from our point of view, we are not moving as quickly as we should be. Different incentives and statutory provisions should be combined. Residents' companies or registered cooperative societies in the building and energy sectors may help to solve this problem.

2. Conclusion

There are a lot of good examples but it will be nessecary to implement a low carbon housing in short and medium terms.
The WBGU - German Advisory Council on Global Change published a flagship report called: “World in Transition – a Social Contract for Sustainability”

“In this report, the WBGU explains the reasons for the desperate need for a post-fossil economic strategy, yet it also concludes that the transition to sustainability is achievable, and presents ten concrete packages of measures to accelerate the imperative restructuring. If the transformation really is to succeed, we have to enter into a social contract for innovation, in the form of a new kind of discourse between governments and citizens, both within and beyond the boundaries of the nation state.” [3]

Strategies for Climate Neutrality in the Building Sector till 2050

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Summary – Extended Abstract

To reach the global aims of climate protection the European Union has to reduce CO2-emissions by 80 to 95 percent till 2050. In the building sector it is possible to realize plus energy balances with market-driven techniques in an economic way. We can do this for single buildings and also for urban structures in opposite to other sectors like traffic and industry. What developments have to be done concerning building envelope and technique for heating, domestic hot water and ventilation, for renewable energies, for urban and regional climate protection concepts to achieve climate neutrality in the building sector?

The components will be analysed and examples for solutions will be given, how to succeed in this important question. The target is to consider building culture and heritage aspects as well as economical, ecological and social aspects.

High efficient components for the building envelope have been introduced successful into the market within the last ten to twenty years. They are available as high quality architectural solutions and mostly high interesting concerning the economic view. In most cases the additional invest for the constructions of wall, roof and ceilings relating to the normal standard will be 10 to 15 € per m² construction surface. And there will be the advantage, that you will have a solution for 40 years and will not have another improvement after 15 years. Constructions with heritage aspects of course may need additional invests.

In the sector of **building services engineering** we will have paradigm change. When a high efficient three room flat even in cold winter can be heated by ten tea candles, this very low heat load can be solved by very lean techniques. Over this the energy demand for heating, domestic hot water and household is rising to almost the same level. So new synergetic engineering solutions will be possible, which can be much more cost-efficient than standard systems. We have to add plus energy components as integrated solutions into the technique system of the buildings – and of course they have to be integrated in the architectural design.

As **examples in the plus energy standard** an one family building in Erlangen will be presented with its details and a multy family building in Bad Aibling. The basis system is passivehouse technology together with renewable energies for heating and PV-panels for the production of electricity. Further examples are the concepts for plus energy refurbishment of a school, a town hall and a monastery.

Urban plus energy concepts will be presented for park-condominium Nuremberg-West with 1030 flats and Wohnpark Strubergasse in Salzburg with 500 flats.

A **research project for urban energetic refurbishment** with broad effect was realized with promotion by DBU. Eight large urban quarters owned by different companies in whole Germany were processed together with the GdW. The technical solutions were optimized on basis of Passivehouse technology. The additional invest for the high efficient standards related to normal refurbishment could be limited by 60 to 120 € per m² living space. The KfW promotion programme Effi-

zienhaus 55 led to economical solutions under the condition of optimized planning. The energetic-dominated promotion programme should be added by programs for regional specific situations.

Communal climate protection concepts are shown by examples of Neumarkt i. d. Opf. and the city of Nuremberg. The potentials for efficiency and renewable energies were evaluated and strategies for the Energiewende / Energy Turn were shown how to achieve climate neutrality.

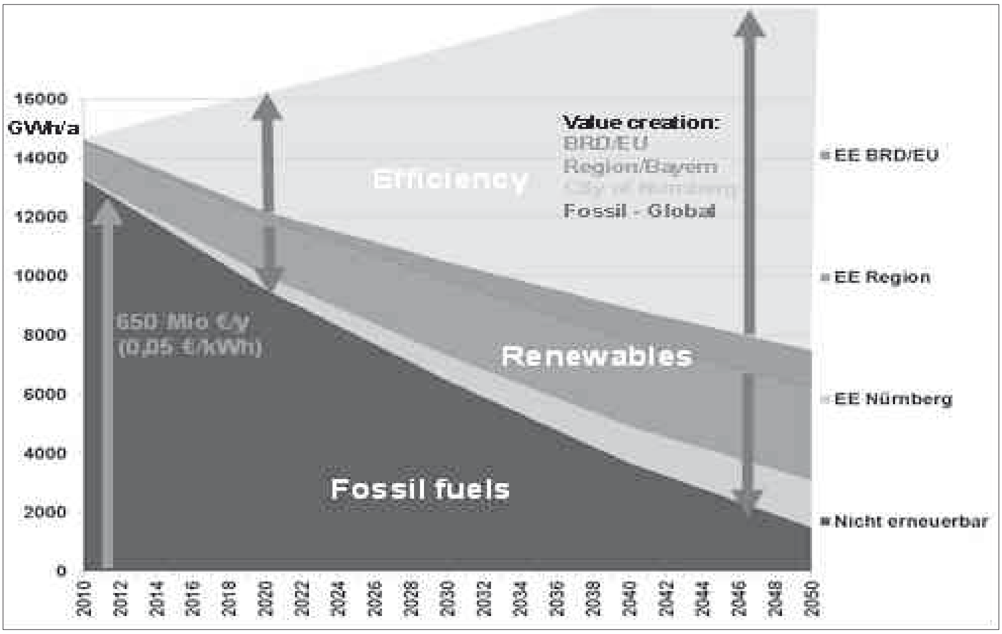

Figure 1 Energy Strategy Nuremberg 2050 – Climate Protection Scenario:Communal and Regional Value Creation

Energiewende / Energy turn & Building culture: It is possible to achieve climate neutrality by actual market-driven components and techniques. Energetic refurbishment is not only a great chance for the development of the building stock, but can also catalyse the demands of Building culture and social-urban qualities.

Keywords: climate neutrality, high efficient refurbishment of buildings, Passivehouse, Plus energy standard, climate protection

Analysis of Zoning Strategies of Dynamic Thermal Simulations on an Existing Structure

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Summary

In building energy analysis software, simplified model is required for the realization of thermal and other analysis. Thermal zoning is challenging issue for the thermal analysis of existing buildings on the basis of modelling drawbacks. In this paper, considering the aforementioned issue of thermal zonings, 3- storey school building in Mombasa, Kenya is modelled with 6 different zoning strategies to analyse different approaches and their outcomes. According to thermal analysis of each case, temperature variations of different indoor environment of building are compared according to the detailed zoning alternative in order to present the efficiency of zoning strategies in Ecotect for different climatic design days of Mombasa, Kenya.

Keywords: Ecotect, Zoning strategy, Thermal Analysis, Mombasa

1. Introduction

Autodesk Ecotect Analysis 2011 has some limitations on analysis but it is distinguished from other energy analysis programs, as being a user-friendly program with its highly efficient architectural visual analysis tools including thermal, energy, lighting, shading, acoustic, and cost calculations [2]. Thermal zoning is a challenging issue for the thermal analysis of existing buildings on the basis of simplification and real-like modelling. Each thermal zone can be modelled separately however the zones which have similar heat flux might be accepted as combined zone in Ecotect. In this paper, considering the aforementioned issue of thermal zonings, 3-storey school building in Mombasa, Kenya is modelled with six different zoning strategies to analyse different approaches and their outcomes. According to thermal analysis of each case, temperature variations of different indoor environment of building are compared taking reference to the detailed zoning alternative in order to present the efficiency of zoning strategies in Ecotect.

2. Results

A zone with same thermal, volumetric and architectural properties are introduced to each alternative as a reference zone for thermal analysis which would give thermal behaviour of a single zone in the whole system and the impacts of detailing level of zoning approaches on the single zone. Reference zone and temperature variations with respect to different strategies are analysed considering five design days. According to data obtained via the programme temperature differences between reference zone of Alt 5 and that of other alternatives are very low for both daily and operation hour averages in each specific day. Inside temperature of the east part of second storey of case study analysed for highest temperature (average) day of year, 19 March, with six alternatives. Introduction of particular zones based on orientation of spaces, number and activity of occupants and architectural planning enable users to get more detailed values peculiar to separate zones. The behaviour of zones does not change dramatically with partition walls and doors. However, temperature values vary 7 °C between the coldest and hottest zone of Alt 5, whereas single temperature value has been obtained for Alt 1 and 2 for aforementioned part of building.

3. Conclusion

In this paper, various zoning combinations and their influences on a single zone and part of building have been studied with the case study, school building, from Mombasa, Kenya. Climate data of case study for five design days have been analysed for six different zoning alternatives.. Then thermal analysis results of the others are to compare with the findings of Alt 5 selected as reference zoning since all rooms and spaces are defined as separate zones. Moreover, single thermal zone for an office room in the second storey is remained for all alternatives in order to compare the temperature values due to different strategies on this space.

According to the results, there are slight temperature variations when reference zone for different zoning strategies are examined. Zoning strategies show its importance when larger space such a part, storey or addition of building is needed to be sought. When large space is treated entirely as one single zone, one single average value is acquired, however the detailed approaches considering existing architectural plans thus various thermal zones give more specific values. Simplification of zoning is useful for the analysis of single zone in order to use time efficiently. The differences between Alt 5 and the others are in the accepted limits; therefore simpler zoning strategy not only gives consistent outcome but also helps the users to save time.

Energy Development Planning

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Summary

The “energy development plan” or “energy use plan” has been evolved by the Department of Building Climatology and Building Services, Prof. Dr.-Ing. Dr. h.c. Gerhard Hausladen, at Technische Universität München, in order to provide municipalities, respectively cities, with a spatial planning tool in the field of energy. The major findings are documented in a “Guideline Energy Development Plan” [1], which has been published by the Bavarian State Ministries and is applicable to all municipalities.

Keywords: energy development plan, energy use plan, energy saving, energy efficiency, renewable energies, energy concepts, spatial planning

1 Introduction

Due to climate change, the limited resource of fossil fuels, and rising energy prices, there are a growing number of visions and specific goals for energy conservation and supply, as well as for the reduction of greenhouse gas emissions, formulated on the municipal or regional level. However, in many cases, there is a lack of overriding energy concepts in order to achieve the formulated objectives. Based on a municipal or regional energy use plan, single measures in terms of energy saving, energy efficiency and renewable energies can specifically be developed and harmonized among one another.

2 Description of approach

2.1 Survey and potential analysis

The fundament of an energy use plan is an individually tailored survey and analysis of potential, whose results provide a detailed energy profile of the particular site. Within the analysis of the existing energy demand, heat plays an important role as it is the kind of energy which can especially be dealt with on the municipal scale. When analysing the structure of heat demand, the creation of spatially differentiated heat demand maps is of major importance. Such maps show, in which parts of the community the “density” of heat demand is particularly high, which allows to evaluate the feasibility of district heating networks.

Additionally to a mere local scale, electricity also has to be considered and analysed on a nationwide or even international level in order to deal with the constantly increasing degree of fluctuating electricity production in Germany.

Besides the analysis of the energy demand, also the existing energy infrastructure is investigated and illustrated when setting the basis for an energy development plan. Therefore, all existing plants are taken into account, larger ones as well as those installed in individual homes, if possible. Furthermore, the natural gas networks and existing district heating systems are recorded, including technical data.

The variety and extent of locally available renewable energies strongly depends on the structure of a municipality, e.g. the fraction of forest or agricultural area. Generally, all kinds of renewable energies as well as sources of waste heat have to be analysed, also regarding their quantitative and temporal availability and in the case of heat sources, their temperature level.

2.2 Concept development and energy use plan

Based on the comprehensive results of the stocktaking process, individually tailored sustainable energy concepts can be developed for a municipality, taking into account energy saving and energy efficiency. When evolving new supply concepts, the locally available energy potentials should be prioritised according to their primary energy factors, respectively their global warming potential. To accompany concept development, aspects of urban planning, such as location, size and type of development area, or planned or possible measures of re-densification are also taken account of.

3 Conclusion

The need for and the benefit of new planning instruments and levels in the field of energy was proved within the different research projects which have been conducted at the department during the last years. It has also been concluded, which aspects of energy planning should be dealt with on which level and when it is most necessary to cooperate inter-communally. However, there is still need to develop methods, how municipal energy concepts can successfully be integrated into concepts on a regional and national level, especially considering electricity supply and distribution.

References

[1] HAUSLADEN G., WAGNER T., BONNET C., SCHMID T., et al., „Leitfaden Energienutzungsplan“, Munich, 2011.

3. Design, Architecture and Education

A Case Study of Retrofitting a Non-Domestic Building in Scotland

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Summary

Enhancing the energy performance of buildings is a complex undertaking which involves the implementation of various measures which can include: insulation using innovative technologies in-particular for hard-to-treat buildings (e.g. historic listed buildings), installation of small scale renewable technologies, such as PV solar, solar thermal, wind-turbines…etc, and altering end-users behaviours to reduce energy consumption.This paper presents a case study of a non-domestic building (Further Education –FE- College) in Edinburgh. The paper reports on the progress to-date for the energy refurbishment of the building which is focused on investment in renewable energy technologies. Phase one, which is now completed, involved the installation of a 50 kWp PV panels on the roof, whereas possible plans for phase two, such as Combined Heat and Power (CHP) plant and Fuel Cells, are discussed. The benefits accrued from investment in renewable technologies can include: potential energy savings, research and educational, and income generation. Drawing on this project experience, the following issues should be considered when investing in renewable technologies in the future: funding schemes and ROI, technology selection and integration, skills and training, and stakeholder engagement.

A shortcoming of small-scale renewable technologies is the provision of intermittent supply which poses a risk for maintaining security of energy supply. As such, it has to be used in combination of energy storage mechanisms such as hydrogen storage and fuel cells, which has the potential for providing an alternative to costly investments in large polluting central power plants whilst improving power quality, supply flexibility, maintaining system stability, reducing transmission and distribution losses and costs. Finally, rigorous evaluations of different interventions for enhancing the energy performance of buildings should be carried-out in the context of different buildings types. Such evaluations should provide indispensible case studies to establish the efficacy of these technologies in-practice.

Keywords: Retrofitting; PV units; Energy performance; and Buildings.

Toward Nearly Zero-Energy Building - Example from Montenegro

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Summary

According to the Directive 2010/31/EU on the Energy performance of buildings, one of the goal of this Directive is „to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings”.
In Montenegro there are currently no policies to stimulate this transformation. An this moment there are few buildings which can be classified to energy efficient in Montenegro.
One of is a house of the Adzic family, which is located in downtown Niksic, and it is a first new construction facility in Montenegro that can also be classified as an environmental and energy-efficient building.

1. Introduction

In accordance with general tendencies towards improving energy efficiency in buildings, albeit with some delay in comparison with most countries in European Union, Montenegro undertook concrete measures by enacting the Law on energy efficiency in 2011 . Meanwhile drafting proces contains only few regulations.
The family house Adzic, which is located in downtown Nikšić, is a first new constructed facility in Montenegro that can also be classified as an environmental and energy-efficient building. The Adzic house is designed in 2003, and finished in 2008.
Primary concept was based on the design of energy efficient and environemental friendly house.
In the 2003 year it was a very new and relatively unknown concept in the architectural design in Montenegro.
Now the Adzic house is an experimental and also ademonstrative example in terms of energy efficiency in Montenegro.
But given the lack of knowledge about energy efficiency in 2003 year this house based on the energy required for heating per m² belongs to the class C power. Total energy demand for Family house Adzic is 131,0 kWh/m^2, of useful floor area.
In this paper several technical measures will be represented that will enable transformation of this house to nearly zero-energy building.
Methodology will be based on an analysis of existing energy losses and recovery thereof to a nearly zero-energy building standard.

2. Results

In this paper, for the purpose of this analysis, in order to increase the energy efficiency three measures are selected:
1. Improving thermal insulation of envelope of house;
2. Application of heat pump;
3. Application of PV panels.

After analysis it is shown that for the Family house Adzic all these measures together could lead to a reduced energy requirement for heating up to the level of zero energy and also to the level of zero carbon. It is a theoretically possible, but there are several limitations.
In the example of improving thermal insulation of the house envelope it is important to do a cost-benefit analysis, and define technical solutions for reconstruction the existing envelope.
Heat pump is the best solution, with large potential of energy savings, and it is very easy to install. In the example of the Family house Adzic the ability to use well water is a great advantage that causes a high factor of utillization of heat pump.
Production of electricity from PV panels is a useful addition, but at this point in Montenegro there are obstacles in the law and technical conditions.
In this paper cost analysis was not performed, but it is necessary in any real solution.

3. Conclusion

The family house Adzic iz one brave attempt to project an energy-efficient home in circumstances where, even after ten years there is no clear legal framework in this area. Classification C, indicates that the project meets the current standards.
During analysis of the energy potential of the building with the use of heat pumps, PV panels and improving characteristics can be obtained even greater savings and reduce CO_2 emission as the primary goal.
Implementing the goals of the Directive of the Energy performance of buildings is a big challenge, especially in countries that have not yet joined the EU.
At the first step it is very important to have a consistent definition, which should contribute at the same time to both energy and CO_2 emission reductions. Hence, the minimum requirements for the energy performance of the building should use an energy indicator that can properly reflect both energy and CO_2 emissions of the building as the reduced energy consumption should lead to a proportional reduction of CO_2 emissions.
Without Law legislation the application of the principles of energy efficiency is difficult to achieve.

Can you Produce a Higher Quality of Construction with less Cost and Greater Speed through Prefabrication?

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Summary

Increasing global population growth and rising urban migration rates are indicators of a continuous increasing demand for housing. To reduce the associated land use as much as possible, higher building densities and compact building structures are essential. This paper describes how current construction techniques of the building industry must undergo a rapid change. Ecologically and economically optimized workflows along with applications of high performance technologies are relevant to meet the requirements of future buildings and their emergence.

Keywords: Serial Manufacturing Processes; Modular Building Design; Integrative Building Components; Off-Site Manufacture and Construction; Ecological and Economical Optimisation of Building Construction Processes

Abstract

Examining methods of the prefab-building industry, the paper conveys and highlights key-aspects of production and manufacturing the building- and comparable industries. Based on serial manufacturing and automated processes, operations are categorized and assessed for transfer analogies. Outlining applicable transfer knowledge, the relevance of a change for the building and construction sector becomes apparent. Current methods of manufacture have to turn into integrative workflows creating functional coherences, which are significant for a holistic building assessment. Predominantly, the first stages of the design concept require already the buildings' integration of functions as well as the versatile usage of part. Used materials designed as integrated components following smart assembly and disassembly strategies are being researched and valued regarding their ecological and economical implementation. The paper concludes with presenting applicable methods of construction for multi-story buildings based on serial processes and high performance technologies with minimal limitations of the overall design flexibility.

To meet the requirements of future buildings and their emergence, current production techniques in the building industry must allow for the application of high performance technologies and qualitatively and quantitatively optimized processes. Designed as integrated components following smart assembly and disassembly strategies, used materials need to be examined regarding their embodied energy and sustainable, resource efficient aspects. The essence of progressive work processes is to unify these materials, standardize interfaces and as a result, simplify building technologies.
Through prefabrication, building components achieve ultimate precision and completion qualities. Controlled manufacturing processes support the coordination of joints and connections on site and reduce non-standardized interfaces. In addition, optimised construction and assembly strategies

generate a transparent cost and time management. Compared to conventional construction methods, cost efficient delays are omitted and a more rapid and smooth building process takes place.
In building construction, the prefabrication industry denies leadership in the segment of prefabricated housing and off-site construction processes. Current technologies are analyzed regarding optimised material use and efficient manufacturing processes and transferred for applicability in multi-storey building structures.
In addition to an analysis of manufacturing processes of the prefab-building industry, methods of production of alternative industries are relevant to rethink and progress in the future buidling segment. Based on serial manufacturing in automotive and automated processes of the shipbuilding sector, operations are categorized and assessed for transfer analogies. Within global sizing and measuring standards, their module- and component design is based on highly efficient techniques for a large variety of very complex products.

On this basis, possible solutions for multi-story building structures and their production processes are presented. Characterized by their high degree of prefabrication, solutions and techniques for future construction processes need to provide maximum design flexibility, taking logistic and transport-related dependencies into account.

Fig. 1: On-Site Assembly and Installation Processes at T30A Tower Hotel, BSB Sustainable Building

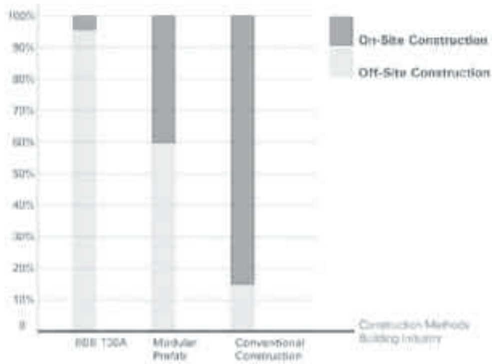

Fig. 2: Average Amount of On- and Off-Site Processes according to Construction Technique

Potential of Lighting Retrofit for Energy Saving in Existing Institutional Buildings

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Summary

This study projects electricity savings, cost-benefit analysis and illuminance distribution of lighting retrofits in existing institutional building. The cost-benefit is determined as a function of energy savings due to retrofit of more efficient lighting system. The energy savings were calculated based on 79% of potential retrofits of inefficient lighting in an institutional building. The results indicate that total energy consumption will decrease around 10-11% over a year. The return in retrofitting cost is at 2.56 years payback period. From the analysis, it can be concluded that using energy efficient lighting system could save a significant amount of energy and cost. Therefore, proper daylighting design recommendation is needed for greater energy saving and visual comfort in Malaysian institutional buildings while the sufficient quality of daylight is available for free.

KEYWORDS: Lighting retrofit, Energy saving, Payback, Institutional building

1. Introduction

In Malaysia, lighting is the second electric power consumption after air conditioning. The electricity demand will increase by 4.7 percent per year to reach 274TWh in 2030, thereby making Malaysia a net energy importer in the next two decades. Net import dependency will increase from minus 57 percent in 2002 to 32 percent in 2030. Lighting retrofit, which is the replacement of inefficient lighting with the efficient one, is an efficient way to save energy and cost in existing buildings. Electricity savings over time is significant enough to not only pay for the new lighting, but also produce return on the investment. Despite all research in the area, a few have been conducted on various aspects of energy conservation and management in various sectors of energy consumption in Malaysia. These studies specifically deal with projected electricity savings and cost-benefit analysis of lighting retrofit in residential sectors.

Present study attempts to calculate potential electricity savings, cost-benefit analysis and illuminance distribution of lighting retrofit in an institutional building in Malaysia. After assessing the existing situation, recommendations are made for further improvement of the available systems and implementation of new programs.

4. Results

The calculation results for energy consumption, potential energy saving, bill savings and payback period is presented in this section. The calculation results for lighting retrofit have potential energy saving ratios of 44.6% or more in lighting system. Total energy consumed in Block A was around

327,000 kWh or equal RM102,000 (USD3500.00) in 2011; therefore, existing lighting system consumed about 24% of the total energy consumption of the building, the adoption of efficient lighting systems such as T5 lights should reduce total energy consumption of the building by 10-11% over a year. In addition, annual bill saving should be RM 9,804. It also shows that total annual electricity bill saving at the end of lifetime of T5 lighting system, nine years, is considerable amount of RM 88,236. By 79% retrofitting, it could be seen that payback period for T5 is only required 2.56 years to recover back all the investment, which is less than one third of its lifetime.

After identifying the amount of energy saved after lighting retrofit in Block A, the next step is to compare illuminance distribution of artificial lighting before and after retrofit. For this purpose in-situ measurement was conducted within 14 selected rooms from different levels to determine average artificial illuminance. Although the uniformity of illuminance distribution in all selected rooms improved slightly after retrofit, average illuminance of artificial lighting after retrofit is almost similar to the previous situation.

5. Conclusion

This study estimates that a 10-11% reduction in total energy consumption of existing building could be achieved by replacing old T8 fluorescent lamps with T5 fluorescent lamps. The results show that T5 system is suitable for retrofit system. This is because the energy consume by the T5 system reduce about half of the T8 system; moreover, the payback periods of T5 lighting system is slightly less than one third of T5 lifetime. In addition, by utilizing daylight as a free source of energy for interior illuminance the amount of saving might be much greater. Proper daylighting design recommendation is needed for energy saving and visual comfort in Malaysian Institutional buildings to predict the impact of daylighting on the overall building energy use.

Monitoring of “Efficiency House Plus Standard” Pilots

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Summary

In the context of the promotional program “Pilot projects achieving Efficiency House Plus Standard“ established by the Federal German Ministry of Transport, Building and Urban Development (BMVBS), six German manufacturers of prefabricated buildings have developed surplus energy houses as a showcase in the exhibition area prefab world Cologne.
In the annual balance, a so-called 'Efficiency House Plus' generates more energy than it needs for its own use. It either feeds surplus energy back into the public grid or uses it for electro-mobility. Most buildings have a compact design and the energy performance of the building constructions is optimized. As a rule, the heating demand of most of the pilot houses is slightly above the energy requirement of passive houses. The optimization of both building construction and technical equipment led to the best possible economic concept.
To cover the required heat demand, heat pumps are used in most houses. All buildings are equipped with a mechanical ventilation system using heat recovery. Energy profits are gained by photovoltaic modules installed as roof-top or roof- or façade-integrated solutions. To increase the degree of self-use, surplus energy is stored in a battery in some of the houses.
For the monitoring program, the energy flows of the buildings are measured, recorded and analysed by Fraunhofer IBP. The measuring configuration intends to determine both the monthly energy balances of the building and the performance of the installed technology. Further parameters measured in selected rooms include air temperature, relative air humidity and $C0_2$ concentration levels. The contribution by the photovoltaic plant (which is used on-site or fed into the public grid) and the overall consumption of all electrical appliances of the houses are recorded continuously.
After completion of the houses in spring 2012 the 2-year monitoring period started. Meanwhile, first measurements are available for the period from March 2012 through February 2013.

Keywords: Efficiency house Plus, final energy, surplus energy, PV-area, degree of self-used PV, monitoring, energy flow

In the context of the promotional program “Pilot projects achieving Efficiency House Plus Standard“ established by the Federal German Ministry of Transport, Building and Urban Development (BMVBS), six German manufacturers of prefabricated buildings (Bien-Zenker, Finger, Huf, Lux, Schwörer, Weber) have developed surplus energy houses as a showcase in the exhibition area prefab world Cologne.
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To cover the required heat demand, heat pumps are used in most houses. All buildings are equipped with a mechanical ventilation system using heat recovery. Energy profits are gained by photovoltaic modules installed as roof-top or roof- or façade-integrated solutions. To increase the degree of self-use, surplus energy is stored in a battery in some of the houses.

	Technologies						
	Innovative facade	High-perfor-mance lighting	Energy-manage-ment	Low-temperature heating system	On-site renew-ables	Elektricity storage	Electro-mobility
Efficiency house plus							
(1) HUF HAUS	☑	☑	☑	☑	☑	☑	–
(2) Schwörer Haus	–	☑	☑	☑	☑	–	☑
(3) Bien-Zenker	☑	☑	☑	☑	☑	☑	☑
(4) WeberHaus	–	☑	☑	☑	☑	☑	☑
(5) FingerHaus	–	☑	☑	☑	☑	–	–
(6) Lux Haus	–	☑	☑	☑	☑	–	–

Technologies used in pilot projects from prefab world Cologne

For the monitoring program, the energy flows of the buildings are measured, recorded and analysed by Fraunhofer IBP. The measuring configuration intends to determine both the monthly energy balances of the building and the performance of the installed technology (split up in the energy use for space and DHW heating, lighting, auxiliary energy and electrical devices). Further parameters measured in selected rooms include air temperature, relative air humidity and $C0_2$ concentration levels. The contribution by the photovoltaic plant (which is used on-site or fed into the public grid) and the overall consumption of all electrical appliances of the houses are recorded continuously.
After completion of the houses in spring 2012 the 2-year monitoring period started. Meanwhile, first measurements are available for the period from March 2012 through February 2013. All energy flows are recorded according to a measurement concept developed by Fraunhofer IBP together with the project partners. The overall energy consumption and the energy generated from the PV installations have been measured up to now. Some project partners are further optimizing their data collection and data transfer relating to the individual consumption of each appliance (e.g. lighting, electrical sockets).

Refurbishment of Listed Post-War Buildings with Reference to Schillerpark Estate in Berlin

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Keywords:
Integral planning, energy-efficient refurbishment, sustainability, Brenne, DBU, monument conservation, post-war modernism, Hans Hoffmann, Schillerpark, flower window

Extended abstract

Any planning for building work in existing buildings must begin with a detailed consideration of the building itself in order to become acquainted with its design and structure and identify the potential ways in which the refurbishment can be carried out. In this process, each individual component must be considered to determine how it affects the structural fabric of the building, whether its appearance should be preserved in the interest of monument conservation and how much it could contribute to an improvement in the building's energy performance, especially from an economic perspective. In the interest of the client and the building it is advisable to draw up a list of the value of the components (monument conservation, energy, costs etc.).

For example, in the buildings designed by Hans Hoffmann in the late 1950s in the buffer zone of the UNESCO World Cultural Heritage site “Schillerpark Estate” it was found that the flower windows not only created a beautiful link between the living space and the outside, they also act as an ideal thermal and acoustic buffer zone. And the broad roof overhang has significantly reduced the weathering to the mineral facade rendering and the wooden windows.

A harmonisation of the concerns of monument conservation - i.e. the greatest possible preservation of the monument's fabric - with the economic interests of the client was achieved by cooperation with the German Environment Foundation (*Deutsche Bundesstiftung Umwelt*, DBU) and an integral research project financed by the foundation under the title “Monument and energy – post-war modernism”. This project enabled the participants in the planning process, such as the Technical University of Dresden as a scientific research institute, the architect, the building services planner, the building owner *Berliner Bau- und Wohnungsgenossenschaft von 1892 eG* and a selected medium-sized business company to develop an overall energy efficiency concept for the refurbishment of Hoffmann's 4-storey residential buildings and the 112 residential units in accordance with conservation principles. The goal of the client was to safeguard the fabric of the buildings in the long-term and minimise maintenance costs taking the circumstances prescribed by the monument conservation authority into account, and thus to encourage the tenants to remain loyal to the estate.

In detailed calculations and computer simulations by the Technical University of Dresden, a number of optimisation variants for the energy-efficient remediation of the facades were examined, with special attention to how to treat Hoffmann's typical walk-in flower windows and whether to preserve or dismantle them. This gave the client good arguments to preserve these elements which are so eminently important for the monument character of the buildings. Another result of the scientific investigations was that the radiators were retained at the centre of the apartments. As a result, the disruption of the tenants' living environment could be reduced to a minimum.

The flower windows were included as a positive factor in the required statutory ventilation concept which envisaged outdoor air flowing through concealed slits in the outer element of the flower window into the 50 cm wide space between the two window elements, where it heats up naturally. It then enters the living space via humidity-sensitive air inlets in the transom over the door of the inner flower window element.

All of the work that was done, including the complete replacement of all supply and disposal pipes, made a major contribution to the improved energy efficiency of the buildings. The need for primary energy was reduced by approx. 80%, not least because of the switch from gas central heating to district heat. The primary energy value of approx. 54 kWh/m²a even fulfilled the requirement for a comparable new building in the Energy Saving Ordinance (EnEV 2009). But the project was only completed at the end of 2011 and the beginning of 2012, so the energy consumption values for a full heating period are not yet available. Mathematically, however, the final energy demand there has also seen a significant improvement of approx. 55%, to approx. 112 kWh/m²a. The reduction in the emissions of CO_2, in keeping with environmental policy goals, was achieved to a considerable extent, with savings of approx. 55% to approx. 157 t/a.

For the occupants, the refurbishment not only brought the quality of the apartments up to modern standards, it also improved the ventilation of the living space and the insulation from external sound and reduced their monthly operating costs by approx. 40%, depending on their customary use.

Fig. 1: Balcony facade before the refurbishment [1]

Fig. 2: Balcony facade after the refurbishment [1]

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Summary

Despite the global world crisis, Croatian tourism in the last four recession years has broken all records and placed Croatia among the top tourist destinations in the world.

Tourism and agriculture, as key economic sectors in Croatia, as well as all other industries: forestry, lumber industry, food industry, etc., should be completely redefined and developed - new economic development is needed within the new, overall context of the just commencing EU membership and European integration, and especially in the context of global, key challenges of the new millennium: sustainability, responsible management, independence at all levels of society and the economy. New definition and development of the unique characteristics of Croatia is also needed.

It is through this overall approach mentioned above in a newly defined green Croatian tourism, that it is possible to realize +green spa, +green hotels, as well as hotel facilities with benefits and savings for customers, all other participants as well as for the environment.

Keywords: +green concept, +green thermal spas, sustainable architecture projects, green tourism, green innovations, networked design, thermal towns, EEE (Energy efficiency and ecological suitability), RES (Renewable energy sources)

1. Introduction

The authorized EU +green concept is a project that the Author has been developing since 2003, between Germany and Croatia, which focuses on the following: sustainable development, sustainable architecture, green tourism (primarily +green thermal spas and +green hotels) as well as green innovation.

In +green projects the Author brings together a complex interdisciplinary group of experts with international references, cooperating with the Croatian Chamber of Commerce (HGK) since 2008. The original EU authorized pilot +green spa project began in 2011, developed using the Daruvar thermal spas as an example. It is a model form to be replicated, generated from the experience of EU German practice, for complex projects and their multidisciplinary strategies.

The multi-layered and exceptional wealth of the Special Hospital for Medical Rehabilitation (SBMR Daruvar) - natural and health resources, cultural heritage, a protected 9.5 hectare park, spa tradition, architecture and unique surroundings - require a special +green concept approach.

The project was designed in a series of levels of component +green studies which are collectively preparing a future, long-term solution and creating a unique brand of +green health tourism, regionally, nationally and cross-border.Through innovative +green approaches at all levels, component +green studies are being created, designed and connected within the structure of EU authorized, inter-disciplinary umbrella +green studies, thus creating completely new facilities, such as, for example, the possibility of innovative utilization of geothermal water as a source of energy, the utilization of the available RES+EEE potential of a location, synergy with cultural and archeological tourism and other types of tourism, which potentially form a new +green brand of health tourism. As a result of the compatibility of their facilities, the first replication of the EU Daruvar thermal spas authorized pilot project has been realized with the authorized Lipik thermal spas project. With only 20 km between them they represent a strong synergy of the medical profession and health tourism in two thermal towns.

2. +Green Thermal spas Daruvar: the first EHTTA member in this region

Health, medical and wellness tourism provide added value to Croatia's tourism offer, and in 2009 these types of tourism accounted for 1.2% of the Croatian tourism offer. As this figure for the EU is 20% and is growing steadily, and in Slovenia amounted to over 30%, it is clear that Croatia needs to invest even more in this type of tourism in terms of infrastructure, supply and promotion.

Thermal destinations in the region began to be used in the form they are now 200 years ago. For this type of tourism, it is important to realize an improved state of clients' health, using tradition while at the same time respecting the principles of sustainable development, as well as needing to continually work on the introduction of new services, because tourism develops rapidly, and tourist demand changes frequently. It is this very multi-layered comprehensive approach within the framework of thermal destinations that is the basis of the EU authorized +green concept pilot projects modeled on the example of the Daruvar thermal spas.

The international non-profit association called the European Historic Thermal Towns Association (hereinafter the EHTTA) was established in 2009 in Brussels, to create a lasting European organization, with the goal of forming a network of towns able to boast a longstanding tradition of thermal waters and a rich heritage, to preserve their history, preserve and protect their cultural heritage as thermal towns, and along with all of this creative and innovative policies for improvement and promotion would be defined. Through its activities the goal is to strengthen the cooperation of thermal towns and health resorts at a trans-European level. The European Council recognizes 29 cultural routes, including the EHTTA.

Health and Environment-Friendly Constructional Products for Improving Quality of Life

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Summary

Background: Regulation (EU) No. 305/2011 defines seven basic requirements for constructional products and constructional works that have to be fulfilled throughout the whole life cycle of a building. The basic requirements No. 3, Hygiene, health and the environment and No. 7, Sustainable use of natural resources, are equivalently treated as other requirements in the Regulation. On the level of assessment and verification of product`s performance in relation to the essential characteristics, high level of protection of health and safety has to be taken into the account. Moreover, the declaration of performance should be accompanied by information on the content of hazardous substances in the product in order to improve the possibilities for sustainable construction and to facilitate the development of environment-friendly products. Any product that presents a risk to health and safety has to be withdrawn from the market. Despite the requirements, there are still many materials at the market that are health and environment-unfriendly. The purpose of this study is to examine the prevalence and use of these products in buildings, identify risk factors, and to propose a recommendation system for the prevention of negative health effects. The system is presented on an example of PVC, widely used in buildings, with serious health concerns. **Methods:** Literature review was carried out studying the usage of building materials with identified health risks. **Results:** On the basis of literature review, the starting points for the preparation of recommendations were made. They include systematically defined actions, specific for built environment. For the prevention of negative health effects, actions are defined on the level of the whole life cycle, from the design stages to the stages of usage and maintenance, and to the final disposal. **Conclusions:** This study presents a new approach towards healthier indoor environments. The presented approach is necessary for the design of sustainable buildings, and as a basis for successful renovations.

Keywords: building materials; health hazard; indoor air quality; alternatives; legislation.

The Age of Positive Energy Buildings has come

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Summary

Undoubtedly, the development of the surplus energy house marks another quantum leap in the field of energy research to which Fraunhofer IBP research staff contributed their share, proving great commitment and initiative. In the meantime, IBP's Heat Technology team has extended its scope, now providing surplus energy building concepts not only for various residential buildings, school buildings and other educational buildings, but also for office buildings and even for existing buildings. Each of the 250 exciting pilot building projects the Heat Technology team has realized so far has taken the development a step further.

Buildings functioning as energy providers create a scenario that opens up completely new ways of securing the energy supply. To ensure sustainable success, it takes both: detailed, fully developed concepts of building types and excellent quality of building construction. Equipped with these parameters, energy solutions for districts or even for entire cities can be tackled.

The paper presents experiences made at various surplus energy buildings based on detailed measurement concept, which enables the IBP researchers to evaluate the design results obtained for different building concepts. The measurement configuration allows establishing a comprehensive balance of energy flows on a monthly basis, thus visualizing the performance of the installed plant components. In this way, users will keep informed on the current status of their energy balances. Besides, the air temperatures and CO_2-levels measured in relevant spaces (like living rooms or bedrooms) are continuously recorded.

Keywords: Energy surplus buildings, pilot projects, efficiency house plus, calculation, definition, evaluation, energy concepts, NZEB, high performance buildings

Introduction

In Germany, energy-saving buildings have a long tradition. For more than 30 years now the climate neutral building of the future has been a subject of research. More than 15 years ago, the low-energy building was made the statutory minimum standard for new buildings (laid down in the German energy Saving Ordinance - EnEV). Thanks to intensive research and development work it has now become possible to improve buildings to such an extent that they can generate energy instead of using it. This outshines any other developments that still require a residual amount of energy for running the building

The 'efficiency-house plus' which was initiated by the German Federal Ministry of Transport, Building and Urban Affairs (BMVBS) enables innovative partners in the building industry to prove their pioneering spirit in practical building applications, thus demonstrating their market leadership, as this house is the built answer to the challenges faced by our and future generations, which makes it a very sustainable venture! Besides, having been developed and produced in Germany, it is truly "Made in Germany“. The efficiency-house plus allows to generate more energy in the course of a year than the building and its users will actually need. It does not depend on a particular technology but can be realised in various ways, using an intelligent combination of energy-efficient construction technologies and renewable energy-generation systems. In this way, it presents an approach that is open to different technologies.

The building blocks of the 'efficiency-house plus': energy efficiency and renewable energy

Compared to conventional types of construction, the efficiency-house plus is based on 3 pillars, namely to

- increase the building's energy efficiency as much as possible
- reduce the energy demand of the domestic processes as far as possible
- use renewable energy to cover the residual energy demand

As this building concept requires that the total energy need of the house must be covered by renewable energy that is available in the nearby surroundings, the energy demand has to be reduced by significantly improving the building's energy performance.

The BMVBS model project 'Efficiency-house plus'

The model project started in summer of 2011. It is based on a specially issued BMVBS funding directive, which is part of the National Climate Protection Initiative of the federal government. Eligible for funding are exclusively residential buildings achieving "plus-energy standard“ (single/ dual family homes, serial houses and multi-family houses) that will be built in Germany. The initiative is run under the trademark of "Efficiency-house plus“, which is held jointly by BMVBS, the German Reconstruction Loan Corporation's KfW-bank group and by dena (the German Energy Agency). To prepare and support the initiative, Fraunhofer Institute for Building Physics developed an assessment method which is based on the German Energy Saving Ordinance (EnEV). This new method was extended to include the energy need for lighting and domestic appliances; it also considers the amount of regenerative excess energy that was produced within the balance zone but then fed into the grid.

Manufacturers of prefabricated houses have picked up the initiative and focus on this field of interest in their newly established "FertighausWelt Köln" ('World of Prefabricated Homes' at Cologne, Germany). Participating companies Bien-Zenker, FingerHaus, Huf Haus, Lux Haus, Schwoerer Haus and WeberHaus have each built an efficiency-house plus (for exhibition purposes) on the site and have joined the evaluation measurement programme. Lately, further private initiatives could be included in the evaluation process. In 2012, further projects were added; at present, more than 30 projects have been integrated in the network.

The complete paper and the presentation at the conference presents the key technologies that are chosen for the different building concepts and the experiences made with costs and economic efficiency with the mentioned buildings and other applications.

ACTIVE HOUSE a Vision of Future Sustainable Buildings - Buildings that gives more than they take

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Summary

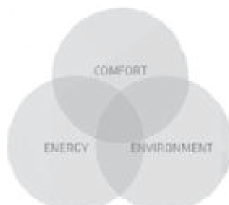
The aim of this paper is to illustrate the possibility for implementation of the Energy Performance of Buildings Directive and development of a methodology for nearly Zero-Energy Buildings and CO_2 neutral building, which at the same time sets high requirement for comfort, environment and sustainable development. It can be done by focusing on Active House Vision and the combination of the principles Comfort, Energy and Environment. The Active House vision can be a tool for member states in their implementation of nearly Zero-Energy Buildings and tools towards a carbon neutral and sustainable development within buildings.

1. Active House Vision

Active House vision defines highly ambitious goals for the future building stock, with a framework for how to design and renovate buildings that contribute positively to human health and wellbeing by focusing on energy efficiency, indoor and outdoor environment and the use of renewable energy.

1.1 Improve quality of life

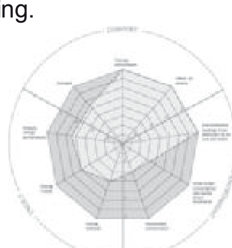
People spend up to 90% of their time indoors and often in buildings that are not holistic optimized in combination of energy efficiency and indoor comfort. Humans need comfortable thermal conditions, fresh air and daylight. Active House seeks to respond to these factors and is evaluated on the basis of the interaction between comfort, energy and environment.



2. Design, specification and evaluation

The design of an Active House is based on the overall performance of the building. It is the interaction and the balance between the individual solutions that creates a sustainable building. Active House Specifications divide the key principles into 9 quantitative parameters, (Daylight, Thermal comfort, Air quality, Energy demand, Renewable energy, Primary energy performance, Environmental loadings, Fresh water consumption and Sustainable construction) which all are based on the holistic performance and needed to evaluate a sustainable building.

The specification can be used across borders, regions and within different climate zones. Firstly because the evaluation and the methodology to describe the quantitative parameters sets performance requirement and follow international and national calculation methods, secondly because the specification do not set specific requirements to individual solutions, keeping this as a national and regional activity based on the climate and culture.



3. Best Practice

Solhuset (Sunhouse) is a 1300 m^2 integrated childcare centre. The vision was to set new standards for future sustainable childcare centres.

It rests on the Active House principles and has been designed with high ambitions to create a healthy and comfortable indoor climate with plenty of daylight and fresh air. The purely architectural solutions – the form of the building and the choice of materials ensure that even without any renewable technologies the buildings energy demand is 48 kWh/m^2 The design has integrated environmental issues and demonstrate sustainable buildings can be designed with technologies of today. The design has become an integrated part of the children's playing and education with greenhouses where staff and children can grow plants, and touch-screen TVs that will allow the children to monitor the indoor climate and energy performance.

4. Conclusions

Already today the experience and technologies for design and development of future sustainable buildings are available. We can meet the future requirement to buildings with the solutions that are available, the challenges is to integrate the individual solutions into a sustainable design.

There is a need to secure legislative focus on comfort in buildings and the EPBD partly touch upon it however comfort should be integrated further in the next recast. National legislation should already now include comfort into the requirement for nearly Zero-Energy Buildings.

The Active House Specification can be a tool for authorities in implementation of nearly Zero-Energy Buildings into national legislation as the specification are based on national and international methodologies and can easily be used in all countries with different climate and culture, without modifications to the classification.

The PPP Project “Realschule Poing“ Receives an “A+” in Sustainability

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Summary

Realschule Poing (secondary school) was realised in 2012 as a public private partnership (PPP) project. In a PPP, planning, construction, operation and maintenance are delivered by a private consortium on behalf of the local authority. It aims at providing public services in a less expensive and more efficient manner by involving private sector resources and expert knowledge.

Landkreis Ebersberg, a local authority east of Munich, wanted to build a highly ecological, user-oriented and cost-efficient secondary school and secure its operation over 20 years. To this end, the local authority developed detailed specifications for sustainable construction and operation and decided to realise the project as PPP that takes into account life cycle costs. The economic efficiency of this procurement alternative was expected to be 7,3% higher than the conventional realisation.

Keywords: PlusEnergy® building; certified PassiveHouse; life cycle costs; barrier-free; public private partnership (PPP) project, sustainable construction

1. The project

SKE Facility Management GmbH realised Realschule Poing, a secondary school with triplex gymnasium for 580 students. The school comprises around 13,000 sqm gross floor area. It has been in use since August 2012 and was officially dedicated on 27th November 2012.

The school is a certified PassiveHouse and all necessary energy is produced from renewable resources. In addition, the school is a PlusEnergy® building that produces more energy than its users consume. The calculated requirement for primary energy is 670,208 kWh per year, while the photovoltaic facility on the roof produces 683,000 kWh per year. This results in a surplus of 12,792 kWh per year primary energy. The photovoltaic system compensates the carbon footprint of Realschule Poing to 72,328 kg CO_2 per year, while a conventional school produces around 250,000 kg CO2 per year.

2. What are the sustainability aspects of Realschule Poing?

However, this is not the only sustainability aspect of the project.

2.1 Environmental aspects

The compact three storey building is airproof and highly thermally isolated, including triple glazing. A ventilation system with heat recovery maintains good air quality. An external geothermal power station and a well system make use of locally available resources. The photovoltaic roof generates 370 kilowatt-peak. The cooling in the summer is supported by activating the inert mass of the reinforced concrete structure. Environmental friendly building materials are used, wherever possible. The thermal insulation consists of recyclable materials with a positive life cycle balance. The facade is made of locally resourced larch wood, which is untreated in order to minimise maintenance costs.

2.2 Economic aspects

Several measures optimise the space efficiency of the school: The canteen and the gym are shared with neighbouring schools. The centrally located entrance hall is also used as assembly hall and can be enlarged to the surrounding rooms by opening mobile walls. All building materials and technical facilities are selected according to a thorough life cycle assessment that takes into account not only investment costs, but also operation, maintenance, and energy consumption. This life cycle assessment, a standard requirement in a PPP project, increases economic sustainability.

2.3 Social aspects

The project is based on a thorough assessment of the user requirements and the educational concept. In this respect, the "Fachraumprinzip" plays an important role: Rooms are not allocated to individual classes, but to specific subjects and are furnished accordingly. The students move between these rooms during the day. This principle does not only reduce floor space needs, but also increases the flexibility of the building. The entire school is barrier-free accessible.

3. Conclusion

As the PPP-approach considers not only the investment, but the entire life cycle costs, the long term benefits of specific sustainability features often neglected in public buildings are revealed. Hence, the PPP approach strengthens a holistic view on sustainability balancing environmental aspects with their economic and social impact. In this regard, the Realschule Poing can serve as a model.

New Office Building Allianz Deutschland Campus

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Summary

The presentation will give a general overview of the planning process of the sustainable office building as part of the Allianz Deutschland Campus. The current state of planning, the involvement of stakeholders including opportunities and obstacles will be discussed.

Keywords: integral planning process, high flexibility, healthy materials and risk prevention, reduced energy consumption, efficient use of resources, sustainable energy sources, DGNB

Extended abstract

According to UNEP, reducing CO^2-emissions is key to protecting our environment across the globe. Allianz is fully committed to this important goal. As an insurance company, reducing CO^2 emissions is in our own interest, because we are in the business of protecting our many clients against the negative financial effects of natural catastrophes.

Allianz Deutschland AG has been able to reduce CO^2 emissions significantly over the last years. A great many measures are being put into place to achieve further CO^2 reductions. These include several building modernizations, site optimizations and new constructions.

Allianz is currently in the process of optimizing some head office locations. As part of this project, Allianz Deutschland AG is merging five separate sites in the Munich area into a single location. As a result, the “Allianz Deutschland Campus” in Unterföhring near Munich will comprise more than 8,000 workplaces. This will, for instance, reduce the physical distance between all head office departments of the headquarters, thus allowing for better communication and less travelling.

Fig. 1: Site location plan Allianz Deutschland Campus, Unterföhring next to Munich

A new office building is designed to complete the Campus. It will accommodate around 1,600 employees and will create much needed space for the Campus as a whole. The new building is extraordinarily flexible with regards to possible future adaptations, has high standards in protecting employees and guests, reduces energy consumption and uses sustainable energy resources.

Both investors and users interests will be considered throughout the entire integral planning process. Therefore, we decided to hire a DGNB auditor to give us a second neutral opinion and to advise us on ecological, economical and socio-cultural aspects.

Fig. 2: View of the façade / the main entrance Dieselstraße (Auer+Weber+Assoziierte, architects)

Which way does it cost less to Build Net Zero Energy Buildings?

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Extended Abstract

The EU's Energy Performance of Buildings Directive (EPBD), introduced in 2002 with its recast in 2010, is the main legislative instrument for improving the energy performance of the building stock in the European Union. By 2020, all new buildings constructed in Europe, not to mention an increased number of existing buildings undergoing refurbishment, must reach the "nearly-zero energy" target level. Although the exact definition of this term is not unified throughout the EU, it is a common interest to investigate on time to what extent and by what means the nearly zero energy level may be reached. As engineers it is our task to provide the solutions that can help achieve these targets.

In our study, the potential strategies to reduce the primary energy needs of a new office building in Budapest, Hungary was investigated. This paper covers the energy saving and energy utilization measures (onsite/offsite) available through the example of this case study. This study focuses on the main question of an office developer today, whether it is more advantageous to implement onsite or to install offsite energy saving/production solutions in case of an infill office development in Hungary.
The building as designed was analyzed and the potential additional measures not included in the original design were identified. As the building is located in a dense urban area, specific constraints were to be taken into account: to befit the neighbouring buildings and the urban landscape, to provide the maximum floor to site area and to provide an efficient space utilization, etc. The building was originally designed with state-of-the-art solutions, with the potential to receive an "A" level building energy performance certificate, and a LEED Gold certification level.
The solutions incorporated into the original building design and the potential further savings were analyzed one by one quantitatively and qualitatively as well, with the help of a dynamic building energy modelling tool. The main aspects of the comparison were to determine both the costs and the potential energy savings or production of these measures.

It was shown that the architectural solutions having a potential to reduce heating energy were limited due to the originally designed, highly insulated, airtight building skin. However, the possibilities of night time ventilation and the installation of cool roofs could be introduced as effective passive cooling measures.
The highest potential in reducing HVAC energy needs was to determine the optimal indoor air quality requirements and adjusting the HVAC system so that no unwanted oversizing occurs. Reducing the fresh air to an acceptable level and introducing CO_2 monitoring cut the ventilation energy by 32%. The fine tuning of the HVAC systems by e.g. providing high efficiency heat

recovery systems reduced energy needs further on.
The optimized building construction and HVAC and lighting systems resulted in a 20% reduction of total primary energy needs. Most of the solutions were low-cost no cost solutions, the highest expenditure was the increased number of windows and the motorized opening coupled with BMS for providing night time ventilation.

After reducing the HVAC energy needs, on-site renewable were introduced to compensate for the remaining energy needs. Onsite PV panels of 100kWp were proposed with notable investments costs.

It was shown that with on-site energy efficiency and renewable energy solutions the building primary energy need could be reduced by a 32.5%, where the primary energy need was reduced from 66.1 kWh/m^2year to 44.6 kWh/m^2year.

In this case study the NZEB could not be reached with onsite measures, as the renewable onsite could not compensate the total remaining energy need. However, onsite energy consumption could have been decreased even more if natural ventilation and elimination of suspended ceilings, resulting in a more efficient night time ventilation were accepted. However, these measures had to be excluded as they were deemed currently unacceptable for a modern office space.

In the current project an off-site solar power plant was suggested to compensate for the remaining energy needs. The installation of the off-site power plant was found to be a more cost effective solution than the majority of the onsite measures, but only up to an installed capacity of 500kWp. Thus, the onsite measures should ensure that the remaining energy needs can be covered by a power plant of this size.

Keywords: Net zero energy; onsite; offsite; energy saving measure; simulation

Practical Experiences with Refurbishing Seven Apartment Buildings to Zero-Emission Level

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Summary

Seven apartment dwellings have been refurbished to passive house standard with recycled and renewable materials. Additional measures have been established to reduce energy demand for heat distribution, domestic hot water, auxiliary and household electricity. With a biomass co-generation the buildings should reach a zero-emission level.

A detailed monitoring of the apartments and the installation engineering showed temperatures of about 22 °C in the apartments leading to a higher comfort level than designed. The household electricity consumption of 25.2 kWh/(m²a) fell 11 % below the designed values. The measured thermal heat consumption of 26.7 kWh/(m²a) exceeds the calculated values, originating mainly from the higher temperatures and lower internal heat gains from persons and electricity. Experiences from the operating phase of the buildings show the importance of the supervision of the installation engineering to optimize the energy efficiency. In the paper different measures to improve the reliability and efficiency of installation engineering are suggested.

Keywords: retrofit, zero-emission, best practice, renewable insulation, efficient installation engineering, monitoring results

1. Building concept

Between 2008 and 2011 the housing company ABG Frankfurt Holding retrofitted seven apartment dwellings built in 1956. The 61 apartments have a total reference area of approximately 3800 square metres. The seven houses in Frankfurt, Main, Germany, are assembled in three blocks of houses with four to six storeys each.

Overall aim of the project was to reach zero-emission level for heating, domestic hot water (dhw) and auxiliary energy. Therefore additional efforts were made to reduce distribution heat losses, energy for dhw production and household electricity.

After the retrofit the dwellings reach the passive house standard. Apart from marketable certified products building insulation, including the façades, was mainly made out of renewable raw materials to reduce the cumulative energy requirements (cer). The construction elements meet the requirements of the passive house standard, are designed for retrofit and for apartment dwellings with their increased requirements for fire control.

2. Results

It was possible to insulate nearly the whole opaque building envelope of the seven apartment dwellings with recycled and renewable materials. This leads to low cumulative energy requirements (cer) and could be an alternative to external thermal insulation composite systems

out of non degradable materials. The consequences are higher costs of about 141 €/m² area of component and higher planning and quality ensuring efforts.
The measured room temperatures are about 2 K higher than standard boundary conditions, which can be seen also in other retrofitted apartment dwellings. In consequence we would suggest for planning zero-energy or zero-emission buildings to take this circumstance into account and calculate the energy balance with the increased but realistic higher room temperature of 22 °C to reach zero-energy / zero-emission in reality. Maybe the approach for single family houses could be slightly lower.
The heat energy consumption is higher than calculated with standard boundary conditions, but most part of the excess consumption is used by the tenants for increasing comfort and living space. The reduction of these remaining kilowatt hours describes the need for interventions to motivate tenants to optimize their user behaviour.
Implementing zero-/plus-energy or zero-emission houses leads to more complex installation engineering to produce electrical energy in addition to the thermal heat. That increases the demand for detailed planning and surveying during at least the first years of operation. Also self control for renewable installation engineering could be increased to get better efficiencies. The acceptance test after building process could be enlarged by the results of a total year of operation to proof not only the individual function but the interaction of all components.

3. Conclusions

Although all difficulties during the project realization and operation the measured heat consumption could be reduced by more than 70 % (measured before and after retrofit), despite the increased thermal comfort in the apartments. That shows the importance of reducing the energy consumption for heating, domestic hot water, heat storage and distribution as well as auxiliary and household electricity when planning a zero-/plus-energy or zero-emission dwelling. If these efficiency concepts are implemented with top priority a failure in installation engineering won’t challenge the whole building concept. After solving the problems with the co-generation (soot production) at the end of 2012 the buildings will reach a zero-emission and a plus-energy level for the mentioned categories.

A Review of Research on the Impact of Wind-Driven Rain on Scottish Traditional Wall Construction and its Internal Insulation Retrofit

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Summary

Scotland's building stock consists of a large portion of buildings erected before the end of the First World War. The external walls of these pre-1919 buildings are generally solid stone walls and are therefore moisture permeable. The hygrothermal performance of such 'traditional' walls is dependent on external and internal climate conditions. Particularly precipitation in the form of wind-driven rain has a significant impact. Due to climate change these external conditions are significantly changing, thereby altering the hygrothermal performance of such walls. Furthermore, improving the energy efficiency of Scotland's existing building stock is essential to achieve the climate-change targets set by European, UK and Scottish legislation. Most pre-1919 buidlings in Scotland are considered to be 'historic buildings' and external insulation retrofit is therefore often thought of as inappropriate for conservation reasons, leaving the retrofit with internal wall insulation as the only option for energy-efficiency upgrades to such walls. The full paper to this extended abstract critically reviews recently completed and ongoing UK research projects, particularly those concerned with increased levels of precipitation and severe wind-driven rain and its potential impact of moisture penetration reaching internal wall faces. It discusses to what degree the results of these current research projects are able to inform a better understanding of the long-term impacts of wind-driven rain on Scotland's solid stone walls and the associated risks for their retrofit with internal wall insulation. The extended abstract below gives an outline of the full paper.

Keywords: Energy efficiency; wind-driven rain; internal wall insulation; building retrofit; historic buildings; traditional wall construction; solid stone wall; hygrothermal assessment; research review

EXTENDED ABSTRACT

Improving the energy efficiency of Scotland's existing building stock is essential to achieve the climate-change targets set by European, UK and Scottish legislation. This will have to include improvements to the pre-1919 building stock, which constitutes approximately 20% of dwellings in Scotland. Many of these buildings are of heritage value (or heritage significance), but only a small portion is heritage designated or heritage protected. However, pre-1919 buildings are distinct from many later buildings due to the design of their building envelopes. The typical example of pre-1919 wall construction in Scotland is the 600 mm thick wall constructed from natural stone, bedded in lime mortar. The walls' external surfaces are either finished with lime render or left exposed. Such walls are therefore constructed from material and techniques that allow the penetration of air and moisture, but constructed to a thickness substantial enough to prevent moisture from reaching the internal wall faces. Such walls are referred to in Scotland as 'traditional walls'.

The hygrothermal performance (i.e. the combined heat and moisture performance) of traditional walls is dependent on external and internal climate conditions. Particularly precipitation in the form of rain has a significant impact. Due to climate change these external conditions are changing significantly, thereby altering the hygrothermal performance of such walls. This can lead long-term to increased wetting-and-drying cycles and to higher levels of moisture content in such building elements, thereby changing the deterioration patterns of the building materials used. These changes are most likely to occur in locations with a combination of high levels of rainfall and wind speed, resulting in wind-driven rain, also referred to as ‘driving rain’, a weather phenomenon which often occurs in Scotland and can particularly be experienced at Scotland’s west coast. Wind-driven rain can significantly contribute to the moisture penetration of exposed stone walls and might, under particular conditions, even penetrate through them, thereby reaching internal wall faces.

Upgrading the building envelope can, depending on the building type, be an important measure to achieve meaningful energy-efficiency improvements. For historic buildings retrofitting walls with external insulation is often considered inappropriate for conservation reasons, as this significantly alters the exterior appearance and therefore the character of such buildings. With no cavity extent within the masonry of traditionally constructed walls, the only option for energy-efficiency upgrades is to retrofit with internal wall insulation. However, any ‘through-penetration’ of rainwater is likely to also impact on these internal retrofits, potentially causing the long-term deterioration of the retrofit materials and mould growth, a health risk for buildings occupants.

Scotland has a temperate, oceanic climate with often wet, windy and changeable but rarely extreme weather. Scotland’s west coast receives high levels of precipitation yearround mostly in the form of rain, making it one of the wettest places in Europe. The concurrence of high levels of rainfall and wind speed make the Scottish west coast also one of the European areas worst affected by wind-driven rain. *UK Climate Predictions 2009* estimate that in the future Scotland is likely to be warmer overall, but also wetter, particularly in its coastal regions. Paired with Scotland’s high wind speeds, it is very likely that the Scottish west coast will experience an increase in wind-driven rain and that these increases could reach drastic levels.

The full paper of this abstract, firstly, introduces energy-efficiency policies relevant to Scotland, its pre-1919 building stock and the country’s climatic conditions. Secondly, the paper discusses the information on wind-driven rain available for the British Isles. Then the full paper critically reviews recently completed and ongoing UK research projects, particularly those concerned with increased levels of precipitation and severe wind-driven rain and its potential impact due to moisture through-penetration. Some of the presented research projects were initiated or are supported by Historic Scotland, an agency of the Scottish Government and charged with safeguarding Scotland’s historic environment. Lastly, the paper discusses to what degree results of these recent research projects are able to inform, to date, a better understanding of the long-term impacts of wind-driven rain on Scotland’s solid stone walls and the associated risks for their retrofit with internal wall insulation.

The research review in the full paper of this abstract includes research carried out by Building Life Consultancy, English Heritage, Glasgow Caledonian University, Queen’s University Belfast and the Society for the Protection of Ancient Buildings. The research includes field and laboratory research as well as computer simulation using WUFI for hygrothermal assessments.

The results from the reviewed research indicate that increased levels of precipitation will accelerate material deterioration. It is difficult to estimate if wind-driven rain is going to become a problem long-term for Scotland’s traditional building stock and, if so, in which regions of Scotland and under which climatic conditions. The impact of climate change on present and future levels of wind-driven rain in Scotland is not adequately researched. It appears that only limited research on the impact of wind-driven rain on traditional buildings is available and that it rarely considers Scotland’s climate conditions or building construction techniques. The research, conducted to date, on the likelihood of rainwater through-penetration and its impact on the retrofit of internal wall insulation is inconclusive, but suggests that risks might exist for particular retrofit scenarios under particular local weather conditions. Taking climate-change predictions for Scotland into account, it cannot be ruled out that wind-driven rain, particularly in some locations along Scotland’s west coast, might become a more often occuring building-fabric issue long-term and may result in rainwater through-penetration affecting detrimentally some forms of internal wall insulation retrofit.

Effect of Moisture on the Sound Insulation of Building Components

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Summary

Water is an essential part in the production and application of building materials. Several years may pass until construction moisture dries out and the building components achieve moisture equilibrium. This paper investigates the influence of water contents in walls on the sound insulation properties. Therefore, monolithic walls made of different materials with variable moisture levels were systematically measured. The results clearly showed: The higher the moisture content, the higher the sound insulation. However, the effect of moisture on sound insulation cannot be explained by the increase of mass due to the additional water content alone. Thus further acoustic parameters like the loss factor or the module of elasticity were determined in dependence of moisture. Furthermore the change in water content of several walls was calculated by transient hygrothermal simulation for a period of several years. By coupling the calculation results with the acoustic measurement data the seasonal variation of the sound reduction index of walls could be determined.

Keywords: Moisture content; monolithic walls; sound insulation; acoustic comfort, sustainability

Sound insulation

The sound insulation of building components is an essential factor for the acoustical comfort in interiors of residential and non-residential buildings. Thus, building components make a significant contribution to the socio-cultural and functional quality in the field of sustainable buildings. A permanently positive influence is achieved in this way to preserve health and thus the performance of adults as well as children. Moreover, these factors effectively contribute to preserve the value of a building.

The moisture trapped in the pore volume of the building material definitely modifies the airborne sound reduction index of the respective building component. It could be demonstrated without any exception: The higher the moisture content, the higher the airborne sound insulation (Figure 1). Therefore a critical verification of the periods of drying out of newly manufactured building components to be tested in the laboratory or by in-situ measurements in new buildings is needed. According to the measurement results a period of dehumidification of two to six weeks is definitely too short for the investigation of walls. The values of the measured sound reduction indexes are too favorable with nearly three decibel. The determination and definition of the moisture content alone, as is usual nowadays, is not adequate. An appropriate moisture reduction of the measured values could contribute to a more realistic assessment of sound insulation, and to achieve more security in designing buildings.

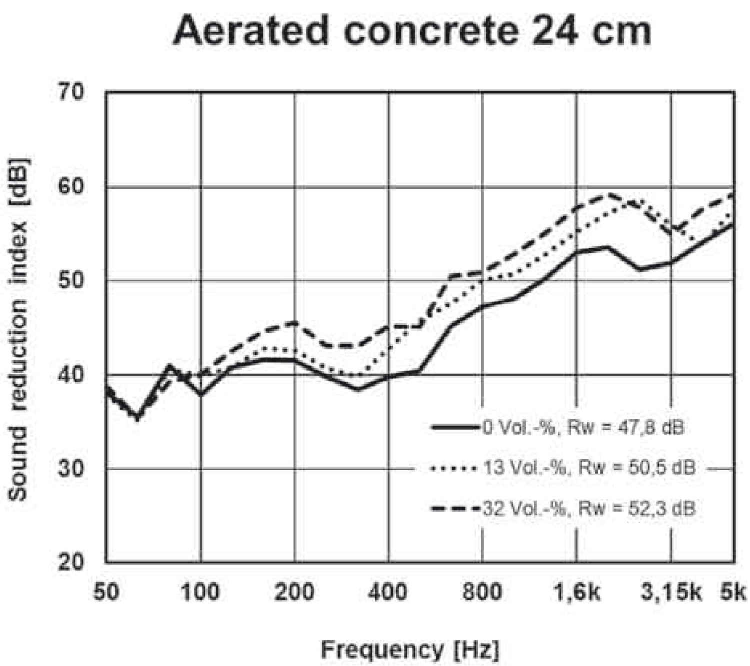

Fig. 1: Development of the frequency-dependent airborne sound reduction index for one and the same aerated concrete wall. The curve of the water-saturated, of a medium wet and the dry state of the wall is represented. Lime sand and lightweight concrete masonry were also investigated.

New Construction of an Energy-Surplus Day Care Center for Children to Experience Energy-Efficiency

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Summary

Initiated by the commitment of the mayor and public participation within the municipality Höhenkirchen-Siegertsbrunn in the South-West of Munich, the need for generating new child care facilities led to the realization of an energy-surplus day care center. This building illustrates how ecological and economic sustainability can go along with innovative techniques and architectural design, achieving high comfort and energy efficiency, simultaneously providing a child-oriented and enjoyable surrounding. This lighthouse project aims at increasing awareness and interest within the community and beyond for the issue of energy efficiency.

Ensuring the successful implementation of this demanding task, a qualified team of architects, installation engineers and researchers of the Fraunhofer Institute for Building Physics closely worked together from the very beginning of the design process, joining forces and knowledge. The project was awarded a prize by an expert committee and is supported by the German Federal Ministry of Economics and Technology within the funding program “Research for energy-optimized construction” (EnOB). This includes scientific guidance in planning, construction and start-up as well as a two-year monitoring phase.

The energy concept includes the following features, partially influencing each other. It is based on minimizing the energy need, to be covered, eventually, by highly efficient systems using renewable energy sources.

- Highly energy-efficient building envelope
  High level of thermal insulation, triple-glazing, eliminating thermal bridges, air-tightness
- Seasonal hybrid ventilation system
  Winter: demand-controlled ventilation system, preheated supply air, excellent heat recovery
  Summer: natural ventilation and passive cooling, both supported by a solar chimney
- Intelligent control systems
  Demand-controlled Opening and Shutdown of heating and ventilation units
- Intelligent Lighting
  Systems optimizing daylight-use and automatic control systems
- Low Exergy Heating System
  Low temperature level, effective heat pumps, solar thermal system

Following the energy concept, the building can finally be operated solely by electricity, additionally using the natural renewable sources of solar and geothermal energy. The electric power will be generated by photovoltaic modules, set up on the roof of the building. This solar power system is designed to provide more electricity throughout the year than required for running the building with all its need. As electricity is the only energy carrier, both types of energy balances, primary and delivered, will result in a surplus.

For developing and rating of the building's energy performance calculations were performed according to the German standard "DIN V 18599: Energy efficiency of buildings - Calculation of the energy needs, delivered energy and primary energy for heating, cooling, ventilation, domestic hot water and lighting". To obtain realistic energy demand values, user and site-specific boundary conditions were applied instead of standardized parameters, wherever possible. The following table shows the resulting area-specific energy values for energy need, delivered and primary energy, where the solar-generated electricity is not included. Taking into account the electricity generated by the PV system, the delivered and primary energy will be less than zero due to the surplus derived.

Energy Demand	**Energy Need**		**Delivered Energy***		**Primary Energy****	
(PV system not included)	[MWh/a]	[kWh/m²a]	[MWh/a]	[kWh/m²a]	[MWh/a]	[kWh/m²a]
Heating	17.7	12.3	4.8	3.3	12.5	8.7
DHW	13.5	9.4	4.7	3.2	12.1	8.4
Lighting	8.0	5.5	8.0	5.5	20.8	14.4
Ventilation	0	0	7.3	5.0	18.9	13.1
Total	**39.2**	**27.2**	**24.7**	**17.1**	**64.3**	**44.6**
Reference value***		55.4		75.1		105.2

* Electricity is the only energy carrier used. Considering the need throughout the year, it is solely produced by the rooftop photovoltaic system, even more than required, thus generating a surplus.

** The primary factor applied is 2.6.

*** Not conforming to the regulation, but may be considered as benchmark, helping interpreting the results.

Due to variety and amount of automatic systems installed, this building can be considered as high-tech. In consequence, for successful operation calibration, commissioning and monitoring are essential. The finally achieved results are of great interest, especially for comparison of calculated and actual energy values. The building will be monitored for two years.

Keywords: Energy-Surplus Building; Energy Concept; Energy Efficiency

Improving the Energy Performance of Museum Buildings - Development and Evaluation of Sustainable Refurbishment Strategies

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Summary

The energy performance of a museum building is characterized by severe indoor climate conditions originating from preventive conservation requirements. Therefore, reducing the building's energy demand, while simultaneously providing a stable indoor climate, is a challenging task that becomes increasingly complex when all influential variables are considered, for example fluctuations in the numbers of visitors or social events outside the usual opening hours. In addition, engineers' and architects' freedom of action is, in many cases, limited by museum presentation concepts, architectural challenges or even cultural heritage protection. On the other hand, museums, like all public buildings, contain a high potential for reducing energy costs by simultaneously raising public awareness regarding important issues such as carbon emission reductions and sustainability.

In order to maximise the multifaceted benefits of museum refurbishment projects, a team of five German universities and research institutions have cooperated in developing forward-looking refurbishment strategies by accompanying different museums through their refurbishment processes as well as by focusing on arising research questions. Besides the observation and evaluation of refurbishment projects the main action field is the enlargement of basic knowledge, aiming to enhance the quality of refurbishment strategies. The main points of focus are:

1. to reduce the energy demand of the museum buildings,
2. to guarantee appropriate indoor climate conditions for an object-oriented preservation.

In the course of the research project "Sustainable Refurbishment of Museum Buildings", the research partners have kept records of the operation parameters of several museum buildings and examined and compared the execution of different refurbishment strategies. This general approach is backed up by research on preventive conservation requirements, details of indoor climate and life-cycle analyses.

Keywords: museum buildings, energy efficiency, sustainability, preventive conservation, climate stability, refurbishment

Energy Positive Buildings- Impact of the Building Envelope

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Summary

Only the combination of Engineering know-how and Climatic design can support the common goal to achieve zero energy or even energy plus buildings. Besides of the building process of the past, future building concepts require the early cooperation between all stakeholders and competencies. The building envelope, correctly designed and layouted, minimizes the total energy demand by 50% and more. At the same time user comfort can be increased by a factor 2 or more, when compared with current building practise. The use of phase change materials within the building envelope supports lightweight curtain walls to become a temporay heat storage, minimizing cooling energy demand during day time. Breathing curtain wall concepts have proven to balance different demands of a heating and a cooling season, also integration active and passive sunshading strategies. Thus not only from an energetic point of view but in addition from a users point of.

Keywords: Building envelope, double skin, solar integration, positive energy balance, zero emission, user comfort, phase change material

1. Introduction

In the current discussion about global warming and the ways to minimize the impact of mankind, the focus is coming more and more towards the buildings industry. 40% of the annual global energy demand is caused by buildings, to errect, maintain, operate and to demolish these. Existing construction example have shown that this impact can be reduced to 20%, only impacted by the adequate design of the building envelope. Yet new technologies are just one aspect to achieve this. Even as important is the ability of industry to combine competences and technologies, seen from the users comfort necessities: Lighting, air ventilation, heating, cooling.

2. Results

Important part for the development of new design concepts is the ability to validate its performances. Beside the possibility to achieve this verfications by computer simulations, another possibility is to measure the performance. Past experience has proven, that the combination of practical testing and numerical simulation leads to the best evaluation of the impact of curtain wall design options.

2.1 Measurement Results – An Excerpt

During the past years numerous curtain wall variations and material trails have been executed. As examples 3 major activities are mentioned: Energy Demand Reduction, Energy Storage (PCM) and Energy Gain Integration.

2.1.1 Curtain wall variations – Energy Demand Reduction

The comparison measurement of 4 curtain wall options:

a. **Single skin** with exterior shading device
b. **Single skin** with interior shading device
c. **Double skin** with shading device incorporated into the air cavity, air cavity in and outlet are permanent open
d. **Double skin** with shading device incorporated into the air cavity, air cavity in and outlet are adjustable

Indicate that the curtain wall a) realises the same “PPD” value, than a traditional double skin variation c). Both max “PPD” value becomes ~ 20% at 6 p.m., on a warm summer day. The “breathing” double skin system variation d) shows a value of max. ~ 10% “PPD” at the same point in time. Lowest performance acc. to the ISO 7730 calculation delivers curtain wall variation b) with a peak of > 90% “PPD” between 3 and 7 p.m. the same day.

2.1.2 Phase Change Materials – Energy Storage Integration

Lightweight structures as curtain walls normally can hardly compete with the heat storage capacity of concrete. Therefore buildings tend to overheat faster or demand active cooling systems to avoid this. The idea was to fill the hollow cavities of curtain wall aluminium profiles with phase change materials and to investigate its impact on the room temperature development.
The measurement was performed 2 times. The 1st one was done within the passive test cell, located in South of Germany. Here the indication was done via the comparison of the room air temperature development of 2 similar rooms, one with PCM filled profiles and one without PCM filled rooms. The measurement was made over several days during a summer period.
The room temperature of the one equipped with PCM was up to 1.5 K less, than the temperature in the room without PCM. The temperature inside the profiles was 6.5 K less for the PCM filled one, indicating the heat storage activity of the PCM. This stored heat was emitted completely during the night by natural ventilation through opened windows (Tilt mode).
The 2nd test was done in the test container, which can be conditioned. Here the effectively of the PCM filled solution was measured by the amount of energy needed to condition that room to the same room air temperature level, than the 2nd test room without the PCM inside. For that test the profiles of room “1” have been filled with 31.5 kg of salt based PCM. That amount of material has in theory a latent heat of fusion of 4990 kJ, heat due to temperature increase of 528 kJ, thus summing up to a theoretical total heat storage capacity of 5518 kJ. The measured value was 5718 kJ, indicating that the entire PCM has performed the phase change.

2.1.3 Solar Thermal Collector Curtain Wall Integration – Energy Gain Integration

The project to integrate solar thermal collectors into the curtain wall, was initiated by the University of Stuttgart and several industry as well as research partners and institutes joined in, cross financed by the Federal Ministry of Environment, Security and Nuclear Security.
The aim was to integrated solar thermal collectors into the vertical curtain wall area and to achieve a 100% surface covering of the building envelope.
A 100% covering might provide a plus when it comes to maximize the energy gain, but will lead to a 0% user comfort, equal to a 100% “PPD” value, as one major requirement of user comfort “visual contact to the environment” $\tau_v > 0{,}2$ could not be fulfilled any longer.
The result was that into the curtain wall unit a vacuum tube collector was integrated, each tube with a certain distance from each other to ensure visible transparency. To compensate energy gain efficiency losses due to the increased distance between the tubes, a bended and punched reflector shield was developed and placed as backside cover of the tubes.
In practical measurements of the vacuum tube collectors the punching degree was defined to be 19%, leading to no significant losses is collector efficiency. The reflector shape design leads to a total energy gain between 250 and 350 kWh/ (m²a) at a south exposed, vertical (90°) wall.

3. Conclusions

The results have shown, that the goal to achieve zero energy or energy surplus building need a combined research effort of industry, authorities, institutes and partners. Energy efficient buildings are not for tomorrow, but possible already today. Not as single landmarks, but as building standards. Solutions and research results exist to back this. Main blocking factors for a fast application is the current set-up of the building industry, as that new solutions and technologies demand a kind of system integrator. Today the construction process is sequential, with more or less clearly defined interfaces between the construction parties. Upfront holistic planning and a life cycle costing approach is not widely spread, thus also hindering fast evolutions in the construction sector. Here political will must materialise into regulations and technical standards, supporting and not hindering that aim.

Towards Cost Optimal Net Zero Energy Building Concepts for Nordic Urban Areas

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Keywords: NZEB, value creation, user behaviour, building

Introduction

Climate change mitigation is one of the greatest challenges facing society today. It has led to the emergence of the fastest growing new investment market in the world with over US$260 billion investments annually [1]. Inside the climate mitigation market, the construction sector is assessed to offer a wide scope of opportunities for new cost effective sustainability products and services [2-3]. In particular, the situation calls for radical solutions as the time frame for corrective actions is short, for example to produce almost zero energy buildings by year 2021 – in less than ten years. The concept of Net Zero Energy Building (NZEB) has recently been evolving from research to reality to realize the ambitious targets.

NZEB is a relatively widely researched area. However, we would like to suggest that several crucial research questions are still open ended. This study aims to identify most critical research targets in the field of residential NZEB for Nordic urban environments. A literature review and a workshop for eight construction sector professionals were conducted to identify the research questions. The eight professionals are management team members from three leading publicly listed Finnish construction sector companies i.e., an energy efficient steel structure manufacturing company, a contractor and maintenance service conglomerate, and a sustainable construction consulting and engineering company.

Empirical observations

Empirical observations from the expert workshop are presented below. The observations are thematically categorized according to the three key themes identified in the literature review. First, we concentrate on the value creation and decision-making mechanisms of building user and owners. Second, we look at NZEB concepts for residential markets. Third, we discuss potential technical solutions for NZEB.

Energy efficiency and value creation for building users and owners

Understanding NZEB user and owner behaviour is at the heart of developing and commercializing a successful NZEB concept. As energy efficiency developments in the construction sector are mainly driven by regulatory actions and market demand, understanding of building user and owner behaviour and decision-making towards their development plays a crucial role on determining their needs and characteristics.

A big research gap exists in understanding the residential building user and owner, i.e. consumer, behaviour. In particular, the industry experts underlined the importance of in depth understanding of residential building user and owner segment characteristics, their specific value creation dynamics and decision-making systems related to NZEB. Several potential research questions emerged e.g., how consumers react with sustainability and how it really affects on his/her behaviour and every-day life, what is the time frame of consumers' behaviour change, what is the logic of willingness to pay for sustainable solutions in housing, how consumers could be involved in urban development process? Moreover, the industry experts call for empirical research on simple decision-maker tools and typology to produce low-carbon urban areas.

NZEB concept for residential markets in Nordic countries

According to the experts, NZEB development requires research efforts to increase understanding and knowledge on the NZEB system boundaries, energy production mix and cost optimality in an urban area setting. In particular, the decision makers lack of objective information in technological solutions for energy production and storage technologies in urban concepts. For example, the industry would benefit from research focusing on verifying the results of current centralized energy production and storage technologies and characterizing the centralized energy production and storage solutions available in 5 years. In addition, the experts pointed out that there is a lack of concept level research particularly in the areas of digital services for NZEB and dynamic user management of NZEB.

Potential technical solutions for NZEB

The expert workshop discussion highlighted the importance of further research for NZEB technical solutions - what are the optimal technological solutions of NZEB building in Nordic conditions? Only a few studies focus on identifying the current state and best technological practices of NZEB. In addition, the literature dealing with the NZEB solution optimization (in terms of energy, technical, environmental and economic performance) is scarce and mostly concentrates on partial optimization. Moreover, the literature addressing the potential of emerging technologies – such as functional materials applications – calls for technical research to take their NZEB applications into practice. Moreover, the industry experts emphasized the role of building integrated renewable energy technology, energy production systems, simulation, indoor environment criteria, natural light optimization, NZEB systems maintenance and waste m anagement for further research in the area.

Conclusion

The key findings suggest that there is a big research gap concerning NZEB's user and owner behaviour, decision-making, and value creation. Moreover, it is evident that to create markets for NZEB and to meet ambitious the energy efficiency targets, more research is needed especially on the NZEB boundaries and energy production mixes in an urban area setting. Finally, the results of this paper highlight the importance of further research for NZEB's technical solutions portfolio. Currently only a few studies focus on identifying the current state and best practices of NZEB. In addition, the literature dealing with the NZEB solution optimization – in terms of energy, technical, environmental and economic performance – is scarce and mostly concentrates on partial optimization. Moreover, the literature addressing the potential of emerging technologies – such as functional materials applications - calls for technical research to take their NZEB applications into practice.

EFFESUS – Energy Efficiency for EU Historic Districts Sustainability

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Extended Abstract

The EFFESUS concept is to reduce the environmental impact of Europe's valuable urban heritage by making significant improvements to its energy efficiency while conserving and even promoting the cultural, historic, urban and architectural values of European's historic cities. The overall objective is to develop and demonstrate, through case studies, a methodology and criteria for selecting and prioritizing energy efficiency interventions. These will be based on existing and new cost-effective technologies and systems compatible with heritage values, and thus significantly improve the life cycle energy efficiency in the rehabilitation of historic districts. The selected case studies are located in European UNESCO world heritage cities with different climate zones and range from Santiago de Compostela to Genova, Budapest and Istanbul, from Bamberg, to Visby and Glasgow.

The main goal of EFFESUS is to develop and demonstrate, through case studies a methodology for assessing and selecting energy efficiency interventions, based on existing and new technologies that are compatible with heritage values. The environment in historic buildings and urban districts is controlled differently from modern cities and accordingly a multi-scale data model for the management of energy is developed along with a decision support system for building owners, communalities and other stakeholders. In addition, new non-invasive, reversible yet cost-effective technologies for significantly improving thermal properties are investigated. Finally, solutions for overcoming non-technical barriers in the context of market implementation are being developed by EFFESUS. Amongst coherent market launch strategies for the further or newly developed technologies and services along the value chain, target-group specific strategies for a continuous dialogue between the various stakeholders involved are in the focus. The intention is to avoid conflicts as well as developments that do not meet the needs of the market

Fraunhofer IBP will be addressing the issues of how to supply energy efficiently and how to incorporate these supply arrangements into the building fabric of historic districts. A variety of insulation measures and insulating plasters will be developed in collaboration with projects partners, tested at Fraunhofer IBP's open testing facility at Holzkirchen. The Energy Systems department will be focusing a harnessing energy sources within local regions and implementing them into smart energy-management systems in partner cities. The role of Fraunhofer MOEZ is, firstly to devise a market launch strategy for the technologies and services that are being newly further developed in the project. Secondly, the institute is developing target-group specific concepts for an on-going dialogue between the various stakeholder's involved, particularly house owner and tenants. This is intended to avoid conflicts as well as conflicts that don net meet the needs of the market.

Keywords: Energy efficiency; cultural heritage; historic districts

Fig. 1: Geographic distribution of EFFESUS partners and case studies. © Historic Scotland.

Building Retrofit with Multifunctional and Prefabricated Window Elements

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Abstract

In most industrialized countries new buildings contribute only 10 -20 % additional energy to the overall energy consumption whereas more than 80 % are represented by the existing building stock. Nevertheless the actual retrofit rate addressing the enhancement of energy efficiency is less than 1% per year. Due to high investment costs, most present building renovations address single building parts as roofs, facades or heating systems only. This often results in not inter-coordinated and thus inefficient and finally expensive solutions, without an appropriate long-term reduction of energy demands.

Prefabricated facade systems have a high potential to overcome the problems of traditional retrofit measures. With a suitable integration of building services into the prefabricated elements, an installation of the retrofit system from the outside of the building will be possible leading to minimized disturbances of tenants.

Based on the experience gained from previous projects using large scale prefabricated façade elements, an alternative approach is proposed by the Fraunhofer Institute for Building Physics. Hereby, the development of small-sized elements with integrated building service components is seen to provide higher flexibility in terms of integration into the traditional construction process. The installation of the window including the sealing and connection with the rest of the façade and its insulation system is usually the most critical part of renovation work. Elements focusing on the window are concentrating on these aspects and can be either produced as wood or as an external thermal insulation compound system (ETICS).

Regarding this, a window prototype has been developed, which already holds an insulation frame to cover the existing façade and a technical box providing additional functionalities like ventilation, energy delivery systems, renewable energy systems like solar thermal or PV and ICT components. Apart from integrating different technologies, the technical box can serve as the interface for the installations in the façade element and the installations inside the building.

 

Fig. 1: Prototype of the ETICS basic window module

The whole window element is produced off-site and can be mounted into the existing window hole from the outside. The solution enables:

- the placement of the window with a special frame system in the energetically optimal location of the heat insulating layer
- supplying air through frame-integrated channels
- designing a window element, which has an insulation frame (ETICS) with partial finish
- all technically demanding work (window sills, blinds, plaster splints, etc.) is to be carried out off-site

The "remaining insulation work" of the façade, for which the additional insulation material is subsequently attached between the already installed windows (using a scaffolding), and the wall finish (plaster and paint system) are carried out in a traditional way. For such a product, new business models including concepts for the whole process chain from planning to manufacturing, transport, mounting and commissioning are required. Especially for the mounting, a compromise between the usage of scaffolding, cranes and man power has to be identified.

The development of the prefabricated window element, which has been supported by the Federal Ministry of Economics and Technology, will be continued in the project RETROKIT, funded by the European Commission. In this project, 18 partners from all over Europe are working for four years on a systemic approach for building renovations. In order to overcome not only technical but also social, industrial and economic barriers for the performance of renovation projects, a modular and flexible retrofitting tool box, in which the window element is one solution, will be developed.

Keywords: Retrofitting of buildings, prefabrication, multifunctional, façade system

Sustainable Building Laboratory in Africa

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Summary

Combining theoretical design and research with the practice of experimental building, design-build projects lead to an in-depth understanding of the relation between material, construction and aesthetics. For a period of more than five years, students of architecture at the Technische Universität München have been offered the possibility to participate in realistic projects in several African countries, which were not only designed but also built by the design team. They are an excellent method of improving social and environmental awareness through personal experience. An exchange of ideas between students and academics with different background, tolerance for unusual solutions and an informal platform for research and discussion are also part of the concept.

Keywords: student project; sustainable construction; design-build; resource efficiency; simple building

1. Introduction

Assuming that architectural design involves an artistic vision as well as technical solutions for realisation, both aspects are equally important parts of the overall learning objective. While design can be taught on a theoretical basis, ideas for realisation are missed out in many cases. Students will readily rely on expected technical solutions offered by industry in the outside world, failing to understand the close connection between a structural concept, architectural detailing and the formal and spatial depth of their design work.

2. Objectives

A major part of the architectural education process depends on balancing internal and external constraints within a specific architectural design. This is highly complex procedure, in which problem definition and problem solving are equally important. Design-build projects offer the possibility to combine theoretical design with the practice of experimental building. Through the personal experience of building their own construction and details, students will put their ideas to the test, redesigning a first idea to the state of technical feasibility. The projects described in this paper derive part of their very focussed and concentrated atmosphere from the exposure of the work-groups to an unknown environment with unexpected conditions. Tolerance for unusual solutions, an exchange of ideas between students and academics with different background and an informal platform for research and discussion are part of the concept.

3. Concept

Practice-oriented education at higher education level for architects and engineers is currently not the rule. Practice orientation improves students' understanding of complex design processes, as well as their practical skills, creativity and problem-solving abilities. Architectural prototypes as physically built realisations are used to test and explore a system with clearly defined, but unresolved questions, and to experiment with building typologies, experimental constructions and new technologies. A practical approach to architectural education is based to a great extend on building prototypes: in addition to small-scale design models, in this case there are also larger representations of certain details as well as full scale building parts and finally the whole building. Experimenting with building materials was a mayor part of the educational programme. From the very beginning the inner logic of the architectural design was influenced and formed by the characteristics of building materials. The aim was to use materials that are locally available, ecologically sustainable and practicable for unskilled workers.

Workshop building constructed by a group of student during a design-build project near Nairobi, Kenya

5. Conclusion

The difficult environment of a foreign place, in this case African countries where the high effort of preparing and organising the construction process is characterised by a lack of information, is an important aspect of the design-build studio work. Contrary to development aid projects, it is possible to develop very specific and adequate solutions for local challenges during the very intensive, one-year design work even in small projects. University infrastructure provides a substantial variety of experts who can help to find profound concepts. In cooperation with local universities the design-build projects offer the opportunity for long-term collaboration and for a two-way knowledge transfer:

Efficiency of Electric Local Heating of Thermal Bridges

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Summary

For three different thermal bridges it is investigated whether from an energetic side of view a local heating of the affected areas is superior to an increased ventilation in order to prevent mould growth. For a common type of dwelling and a "basic" air change rate of 0.3 h^{-1}, which results in mould growth on all three thermal bridges, it was examined which additional air change rate is necessary to prevent mould growth. Subsequently, heating cables were simulated at the thermal bridges and the energy as well as the primary energy consumption compared for both scenarios. It turns out that energy consumption is lower in the case of the heating cable at all thermal bridges. However considering the primary energy factor of the different energy sources the use of the heating cable is not always better.

Extended Abstract

Within the framework of this paper it is investigated, whether it is more reasonable to use local heating to avoid mould growth on thermal bridges than a higher ventilation rate of the rooms in question with the respective higher heat losses due to ventilation. Three different thermal bridges, external wall edge, balcony slab and floor slab support (Fig. 1), are investigated at the locations Hof (cold location), Würzburg (moderate location) and Freiburg (warm location). A common apartment located in the center of a multi-story apartment house is taken as a basis for investigations. On the basis of a „basic“ air change rate of 0.3 h^{-1}, when mould growth occurs on all three thermal bridges, it is investigated from which ventilation rate mould growth can be avoided at the respective location and on the selected thermal bridges, and how much heat loss for ventilation is generated. Then, with the same „basic“ air change rate the use of a heating cable is simulated as an alternative to the additional ventilation rate, whereby the heating capacity of the heating cable as well as the operation period can be varied. The energy demand is compared to the primary energy demand.

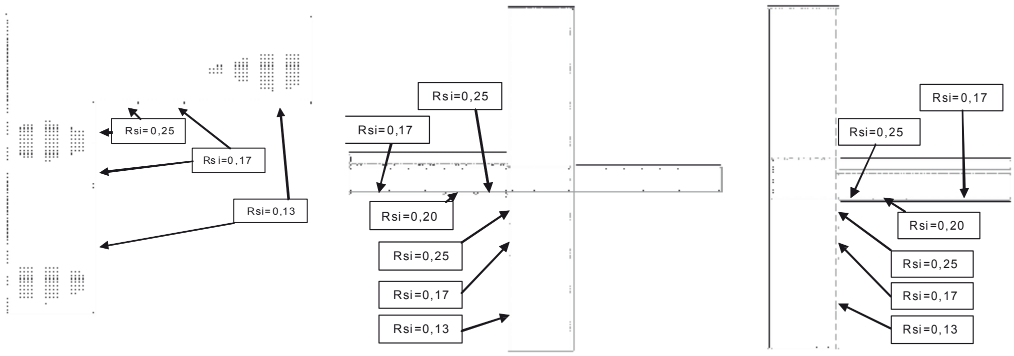

Fig. 1: Setup of external wall edge (left), balcony slab (centre) and floor slab support (right). Local heat transmission resistances in m²K/W are integrated in the drawing

It is obvious that the energy demand for the use of the heating cable is lower at all investigated thermal bridges and locations than for the additional window ventilation (Table 1). However, if the primary energy demand is compared by considering the primary energy factor of the various energy carriers, the use of the heating cable is not always the better choice. This is especially true, if energy carriers with a smaller primary energy factor are used for heating (district heating or regenerative energies).

Table 1: Comparison of the energy demand for ventilation additional to an air change rate of 0.3 h^{-1} and the use of a heating cable.

Thermal bridge	additional demand of ventilation to air change rate 0.3 h^{-1}						heating cable
	location Hof [kWh]	air change rate [h^{-1}]	location Würzburg [kWh]	air change rate [h^{-1}]	location Freiburg [kWh]	air change rate [h^{-1}]	All three locations [kWh]
external wall edge	3.525	0.7	2.952	0.7	1.962	0.6	430
balcony slab	2.643	0.6	2.214	0.6	1.962	0.6	256
floor slab support	1.762	0.5	2.214	0.6	1.309	0.5	615

The air change rate of 0.3 h^{-1} taken as a basis may be realistic in numerous cases, but represents only the lower limit of usual ventilation rates in the stock of existing buildings. Anyhow, for an air change rate of 0.5 h^{-1}, which is characteristic of old buildings and frequently achieved by the infiltration air change alone, the use of the heating cable is more energy-efficient than a higher rate of window ventilation. Moreover, as experience shows users only rarely change their ventilation behaviour so that the requirements of higher rates of window ventilation usually show little effect. In many cases, a higher air change rate could only be achieved by air-conditioning systems.

From the building physical and energetic point of view it is reasonable to solve the problem of thermal bridges by adequate measures of thermal insulation. Since these thermal insulation measures are not easily accepted by owners and according to local conditions their realization is complex and expensive, the additional heating of thermal weak points at least as a temporal solution is an adequate measure from the energetic as well as financial point of view, which can be better suited than additional window ventilation. However, the additional risk of fire must also be taken into consideration. This kind of electrical heating should not be used in any case to avoid mould growth behind furniture placed in front of external walls with insufficient thermal insulation.

Keywords: Thermal bridges; local heating, energy efficiency

TES EnergyFacade – Proven Practice

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'TES EnergyFaçade' stands for the application of prefabricated timber elements offering solutions for the energy efficient building envelope refurbishment as well as building extensions.
The paper presents lessons learnt from several built projects of different types (public, residential buildings) and scales (up to six floors) and demonstrates the possibilities, the timber construction sector offers for building modernization on a European level.

Keywords: Building modernization, refurbishment, energy-efficiency, TES EnergyFacade, wood construction

1. Introduction

'TES EnergyFaçade' stands for the application of prefabricated timber elements offering solutions for the energy efficient building envelope refurbishment as well as building extensions.
'TES EnergyFaçade' provides a structured guideline for the application of prefabricated large-sized timber framed elements along the workflow from planning, digital measurement, off-site production and on-site assembly. The elements combine a self-supporting structure with an infill of insulation and a panelling offering the possibility to utilise a great variety of cladding materials (e.g. timber panels, sawn boards, tin, plaster etc).

'TES EnergyFaçade', advanced by value-adding attributes (i.e. elements with integrated HVAC components) provides the answer to a new, industrialised holistic and cost-efficient refurbishment system.

The stakeholders of a renovation project benefit from the transformation of the refurbishment business from a resource-intensive to a value-added knowledge intensive, innovative and globally competitive industry based on sustainable use of renewable materials by:

- Predictable project development concerning cost and time based on a holistic workflow from planning, production and site management
- Precision and quality of the building system based on the competence of the timber construction sector
- Ecological benefit of wood with positive LCA effect
- Reduction of time on-site with less noise and disturbance
- Design freedom by applicability of a great variety of cladding materials
- Integration of load bearing, space elements and / or solar active or HVAC components

2. Conclusion

Contemporary timber construction is characterized by standardized planning and construction processes with a high level of prefabrication. This offers great opportunities for the task of building modernization. Using maximum sized prefabricated elements is a premise of the economy and requires increased effort of planning, in which on the basis of a thorough building analysis, the design of the elements, their transport logistics and assembly are considered.

Rationality and precision determine the manufacturing process. Standardized, optimized and monitored production processes from the inventory management to the production allow a controlled and high standard of quality. The use of prefabricated construction elements improves productivity during the on-site assembly and thus leads to less disruption of operations and the living environment.

In addition to residential buildings, public buildings such as schools, kindergartens, and administration buildings require refurbishment methods in the ongoing operation. Wood construction can offer intelligent and resource-efficient solutions in many areas. The opportunities lie in the individualized prefabrication to offer tailor-made solutions for the modernization of our building stock.

Block of Flats from 1958, Rejuvenated with Wood

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Summary
A rundown 1958 post-war housing estate in the west of Munich was first an object of study, then a planning model and finally a showcase project for holistic wood renovation. For an ideal lifecycle balance and overall economy, the following is vital: maintain the carrier substance, rebuild, recompress, passive-building envelope pre-fabricated in wood, timeless design and regenerative energy supply.

Keywords
Solar construction, renew stock, recompress, set of objectives, lifecycle balance, grey energy, wooden construction, pre-fabrication, passive house, solar energy

Location	Munich-Sendling, Badgasteiner-/ Fernpaßstraße Building
owner	GWG Städt. Wohnungsgesellschaft München mbH
Planning+construction management	KLA Kaufmann.Lichtblau.Architekten, München/ Schwarzach
Structural planning	MKP Merz.Kley.Partner/ EST Energie.System.Technik
Funding/ Research	KFW, dena, LH München, E2ReBuild
Construction dates	Original 1958/ Constr. Phase 1 2010-11 (Phase 2 2012-13)
Net dwelling area	3.323 m2 (originally 2.012 m2, + 65 %)
Units	46 flats/ district housing office (originally 36 flats)
Envelope quality Ht’	0.26 W/m2K (originally 1.56 W/m2K)
End energy	22 kWh/m2a (originally 280 kWh/m2a)
Primary energy	22 kWh/m2a (originally 340 kWh/m2a)
Building cost	950 €/ m2 GFA (German DIN cost groups 300/400, gross

Abstract

The housing estate owned by GWG was still in its original condition from the late 1950's when planning began. Typical features included: widely spaced blocks of flats with nondescript outdoor lawn areas; mixed masonry construction with wooden-framed windows and concrete ceilings below non-insulated roofs; spartan, standard floor plans for flats around internal stairwells; massive deficits concerning fire safety, sound insulation, variability and comfort; basic building technology, high energy costs, inacceptable indoor climate.

The planning process for the necessary complete renovation began in 2007 with a student project entitled "Weiterbauen" (Building further) at the Technical University of Munich, Faculty of Architecture, Wooden Construction). Starting from this basis, the architects and building owner prepared a catalogue of target specifications concerning:
A High-quality usage: Quantity, quality, accessibility (disabled-friendly) and outdoor areas
B Energy for the future: Efficiency, regenerative supply and overall economics
C Sustainable construction: Substance-conserving, ecological wooden construction, process and design.

The planning team led by Kaufmann.Lichtblau.Architekten developed a higher-density renovation model. By incorporating a new building for the district office of GWG, the load-bearing structure of the original buildings could be retained but the access was changed, and the flats were transformed into individual modern residential units with attractive outdoor areas. The new building envelope, including that for an added storey, consists of pre-fabricated wooden elements meeting passive-building standards, with maintenance-free wall cladding and green roofs. Exemplary solutions were developed for life-cycle and energy balances, building science and structural aspects, fire safety, sound insulation and an efficient construction process.

The first building phase was completed in 2012, phase 2 has begun. Holistic value enhancement, energy efficiency which is fit for the future and a wooden construction offering active climate protection, combined with optimal usage quality, promise the highest total economic viability for generations.

Relevance of Thermal Fluxes through the Building´s Interior Partitions

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Summary

Efficient thermal insulation has so far been aimed at improving building envelopes, understanding a building as a unique thermal space. Although it could be the case in some kinds of constructions, because of the higher degree of independence of individual persons and the concentration of people in multi-story buildings internal energy fluxes are generated and this caused us to wonder about the relevance of climatic energy loss through interior partitions according to different occupancy patterns. We tested one real Uni-thermal-Zone-Buildings and one virtual Multi-thermal-Zone-Buildings in order to determine the relevance of these thermal losses in the main buildings typology to identify a week point to focus on.

Keywords: thermal energy fluxes; occupancy patterns; thermal insulation; interior partitions.

Extended abstract

Thermal efficiency in buildings is becoming one of the most useful parameters to improve our buildings and contribute to save energy and money for both inhabitants and countries. Furthermore, it could suppose an opportunity to redefine the goal of architecture, which would then center on the building's utilization stage instead of its design or construction stage. However, thermal efficiency in buildings has so far focused on improving building envelopes and concentrating on the relation between interior and exterior spaces. This is a very important approach to the topic and has been deeply studied all over the world by very efficient teams and companies, but we wondered about what happens inside the building. As we know, buildings do not work as a single space with only one activity, but rather function as a conglomerate of activities and spaces with different heating needs. In consequence, we focused on calibrating the relevance of thermal fluxes through these interior building partitions comparing them with thermal fluxes through all exterior enclosures. That way we could determine the importance of incorporating thermal insulation in these interior partitions to achieve a better thermal efficiency in buildings.

Aiming to answer this question, we designed a progressive approach to the phenomenon by dividing our research project into two main building typologies. The first ones are called Uni-thermal-Zone-Buildings (UZB) and consist of all those buildings using a programme with no big heating need differences between spaces. Public facilities are usually included in this building typology due to the missing physical partitions between different utilizations. The UZB case study we chose is the Vallès Higher School of Architecture (ETSAV) from the Polytechnic University of

Catalunya (UPC). The second building typology we used in our research are the Multy-thermal-Zone-Buildings (MZB) which encompasses all residential buildings. In this case, the main feature is the great fragmentation of the spaces. In residential buildings, for instance, each dwelling has six surfaces through which to gain or lose heat. The same thing happens in hotels and all those buildings with a high physical, if not thermal, space compartmentalization.

Once this first classification was completed, we started studying UZB as we supposed them to be conceptually simpler than MZB, which could subsequently help us to properly understand the phenomenon. First of all, we developed a surface and ambiance temperature measurement protocol with the objective of proving the phenomenon's existence. For that reason, we registered the ambiance temperature of some ETSAV's spaces during six months, to then compare them with the surface temperatures of the same specific spaces chosen for their characteristic conditions. The results pointed out that there were energy fluxes through all partitions we tested, and so we delved farther into the research. The second step, according to UZB, consisted in developing a thermal calculation model in which we would be able to compare energy losses through interior and exterior partitions. To achieve this, we selected the ETSAV building, which is fully monitored by SIRENA systems from the UPC (http://www.upc.edu/sirena), thereby providing us with the electricity and gas value used in the building, as well as enabling us to calibrate our model according to real energy consumption. To develop this thermal model we chose to work with the excel format and calculate the parameters of thermal loss through the building's envelop, interior partitions and through air renovation. To gauge thermal gain we took occupation, electric consumption and gas consumption into account. With these basic items we were able to calculate and compare thermal losses through interior and exterior partitions. The results show that, in our UZB case study, 20,46% of heat loss occurs through interior partitions, which might not appear to be a great amount but is actually significant if we review the building's construction. It is a building with an enormous air volume along with low variability of temperature between different spaces and a very low thermal efficiency in the façade because of the seen structure, which constitutes a big cold bridge, in addition to the simple windows designed without considering the transmittance value.

With these first results in hand, and knowing more about what the phenomenon represents, we walked into MZB, to check the relevance of thermal fluxes through interior partitions in that building typology. In this case, we used a basic virtual 3D shape to represent our building. We put together a 3x3 mesh with two-façade units, resulting in an overall of nine spaces. We worked on the most basic model of multi-story building using the same excel styled model and the same parameters as we did with the UZB. In this case, the amount of energy lost through interior partitions ranged from 25,7% to more than 70% of the total heat loss. We can hence see that these interior energy loses can reach very high values in MZB and could thereby expose an important area to work on if we want to improve the thermal efficiency of this building.

To conclude, we would like to point out the relevance of the typology-dependent thermal behaviour of buildings. There is not just one approach or solution to improve a building's thermal efficiency. As we see, the main problem to achieve a correct energy efficiency in UZB is not thermal loss through interior partitions. In MZB, on the other hand, it plays a key role in this. It could therefore be interesting to think about independent thermal zones in MZB overlapping each housing unit, allowing the users to consume just what they need. Moreover, the residential sector is the most usual in building typologies and could represent an excellent opportunity to further improve inhabitants' comfort. Finally, we realized that, according to thermal efficiency, the more the façade is improved, the more significance heat loss through interior partitions acquires. This point leads us to wonder whether both interior and exterior partitions should be drawn up together in order to reach a balanced thermal behaviour of the buildings. Otherwise, we could have been working on just half the problem.

Short bibliography

:: paper: "Una visión-país para el sector de la edificaicón en España. Hoja de ruta para un nuevo sector de la vivienda". Grupo de Trabajo sobre Rehabilitación [GTR]. Albert Cuchí i Peter Sweatman. Novembre 2011.

Towards Climate-Based Irradiation Recommendations for Optimal Solar Design: Insights from a Parametric Study

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Summary

In the early phases of the building design process, decisions are made on certain geometrical parameters, which strongly dictate the future performance of the building. This paper presents the results of two parametric studies conducted to investigate the impact of specific design parameters on three performance indicators related to solar potential and thermal and visual comfort. Results indicate which parameter has the strongest impact on each indicator and provide useful and potentially non-intuitive insights into the dynamics of building performance.

Keywords: solar potential, comfort, parametric study, early design parameters, passive zone

1. Introduction

At the early design phase, practitioners must take decisions on various design parameters, such as building height and orientation. Such decisions dictate to a large extent the future performance of the building in terms of energy consumption. This study aims at investigating the implications of such early design parameters with respect to three performance criteria: (i) solar potential (for passive and active exploitation), and (ii) thermal and (iii) visual comfort of occupants.

2. Methodology

To study the impact of early design parameters on the three performance criteria, two parametric experiments were conducted. Each experiment consisted in a set of design iterations, referred to as scenarios, and characterized by specific parameter values. Each scenario was modeled and evaluated in an iterative process using the DesignBuilder software. The base case model for each experiment consisted in a virtual generic office building of one floor (4 m high) located in Geneva, Switzerland, with a brick façade, a flat roof, dimensions of 20 m by 20 m (exp. 1) and 45 m by 40 m (exp. 2), and default construction values as given by DesignBuilder. The first experiment focused on three early design parameters: height (4 m vs 20 m), window-to-wall ratio (30% vs 70%), and roof inclination (flat vs pitched), while experiment 2 focused on the passive zone (proportion of area falling within 6 m of an exposed façade; 49% vs 100%) and building orientation (N-S vs E-W alignment).

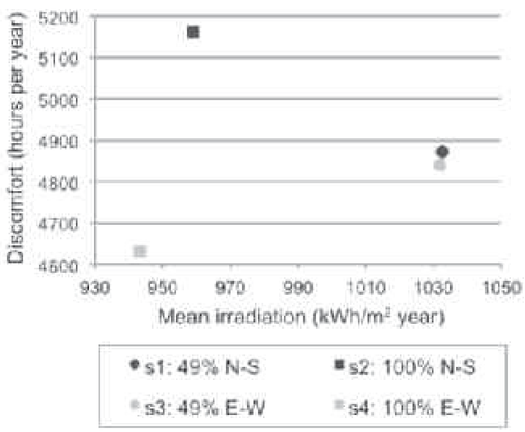

Fig. 1: Thermal comfort (discomfort hours) versus solar potential (mean irradiation) for each scenario of experiment 2.

The evaluation of each performance criteria was done using a specific indicator. The solar potential was evaluated based on the average irradiation received on all exposed surfaces (walls and roof) throughout the year, expressed in kWh/m^2 yr. Thermal comfort was evaluated based on the operative temperature of the free-running building and its deviation from the comfort zone calculated using the

ASHRAE adaptive comfort model. Visual comfort was evaluated using the daylight autonomy indicator provided by the LEED v3 NC 2009 IEQ 8.1 report outputted by DesignBuilder.

3. Main Results

Results for experiment 1 indicate that scenarios of lower height (4 m) have less discomfort hours, while having a higher mean irradiation. Analysing the percent contribution of each parameter show that building height dictates to a large extent the irradiation level, while this level is practically unaffected by the roof inclination, thus a parameter of no significant importance in the studied context when it comes to designing for active solar system installation. These results provide useful and possibly unintuitive information to practitioners. In experiment 2 (Fig. 1), when increasing the passive zone surface (circles to squares), the effect on the discomfort level varies based on the orientation: an increase in the discomfort hours occurs for the N-S orientation, while a decrease is observed for the E-W orientation. These results demonstrate the existence of a significant interaction between these two parameters that affects thermal comfort performance.

4. Conclusion

Two parametric studies were conducted on a virtual office building located in Geneva. The outcomes suggest that specific early design parameters, namely orientation and proportion of passive zone, cannot be considered independently when assessing their impact on specific building performance criteria, while others (height, roof inclination and window-to-wall ratio) do not present any such interaction. These results provide a motivation to pursue the development of a comprehensive evaluation method joining performance criteria relating to solar potential and comfort.

Case Study: Sustainable Icons for Mega Events: FIFA WC 2010, UEFA EURO 2012, FIFA WC 2014

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Summary

Designing stadia as big, spectacular spaces for major events is a challenging and complex task. With over 20 built stadia gmp - Architects von Gerkan, Marg and Partners have been developing strategies in stadium construction that meet the challenges not also for the FIFA requirements but also of sustainable structures. Stadiums used during the football World Cup in Germany in 2006 (Berlin, Frankfurt and Cologne), for the 2010 event in South Africa (Cape Town, Durban and Port Elizabeth) and those for the upcoming World Cup in Brazil in 2014 (Manaus, Belo Horizonte and Brasilia). gmp Architects aim for increasing a social value, which transcends major events – to earn social acceptance, create regional identities, shape urban development or rather find integration and increase the positive image of sporting events. In this context sustainability is not limited to energy efficiency in operations and construction, but also the maximum of flexibility and long term utilization of stadiums meeting multifunctional requirements, not only for sports, but also for other mega events like concerts etc. or for office, hotel and other touristic or commercial purpose.

Keywords: simplicity; variety and uniformity; distinctiveness; structural order, dialogical design

1. Introduction – gmp - Architects von Gerkan, Marg and Partners

Founded by Meinhard von Gerkan and Volkwin Marg in 1965, gmp has grown to one of the major architectural offices with more than 600 employees in eleven offices in Germany, China, Brazil, Russia and Qatar. More than 300 buildings have been constructed by gmp worldwide. gmp has designed museums, theatres and concert halls, office buildings, commercial centres and hospitals as well as research facilities, buildings for transportation, master plans, trade and industry buildings, educational and sports facilities. With the FIFA venues built for the World Cup 2006 in Germany, the Stadiums for the South African World Cup 2010, for the UEFA EURO 2012 in Poland and Ukraine and also for our task in Brazil for the FIFA WC 2014, gmp is recognized as one of the most professional stadium architects worldwide.

2. Stadia built for mega events: icon versus sustainability? - Examples

Designed for the FIFA WC 2010 in South Africa, the Moses Mabhida Stadium in Durban, is situated on an elevated platform in the central sportspark on the shore of the Indian Ocean. A 105 m arch rises high over the stadium as a landmark visible from afar. It incorporates a cable drawn Sky Car and carries the weight of the inner membrane roof. The shape of the bowl results from the interaction of the circular roof structure with the triple-radius geometry of the arena. The façade membrane of perforated metal sheeting provides protection against driving rain, strong winds and direct sunlight without excluding the outside world. The stadium has been designed to attract public interest and activities 7 days a week. Major events have been hosted and also shops, restaurants, cafes and a gym operates day and night.

The duality of a solid historic stone base and the new structure made of steel, glass and PTFE membrane characterizes the design of the National Stadium in Warsaw, built for the UEFA EURO 2012 in Poland. Also unmistakable as a feature visible from a distance is the facade, made up of expanded metal panels in the Polish national colours of red and white. As the stadium is not regularly used by a particular football club, major provision was made for office and conference use, a museum, a restaurant and fitness club so as to ensure regular commercial use of the stadium throughout the year in addition to sporadic concerts and sports events. The closable inner membrane roof is one particular feature ensuring year-round utilization. The stadium constitutes a sustainable urban-planning and functional development for the City of Warsaw.

The “Arena da Amazônia” in Manaus, build for the 20th FIFA World Championship in 2014 in Brazil, will be one of the world’s first LEED certified stadiums. Criteria in this rigorous certification process include location, construction sequence, transportation routes and the primary energy content of all materials, water management, energy consumption, regulation and control technology, waste management, as well as the ongoing monitoring of operations. Manaus, a city with a million inhabitants, is located in the middle of the Amazon jungle. The city’s fascinating cultural heritage and the beautiful rainforest surroundings turns it into a major tourist destination. With the „Arena da Amazônia“ the city gains a distinctive landmark, which embodies the standards of the responsible use of natural resources.

3. Conclusion – Sustainability as an essential aspect of iconic stadium design

The presented examples of stadia all give in insight into sustainable stadia design. Our understanding of design philosophy is based on a complete integral approach to sustainability. Whereas the public and academic discussion very often concentrates merely on the figures and concepts of the technical installations our designs also include social, spatial and conceptual aspects. Multifunctional purpose is crucial in terms of life-cycle, attracting public interest and activities. Considering the ecological aspects as an integral part of the design from the very beginning opens the door for creating a synergy between technical demands of the games and long term responsibility for future generations.

Analysis of Respondents' Opinion on Smart Buildings

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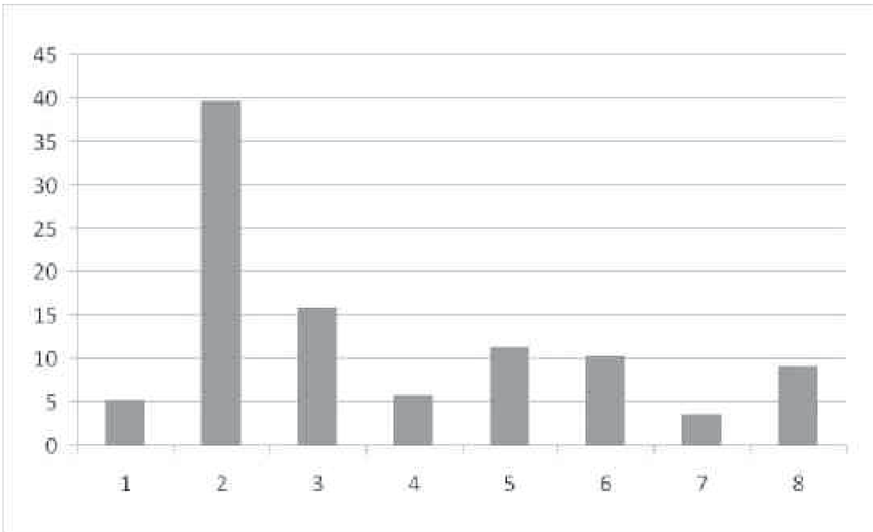
Keywords: Smart buildings, Comfort, Indoor environment factors

Extended abstract

The definition of smart building changes by various countries and in the time. But the main objective of smart building remains easier and pleasant habitation or workplace of users. A smart indoor space should be an adaptable and dynamic environment that optimizes user services and management processes using smart systems. The most important is to capture the degree of intelligence that is needed to ensure comfort of users. But every person has individual needs and requirements. So how could smart buildings look like according to needs of users?
The most important tool in creating a satisfactory indoor environment is feedback from building users. It is very important to think of future building users, character and sort of work performed and particularity of each of them so as to provide the best user's performance rate. Application of post-occupation evaluation results can bring a lot of impulses to remedy various kinds of factors, whether in existing or future projects.
Evaluation investigates a collection of information that relates to smart buildings in Slovak republic, building in term of intelligence and suggests the most important factors of indoor environment by respondents from view of their performance. Respondents were users that perform a sedentary work in different office buildings with various intelligence rates of buildings. Final count of evaluated questionnaires was 177. The questionnaire consists of demographic characteristics (gender and age), the questions about respondents' opinion on smart buildings and what benefits and characters that they should provide. What sort of operation do they desire in their workplaces? Would they want to work in smart or standard building?
The following factors are evaluated by respondents: temperature, quality of indoor air, ventilation, lighting, acoustic, visual contact with outdoor environment, and contact with plants in the workplace, electro smog and character of workplace and facilities. These factors were evaluated according to their impact on users' comfort and performance in general at their workplaces. Respondents attributed importance of the factors in the interface 1 to 10, where 1 means the least and 10 the largest impact on users' comfort and performance. Respondents also expressed other needs and requirements which have effect on their well- being. Important part of the questionnaire consists of respondents' opinion about ideal building of their workplace, its main significant properties and abilities leading to filling up their needs and requirements.
Research participants consist of 43% women and 57% men. Age of respondents is 20 - 30 years (73%), 30 - 40 (20%), 40 - 50 (3%) and over 50 years (4%). The vast majority of respondents (89%) answered that they have knowledge about smart buildings. Results of evaluated workplace factors show that thermal state and air quality has significant impact on respondents' comfort. Other significant factors are lighting and acoustic. Results also show that thermal state has significant impact on respondents' performance, air quality and lighting has significant impact on respondents' performance too. The answers about respondents' opinion on smart buildings were different (Fig. 1)



1- The building, which provides comfortable environment for users; 2- automatically controlled building; 3- energy efficient building, which uses of renewable energy sources and providing comfort to users; 4- The building, which should be safe for users, ensure the required indoor environment quality and comfort for the user; 5- The building with technologies which providing required indoor environment quality, comfort for users and energy saving; 6- The building with technologies which are able to communicate with each other and has the ability to predict and respond to users' needs; 7- The building with ability to respond to the conditions of the external and indoor environment; 8- Vague or no answer.
Fig. 1: Results of respondent's opinion on smart buildings

The thermal state, air quality, lighting and acoustics of indoor environment and work facilities and equipment was signified as the most important factors of the workplace by users. The other environmental factors like manual control of air temperature, air quality and lighting, sufficient amount of day-lighting, color design and cleanliness of the workplace, layout, and rest room with greenery, safety and ventilation rate in the workplace, the visual contact with exterior and contact with greenery of user (whether from indoors or outdoors) were another recurring factors related with their respondents' comfort and performance.

Sustainability Evaluation of Building Materials of 5 Buildings in Slovakia

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Summary

Building activity has recently become unsustainable. Several strategies have been introduced to reduce amount of operational energy and CO_2 emissions. In this paper building materials of 5 Slovak houses were analyzed in terms of environmental performance. Evaluation included the weight of materials, embodied energy and embodied CO_2 and SO_2 emissions. Analysis has proven that the selection of building materials is an important factor to influence the environmental profile.

Keywords: Environmental assessment, environmental profile, embodied energy, embodied CO_2

Construction industry has led to the deterioration of environment. Responsibility for the depletion of 40% of stone, 25% of wood or 16% of water and for production of CO_2 has become investigated by many researchers [1, 2]. The regulations are mostly usage phase-oriented, but also other stages of life cycle should be assessed. This paper is aimed at analysis of weight, embodied energy, embodied CO_2 and SO_2 emissions within cradle gate boundaries of materials of 5 Slovak houses.
Foundations consisted of concrete and gravel. Damp proof course was made of bitumen or plastic sheets. Ceramic or aerated concrete blocks were used for walls. Material of ceilings was reinforced concrete, ceramic block or wood. Roof was constructed of wood, while roofs weatherproofing consisted of various materials. Polystyrene and mineral wool were also used. Surfaces included wide range of plasters and floor surfaces. Wood or plastic windows frames were use.
Building materials divided into structures and material groups and evaluated within cradle to gate, as well as normalized. The total environmental profile of houses is presented in table 1.

Table 1: Overall environmental profile

	H1	H2	H3	H4	H5
Weight - kg	238428.7	314228.6	366986.6	175189.2	371087.6
PEI – MJ/kg	2.290	1.821	1.705	2.053	2.194
GWP - kg CO_2eq/kg	0.130	0.139	0.100	0.060	0.110
AP - g SO_2eq/kg	0.650	0.585	0.532	0.587	0.700

Normalized values presented in table 2 reveal more accurate comparison of buildings.

Table 2: Normalized environmental profile

Normalized	H1	H2	H3	H4	H5
Weight/useful area (kg/m^2)	1952.9	2548.9	2891.0	2187.1	2637.6
PEI/useful area (MJ/m^2)	4471.7	4640.4	4928.4	4490.3	5787.5
GWP/useful area (kg CO_2eq/m^2)	254.1	353.7	289.9	132.2	291.2
AP/useful area (kg SO_2eq/m^2)	1.269	1.491	1.539	1.285	1.846

For a more precise analysis the building materials were classified into structures (figure 1).

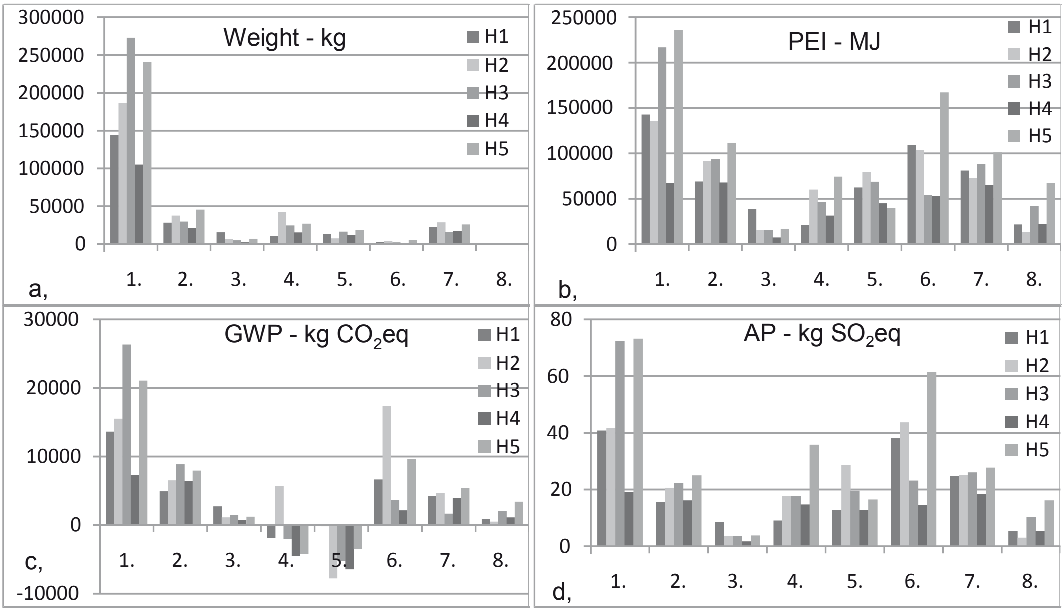

Fig. 1: Environmental profile of structures (1-underwork, 2-vertical load bearing structures, 3-partition structures, 4-ceiling, 5-roof, 6-thermal insulation, 7-surfaces, 8-doors & windows)

The materials selection is an important factor in building design. Environmental impact of materials of underwork and vertical load bearing structures (concrete, ceramic brick etc.) is relatively negative as high values of PEI, GWP or AP were reached, but also materials with relative low percentage of weight (e.g. thermal insulation) caused the negative environmental impact on GWP and AP. The results of study have proven that the investigation of sustainable building is necessary.

1. References

[1] DIXIT M. K., FERNANDEZ-SOLIS J. L., LAVY S., CULP C. H., “Identification of parameters for embodied energy measurement: A literature review”, *Energy and Buildings,* Vol. 42, Issue 8, 2010, *pp.* 1238-1247.

[2] ASIF M., MUNEER T., KELLEY R, “Life cycle assessment: A case study of a dwelling home in Scotland”, *Building and Environment*, Vol. 42, Issue 3, 2007, pp. 1391-1394.

Typological Examination of (Tensile) Membrane Structures in Building Exteriors Using Constructive Considerations

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Summary

Being part of the research project “membrane structures for thermal retrofitting of buildings (MESG)”, this typological approach on the possibilities of application of membrane structures in building construction.

While MESG actually focused on thermal retrofitting of buildings, the typology tries to create an overview of the possibilities and examines membrane constructions on different levels. Main goal of the research on the typology was to provide a well structured but extensive overview to determine where the biggest gains may be reached by specific constructive improvement of membrane structures and targeted advancement of the applied materials.
It was an interesting tour from traditional architecture, using thin layers as basic protection from sun, wind, rain and cold temperatures up to modern building technique, with its high-tech approach and fascinating future design and development options.

Basically, the main interest using these extremely thin and lightweight construction parts is to provide protection from the elements.
Nomadic cultures have used the advantages of membrane constructions for a long time. Most nomad dwellings are designed to be dismantled and carried by Horse, Ox, Camel or Yak. They are of comparatively very low weight and can be assembled and disassembled very fast. These two advantages predestine membranes to be used in mobile or temporal buildings.

When looked upon in more depth, there are many possibilities to improve the structural-physical effectiveness of buildings by using membranes.
Almost always, a characteristic architectural language develops by the structural demand of these constructions – all load transfer via membranes can only be done by tensile stress, unlike load transfer in traditional building parts, mainly relying on bending resistance. Being extremely lightweight, foils and fabrics are ideal for mobile constructions, retractable/movable parts and prefabricated modular parts.

In nature, membranes often not only separate the inside from the outside, but take over more complex tasks. Selective permeability allows the membrane to keep unwanted substances out and to regulate. While cell membranes can’t really be compared to membranes in construction, which consist of one or few comparably very simple materials, it is very challenging to think about the possibilities a thin, polyvalent building skin could offer.

Membrane materials are also promising form an ecological point of view. They help to decrease the total mass of building skins and supporting bearing structures, thus reducing energy

consumption in production and construction.

During the research Project, several buildings were considered for practical examination. By analyzing real situations with real buildings, it should be prevented to consider approaches that most likely can’t be translated into actual solutions for the building sector. One of them was a courtyard at Technische Universität München (TUM).

By developing a precise architectural design, the application of a membrane roof to close an open courtyard, surrounded by façades protected by preservation order, was examined in a practical and realistic manner. Different versions of bearing structures were considered and optimized for the given task. They were precisely calculated by structural engineers, estimating the dimensions of every part of the structural System.

This allowed to assess the primary energy used to fabricate the construction parts, making it possible to compare a membrane-cushion roof to a roof with classic overhead glazing by means of primary energy used in production (cradle to gate).
Furthermore, these numbers were compared to the energy necessary to pressurize the cushions, considering a longer period of time up to estimated 80 years of total building lifetime.

The results of the typological examinations and of the situation analyzed in detail will be presented, as seen from an architects point of view

Keywords: Textile architecture, membranes, building material, typology, energy efficiency

Hi-Hech Low-Tech: An Experimental Sustainable House

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Summary

Why should we think it is sustainable to buy a prefabricated wood house in northern Italy and to assemble it 1000 km far away in southern Italy? Which features should a small house have in order to be suitable for southern Italy climate and landscape? The design team I belong to, tried to give an answer to this question by taking part to the Italian Ministry for Environment, Territory and Sea competition Ecoluoghi 2011 to design a 45m^2 sustainable house. The project “Low-Tech High-Tech” was awarded, with other projects, in 2011 and the prototype of the house was built and eventually exhibited at the MAXXI Museum (National Museum of the 21st Century Arts) of Rome in summer 2012. The name we chose for the project, “Low-Tech, Hi-Tech”, well embodies the concept that lies underneath it: to take advantage from this apparent opposition of terms.

Method

The prototype made it mainly possible to test the constructability of the project on the base of the following “sustainability” criteria

- to reduce long distance transportation of heavy materials
- to concentrate the hi-tech performance in few elements of the building
- to support local economy
- to favour the integration with the local landscape
- to maximize the reuse of building material
- to minimize the consumption of soil and non-renewable energy
- to keep costs affordable

Results

From the “Low-tech” approach we took some “vernacular” elements belonging to southern Italian architecture: thick stone walls with small windows, tall roofs to facilitate the hot air stratification and circulation, open shaded spaces where to expand the activity of the house; from the “High-tech” approach we employed high thermal performance materials to minimize heat losses, a convertible winter garden made of EFTE air cushions, solar panels to gain thermal and electric energy and high performance heating plant.

The Low-tech domain capitalized on simplified building techniques, recycled or easily available materials and implied making use of local unskilled manpower. The “Hi-tech” area applied, instead, to technologically more complex building elements, often produced in far areas of the country and requiring skilled work. In Mediterranean countries, where mild winters alternate to hot summers, the internal comfort is essentially stemming from a good control on irradiation thermal gain and from a good ventilation of the rooms. Here below we provide a description of the features of the house according to the principles of sustainability, constructability, adaptability, comfort.

- Sustainability

The Low-Tech elements of the house are: the load-bearing 55 cm thick wall, combining a high thermal inertia (16h), and good insulation (0.27 W/m^2 K), and the external coating in local stones without mortar (as if for the construction of a dry wall). This is contained in wire mesh gabions and has the function to protects the wall from solar irradiation. High-tech elements included in the project are the winter garden structure and the windows. The winter garden, with low temperatures, has the task of working as a buffer zone between the outside and the glass wall to the south.

- Adaptability

In order to reach the goal of adaptability to the landscape and use, we applied the camouflage approach by recycling part of the material extracted from the excavation to cover the external walls. The need of “adaptability” to different weather conditions was met by transforming the traditional “porch” in a year-long liveable place, where residents can spend their time out-door also with different climatic conditions.

- Comfort

Interior comfort is based on the use of natural resources (sun, wind, water and soil), by focusing on the integration of active and passive behaviour of the house. The house, according to the calculations of the testing model, is ranked class A with an average consumption of 25 kWh/m^2 year.

- Constructability

Building up the “Low-tech” part of the house is easy to do. The “Low-tech” consists of heavy masonry envelope. This does not require skilled workers and materials can be found on the local markets. The external coating is an evolution of the traditional dry stonewall, with stones taken from excavation made in the local soil. We use box shaped elements made with steel mesh. The High-tech elements are mainly represented by the winter garden, the windows, and the mechanical plants. They all need skilled workers and transportation from distant markets.

Conclusion

The “Low-tech high-tech” house embodies a combination of a semi-prefabricated and a semi-handmade building at reasonable costs. Without the need to repeat vernacular house type, simplified technologies (low-tech) have been used wherever these proved to be compliant with the required performance, whereas advanced (hi-tech) technological solutions were applied to obtain the highest levels of performance. The results show a possible perspective to look at the issue of southern Europe sustainable house building.

Fig. 1; The prototype of the “Low-tech High-tech” house exhibited at the MAXXI of Rome

Keywords: Hi-tech Low-tech; prototype; Mediterranean; low cost; sustainable small house,

Guidelines for Low-Cost, Energy-Efficient House in Iraq

Case Study: Single-Family House in Baghdad

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Summary

The goals of this study are to determine specific guidelines for Iraqi architects to contribute to the design and composition of energy-efficient housing units within the limits of a normal budget, locally available materials and technologies. These units can provide comfort despite the current energy situation in Iraq. The study is based on a computer simulation for a reference building in Baghdad, which has been selected according to the urban conditions, building legislations, housing market and statistics.

Keywords: Iraq, Housing, Energy- efficiency, Cost, Simulation, Optimisation, Material

1. Introduction

The goal of the study is to determine guidelines for architects and developers to the design and implement energy-efficient housing. The term low-cost means a house built with a comparable investment as the “conventional“ house, whereas the term energy-efficient implies comfort can be achieved with the energy resources available today.

Iraq faces a serious shortage in housing units due to decades of war, sanctions and corruption the shortage is estimated to be about 1.27 million additional units for the period from 2006 to 2016. Moreover, the electricity supply is highly unreliable as the production does not exceed 50% of the demand and the supply hours now hardly exceed 8 hours per day in Baghdad and people have to pay extra for electricity supplied by private generators places in the neighbourhoods.

After analysing the current conditions and local climate of Baghdad, a focus building is selected according to urban, economic, legal constrains as well as construction materials and techniques. Figures dealing with average energy demand in housing units are not available; therefore, computer-based simulation using Ecotect analysis programme is used to calculate the energy demand of the focus building to get an impression of what is the energy demand of a typical house. The next step is the building optimisation by selecting different parameters in terms of material choices, window types, window sizes, colour and shading. The last step is to develop some energy scenarios for the house with different HVAC systems by comparing the investment and energy cost for different alternatives while mentioning some other impacts that might not be clear when only economy is considered.

2. Results & conclusion

The heating and cooling loads for the reference building were 43.68 KWh/m².a and 98.09 KWh/m².a respectively with maximum heating power of 9608 Watt at 08:00 on 13th January and max cooling power of 16989 Watt at 15:00 on 16th September. Different thicknesses for the exterior brick walls as well as the possibility of using ICF (insulated concrete form) were tested, better windows with smaller sizes and different shape according to orientation. Shading devices were also included to reduce the cooling load in summer without blocking solar radiation in winter. The most efficient material alternative was the ICF structure with smaller double-glazed windows and shading devices which has an annual load of about 53.24 KWh/m².a for heating and cooling.

The comparison was between three main scenarios; the reference building; the optimized building with 36-cm thick walls and the optimized with ICF walls. In the optimized scenarios it was possible to use evaporative coolers which consume less energy compared to split-unit air conditioners. The comparison was based on the construction cost and the energy cost which is calculated according to the prices of private generators neglecting the subsidised and unreliable electricity from the national grid. The private electricity is priced by amperes assuming a monthly supply of 16 hours a day would cost 20 USD/ Amp. The table below depicts the estimated construction costs (including AC or evaporative coolers and heaters) and the annual energy costs.

Scenario		Construction cost USD	Energy costUSD
Reference Building		103983.25	5520
Optimised-36	AC	121913.25	2700
	Evaporative cooler	122783	620
Optimised ICF	AC	108423.6	2700
	Evaporative cooler	106693.6	613

The final results displayed the main recommendations and the possibility to achieve up to 50% energy reduction with a pay-back period not exceeding two years in some cases. There are some measures that have big energy saving potential such as improving air tightness, shading devices, high thermal mass and the use of evaporative coolers. Yet, some of the measures may require big investment or have some bad environmental impacts. Some other good measures are already being implemented such as the compactness and high thermal mass.

Learning and Community Life: Educational and Cultural Buildings to Improve the Quality of life in Medellín, Colombia

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Summary

Since 2002, the public and private sectors in Medellin, Colombia, have planned the design and construction of 22 new daycare centers, the physical improvement of more than 150 schools, the construction of ten new quality-certified schools, eight new libraries and new buildings in the public and private universities of the city. All of this work has been a strategy to improve the quality of education and to conceive a better future through knowledge, culture and wellbeing.

The city has tropical weather and is located at 1450 meters above sea level. Most of the time, these kinds of buildings require the use of mechanical equipment, which increases energy consumption and general overhead costs, to provide comfort inside. With this equipment the energy consumption rises and also its general overhead costs.

This investigation is based on the production of new knowledge to design and build educational spaces with a rational, efficient and sustainable use of necessary resources for their operation, according to the environmental conditions of the context. The investigation has applied its results to three educational and cultural buildings in Medellín: a daycare center, a university building and a cultural square next to a library.

The main question of this investigation was how to generate architectural design strategies through façade and roof systems to control the temperature in the interior of these buildings without using mechanical equipment and to have naturally illuminated and ventilated spaces with high levels of comfort and low energetic consumption.

The Daycare Center and Family Home has been constructed in Moravia, a neighborhood (barrio) located over a former landfill area in the shape of a hill. The building takes advantages of topography to conjugate open spaces (playgrounds) and closed spaces (classrooms). An analysis made through the use of models and software allowed the definition of strategies to control sunlight and wind on the building's façades.

In the Universidad Pontificia Bolivariana (UPB) of Medellin, the School of Engineering building has its longest façades facing east and west due to the characteristics of the terrain where it is located. In order to block the annoying sunlight, there is a system of double skin, which consists of the design of two similar façades separated one from the other, thus creating an air chamber in between. As a result of the previous investigation, it was found that the openings on each façade are not aligned. This allows light and wind to enter freely into the building but block direct sunrays, allowing the classrooms to have a comfortable interior environment without the use of mechanical equipment. It was necessary to investigate the modulation of the windows in the interior façades and the proportion of the openings on the outside façade. The lighting strategies for the classrooms consist of the reflection of indirect sunlight on the white walls inside the building.

The third project is the Literature Park, an urban and cultural space adjacent to the *Piloto* Public Library. This covered space takes advantage of the shadow provided by the existing trees and a double-cover system controls the entry of sunlight, generating an urban space with comfortable lightning and ventilation. At the plaza entrance, the upper cover was built using translucent polycarbonate to prevent water filtration. The lower cover was built with modular elements to control the entry of sunlight and reduce the intensity of natural light in a square designed for cultural and academic events. Using a shadow diagram constructed to simulate the latitude of Medellin with the exact location of the project, we reached the desired levels of lighting and air quality. The shade provided by the vegetation and the cover makes a transition in light intensity from an urban space to the interior of the library.

Having knowledge of the bioclimatic behavior, these previous analyses allowed us to generate architectural design strategies and environmental qualifications that determine the aesthetics of the buildings. Solar control strategies provide the highest level of comfort without using air conditioning and mechanical systems to ensure adequate natural lighting. This foreknowledge allowed us to design buildings with lower energy consumption that generate sustainability criteria, while providing spaces for culture and education to improve the quality of life of these communities.

Keywords: Education, sun control, natural lighting, natural ventilation, comfort, sustainability.

ClimaDesignCompetition - Methodological Principles for Implementing Sustainable Issues in Architecture Competitions

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Summary

Architecture competitions offer the possibility to find an aesthetic and suitable solution out of a number of design proposals. Preliminary design influences at most the life cycle performance of buildings and of urban projects. Therefore the issue of sustainable development is increasingly entering the design competitions. For a feasible and successful competition the use of appropriate assessment criteria according to its aims and objectives is important. The optimized framework and the specific methodology for all stages of the competition makes it possible to base the jury decision on appropriate information and with appreciation for the workload of the participants.
The paper presents the results of a completed research project [1] and an ongoing PhD.

Keywords: Architecture, Competition, Assessment Process, Criteria, Sustainability, Information Transfer, Visualisation, Methodology

1. Introduction

Architectural competitions are an established evaluation method for initial design of construction and development projects. They meet exactly those phases of the project development that determine the future building's design. It is thus only natural that ecologic and economic aspects of sustainability are catching up with established socio-cultural aspects and are often appearing in the briefs of architectural competitions. This actually causes discussions among experts and owners, because the established processes do not provide satisfying means for evaluating those aspects and requirements stated in the briefs are often overloaded and out of proportion.

2. Results

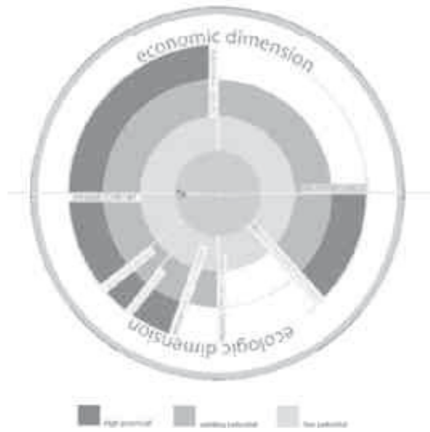
This paper summarises the completed research project „ClimaDesignCompetition“ [1] and an ongoing dissertation with the preliminary title “Evaluation criteria for aspects of sustainability in architectural competitions”. The goal of this research effort is to extend the existing evaluation criteria and to methodically adjust competition processes so that architectural competitions will continue to be an effective decision tool for aesthetic sustainable building solutions. Following results are related to the stages of architecture competitions.

2.1 Concept Phase and Competition brief

Prior to publishing a call for proposals, the project initiator and his competition advisors, as well as all other involved parties, must decide on formal and organisational agreements, technical requirements and goals. Similar to the initial design phases of a building, that are so crucial for the later performance of the finished building, the concept phase bears the largest potential for laying the groundwork to a successful architecture competition.

There are a number of factors that ensure the adequacy of a competition process: selecting the right type of competition; defining deliverables, project goals, assessment criteria (Fig. 1) and selecting of jury members thoughtful. To achieve a transparent competition process the participants must via the brief understand what is expected of them, what will be assessed in the preliminary assessment, and what criteria the jury will apply when deciding on the ranking of proposals.

Fig. 1, left: Assessment criteria and indicators
Fig. 2, right: Graphical display of project's preliminary assessment. The graphic shows an assessment example of a project with differentiated weakness: high, existing and low potential criteria



2.2 Preliminary Assessment and Jury

The presentation of results of the preliminary assessment published in the preliminary report should avoid extensive texts and written explanations. It is advisable to display apparently how the individual criteria were evaluated. The developed circular graphic in Fig. 2 displays the different criteria as individual segments. Each segment shows the associated potential as "low potential", "potential existing", and "high potential" visible as coloured ring.
Practically, detailed presentations of the results of the preliminary sustainability assessment of the submissions in the first stage of the jury meeting are associated with an immense time consumption due the number of proposals remaining in the assessment process. The scope of information provided should match the actual expertise of the jury. Extensive reports and detailed statements concerning individual criteria and higher-level correlations are of relevance after the number of remaining proposals is far reduced and the jury is discussing the awards.

2.3 Conclusions

In order to introduce sustainability issues into the evaluation discussions of architecture competitions, sustainability must be included in every phase of the competition process but avoid to over-instrumentalise the topic. The goal should be to implement a competition process that is adequate for the special project requirements to maintain a practical and holistic evaluation system. The introduced practical methodology for competition process is complemented by the development of a software-based tool [1]. This was designed specifically for simplifying data collection and evaluation, and for creating the final evaluation charts. Additional functionality will be developed to support the competition process, featuring the drafting of the competition brief, the preliminary assessment and the meeting of the jury.

3. References

[1] HAUSLADEN G., RIEMER H. and DRITTENPREIS J., "ClimaDesignCompetition. Methodik zur Durchführung von Architekturwettbewerben…", Berlin. 2008-2010, München, 2010.

Elastomeric Reflective Maintenance Coatings Increase Longevity & Energy Savings of Bitumen Roofing

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KEYWORDS: Sustainability; energy; reflective; coatings; bitumen; acrylic

Summary

1. Introduction

Bitumen is one of the most common waterproof materials used in building construction and commercial low-slope roofing applications around the world. Bitumen can be prepared in solventborne and waterborne/emulsion coatings as well as molten applied built-up-roofs and rolled roofing membranes. Modification of asphalt with atactic polypropylene (APP) or styrene butadiene styrene (SBS) copolymers has increased its durability substantially. However the quality of bitumen used in roofing applications is changing. Bitumen "crackers" convert portions of bitumen into more valuable fuel derivatives changing the visco-elastic nature of the material. And because bitumen is black it has high thermal absorption subject to natural degradation mechanisms which reduce its service life. Exterior induced natural degradation factors include UV induced chain scission, thermal degradation, freeze/thaw cycling and moisture absorption/extraction effects. The end result of long term bitumen weathering is a reduction in base weight of roofing product due to migration of bitumen fractions followed by embrittlement, cracking and erosion. One way to extend the longevity of bitumen roofs is to apply a white reflective coating.

2. Results

Experiments were undertaken to improve the weatherability of bitumen roofing by applying white reflective roof coatings. Coated and uncoated bitumen samples were exposed to UV-light and moisture and temperature extremes in a six year exterior weathering study to prepare samples for analysis. Using recommended extraction analytical methods, coated and uncoated bitumen samples were measured for retained fractions of bitumen, weight loss, surface temperature and solar reflectivity. Results demonstrate that white acrylic, reflective roof coatings applied to bitumen products can protect against UV-induced degradation, reduce light fraction migration and decrease embrittlement.

Additonal benefits to the application of white reflective coatings incude reduction in size of air conditioning unit, measured energy reduction through lower summertime air conditioning electrical usage, calculations of energy savings in worldwide locations, carbon credits calculations, landfill reduction and lower building maintenance costs.

3. Conclusions

The durability advantages of UV protective, pigmented coatings applied to many substrates are well known and have been demonstrated in this study when white acrylic elastomeric roof coatings have been applied to bitumen roofing products. The holistic economic analysis of the features of bitumen coated with white reflective coating clearly shows sustainability advantages. The financial value of reflective coated bitumen for energy saving, life cycle extension, as an alternative to roof tear-off and insulation installation, temperature reduction, green house gas offsets and payback time vs. investment is highly dependant on many, many factors and each individual economic analysis should be considered carefully.

Grammar School, Baesweiler - Modernization, Expansion and Energy-Saving Optimization to Passive House-Standard for new Buildings

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1. Introduction

The energy requirements for new buildings are very high in Germany compared to other states.
But 85% of the total housing stock in Germany was built before 1982 and these buildings consume about 92% of the total energy of all the buildings in Germany. So the greatest energy saving potential is not to find in the construction of new buildings, the greatest energy saving potential lies in the energetic refurbishment of the existing building stock.

2. The grammar school Baesweiler

The city of Baesweiler has set itself the goal to optimize all municipal buildings for energy efficiency and to set signs for other municipalities and to encourage them to follow this idea. In a first step 21 municipal buildings were to analyze regarding their potential for optimization.
For it an exemplary planning strategy was developed. After a detailed inventory including user survey and detailed analysis of the building pools individual targets for each building were defined. These targets reached from EnEV 2007 (required minimum energy saving standard by law in Germany) to Passive House standard. The results have been documented and are available as "DBU study" also for other municipalities.

The energy-saving refurbishment of the grammar school of Baesweiler to passive house construction standard has begun in June 2009 and is coming to end next summer. In this time the building complex will have been renovated in 4 phases during normal operation. The administration building, the complex within the main classrooms and the scientific section are finished. Next spring we will start the refurbishment of the sports hall.

The focus of the renovation of all building sections was laid on a highly insulated facade including passive house windows and also energy saving technical equipments so as a mechanical ventilation system with heat recovery, an energy saving lighting, the installation of a geothermal system and thermal solar plant. With these steps the heating capacity could be reduced by 85% to 245 kW. The heat demand could be reduced from 220 kWh/(m²a) to 15 kWh/(m²a), the annual CO_2-savings of about 530 tons,

This project was the flagship within the state financial support program "investment pact I" of North Rhine Westphalia. Because of that it was supported by a state grant of 4.83 Mio Euros.
After finishing the refurbishment of the building section 1 (the administration building) the City of Baesweiler won the German wide competition "municipal climate protection" and got a price money of 40,000 Euros.
The effects of the energetic refurbishment are now to be examined by means of an extensive monitoring of energetic, technical and ergonomic parameters and evaluated, e.g.:
The CO_2 concentrations are, with few exceptions, below the target value of 800 ppm. The ex-

ceptions can be explained by a very high packing density and are also still well below the requirements of workplace guidelines.

The measured temperature profiles of the building section 1 showed a passive house typical high consistency. A correlation with the temperature outside is not detectable. Immediate aftermath of the finishing of the refurbishment the self-learning center (outside of usage times) tended to become too warm. The setting of the heater thermostat was checked. The result was that the temperature could be lowered in all the rooms generally, because of the good insulation of the passive house the heating of the rooms is already done by heat recovery of the internal loads (people, technical equipment) during the usage times.

Fig.1: View to 'Trakt 1'

Fig. 2: View to 'Trakt 3+4'

The refurbishment of the secondary school of Baesweiler is also a contribution to the necessary reduction of a prejudice that even many architects spread still: "Passive Houses are thickly insulated, disproportionate and faceless boxes that cannot be realized in a high esthetic quality.

Energy Efficient Factories

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Summary

The topics of energy efficiency and sustainability are well established in Germany's building sector. However, industrial buildings were mostly excluded from this development in the past. To achieve high comfort and high energy efficiency standards for industrial buildings planners all over the world are facing different challenges. Within a cooperative research project carried out by the TU München, Department of Building Climatology and Building Services – Prof. Dr.-Ing. Dr. h.c. Gerhard Hausladen and Siemens Real Estate, two different climate zones represented by exemplary cities in Germany and India were analyzed. In further studies, locations such as Russia and China were added. The study presents conceptual solution approaches for the planning of energy efficient factories to support the planning process in different locations.

Keywords: green factory; energy efficiency; industrial buildings; international locations; industrial sector

1. Introduction

The industry sector in Germany is responsible for more than 35 % of the country's greenhouse gas emissions [1]. In addition to the production-related processes, these emissions are due to the energy used for heating, cooling, and ventilation of industrial facilities. These emissions involve high costs for the energy supply and provide a high potential for optimization. The developed guidebook "Green Factory" presents conceptual approaches for the planning of energy efficient industrial buildings at various locations. It serves the planner as assistance throughout the design process. The approaches are based on a sensitivity analysis which covers the determination of parameters with a high influence on the factory's energy demand while considering a range of energy-inputs for different industrial processes.

2. Investigation

A typical Siemens industrial building is used as a base model for the following examination, which are carried out using dynamic building simulations and daylight simulations. Besides various simulations for building specific parameters such as daylighting, orientation, insulation standards, ventilation concepts, air flow rates, and reflectance of the roof. Other parameters such as shift work, useful operating life, and comfort requirements are considered at the beginning of the parameter studies variable internal heat loads, defined as equivalent of the waste heat from industrial processes and different uses of buildings, are used as boundary conditions in the simulation in order to evaluate their impact on the heating and cooling energy demand.

3. Conclusion

The study shows that the production process should be considered at all the locations at the very beginning of the planning phase. An integrated system technology for heating, cooling, and fresh air supply must respond to the industrial production process of the building system services. Two major factors in energy saving can be identified: process heat can be used directly in the building or at the site; and an industrial building must be designed differently depending on whether there are large internal loads or whether there is nearly no production-related waste heat. The focus of industrial buildings located in Germany with low internal loads of 10 - 20 W/m² should lie on the heating demand of the building. If the internal loads are higher, e.g. 30 W/m² or more, the cooling of the building is of higher priority for the interior climate concept. Accordingly, air tightness and thermal insulation are meaningful only at low internal loads.
The importance of the production process is also shown by the analysis of the fresh air supply in industrial buildings. At high internal loads large fresh air flow rates effectively provide a means for passive cooling, thus reducing the need for active cooling. In warm, humid climates with a year-round high solar irradiance such as in Mumbai, India, there is no heating needed in order to comply with the thermal comfort requirements. However, concepts for reducing the cooling demand are necessary for these locations. To lower the effect of the solar irradiation and to improve the energy performance of these buildings highly reflective roof surfaces should be implemented.
Another important finding is that a doubling of the skylight area increases the daylighting factor and the visual comfort level significantly. Energy-efficient industrial buildings therefore do not only have a low energy consumption, but also a reduced greenhouse gas emissions. The industrial sector thus plays an essential role in fulfilling the goals targeted by the German government as well as the world wide climate change mitigation goals.

4. References

[1] McKINSEY&COMPANY: „Kosten und Potenziale der Vermeidung von Treibhausgasemissionen in Deutschland - Sektorperspektive Industrie“, *BDI initiativ - Wirtschaft für Klimaschutz*, 2007

Passive House 'Bruck'

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Summary

Passive House 'Bruck' is the first residential building of its kind designed to meet rigorous European Passive House standards for energy efficiency in China. Commissioned by the development company Landsea and designed by Peter Ruge Architekten, the model apartment complex will assess the optimisation of passive house construction techniques under China's warm humid weather conditions. A highly insulated building envelope and climatic façade system achieve a significant reduction in annual heating demand and total primary energy consumption by controlling thermal loads and regulating interior environmental quality. Through an integrated approach to design, this residential prototype introduces the benefit of passive house living specifically to the Chinese residential market and sets a benchmark for future sustainable development.

Keywords: Passive House; Residential China; Pioneering Construction; Sustainable Design Methods; Ecological Development; Environmental Housing; Energy-Efficient Systems; Testing Models; Climatic Façades; Passive Building Technologies.

1. Introduction

In one generation many urban Chinese have experienced a level of economic development that took the West over three generations to achieve. Throughout these advancements the design of residential spaces has continued to influence and guide social attitudes toward innovative technologies, acting as a testing ground for improved ecological models of living. Herein exists an opportunity and obligation for the commercial sector to inform consumers on the benefits of green construction, and direct residential development in China toward a sustainable future. With the rate at which housing developments are currently implemented, an immediate need for ecological housing alternatives has arisen.

2. Passive House Design

As we move into a new age of technology, the field of architecture should seek development based on guidance from its traditions and a sound understanding of new systems. A building is no longer an isolated entity that consumes, but an integrated mechanism that can also produce and share its resources amongst built environments. Thus architecture is moving further toward a harmonious and intelligent partnership with nature.

This design approach plays a central role in the future strategy of the recognised Chinese real estate development group Landsea. With support from the Passive House Institute in Darmstadt and the Fraunhofer Institute for Building Physics in Munich the companies plans to establish an ecological research and development centre in Changxing, Zhejiang province near the Taihu in China, is now underway. Currently under construction the Passive House ‘Bruck’ is the first housing of this kind to be realized in China’s damp, warm, southern climate, and the first building to be constructed as part of a 100 million Euro investment to that will take place over a 10-year period.

Peter Ruge Architekten’s design for Passive House ‘Bruck’ sets new standards of sustainability through the application of techniques that seek to improve the buildings’ operation over time. With over 20 years experience in environmental design, the company’s comprehensive understanding of local construction techniques, natural resources, climate conditions and culture are integral to the sustainable development strategy. Registering a 95% energy saving over that of a conventional Chinese residential building, Passive House ‘Bruck’ serves as a model apartment complex, consisting of thirty-six single-room flats for staff, six double-room executive suites and four triple-bedroom model apartments. These apartments have been planned for the dual purpose of hosting complex employees, and present Chinese families, interested in the benefits of sustainable housing, an opportunity to temporarily reside in the building. Through this direct experience, prospective clients gain their own understanding of what maximum comfort passive house living has to offer. This approach aims at reducing any previous reservations towards the success of passive house design in diverse weather conditions, whilst providing a platform by which to demonstrate the building’s maximum comfort and quality of residence.

3. Conclusion

Peter Ruge Architekten, together with their client Landsea Europe, the Landsea team of architects and engineers, and in cooperation with Dr. Feist and engineers from the German Passivhaus Institut, have achieved an important architectural milestone through the design of Passive House ‘Bruck’, and the successful introduction of sustainable and future-oriented passive house standards to the Chinese residential housing market.

A More Sustainable Model for the Property Life Cycle

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Summary

Over the last decade, sustainability has become less of a niche interest and it has been adopted more widely in the mainstream of the construction and property professions. Concepts of sustainability continue to develop beyond the basic issues of energy efficiency and material supply. This presents challenges for not only the industry but also for the educators in colleges and universities.

The lifecycle of a building needs to be considered sustainably, so that its economic life and physical life can be extended. We propose a lifecycle model that recognises this by encouraging the investment and construction industries to provide buildings which are durable and future-proofed for adaptive use and upgrading of services and facilities. Enabling durable buildings to be more easily refurbished and upgraded should allow their economic life to be extended. Occupiers and owners can be encouraged to use and manage buildings sustainably through ‘green leases’ which allow the benefits of low energy investment to be shared by both parties to the lease, while also providing processes for the sustainable management of the building.

We propose a model that looks at the building lifecycle as a continuing process of retrofitting and refurbishment of the basic shell of the structure, instead of one modelled on demolition of the building when it reaches the end of its economic life after 50-60 years.

The barriers to this concept of a more sustainable building lifecycle lie in traditional building procurement processes and lease arrangements. The current economic model of investment does not make allowances for sustainability and energy efficiency where this is beneficial in monetary terms. In addition, standard property leases do not encourage landlords to make improvements to the property, where tenants would benefit from reduced energy costs.

The proposed lifecycle presents challenges to the property sector to take a fresh approach to the use and occupation of buildings and to this end the historic environment many examples of buildings which have been adapted to new uses and continue to provide high quality facilities to their users and occupiers.

Solar Energy-Collecting Masonry-Modules as Integrated Low-Tech Heating and Cooling System

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Summary

The development of a load bearing mono-layered building-system whose topology allows for an integration of solar energy harvesting in external walls for sustainable heating and cooling.

Keywords: Low-Tech Solar Collector; Wall-integrated Heating System; Solar Cooling

1.1 Problem statement

Bottom-billion man-made shelters largely depend on the use of open fires to keep the temperature-levels of their habitatii in health- and comfort-defined tolerances, thereby seriously contaminating the ambient air and accelerating deforestation: Could solar energy be tapped
by the building skin, activated as an adaptable low-tech energy-collection and -transportation- system, to largely reduce the need for combustive heat-generation?

1.2 Approach

The experimental development of a modular system, simple in the production of the modules as well as in their assembly, from locally available, minimal embodied energy, resources
(loam, manure, sand) was carried out substantially as a hands-on try-and-error research. Two basic typologies, one for solar heating and one for solar cooling were focussed on.

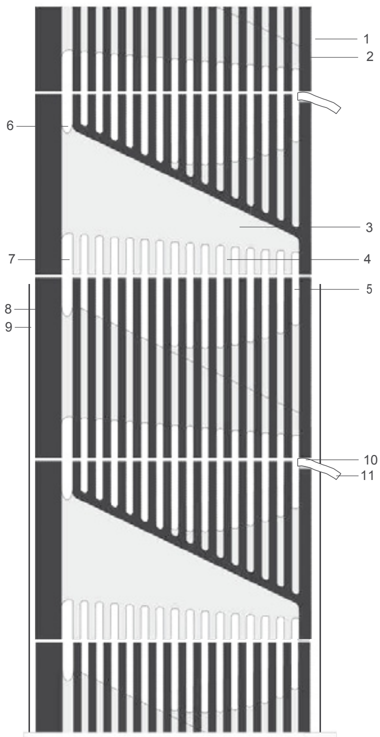
1.3 Results

Various internal morphologies are able to generate a wide range of requirement-profile-adaptable modules, being able to respond to air-temperature and -movement, radiation and available material-characteristics. Adjustable permeability of opaque building-skin allows for the use of solar energy to cater for an improvement in health and comfort.

1.4 Mode of operation

The higher-end compression-molded type »±brick 2.1« (Fig. 2) is the module used for the following explanation of the mode of operation:

In a collector-chamber (5) under the ±brick's solar-heated exterior surface (2, optionally rendered: 1), air is heated up. The warm air rises up, and, through diagonal conduits (3), is driven inwards into a vertical, stack-like channel (6, 7) under the walls inner surface (8, optionally rendered: 9).

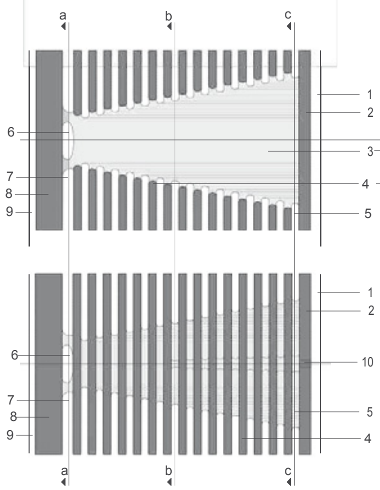


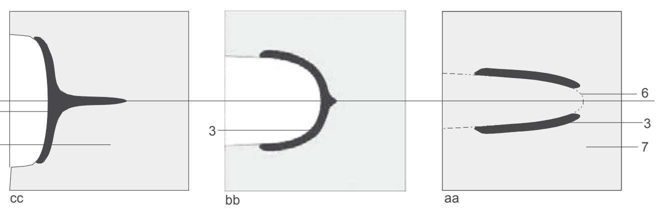
Here, heat-exchanging ribs extract the thermal energy and conduct it in the bricks towards the inner surface to heat the room via radiation & convection.
Fresh air is sucked in through ports (10) equipped with tubular nozzles (11) in the rendered version.
The optional bidirectionally of the fluid-flow, inwards as well as outwards, enables the system also to reduce a walls inner surface-temperature by inverting the flow-direction, sucking in air through high-thermal-mass earth-channels.

Flaps on outlet and optionally as well on intake allow for adjustment of the walls performance to energy-import, insulate or energy-export according to demands and climate.

The system is glued in thin-bed or dry-bonded by die cut elastomer.

Fig. 1: Ceramic Mock-Up of »±brick« Type 2.1
dimension: 240/240/365 mm





1.5 Perspective

The systems functionality is to be evaluated in respect of the parameters material and climate,
it's inner morphology being adapted and optimised with the focus of performance and production.

Fig. 2: ±brick; type 2.1; cross sections, views, sections; inside is situated to the left; not to scale

Building with Wood up to the High-Rise Height Limit

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Summary

We started a project to develop a concept which allows us to construct buildings up to eight storeys with wood as main building material.

Keywords: wood construction; prefabrication; quality management

1. Introduction

The main objective of the project is to develop a construction system which makes it possible to build multi-storey residential buildings fast and cost-effectively, with wood as the main construction material. However, up to now, wood as a construction material for multi-storey buildings is neither common nor considered suitable in urban areas. The distinctive advantage of this construction system, namely short construction times due to a very high degree of prefabrication, however, makes it the ideal building technique within conurbations. Our project intends to show that wood, even in urban areas, can be a viable alternative to concrete, steel and brick for building multi-storey residential buildings.

2. Concept

2.1 Research issue

A four-storeyed timber construction, which was erected at the 'Parkgelände Bad Aibling' in 2010, served as a pilot project for the new construction system for multi-storey residential buildings. Having improved the construction system, another eight-storey building followed in April 2011, which is the tallest wood building in Germany.
The project revealed that wood can also be used as a basic building material for multi-storey buildings, even though the building code in Germany dictates a maximum of five storeys. The whole supporting structure of the building, i.e. load bearing walls and ceilings, is made of wood with the staircase core being the only concrete element due to fire protection regulations. The cladding was mainly made of wood, too, and supplemented with plaster in places.

Wood and plaster also provide a comfortable and healthy indoor climate thanks to their positive moisture regulating effects. Additionally, the visible wooden elements create a pleasant atmosphere, and the massive outer walls provide very good insulation against the heat and cold.

With very good u-values (exterior wall: u=0.12 , roof: u=0.11) an estimated annual heating requirement of 18 kWh/m^2a is achieved, which moves the building extremely close to the 'Passivhaus' standard.

The building's underlying floor plan enables storeys divided into two or three as well as various office types can be realised. As only few load bearing walls are necessary, all floor plans can be individually designed. The funding guidelines of the three biggest federal states of Germany have been followed and the flats are barrier-free and some of them even wheelchair-accessible. The maximum amount of flexibility provided is a very important aspect of sustainability.

The planning team was supported by the University of Munich (TUM), the Rosenheim University of Applied Sciences and the 'ift Rosenheim' who they had been working with on the four-storey building already. The experiences made in that first project helped to enhance and simplify the system in terms of statics, soundproofing and fire protection requirements. As a result, building costs as well as details could be optimised and henceforth can be made use of in future projects.

The decisive advantage of the construction system is the short construction time: The entire four-storey building was erected in only four days with exterior cladding and windows already installed – the eight-storey wood construction was assembled in only three weeks. Thus, the amount of the construction traffic is minimised, which keeps disruptions and pollution in the neighbourhood to a minimum and thus makes this construction system ideal for densification projects in urban areas. All this is made possible by the high rate of prefabrication that furthermore improves the quality of the whole construction process. Having produced the elements under ideal working conditions in the factory, the big units are assembled on-site in a very short space of time with little margin of error.

Building Culture and Resource Efficiency

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Summary

This study investigates the assumption that architectural quality influences a building's life cycle length and thereby its overall energy efficiency. The speed at which innovations in energy efficiency are implemented is identified as a major determining factor for the sustainability of the length of a building's life cycle. As energy efficiency currently increases very rapidly, it is concluded that today's building design needs to find solutions for buildings that can be easily updated or recycled rather than aiming for longevity.

Keywords: architectural quality, cultural aspects of sustainable building, longevity, sustainable architecture

Extended Abstract

Architectural quality

Architectural quality is widely considered independent of if not obstructive to the energy efficiency of a building. In contrast to this point of view, this study assumes that architectural quality can in fact have a positive influence on the energy footprint. As a possible connection between the two the length of life cycle is investigated in detail.

Firstly, factors of architectural quality are considered. Starting with the triad established by Vitruvius - durability, functionality and beauty- architects have developed a catalogue of criteria for good architecture. In most systems of quality evaluation, longevity plays a role as an important indicator. As much as longevity is considered a desirable quality for a building, it is also a quality that is associated with sustainability: The longer a building lasts, the more sustainable it seems. From the perspective of energy efficiency, the underlying reasoning stems from the fact that the construction of a building consumes energy, the so-called embedded energy. As this amount of energy is only spent once, the longer a building lasts the smaller the amount of embedded energy per year of use becomes. Considered from the viewpoint of architectural quality, this means that buildings should be designed to last for a long time, therefore favouring timeless design solutions to a design that is fashionable and spectacular. Often, this approach favours traditional or conservative solutions to buildings over innovative or experimental designs.

Life cycle length

An investigation into actual life cycle lengths of residential buildings in Germany by analysing recent demolition statistics shows that up to 70% of buildings demolished between 2002 and 2011 were built after 1949. Therefore a service life of 100 years as it is used in sustainability calculations might be closer to 50 years, the length of time for a tax-writeoff of a building.

Calculations of energy demand of existing residential buildings show slow improvements of energy efficiency until the 1980's and an accelerated improvement in energy efficiency after 1987, mostly due to energy regulations and resulting innovations in technology.

These numbers are compared to the embedded energy in buildings, estimated to be about 1500 kWh/m² for construction. The results show that until 1957 it would not have been reasonable from an energy perspective to replace a building built before 1918. After that, the amount of time it takes to save overall energy rapidly decreases. Nowadays, by replacing an existing 1918 building by a new more energy efficient building, the overall energy spent on construction of the new building is saved after only 7 years. The simple reason for this is the accelerated innovation in energy efficiency in recent decades. In other words, innovation speed has been such that a building is outdated in terms of its energy consumption considerably faster today than it would have been 100 years ago.

Conclusion

These findings fundamentally change the role of longevity in sustainability considerations. With the current innovation speed in the field of energy efficiency, we have to reconsider the assumption that buildings should last as long as possible. It becomes much more important that they would be either easy to disassemble and replace or easy to update to new construction standards.

Moreover, it is an explicit goal of sustainability considerations to enable future generations to meet their own needs. Therefore we must consider that every generation has a need to realize their own ideas how a building should be designed aesthetically and functionally. Consequently, we should not confront future generations with buildings as a burden from the past, but we should develop concepts for buildings such that their components - including the building site - are reusable.

The most important conclusion from this study is the resulting rethinking of architectural quality in light of aspects of sustainability. Traditional design should be enhanced by concepts to react to and integrate the speed of change in technology and society. Further investigations into other facets of sustainability should render similar results, thus widening and possibly changing our perception of architectural qualities.

Engineered Transparency of Facades

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Keywords: ETFE-film, cushion design, light transmitting plastic sheeting, stadium, façade engineering, thermal comfort, daylight use, lightweight construction

Extended abstract

All different types of material enclosures have an effect to the aesthetic perception of the building surfaces and the user comfort. The minimization of the structure, the maximization of light penetration, the reduction of design constraints represent some of the advantages of using film enclosures for building besides positive ambiental and ecological effects resulting from daylight availability. On the other hand it is obvious that these opportunities and properties implement disadvantages such as a reduced transparency, a complex engineering between structure and film and poor building physic values.

This paper compares transparent building enclosures due to building physics and structural constraints, based on four realized projects by LEICHT Structural engineering and specialist consulting GmbH.

Based on four projects with different design intents the various applications of transparent building enclosures are compared. The projects represent the material range of typical insulated glass, plastic sheeting, ETFE single films and ETFE cushions. The influence of the here selected materials to the structure and vice versa are pointed out by the finalized projects.

By presenting the physical and structural qualities of four materials, this study analyses the materials due to their optimal use and provides qualitative information for structural and architectural decision making. Four realized projects illustrate the theoretical approach.

Fig. 1: Apartment Building 100 11TH Av. New York (copyright by Stutzki)

Fig. 2: Grade stade Le Havre, France (copyright Coda- SCAU KSS)

Fig. 3: Public bath Prienavera, Prien am Chiemsee (copyright Hightex)

Fig. 4: Curt Frenzel Stadion, Augsburg (copyright by Hermann Öttl Architects)

Jean Nouvel named his concept of the Apartment Building 100 Eleventh Avenue, New York, a “vision machine”. The façade is destructed by ignoring a typical façade grid. And the slop of single glass panels produces an impression of changing color due to reflecting effect of the light. Basically the façade technique follows common material composition of glass, steel and aluminum. To ensure a comfort climate for the occupants of the apartments a good proportion of U- and g-Value was applied.

A combination of wide span and lightweight construction with certain requirements of the building physics can be created by applying ETFE-cushions. The roof of the public bath Prienavera in Prien am Chiemsee (Germany) was refurbished with high requirements for the U-value as well as heat insulation for the summer.

The requirements of a stadium construction are totally different. A huge span of the construction to shade mainly all parts necessitates a light enclosure. Shading effects and weather protection have a higher priority than thermal insulation in its tight interpretation. For the “Grande Stade Le Havre” the envelope is a single layer ETFE film. The blue color is given by the local soccer club. To restructure the massive stadium shape four types of blue ETFE-films are irregular arranged.

The architectural intent of an ice floe for the façade of the Curt-Frenzel-Stadion in Augsburg uses neither the structure nor the variation of the facing. The effect of fissuring shall be realized by LED lightning at the interspace of the two façade layers. The lightning effect is pending on the engineering of the structure and the light transmission of the plastic panels.

All projects will be presented and compared by their specific characteristics in the following chapters.

Passive Houses for Different Climate Zones

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Summary

The Passive House strategy – achieve extremely low energy consumptions at high thermal comfort and affordable prices by rigorously minimizing the heat flows – is a very successful approach to sustainable building in Central European climates. We will show how this strategy can be implemented in nearly any climate of the world. To this goal, it is inevitable to carefully adapt the general building design, the components and the mechanical services to the local conditions. It was found that Passive Houses are also economically attractive in most regions of the world.

Keywords: Passive House; building envelope; climate responsive building; warm and cold climates; simulation; economic analysis

Extended Abstract

To date, several thousand Passive Houses have been built, mostly in Central Europe. These buildings can be heated exclusively by the supply air, with an air change rate of 0.3 to 0.4 h^{-1}. The buildings have annual space heating consumptions around 15 kWh per m² living area and year and provide high comfort.

A detailed study applied the Passive House approach of load minimisation to the climates of Yekaterinburg, Tokyo, Shanghai, Dubai and Las Vegas. Space conditioning (heating, cooling & dehumidification) using solely the supply air could be achieved. The corresponding annual energy demand varies widely depending on the climate.

The cold, continental climate of Yekaterinburg requires extremely good thermal protection in every respect and a compact building envelope. Due to the low temperatures, ventilation and infiltration become much more important than in Europe. The use of passive solar gains can be encouraged, provided south orientation and a low horizon are available at the building site.

In Tokyo and Shanghai, heating is still more important than cooling. To allow for supply air heating, lower insulation levels than in Central Europe are sufficient. In summer, movable blinds allow to meet the sensible cooling goal. Dehumidification is dominant over sensible cooling, mechanical services need to be designed and run according to this fact.

In hot and dry Las Vegas, cooling is decisive. 15 to 25 cm of insulation and perfect solar control are required. Energy recovery ventilation increases indoor humidity in the dry desert climate. Very low heating demands are also achieved at this insulation level.

Dubai requires similar opaque elements and MVHR, but in addition triple-pane solar protective glazing and large roof overhangs must be used. Cool colours are nearly inevitable. The hot and sometimes humid climate of the gulf region results in a cooling period of approximately 9 months, with correspondingly high annual energy demands.

Appropriate solutions for mechanical systems have been investigated for all climates. Building design examples with both high energy efficiency and high architectural quality were developed for all five locations.

An economic analysis using world-wide climatic data showed that, with very few exceptions, the strategy of load minimization on a Passive House level is close to a cost-optimum throughout the world.

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Assessment of Economically Feasible Net Zero Energy Building Concepts Using the Example of an Office Building in Germany

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Keywords: nZEB, office building, transient simulation, heat pump, economic feasibility

Summary

Scope of this paper is the evaluation and assessment of a net zero energy building concept in respect of functionality and economic feasibility. The analysed energy concept is based on air source heat pump technologies, a mechanical ventilation system and a photovoltaic system. The evaluation work comprises the monitoring of the described building energy concept, a parametric study on economically feasible improvement potentials as well as a comparative study on alternative energy supply solutions.

1. Introduction

The amended version of the Energy Performance of Buildings Directive (EPBD) describes the harmonized European strategy on energy efficiency in buildings. The political target is to reach economically feasible nearly zero energy buildings in the new building sector until 2021. This task was faced in an international research project, in which major research institutions from Europe have joined in. Scope of the research work was to evaluate and assess the functionality and the economic feasibility of a net zero energy building concept, which was implemented in a representative office building located in Herten. The analysed energy concept is based on air source heat pump technologies for heating, cooling and domestic hot water generation, a mechanical ventilation system with heat recovery unit and a photovoltaic system installed on the roof of a well-insulated, simple structured office building, which supplies the needed electricity to the test office building. The surplus electricity is fed-in into the main grid.

2. Results

The evaluation work comprised the monitoring of the energy concept and the building performance, a parametric study on economically feasible improvement potentials as well as a comparative study on alternative energy supply solutions. The monitoring of the building was based on 15 minutes metering series over one year, which produced data about room temperature, heat mass flows and energy consumption of the diverse building services. Thermal comfort analysis was conducted based on in-situ measurements in summer, winter and during the transition periods. A monthly balancing approach according to DIN 18599 was used for the energy performance calculation according to the German energy saving ordinance (EnEV). Also the analysis of the effectiveness of the overall concept as well as the parametric studies and the comparative analyses of alternative concepts were conducted with the monthly balancing approach. In addition to that, for evaluating the functionality of single building elements as well as for visualizing hourly and daily load variation and temperature curves, a transient building simulation was used.

The achieved findings of the evaluation work proved the chosen approach. The project target of a net zero energy balance was reached and a comfortable indoor climate could be guaranteed. Furthermore, the research work has shown that both, the monthly balancing approach and the transient building simulation, were applicable methods for assessing nZEB concepts and for forecasting the actual energy consumption of nZEB buildings.

A parametric study applied on the implemented building construction and building services has worked out diverse improvement potentials. According to the guideline that the improvement potentials must be cost-efficient, an energy reduction cost curve was developed, which shows the relation between energy saving potential and energy reduction costs for reducing 1 kWh over the lifetime of the building and its building services. The analysed measures comprise the improvement of building the building envelope and connection between building elements as well as optimization of used system technique, system configuration and control strategies. By applying self-financing improvement measures, it was possible to reduce the energy use of the building by more than 20%.

3. Conclusion

The predicted model-based calculate energy need was found to agree almost perfectly with the actually metered consumption data. Both calculation approaches - the transient building simulation and the monthly energy balancing - were proved to be applicable for assessing net zero energy building concepts. Although the net zero energy balance was reached, diverse cost-efficient improvement potentials could be detected in the analysed energy concept. Furthermore, the study also proved that a nearly zero energy building level could be already achieved with the present technologies and the current construction prices and this by following the economic feasibility guideline of the energy reduction law.

Energetic Dynamic Construction Components and Spatial Structures

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Summary

The usage of solar energy has always been part of architectural culture. The 80s architectures responded directly to the consequences of the oil crisis and the burgeoning green movement: energetically zoned, energy-winning "solar houses" emerged - mainly in southern Germany and Switzerland. Building monitoring showed high profits, but also high losses. The loss reduction for buildings came to the fore. Now the recently examined potential lies in the combination of known, spatial strategies and the use of fundamentally new performance materials. Modern technologies, such as control and regulation techniques, can increase the usability of gain enormously. Gain maximization and loss reduction are not mutually exclusive any more. Today, there are housing projects, which use dynamic, energetic components and spatial structures, whose efficiency has not been studied yet.

The home and studio Lang-Kröll of the office Florian Nagler Architekten, Munich, dates from 2001. A house that accommodates the traditional, regional, almost archetypal form of the original house, equally newly transformed. The timber construction is provided with a translucent skin of polycarbonate multi wall sheets forming an air collector. The collector collects energy, insulates and discharges energy equally. It's acting dynamically.
The children riding school Weillimdorf, Architect Werner Grosse, Stuttgart, uses an air collector-wall construction, combined with a hypocaust-construction. The heat distribution and control function are produced by technical features. The house is built in Palisadio system, a construction system of prefabricated timber elements used for ceiling and wall constructions. Polycarbonate sheets form the outer translucent conclusion of the south-facing gable roof and facade air collector.
The Patchworkhouse from the office Pfeifer Roser Kuhn uses similar principles. It differs in the introduction of the heated air into the building system. The project of Florian Nagler Architects works with the use of the collector warm air as a dynamic enveloping outer skin.
The project of Werner Grosse operates with independently produced hot air, which is conducted via air channels in the building system and distributed within the space forming structure. The Patchworkhouse, however, can be considered and furthermore uncompromising, open, energetic dynamic system in which the collector surfaces are thermally connected among themselves and equally with the energy distribution space.

Fig. 1: Dynamic-energetic principles:
1) Studio Lang-Kröll; 2) Children riding school Weillimdorf, 3) Patchworkhouse Müllheim.

The Patchworkhouse was investigated in detail within the research project. The project, sponsored by the DBU, divided into the two-year-cycles, comprehensive, detailed building monitoring (collector temperature / ambient temperature / air room temperature / surface temperature / weather data / humidity values and airflow velocities) of the radical, energetic, dynamic residential building, the Patchworkhouse, the structural investigation of energy-winning space and device structures.
Goals in this project were,
- recording potential energy gain and overheating problems on the realized housing project
- estimating possible potential of solar thermal energy use
- estimating climatic problems during the cooling period
- expressing a planning strategy to develop the potentials and deficits, which describes the building system with its dynamic complexity. Based on these results a design and planning system was developed to describe any energy-winning home energetically.

Energetic, dynamic building structures have enormous energy potential. The solar energy gains can be high; even in low-radiation areas are high profits generated. The careful selection and positioning of the energy-obtaining individual elements and their linkages determine the efficiency of such systems. Only homes that do not overheat in the summer can be efficient. It is apparent that protective elements should be independent of the weather, in some cases independent of the user. The (temporary) decoupling of energetic compounds must be guaranteed. If this is guaranteed, highly efficient structures are possible.

Keywords: energetic-dynamic; energy-winning house system; cybernetic architecture;

Reducing the Climate Change Vulnerability of Social Housing - The Case of San Andres Island

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Extended abstract

Identity and existence of San Andres, a little Caribbean island, are threatened by two phenomena: massive implementation of exogenous materials in the constructions and climate change effects. By other hand the average annual temperature of the air of 27.6°C and an extreme aggressive atmosphere, the life time of the buildings, leads to the disappearance of the traditional polychrome-wood houses disappearing in favor of uncomfortable, high-impact, energy-demanding concrete-buildings.
The island is highly vulnerable and high resolution meteorological models [1] developed by IDEAM [2] provide sensitive changes in the climatic conditions.
According to high resolution meteorological models, projected effects of climate change for 2100 include: changes in rainfall (+2.5÷-10.3%), both sea-level and temperature rise (+23÷32cm), (T_{av}= +1.4°C) as well as hurricanes.

The risk that the island be hit by hurricanes is of considerable impact due to the light materials and the construction techniques of the island, which have the presence of pronounced eaves likely to be removed by hurricanes

In this context, three studies have been developed for the adaptation of housing to the climate change "Integrated National Pilot of adaptation" [3], “Climate Adaptive Houses” [4] both supported by Ecoenvelopes Research Group [5] seeking to mitigating the adverse effects of climate change through specific measures, specifically referred to hot climate ecosystems and insular areas of the Colombian Caribbean region.

The project Climate Change Adapted House proposes two climate-sensitive typologies for housing adapted to climate change in the respect of the material culture and aesthetics and the model of life islanders. Contrary to what the name may suggest, the factors that are considered herein and how to deal with them are quite different from those that characterize European households. One first reason is economic: being the island dependant of the continent in terms of energy and materials, the costs are greater. Considering that designed social housing has a set cost less than or equals to 334 €/m^2, it is not such a financially viable solution, as the use of more efficient and ventilated envelopes or the use of photovoltaic roofs.

The major costs to adapt housing to climate change are justified with the reduction of vulnerability and environmental impact and with the increase of thermal comfort, which in turn enables reducing costs in the life cycle.
The second reason is cultural, given the material culture of the raizal ethnic group characterized by constructive typologies in wood, utilization of attics, with balconies that constitute a quintessential social area and highly permeable to the flow of air.
There are two modes of approach: a holistic vision whose cornerstone is based on heightening awareness on the respect for *Raizal* culture and risk management; then, there is the consideration for a thermally-efficient social housing design, implying low impact and the possibility for gradual improvement.
As a response to the said threats, Climate Change Adapted House proposes climate-sensitive solutions observing respect for the material culture and the islanders’ lifestyle

Principles implemented:
- ≈ Awareness of risks based on dances and music of the island;
- ≈ Compact design, conformed to the Caribbean native culture and materials that reduce the thermal gains;
- ≈ Ventilated envelopes with stack effect, cross ventilation and floor inertia
- ≈ Structural reinforcements, shutters and pile-dwelling to reduce vulnerability to hurricanes and floods;
- ≈ Rain water collection for sanitary use.
- ≈ BIPV roofs with CdTe semiconductors;
- ≈ Wastewater phytodepuration.

The technological results have been oriented toward dry built envelopes allowing the reduction of the impact at the end of life and obtaining thermally certain behaviors when using certified products. Much attention has also been given to the search of equilibrium conditions between the functions of isolation and inertia, in order to determine the most favorable conditions of limitation of thermal gain and appropriate phase angle so that the thermal wave is attenuated while its effects correspond with external thermal conditions that favor fast dissipation.
In order to allow the change of air and nocturnal thermal dissipation, it intervenes on the designed openings to ventilate the people and/or to refresh the floor and ceiling surfaces.
Another aspect that is currently being worked on is the access of light that affects differently whether it comes by direct solar radiation or by indirect means: The intention is to minimize access to the interior of the direct solar radiation, implying thermal gain, without sacrificing the natural lighting through shielding that allows entry of indirect light.

The thermal simulations with ventilated envelopes imply greater comfort regarding 7.3÷10.5°C brick/concrete without air-conditioning; the CFD ones lead to compact forms which reduce resistance to strong winds yet maintaining generous overhangs to minimize thermal gains by direct radiation. The materials are free from chemical pollutants and largely recyclable or reusable.
The prototype of adapted to climate change house will be built in the month of March 2013 and will have the functions of awareness and education on low impact technologies and adaptation to climate change for the islanders.

REFERENCES

[1] J.F Ruiz Murcia, “Climate change in temperature, precipitation and relative humidity for Colombia using high-resolution meteorological models” (Panorama 2011-2100). In http://www.cambioclimatico.gov.co/jsp/loader.jsf?lServicio=Publicaciones&lTipo=publicaciones&lFuncion=loadContenidoPublicacion&id=1326. Retrieved 28.02.2012
[2] IDEAM: Colombian Institute of Hydrology, Meteorology and Environmental Studies
[3] C. Varini, “Climatehouse San Andres. Guidelines for the construction of the house adapted to climate change” In: INAP Integrated National Adaptive Pilot Project - Annex 21, In: http://www.conservation.org.co/iniciativasdetalle.php?idcamp=3
[4] Change Climate Adapted Houses: work in progress financed by United Nations Development Project and National Unity for the Risks and Disasters Management.
[5] Ecoenvelventes (Ecoenvelopes) is a Universidad Piloto de Colombia research program started in 2010 that works in design, simulations and experimentation about the sustainable buildings.

Energy Efficiency Refurbishment of Residential Buildings from the Point of View of the Users

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Summary (Extended abstract)

The reduction of the heating energy consumption of residential buildings contributes substantially to achieving the energy reduction objectives of the energy turn-around in Germany. The individual segments of the urban housing market exhibit very different characteristics, with respect, too, to energy efficiency refurbishment. The present study concentrates on the aspect of the users living in so-called “imperial era” residential buildings, those built during the period between the 1870s and the 1920s, and the development perspectives related to appropriate and sustainable energy efficiency refurbishment. With the help of a survey regarding building measures for saving heating energy undertaken over the course of the research project Energy Improvement and Urban Development (EASE), the situation of energy efficiency refurbishment was examined. The study is based on the research question: Which factors affect the energy efficiency refurbishment of the imperial era multiple-flat buildings, and to what extent do these factors vary in the residential quarters investigated? The survey was carried out in six residential quarters in three German cities. The result compiles the attitude of users toward the issue of consumption of heating energy and energy efficiency refurbishment. These buildings are mostly rented by small-scale landlords and have a quite low rate of energy efficiency refurbishment. Many aspects need to be clarified to improve this situation. The economic framework conditions of landlords have been discussed as relevant factors in a number of studies. The results of this research approach presented also consider other aspects and factors. For example the knowledge of users concerning heating energy consumption as well as its separate costs and the knowledge of building refurbishment conditions are analyzed. Which incentives and initiatives are relevant to persuade the user of a stronger interest in heating energy reduction and energy efficiency refurbishment?

Numerous influence factors have an effect on the upgrading potential of buildings. Residential areas show different levels of upgrading, even just with respect to their particular building structures. But even residential areas with the same building structure differ very markedly in terms of their respective modernization activities.

Keywords: Energy efficiency refurbishment; users attitudes; survey; residential quarters.

Chances Through Renovation of Existing Buildings - Dealing with the GDR (German Democratic Republic) Prefabricated Building Types

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Keywords:compact building; gain of use; low-energy renovation; plus energy standard; renewable energy

Summary

The low-energy renovation of existing buildings with high energy consumption is a very sustainable way to design in regards to resource efficiency, energy efficiency and land saving. As examples of this concept we would like to introduce our 4 projects including: the low-energy renovation of the Kindergarten “Plappersnut” in Wismar, the low-energy renovation of the Kindergarten “Sonnenschein” in Wismar, the plus-energy renovation of the school in Reutershagen, Rostock, and the low-energy renovation and conversion of the former school “Käthe-Kollwitz” into a senior residence in Bützow. These examples and demonstration projects are showing the possibilities for energy consumption reduction of around 65%-100% with low investment costs. All of the buildings mentioned were previously GDR prefabricated building types that have been transformed into compact Green Buildings.

Main features of the building designs:

- A reduction in transmission heat losses by the improvement of the building envelopes insulation
- A reduction of ventilation heat losses by use of the intelligent ventilation concept
- Intermediate unheated spaces covered with a foil as part of a ventilation and energy concept
- Optimisation of technology and the reduction of primary energy needs
- Increasing passive solar gains
- Integrated photovoltaic panels
- Expanding more functional possibilities in later building use.

The “Plus Energy School” in Rostock, has slightly different characteristics to the other three projects. It was renewed to reach the plus energy standard. We transformed two school buildings with complicated floor plans into one compact school building. In order to gain the plus energy standard we used different modern technologies within the building including integrated small wind arrangements, top performance thermo solar arrangement, low temperature ORC solar thermal arrangement and photovoltaic panels.

Environmentally Sound Construction of the Kindergarten - Considering the Whole Life-Cycle Energy Consumption and Solar Energy Use

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Summary

Keywords: three-times zero, life-cycle, regional materials, central buffer zone, evaluation and certification.

From ecological building materials to an environmentally friendly demolition, the “Three-times zero” standard is implemented in every life cycle of a building. The building produces minimal harmful emissions, consumes no fossil energies and resources and it is friendly to the external environment. The ecological materials clay and wood which are used as building materials are irrelevant in the later phases of building disposal as they are easily reused and recycled. Detailed and difficult composite materials and parts are not used in this building. At the end of the building function as a kindergarten, the building can easily be converted to any function due to the flexibility of the plan and structure.

The wooden structure of the Kindergarten is filled with clay bricks and covered with clay plaster. This creates a well-balanced interior climate, maintains low transmission losses and reduces building costs. The external wood-clay walls which are made from regional building materials consume very little primary energy due. This is due to localised production and reduced transportation distances. The reduction of CO_2 emissions is also an important part of the “three-times zero” concept. Efficient high technology use is planned to reduce transmission, ventilation losses and to reduce the heat energy demand. A heat pump is used to heat waste air, solar thermal collectors produce warm water and the photovoltaic panels produce power.

The internal central courtyard is covered with a foil which acts as a buffer storage. This collects the thermal energy overflows during the day and passes them through to the surrounding rooms during the night. The intermediate spaces receive fresh air via earth heat exchangers. The buffer zone reduces the temperature difference between the outside and inside air while offering high possibilities for passive solar gains.

This building should be seen and used as an exemplary building for all users and building companies within the region. It is planned according to the evaluation system for sustainable building (BNB) including the use of different calculations, simulations and measurements which secure sustainable goals and allow certification. With this, the building type of the kindergarten will be created.

Interface Between Building Energy Management System and Smart Grid

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Summary

Intelligent electrical energy supply grids 'Smart Grids', are being developed by electrical distribution companies to cope with fluctuations in energy generation from different renewable energy sources. Supply and demand for energy need to be better balanced in order to achieve improved overall efficiency. Subsequently, process control of energy flows in the buildings in relation to the outside environment and user behaviour also needs to become smart, intelligent and capable of adaptation to changing conditions. Otherwise an undesirable combination of smart infrastructure with a dumb client may result thus leading to inefficient business operations. This motivates for additional flexibility whilst interfacing a Building Energy Management System and the Smart Grid. The interface could be based on existing universal gateway for communication. Furthermore it is of great importance to take in account that attainment of human comfort is the main goal of energy use in buildings. This motivates for greater sophistication in devising appropriate comfort strategy in Building Energy management Systems. Consequently dynamic interactive control between supply from the Smart Grid and respective energy demands from individual buildings becomes a necessity. If this is to be adhered to, comfort within the nanoGrid (the energy infrastructure of a building) as the goal of energy use, should become the leading principle in the control strategy for the micro-Grid in connection with the Smart Grid.

One possible way to cope with this enormous complexity would be the application of autonomous process control on device level using agent technology. This novel, distributed, multi agent decision process for building control are currently being developed. The autonomous, agent based process control device has capabilities of negotiating on a virtual energy market. This is often achieved using game-theory strategies and concepts generally based on price aspects that are a good proxy for energy availability in the Power Grid. The agent paradigm promotes use of independent, loosely coupled software entities that encapsulate some specific functionality and interact with each other to solve tasks. Intelligent agents have several additional capabilities such as autonomy, reactivity, proactivity and social ability, and are can exhibit goal-directed behaviour. These agents are thus capable of making rational decisions based on the knowledge available to them through a knowledge base. Single agents may also cooperate with other agents to solve more complex tasks, thereby realising a type of distributed artificial intelligence known as multi-agent system (MAS).

Essential in the Smart Grids concept is occurrence of a two way communication between energy consumers together and with the energy producers. This can be established by thee coupling with the Building Energy Management System's (BEMS) computers. Adaptation of ICT technology through the conncetion of BEMS to the Smart Grids makes it possible to improve management, distribution and control of energy flows. There are two main challenges for successful development of an interface between Smart Grid and BEMS:

1. The necessity of an integrated intelligent building management system where all facilities can participate equally, and
2. Process control tasks which operate autonomously as well in responds to information from all equipment, appliances, the building, the occupants and much more.

Using a design method based ontology a multi agent application is currently being built. The proposed integral approach encompasses all built environment processes from conceptual initiative, design, construction and real estate management as a seamless whole. This seems to contradict with the subdivision of the construction industry in phases, in which parties operate with opposing interests, resulting in disintegration and waste. The coordination of these independent phases, scales, decision-makings and disciplines are crucial to the creation of a sustainable built environment in which the people concerned feel comfortable. When attempting to integrate sustainable energy aspects into design decision-making, the process must identify opportunities of sustainable energy. To develop our required model of design support, an existing model from the mechanical engineering domain was used, this is Methodical Design.

Taking first experiences of building process control systems for the built environment with agent technology as starting point, a new design method was defined for a flexible approach to integrate users' energy demand and energy infrastructure within and between buildings. The proposed ontological method is a possible solution for the design process support for building advanced agent technology based process control systems for the built environment. In order to allow a stepwise approach in which each design decision has well defined implications, different ontological levels are distinguished for designing energetic process. This paper presents a conceptual framework for coupling Smart Grid and Building Energy Management System through Common Hybrid Agent Platform.

Keywords: Building Energy Management System, Smart Grid, agents, nanoGrid

Integral Design as a Method for Designing Nearly Zero Energy Buildings

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Summary

Due to new regulations of the European Directive buildings need to fulfil stricter energy performance requirements, with as ultimate goal net or nearly Zero Emission Buildings, building design becomes more complex. As a result, building design transfers from a mainly architect led process into a multi-disciplinary design team process to cope with the growing complexity of the program of demands. New approaches are needed to bridge the gap between the worlds of theory and practice in building industry which look at designing as a process in which the concepts of function, behavior and shape of artifacts play a central role. Such integral design approach can eventually lead to an integral process, team and method – all the required conditions for innovation of the end product; the building. As the conceptual design phase is a very critical phase for the outcome of a design process the focus was on this specific phase to look if a design method could help building design team members to cope with their complex task. A supportive design method was developed in cooperation with the Dutch professional organizations of architects and consulting engineers which focused on sustainability and the creation of sustainable solutions in the conceptual phase of building design. Since 2000 together with the Dutch Royal society of architects (BNA), the Dutch Association of Consulting Engineers (ONRI), the Dutch Society of Building Services Engineers (TVVL) and different Roofer associations in total 14 series of workshops were organized in which in total more than two hundred experienced professionals, with at least 10 years experience, from these organizations, voluntarily participated. After extensive experiments with different set ups for implementing the Integral Design approach, in which well over one hundred professionals participated, it was concluded that a good way to test our design approach was a workshop setting for professionals. Therefore workshops were arranged as part of a training program for architects and consulting engineers (structural engineers, building services engineers and building physics engineers) (Savanovic 2009), as well as for architects and contractors (Quanjel 2013). These design exercises were derived from real practice projects and as such were as close to professional practice as possible. The design tasks during the two days are on the same level of complexity and have been used in all workshops. In the workshops stepwise changes to the traditional building design process type, in which the architect starts the process and the other designers join in later in the process, were introduced in the set up of the design sessions. In the final series of the research focussing on the interaction between architects and engineers during the conceptual design phase three different design set ups of participants were tested in four sessions.

In connection with the Integral design research project for professional in the Dutch building industry, we developed an educational project, the master project integral design. Interaction between practice, research and education forms the core of the 'integral approach'. Therefore the concept of the integral design workshop for professionals was implemented within the start-up workshop of our multidisciplinary masters' project. The basis of this project, which serves as a learning-by-doing start-up workshop for master students, is the Integral design method with its use of morphological overviews. The different design assignment all were related to the design of zero energy buildings. These complex tasks require early collaboration of all design disciplines involved in the conceptual building design. Master students from architecture, building physics, building services, building technology and structural engineering participated in the project.

The design method provides overview and helps to structure the communication and reflection between design team members. After testing the method in workshops as part of a training program in industry, the design method was transferred and applied at the department of architecture for master students for their multidisciplinary Master project Integral Design. In the recent years several Master Projects Integral design were held and there has been a continuous development. In the latest editions an intervention during the process was undertaken by adding professionals to the student's teams. This intervention had a limited positive effect on the number of produced sub solutions of around 10%. To fulfil the demand for net Zero Energy Buildings there is a need for new solutions. An increase of the number of generated sub solutions leads to a bigger chance for new acceptable overall solutions to fulfil the demand for net Zero Energy Buildings so therefore we think it is a good idea to combine young designers with a few more experienced designers at the beginning of a project.

Integral design method enables to merge different perspectives of all designers and consulting engineers, involved in the design process. In the conceptual phase of integral design, morphological overview represents the design team's interpretation of the design task and the related design knowledge and as such it defines the problem and solution space of the design task. The integral design method is based on experimental workshops for professionals and was now used to teach multi disciplinary building design to students in workshops during their master project integral design. We researched how for student design teams, interventions to the integral design method could improved the quantitative outcome of the design process. One intervention was tested to further stimulate the creativity of design teams within the integral design process: the adding an experienced professional to student teams. This intervention had a limited positive effect on the increased number of generated solutions and as such had a stimulating effect on the creativity of students within the integral design process.

Keywords: Integral Design, net Zero Energy Buildings

Indoor Micro Climate Optimization: The User in the Loop Approach

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Summary

The customer is the recipient of comfort and energy. How they are cared for is becoming more important for a technical service provider, as this effect directly the productivity of the workers. Especially is it important to take in account the goal of the energy use: human comfort. Dynamic individual local comfort control with the use of low cost wireless sensors and infra red cameras might improve comfort-energy management on workspace and personal level. An experiment was done to determine the relation between local conditioning of sensitive body parts and experienced comfort by the occupants. With two advanced infra red cameras the skin temperature was registered and correlated to the perceived comfort by the user as result of the adjustment of the setting of the electrical heating panel's controls. After this first experiment different shapes and locations of infra red heating panels were evaluated. It was decide to test a new concept, a special low-infra red lamp to optimize the heating effect to the hands in relation to the overall perceived individual comfort. Goal was to determine if the overall room temperature could be lowered when the occupants had additional heating of the hands to feel comfortable. Important for the control of this concept is the reaction time of the human body in relation to the conscious perceived thermal comfort.

The human body can regulate heat flow to the environment by increasing or decreasing the skin blood flow. During mild cool exposure vasoconstriction is the most important thermoregulatory effecter, which can be clearly observed in the upper-extremity region. In addition, the variations in facial skin temperature may also indicate if a person is getting warmer or cooler. The challenge for automatic control of radiant heating is to detect the turning point from a neutral thermal state to a cooler thermal state before the user perceives any cool thermal sensation. The fact that the skin temperature can fluctuate within a range of temperatures without producing any temperature sensation [i.e. the neutral zone] is highly useful in this. A number of user-controlled experiments were performed, in mild cool conditions [Ta=19~20℃], in order to determine if a decreasing trend in skin temperature of the hands or face was observed, before the user performed any heating control action. The only intervention in the individual thermal climate was the use of individually controlled infra red heating panels. The panels were placed vertically in front of the office desk and therefore not optimized to heating the hands. The results 'proof-of-principle' demonstrated that the finger skin temperature was a critical performance indicator of the body thermal state in the cooling region. To test whether the finger temperature was actually useful as control signal, the experiments were reversed: from user-control to semi automatic control.

This study showed the possibilities for including the human body in the control loop of personalized heating systems by IR thermography. The obtained results however, were based on only two subjects [male and female] who participated in this research during several experimentens. More re-

search there for is needed to verify the outcomes. The finger temperature, measured by IR thermography, was tested as feedback control signal for automatic regulation of a radiant hand-heating system by applying different set-points: the small, medium and large bandwidth. The bandwidth is defined as a range of skin temperatures in which the finger temperature was controlled. By controlling the finger temperature in a small bandwidth (Tsk=29-31.5℃), it was possible to respond to user thermal preferences before conscious cool discomfort occurred, while the basic room air temperature was lowered from 22 to 19.5℃. The local- and overall thermal sensation of the subjects were maintained at neutral or slightly higher level, and the subjects [male and female] did not prefer any environmental control action. A correlation between the finger temperature and overall sensation was found ($r2=0.45$, $P<0.05$). By modelling the preference that arises from the interactions with the user, this small bandwidth might be applicable to other individuals. It is already known that individual differences such as body fat percentage, and age, can have a significant influence on respectively the upper-extremity skin temperature and the degree of vasoconstriction. By modeling the preference that arises from the interactions with the user, this small bandwidth might be applicable to other individuals.

The new approach to include the human in the process control loop made it possible to optimize energy use in a room related to the individual comfort of the occupant. By conditioning only the individual critical body parts optimal, the rest of a room can be held on less strict indoor thermal conditions, which saves up to 17% energy while optimizing the individual perceived comfort.

Keywords: Personalized climatization, indoor micro climate optimalization.

Innovative Façade Refurbishment with Integrated Air Ducting for the Existing Building Stock

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Summary

For the successful transition of the energy system being sustainable, the energetic retrofitting of the building stock is a crucial factor. By reducing the heat demand of the existing buildings, both natural resources and the associated CO_2 emissions can be conserved. Extensive refurbishments of buildings often fail due to high costs, leading to only individual measures on the façade like the refurbishment of the building envelope with an exterior insulation finishing system (EIFS) or the replacement of the old windows. The increased sealing of the building envelope of renovated buildings often causes moisture related problems due to improper ventilation. A residential ventilation system with heat recovery can ensure the necessary hygienic air change by reducing the ventilation loss considerably. Retrofitting barriers, such as the high cost of the internal ductwork and the impairments caused by dirt and noise for the tenants often prevent the installation of a central ventilation system.

A promising solution, developed by the Fraunhofer Institute for Building Physics, provides the implementation of the air duct system in the building envelope. In this case, the air ducts are integrated directly in the mounted insulation panels (Fig. 1). Such a system, shown in Fig. 2, is implemented in a demonstration building in Kassel (GER) and investigated with regard to the achievable heat recovery and the energy efficiency of the system.

Fig. 1: Insulation panel with integrated air ducts

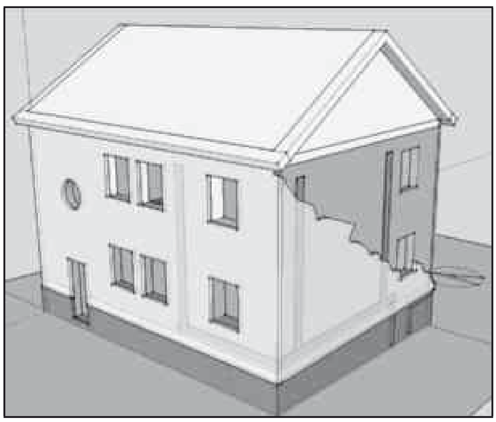

Fig. 2: Scheme of the air ducting on the façade

Parallel to this, the air ducts are investigated in the flow laboratory to optimize the roughness of the ducts and the associated pressure losses. The energy efficient operation of a central residential ventilation system depends significantly on the hydraulic design of the air duct system and the associated power consumption of the fan. The pressure drop of the specially designed air ducts, integrated in the insulation panels, is largely unknown and has not been examined yet.
Furthermore the building and the ventilation system will be implemented in a dynamic computational model, so that design recommendations for optimizing the air duct system on the façade with a high heat recovery potential, low pressure losses and highest energy efficiency can be made.

The project is funded for three years by the scholarship programme of the German Federal Environmental Foundation (DBU).

Sponsored by the Scholarship Programme of the German Federal Environmental Foundation

DBU

Deutsche Bundesstiftung Umwelt

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Keywords: Energetic retrofitting, central ventilation system, air ducting, prefabricated components

4. Methodologies and Tools for Planning, Operation & Deconstruction Processes of Buildings

Analysis, Evaluation and Optimization of Sustainable Urban Districts

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Keywords: urban districts, evaluation, certification, sustainability indicators, life cycle approach

1. Abstract

Our environmental footprint currently exceeds the Earth's regenerative capacity by approximately 30%. If our demands on the planet continue to increase at the present rate we will require the equivalent of two planets by 2030 to maintain our current lifestyle. Cities have a key role to play in sustainable development, as they offer unique possibilities to increase the efficiency of energy, waste, and transportation systems and therefore reduce energy demand per person.
The crucial question is according to which principles cities and urban districts should be designed in order to offer their residents a high quality of life while simultaneously maximizing energy efficiency and minimizing resource demand?
In the spring of 2009 a working group was founded at the DGNB to address this question and develop a certification system for sustainable urban districts, and the final version of this system was presented in June 2012 at the Consense congress and trade fair in Stuttgart.

Following the DGNB's principles, the New Urban Districts occupancy profile represents a logical extension of the DGNB building profiles, with a specific focus on the aspects which fall between the buildings themselves and the district site.
As with the building occupancy profiles, this system will place special emphasis on life cycle assessment and life cycle costs. Additionally, new urban district-specific aspects will be incorporated in the evaluation, such as changes to the local urban climate, biodiversity and habitat integration, transportation system quality, rainwater management, and higher-level concepts for energy, water, and waste management. The buildings themselves need not be certified for an urban district certification and will be considered in the assessment using baseline values.

Fig. 1: DGNB Logo

Because the development of urban districts extends over a long period of time, the pre-certificate (Phase 1) corresponding to the initial urban design phase will be complimented by a further certificate for the planning phase (Phase 2), which will require as a minimum the necessary building permits to have been obtained and the urban development contracts to have been signed. The final certificate is awarded when at least 75% of the district has been completed (Phase 3). The pre-certificate is valid for a period of 3 years, the planning certificate for 5 years, and the final urban district certificate is valid indefinitely.

In summary, the system which has been developed offers many possibilities. It supports and encourages communities and private developers – already during the planning process – to recognize and take advantage of potential areas for optimization, and it creates transparency for the future residents of the urban district. It furthermore serves to prevent imbalances in attractive and livable urban districts, and helps maintain their long-term stability and sustainability.

2. Targets and Criteria of the System

Evaluation Area	No.	Criterion
Environmental Quality (22,5%)	ENV1.1	Life Cycle Assessment
	ENV1.2	Water and Soil Protection
	ENV1.3	Changing Urban Microclimate
	ENV1.4	Biodiversity und Interlinking Habitats
	ENV1.5	Consideration of Possible Impacts on the Environment
	ENV2.1	Land Use
	ENV2.2	Total Primary Energy Demand and Renewable Primary Energy Share
	ENV2.3	Energy-efficient Development Layout
	ENV2.4	Resource-efficient Infrastructure,
	ENV2.5	Local Food Production
	ENV2.6	Water Circulation Systems
Economic Quality (22,5%)	ECO1.1	Life Cycle Costs
	ECO1.2	Fiscal Effects on the Municipality
	ECO2.1	Value Stability
	ECO2.2	Efficient Land Use
Socio-cultural and Functional Quality (22,5%)	SOC1.1	Social and Functional Mix
	SOC1.2	Social and Commercial Infrastructure
	SOC2.1	Objective / Subjective Safety
	SOC2.2	Public Space Amenity Value
	SOC2.3	Noise Protection and Sound Insulation
	SOC3.1	Open Space Offer
	SOC3.2	Inclusive Access
	SOC3.3	Development Layout and Flexible Use
	SOC4.1	Urban Integration
	SOC4.2	Urban Design
	SOC4.3	Use of Existing Structures
	SOC4.4	Art in Public Space
Technical Quality(22,5%)	TEC1.1	Energy Technology
	TEC1.2	Efficient Waste Management
	TEC1.3	Rain Water Management
	TEC1.4	Information and Telecommunication Management
	TEC2.1	Maintenance, Upkeep and Cleaning
	TEC3.1	Quality of Transport Systems
	TEC3.2	Quality of Motor Transport Infrastructure
	TEC3.3	Quality of Public Transport Infrastructure
	TEC3.4	Quality of Bicycling Infrastructure
	TEC3.5	Quality of Pedestrian Infrastructure
Process Quality (10%)	PRO1.1	Participation
	PRO2.1	Conceptual Development Process
	PRO2.2	Integrated Planning
	PRO2.3	Municipal Involvement
	PRO3.1	Management
	PRO3.2	Construction Site and Construction Process
	PRO3.3	Marketing
	PRO3.4	Quality Assurance and Monitoring

Tab. 1: Criteria overview of the DGNB "New Urban Districts" system, effective Jan. 2013

ECOBIM – Value Driven Life Cycle Based Sustainable Business Models

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Summary

Value Driven Life Cycle Based Sustainable Business Models (ecobim, 2012-2014) is a European research project coordinated by VTT Technical Research Centre of Finland under ECO-INNOVERA programme. The project consortium includes SMEs from Finland, Germany and France and the French building research centre CSTB. ecobim's main aim is to develop sustainable construction business models to support paradigm change in eco-innovation. ecobim will draw recommendations to policy makers for its successful implementation covering the whole value chain. A roadmap for new business models will be developed for sustainable construction procurement in collaboration with SMEs. The life-cycle approach considers a wide perspective to adapt to different realities accommodating changes and allowing room for innovation.

Case studies in North, Central and South Europe link ecobim's business model to SMEs' daily practice covering the European dimension and providing business opportunities for the common marketplace. The case studies are national but interactive information exchange ensures covering the whole value chain and considering local features. ecobim intends to positively and widely impact the sustainability of the community while focusing mainly in changing the present paradigm of construction business models, therefore resulting in an improved quality of life for citizens and new business opportunities for the participating partners. This will be supported by better integration of ICT tools, based on PLM (Process Lifecycle Management) to foster collaboration between stakeholders. This paper presents first findings and ambitious objectives of the project.

Keywords: Sustainable eco-innovative construction business models, sustainable construction procurement, life cycle assessment tools, whole construction value chain, ICT, PLM

1. Approach

The construction sector is mainly focused on reducing the initial (investment) costs, rather than applying comprehensive approaches for optimizing total life cycle business models for the benefit of owners, users, the environment and the society. This is partly due to lack of models, methods and tools for total life cycle definition of the design/procurement process, partly due to current business models and contractual frameworks that do not provide space for innovation and novel value sharing schemes.

Currently, there is no tool, any holistic model or method for sustainable eco-innovative construction business models that integrates correctly all aspects of life cycle costs and values (economic, environmental, social and cultural). In addition, creating value is still a rather new concept in the construction industry (particularly for SMEs) and as such it is not yet driving business models or being enabled by contract forms. This makes a paradigm change to eco-innovation even more difficult although very much needed.

2. Objectives

Paradigm change to eco-innovation within the construction sector means more than technological innovation. Sustainable construction business models can support paradigm change in eco-innovation by means of providing a systemic and dynamic approach including Life Cycle Assessment (LCA) and the use of Information and Communication Technologies (ICTs) covering social, environmental and economic aspects in direct collaboration with SMEs. In addition, and while doing so, ecobim will also provide recommendations for policy makers for its successful implementation covering the whole value chain.

SMEs play a very important role in the construction innovation ecosystem. To create new business opportunities for SMEs in a complex and rapidly changing environment, simplicity and agility are key factors to be taken into account. Therefore, a roadmap for new business models for sustainable construction procurement is innovative through flexible life-cycle assessment tools based on indicators and linked to Building Information Models (BIMs). In ecobim, the life-cycle approach considers a wide perspective, to adapt to different realities while being able to accommodate changes and allow room for innovation. Interactions between information and processes will be in the heart of the expected change and will be an important element of the roadmap.

3. Discussion

ecobim intends to initiate the next generation of integrated (social, environmental, economic) user-oriented sustainability assessment tools to aid paradigm change to sustainable eco-innovative construction business models. It will also provide a roadmap to a sustainable eco-innovative paradigm change for enterprises, particularly SMEs, and recommendations for policy makers. Results obtained are intended to be primarily implemented already during the project. IP issues relate with ecobim tools and will be contractually agreed on before the work starts.

Current tools still lack proper integration of the three dimensions that characterize sustainability, and they are commonly not so easy-to-use by key actors in the construction sector, e.g. SMEs. In addition, they are not flexible enough to accommodate changes or to foresee them.

The main output expected is the development of a set of guidelines based on indicators for sustainable eco-innovative construction business models. This process will also provide as a result a roadmap for enterprises, particularly SMEs, and easy-to-understand recommendations for policy makers.

ecobim intends as wide an impact as possible and therefore is planned to be a free-access tool to foster paradigm change to sustainable eco-innovative construction business models. However, VTT will be responsible for and in charge of the development of the tool and its continuous improvement in the future.

LifeCycle Benchmarking – a Fundamental Tool for Planning Sustainable Buildings

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Keywords: **BENCHMARKING – LIFECYCLE MANAGEMENT – PLANNING METHODS**

The Building lifecycle approach is a new paradigm in design and construction. It is actually not yet established in the usual work of architects and engineers. For this purpose methods and tools have been developed to focus the decision-making in the planning process on the Lifecycle Management of building parts and components (Source: H. Balck - "Lifecycle Benchmarking", in 2013 finished German research project of Forschungsinitiative ZukunftBAU - Research partner are Fraport, AUDI, Universitätsklinikum Freiburg)

LifeCycle Benchmarking is focused on "Strategic components"

Strategic components can be found out, when DIN 276 cost positions are related to corresponding follow-up-costs at least on the 4th, better on the 5th or 6th level. These levels are not applied in DIN 276 and have to be defined additional specifical to regarded buildings. The systematic comparison shows a significant range between components which causes high, middle or low costs of energy consumption, operation, maintenance or cleaning costs. Components with a great effect on these follow-up-costs and the like, we call "Strategic Components". In our research we have analyzed as well existing buildings and design concepts. Throughout we have found the same characteristic. Summed up investment costs of Strategic Components often have a part in total sum of investment about 20 % - and this part of investment caused 80% of follow-up-costs. These combined inverse Pareto-spreads (20-80 distribution) are an actual hypothesis, based on our studies.

LCC-Factors

We define LCC-factors as proportion of investment costs and follow-up-costs of the same object within a definite calculation period. Regarded objects are parts of buildings, especially technical equipments and strategic components. The LCC screening of a building by DIN 276 cost positions has a surprising result: within a calculation period of thirty years a small quantity of building components, such as flooring products, lamps, pumps, fans have LCC-factors up to 20 – that is to say the 20-fold of the original costs of purchasing. In contrast a large quantity of construction components, such as external and internal walls, ceilings, roofs, have LCC-factors about 0 to 2 in the same calculation period of thirty years. So 20 % of the total investment includes parts with high LCC-factors and about 80 % of the investment includes parts with low LCC-factors.

LCC-factors are the methodological core of LifeCycle Benchmarking. They shed light on spectra of cost-elements with dual cost-information: Investment cost and follow up cost of each element. Buildings – existing or designed - can completely be decomposed in such elements – and inversely can be composed.

In our research we considered the EU Ökodesign regulation for energy using products (EuP) / energy related products (ErP). Those products are generally strategic components, which can evaluated by LCC-factors. Some EuP products we compared, have very different LCC-factors concerning energy consumption or maintenance. Of greatest interest are products which combine highest rates in energy and maintenance costs – for example lamps, pumps, fans.

Planning building sustainability, supported by LifeCycle Benchmarks

In every building project forecasts of investment costs have always been needed. To these forecasts nowadays follow-up-costs are added, estimating lifecycle cost. A methodological consequence is using LifeCycle Benchmarks. They help to avoid irreversible planning faults and enable the optimization of constructions, technical concepts and the selection of products in the Life Cycle Approach. Major LCC factors indicate high relevance of DIN 276 cost groups with disproportionately high follow-up-costs. In this case additional costs and higher prices for exceptionally efficient products may be accepted – based on low rates of amortization. On the other hand low LCC factors indicate minor relevance of DIN 276 cost groups with insignificant follow-up-costs. In this case prices of products only correspond to levels of quality, because cost savings in the period of use and operating are without foundation.

LCC Factors enable cost estimations in long-term horizons. In dividing up all costs of investment in cost groups with relevant LCC and cost groups with not relevant LCC the above mentioned Pareto distribution will appear as a decision table. Investors and planners can use it to find out the best strategy of reaching an attractive level of sustainability.

Technically and economically controlling in the management of sustainability and purchase

A side effect of using LCC-factors is a new basis of budgeting operation and maintenance costs. Traditionally those budgets are static. But they often are not adequate, because dramatically increasing maintenance costs of building parts at the end of their lifetime, especially of technical equipments, were not anticipated in the budgets. In the LCC approach they get dynamic. Along defined lifecycles of building parts – that requires more differentiated structures of finance plans ! - budgets follow a time based overlay of “Bathtub curves”. Their application on strategic components can help to identify sub-budgets which are critical to success. But they are different and specific to the location profile of buildings and depending on the processes of users. Here some examples from our research partners. Fraport FM Services give high attention on Ventilation, telecommunications technology and escalators. The major focus in central stations of Deutsche Bahn is elevators (vertical logistics). A typical critical success factor in buildings for car production of AUDI are gate systems (horizontal logistics).

Methodical results of our research are new demands and models for purchasing and integrating tenders. Our research partner Fraport intends to use methods and tools of LifeCycle Benchmarking within the Management of Sustainability of the company – with impacts on the process-interface between the actors of planning and the actors of operating / maintenance. The goal is a process of controlling without barriers – based on a purchase due to criterias of sustainability.

To elaborate the basics of “LifeCycle Budgeting and Purchase” the author is involved in ongoing projects at Fraport.

Sustainable Neighbourhoods: Challenges for Research, Policy and Planning

   

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Summary

This paper has three goals: to provide a well-founded survey of basic characteristics of the most relevant existing sustainable neighbourhood assessment systems and tools in Germany and internationally, to present a method for comparing these systems and tools at different levels and finally to point out remaining future requirements towards a more integrative scientific and political approach for dealing with neighbourhoods.

Keywords: sustainable development; neighbourhoods; assessment tools; integrative approach

1. Introduction

Considering their share of global population and the increasing responsibility in global GDP, resource use or CO_2 emissions, cities play a crucial role to achieve a more sustainable development at a national and global level. At the same time, being places of high capital accumulation, knowledge and human resources, innovation potentials, etc., they entail great opportunities to deal with these challenges and to tread paths towards sustainable development.
For this, sustainability-related research, assessment and governance of highly complex urban systems have to consider three main scales: the total city, single buildings and neighbourhoods. While at the city and the building level particular characteristics and conceptual and analytical requirements are dealt with for a long time, neighbourhoods are increasingly moving into the focus of research and policy, as an intermediate level close to the needs and real life of people.

In this paper, a survey of international and national neighbourhood assessment systems is presented, with the aim of providing insights into current practice and trends as well as revealing ambiguities and weaknesses in this field. For the comparison of the selected tools and systems, a generalised approach was developed and applied, where both general features characterizing the object of assessment and the sustainability coverage at different levels were analysed. A clear distinction was made between the performance oriented sustainability assessment of a neighbourhood in terms of a performance measurement tool, and the sustainability assessment of neighbourhood development in terms of a process-related support to decision makers through a system including target values and performance monitoring.

2. Results

The survey has revealed that most of the existing systems and tools focus on the sustainability assessment of new neighbourhood developments, following a performance oriented approach. However, the assessment of an existing neighbourhood based only on its performance at a specific point of time includes the risk of stigmatizing this neighbourhood as “unsustainable”, thus discouraging stakeholders to deal with these cases. In reality, an existing neighbourhood is not an object but rather a process, as it changes and evolves continuously. Therefore, the authors suggest a division of labour between two approaches: in cases of new neighbourhood developments, the absolute performance measurement approach should be applied as usual; in cases of existing neighbourhoods, their progression with respect to (sustainable development) the achievement of specific short-term or longer-term targets should be assessed.
A comparison among the tools and systems regarding the criterion of sustainability coverage can be performed at different levels, e.g. an indicator, criteria or main category (or dimension) level. Based on examples presented in this paper, it can be stated that it is more suitable to compare the systems and tools at an indicator level, as similar criteria can be assessed by different indicators.

3. Conclusion and discussion

As a conclusion, it can be stated that the existing assessment tools and systems analysed in this paper clearly mark a certain progress regarding the expansion from the building to the neighbourhood level, and the scope of applied assessment criteria. The various systems applied are usually derived from the tradition of sustainability certification of buildings. They differ greatly in many aspects and need to be analyzed in greater detail to conclude on the comparability of their outcomes. These certification systems are useful for the planning and implementation of new neighbourhood developments, but do not solve the problem of the development and sustainability-related improvement of the existing ones. Here, it is recommended to build on the traditions of Local Agenda 21 and develop tools that help to determine tailored targets to particular cases as well as to monitor their implementation and measure the success in achieving the targets set. Thus, neighbourhoods with a poorer initial performance have a better chance to be improved in this respect. The advantage of this particular approach lies also in the involvement of local actors in the design of policies and objectives. Nevertheless, several gaps and deficiencies are remaining, particularly with respect to an integrative understanding of both the design of assessment tools and the implementation phase in terms of policy and planning procedures in detail, for instance regarding the question as to the standardization of assessment criteria.

Plus Energy High-rise Buildings in the Subtropical Climate Region - Method for Optimising Solar and Wind Energy Harvesting in the Conceptual Planning Stage

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Abstract

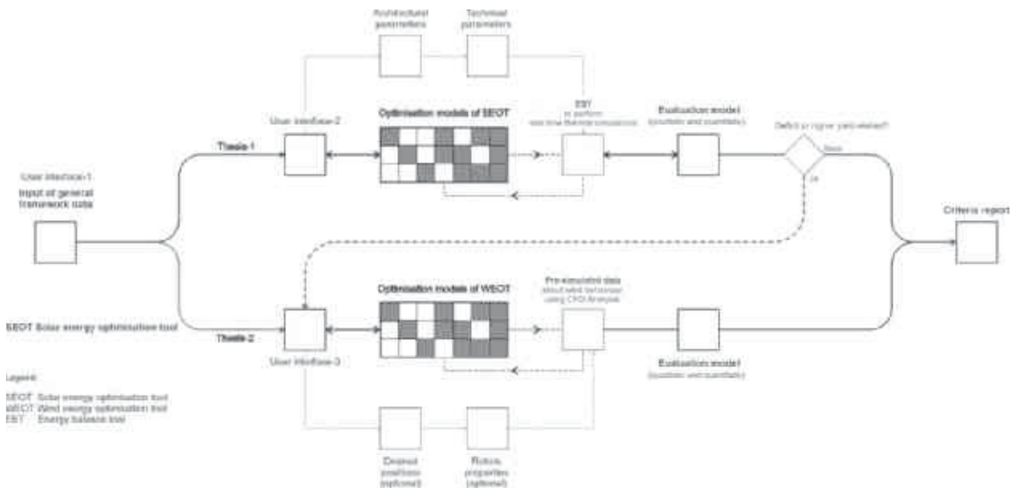

Fig. 1 General structure of the optimisation system

The need for energy efficient high-rise buildings is becoming imperative, especially in rapidly growing economies. This building type, a key for the densification of cities, offers potentials for sustainability that include the exploitation of on-site renewable energy. It is suggested that the high-rise building of the future should not only consume less energy, but also rather energy to the grid. Building integrated energy generating devices are becoming essential components of many low- and high-rise buildings today. However, achieving net-zero or plus-energy balance in high-rise buildings postulates meticulous adjustments on many levels to achieve a successful synergy and to overcome technical insufficiencies. This paper focuses on optimising the incorporation of building integrated photovoltaic (BIPV) and vertical-axis wind turbines (VAWT) in building façade and the building body, respectively. The algorithms developed within the scope of this research enable architects to make early decisions on the energy performance of high-rise buildings with

regard to energy savings and energy generation strategies. The embedded simulation and evaluation programmes in the optimisation process consider the impact of the optimised criteria on user comfort and formal quality. Compared to conventional approaches, the results deviate minimally from an ideal reference model while achieving a plus-energy balance.

The target plus-energy balance is rather more difficult to meet in high-rise buildings than in low-rise buildings. While addressing the formal quality is important in the high- rise design, ensuring maximum performance is of greater importance. This involves achieving a high energy yield and low energy demand while meeting user comfort with the minimum possible technical complexity.

High-rise buildings have the advantage of being exposed to different renewable energy resources. Besides facing high wind velocities the large skin area is located above the most polluted layers of the air which facilitates higher efficiency for solar devices. Within the scope of this paper and as a method to maximise the energy balance while keeping other parameters like comfort within recommended limits, two optimisation tools have been developed that can be used as a stand – alone programmes or as a plug-in into another software. The sotware presented in this reasearch do not produce one single answer to the problem; rather is provides users with a simple instrument that they can manipulate to obtain results that suit their requirements without prior knowledge of programming. Fig. 1 illustrates the basic structure of the developed system. It mainly comprises of two sets of optimisation models that are represented by two tools, solar energy optimisation tool (SEOT) and wind energy optimisation tool (WEOT). Both are supported with grafical user interfaces (GUI) and evluation models. Having tested the presented optimisation system on high-rise models located in cities in the subtropical region, Jeddah, Miami, Durban and Sydney it is now possible to state that the presented tools can be of great support to the architect in the early design phase to produce the basic design criteria of a plus-energy high-rise building. With the help of such programme, the user is able to make decisions concerning the façade performance criteria, while knowing to a great extent their impact on energy, comfort and formal quality.

REAL INVESTOR - The Green Arbitrage Pricing Game
Adaptive Training for Strategic Thinking in Real Estate

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Summary

In 2010 Real Investor was introduced at several universities and since then further developed and improved up to what it is today the ‘Green Arbitrage Pricing Game’. The game is a behavioural approach towards the dynamics of property pricing under constantly changing circumstances like for example: the environment, regulation, the economy and trends in social responsibility.

Investors, asset managers, developers and tenants find themselves in a situation, where each one of them has a dominant strategy with the negative side effect of increasing greenhouse gas emissions. If each party follows its own strategy the total emission of CO2 will be worse if compared to parties working together.

Real Investor is a real world business case that simulates this dilemma, based on the economic and social concepts of game theory. The laboratory setting in the structure of an extensive collective-action game with imperfect information delivers experimental evidence of practical management issues and solutions. In their respective roles the players learn to understand the dynamics of the green property dilemma and to make viable strategic choices for resolving it.

The game of business is modelled in the so-called 'value net' (Brandenburger and Nalebuff 1995). From a company's point of view the players are structured in customers, suppliers, complementors and substitutors. Their business relations can imply simultaneous competition and cooperation. In the 'Green Arbitrage Pricing Game' added value is to be created and captured by developing business relations between fund managers (companies), equity investors (customers), office tenants (suppliers), debt investors (complementors) and government institutions (substitutors).

The game is facilitated by the strategy training toolkit 'RealInvestor'® developed at the EURO Institute of Real Estate Management. The real world business case tackles institutional investments in the Australian office market. The simulation data is based on current input from the Green Building Council of Australia.

This paper describes in detail the way the game evolves over time and what students learn whilst playing the game. Furthermore this paper addresses the framework for integrated learning and training, with the game as its starting point.

Keywords
Investment; real estate; green; strategy; game theory, integrated learning

Challenges in the Sustainability Assessment of Historic Buildings

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Keywords: historic buildings; life cycle assessment; sustainability; embedded energy; grey energy; conservation

Summary

The objective of this research is to find a sustainable material appropriate for reversible wall insulation in historic buildings that satisfies physical and environmental criteria. Since there are currently no established standards for evaluating sustainability of historic buildings, energy-saving measures such as installing insulation must not be directly compared to such measures in newer, more efficient buildings, but rather evaluated independently, taking the cultural value of the historic structure into account.

Introduction

In recent years, several methods and certification systems have been established to assess the sustainability of buildings. However, these methods often neglect historic buildings due to their non-standard characteristics. Such characteristics, often rooted in long cultural traditions, can be found in a wide variety of traditional structures, from rural homes to houses and buildings in small towns to churches, cathedrals, and even castles. The lack of a standard method by which to assess the sustainability of historic buildings is a major gap in the field of green building and has led to an increasing number of researchers and practitioners asking how to best sustainably preserve these historic buildings.

While preservation may be at the forefront of issues to consider when dealing with a historic building, one must also consider the structure's environmental impacts, as with any other building. Due to limited natural resources and the global desire to reduce emissions associated with pollution and climate change, the energy used in buildings for maintenance, heating, and cooling must be minimized. The challenge is to minimize the energy expenditure while maximizing the occupant or usage potential and while preserving the original construction as best as possible. Therefore, the objective of this research is to find an energy-saving wall insulation material for historic buildings that satisfies both physical and environmental criteria.

Reversible Wall Insulation: A Sustainable Way Forward?

Internal wall insulation is normally applied using high adhesive mortar. Any features, including historic plasters or decorative paintings, are typically covered by the internal wall insulation and destroyed when they are subsequently removed. This study, therefore, examines different materials for an internal wall insulation that can be completely removed without damage and is thus safe to use in historic buildings.

This creative insulation solution, however, still may not compare to highly efficient insulation in a newer building, and therefore, the entire historic building can appear less sustainable since energy plays such a large role in the sustainability assessment. The question then is: do historic buildings require their own certification system, a system that takes physical and cultural features into account, or can a broader certification system be developed to sufficiently accommodate the special characteristics of historic buildings?

Conclusions

The green building community lacks a commonly acknowledged sustainability assessment method for evaluating historic buildings. Historic buildings fulfil a variety of functions, and evaluating them based purely on energy performance when comparing them to contemporary structures unduly penalizes their sustainability score. Both the building’s function and its cultural value must be considered in addition to typical sustainability criteria to enable a balanced assessment.

User-Centered Design in Certified Office Buildings

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Summary

The evaluation of certified buildings currently in use shows that amounts of energy demand and energy waste are hardly concurrent. Users usually do not behave as predicted and a lack of knowledge transfer regarding the proper use of buildings can be observed. How can one improve the ability to understand a user's behavior and preferences? How does communication between users and planners take place during the briefing and planning stage? How should communication be designed? The analysis of user participation during the briefing and planning stage of certified buildings (BNB/DGNB) is presented in this paper. How can these findings be integrated into the processes of the German Assessment Schemes (BNB/DGNB)?

Keywords: User-Centered Design; User Representatives; User Group; User Satisfaction Survey; Building Users; Building Evaluation; Sustainability Assessment Schemes; BNB; DGNB

1. Introduction

User-centered design is not only a social value, but has a high influence on the resources and energy efficiency of a building's entire life-cycle. Whether or not the user perspective is sufficiently considered in sustainability assessment schemes is questionable. Since assessment results (e.g. BNB/DGNB, BREAAM, LEED) are based on the quality prognosis of the building's entire lifecycle, a building's users play a key role on the demand side of sustainability assessment schemes. The evaluation of LEED-certified commercial buildings has, for example, shown that amount of energy demand and energy waste are hardly concurrent. Users do not typically behave as predicted and a lack of knowledge transfer regarding the appropriate use of buildings has been observed. Matching user requirements is a very important criterion when seeking sustainability in construction sector. If the usage concepts of existing buildings are in line with user requirements in the long-term, building users may reduce demand for construction projects and conversions (including all labor, resources, and impacts).

Examining the current BNB Scheme for New Office Construction reveals that the interest of users is represented by social dimension criteria, such as thermal, acoustic and visual comfort and air quality. Criteria such as interior design, transparency, privacy, and space for communication are not represented. Relevant criteria may vary according to the building's location and with organization requirements, but the system is not flexible to actively integrate user values. The direct assessment of user participation occurs through the criterion “Integral Planning”. A distinction is made between a consultation and a co-decision procedure. However, there are negligible minimum standards and, due to the maximum score, the role is negligible in relation to the overall system. Fair access for all stakeholders to the participation process is not mentioned. There is no definition of the importance and timing of decisions made by user participation procedure. Above all, methods for the exchange of knowledge between experts and users are not yet part of the system.

2. Case Study Research

The research goal is to formulate the following hypothesis: What do communication strategies look like, which are capable of producing usage concepts with reduced resource waste, but which are also enacted and accepted by users? To this end, an empirical study of communication processes designing certified buildings was conducted. For research methodologies, an ex-post design was chosen in order to highlight the entire process chain from the briefing to the occupation stage. Buildings certified by the German schemes BNB and DGNB comprise the basic sample. This circle of research units is limited by the attribute usage stage, in order to analyze the whole process chain and its influence on use. Hence, office buildings were analyzed, because the first German assessment schemes (BNB/DGNB) were developed for this building type. Data was surveyed from project documentation and interviews with involved stakeholders and users.

For this paper, two exemplary case studies were compared to one another as part of further research on this topic. The office buildings were certified with a BNB/DGNB-Gold standard. Both projects received maximum points in BNB/DGNBs' sub-category user participation. Hence, the user participation in both processes is more comprehensive than in common planning processes for office buildings in Germany because: (1) Direct communication occurred frequently between user representatives and planners, (2) A working group of users was initiated to accompany the planning process. (3) Surveys of user satisfaction with the building in use are conducted regularly. Despite all these measures, the results were different. In Case A, a high degree of user satisfaction with combination offices had been identified. In contrast, in Case B, the users were not satisfied with the open plan offices in one building block. Conversions were required.

In both cases, it is unlikely to find reasons for a lack of information within the communication between user representatives and planners. However, it can be questioned how the communication between user representatives and users had been designed. Do representatives have an idea of the whole spectrum of user interest within the organization? How do they objectively gain employee feedback? In both cases, department managers, staff councils and project teams stayed in close contact with planners. Thus, the involved users can be seen as representatives related to the organization's organigram. But are they able to represent all user groups' attributes? In Case A, there had been a plenary meeting for common users during the briefing stage. The project team presented different office concepts. Beyond information and discussion, they were able to vote for one of the concepts. Thus, the staff council was able to represent a verified opinion of employees, instead of individual opinions. In Case B, a comprehensive presentation at a plenary meeting held by the project team occurred later, during the construction stage and was of an informative nature. In earlier stages, the information exchange between the user group and the users was described as one-sided with rare feedback opportunities.

3. Discussion

The case study investigation discovered that the user interests within an organization must be analyzed differentially in order to recognize the real, rather than the suggested user requirements. In other words, the users' acceptance of their spatial environment is influenced by the representative nature of identified requirements. To ensure that communication results are representative, several factors might be important for the design of communication processes. To name the aspects mentioned above: (1) There must be a minimum of direct communication with all users. (2) The users must be involved before final decisions are made. (3) The users' involvement must be aligned with the existing participation culture.

In the operational stage, changes in planning often result in high expenses, labor, and a waste of resouces. Simply put, it is not sustainable. The proposition of hypotheses mentioned above aims to ensure the identification of real user requirements rather than assumed requirements. However, communication between user representatives and staff is not clearly defined in the BNB/DGNB-System. There is a need for further research into how these findings can be integrated into the processes of the German Assessment Schemes (BNB/DGNB).

Evaluating Performance of Building Structures in Compliance with Sustainable Concept

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Extended Abstract

The Human being, as other living creatures, grows and depends on the conditions of the surrounding environment. Therefore, preserving environment and reducing negative environmental impacts is matter of survival [1]. The building sector is known to be dominant consumer of energy resources, contributor to greenhouse gas emissions and other environmental impacts. The existing building stock accounts for over 40% of final energy consumption in the European Union member states and are responsible for more than one third of final greenhouse gas emissions. The residential buildings consume approximately 63% of total energy consumption in the buildings sector [2]. The analysis residential buildings in Hong Kong indicated that the embodied energy could account for up to 40% of the life-cycle energy used in residential buildings [3]. These embodied impacts of building materials and components achieve high values mainly in the case of extremely energy performance residential building. Environmental analysis of life-cycle impacts of single-family house demonstrated that exterior walls were by far the most significant construction component with 35% of embodied energy and 43% of embodied emissions of CO_2-eq associated with the construction phase [4].

This case study evaluates environmental building material performance of assemblies for exterior wall of nearly zero houses through environmental indicators such as embodied energy from non-renewable resources, embodied emissions of CO_2-eq and SO_2-eq by using methodology Life cycle assessment (within boundary from cradle to gate). This methodology helps to make decisions in sustainable building design. For purpose of reduction of future energy demand during operation, the material compositions of exterior wall are compared through selected thermal-physical aspects such as U-value, surface thermal capacity, relaxation time and surface temperature. All results are compared by using multi-dimensional evaluation approach through four mathematical methods (WSA, TOPSIS, IPA and CDA). The weighting of assessed aspects is calculated by using Saaty's method in order to elimination of subjectivity. The multi-criteria decision analysis (MCDA) demonstrates that this way of material optimisation of exterior walls it is possible to ensure markedly reduction of total energy consumption and carbon footprint of building.

The wall assembly 2 from massive wood panel and other materials on wood base is able to absorb enormous amount of CO_2 emissions (more than 300 kg of CO_2-eq per square meter) and it can assure by 56% - 86% higher elimination of CO_2 emissions in comparison with other alternatives. This wall 2 improves overall energy balance of structure in despite of it achieves the highest value of embodied energy in comparison with other alternatives. It is the fact that the relaxation time and

surface thermal capacity have the highest share in weighting (27%) and the wall 2 reaches by 52% - 82% better value of relaxation time than other alternatives and by 64% - 88% better value of parameter thermal capacity than others.

The overall environmental and energy performance of building structures is important in achieving sustainability of building. The careful selection of materials for design process plays significant role during the life cycle of building and represent the easiest way for designers to begin incorporating environmental criteria in building project.

References

[1] NEIVA S., MATEUS R., and BRAGANÇA L., “Environmental LCA database for conventional Portuguese building Technologies”, *Proceedings of the 1st International Conference on Building Sustainability Assessment*, Porto, Portugal, 23.-25. May 2012, pp. 613-620.

[2] BALARAS C. A., et al, “European residential buildings and empirical assessment of the Hellenic building stock, energy consumption, emissions and potential energy savings”, *Building and Environment*, Vol. 42, No. 3, 2007,pp. 1298-1314.

[3] CHEN T.Y., BURNETT J., and CHAU C.K., “Analysis of embodied energy use in the residential building of Hong Kong”, *Energy*, Vol. 26, No. 4, 2001,pp. 323-340.

[4] MONTEIRO H., and FREIRE F., “Environmental Life-Cycle Impacts of a Single-family house in Portugal”, *Gazi University Journal of Science*, Vol.24, No.3, 2011, pp. 527-534.

A Case Study to Investigate the Life Cycle Carbon Emissions and Carbon Storage Capacity of a Cross Laminated Timber, Multi-Storey Residential Building

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Extended Abstract

Forests are a store of carbon and an eco-system that continually removes carbon dioxide from the atmosphere. If they are sustainably managed, the carbon store can be maintained at a constant level, while the trees removed and converted to timber products can form an additional long term carbon store. The total carbon store in the forest and associated ‘wood chain’ therefore increases over time, given appropriate management. This increasing carbon store can be further enhanced with afforestation. The UK’s forest area has increased continually since the early 1900s, although the rate of increase has declined since its peak in the late 1980s, and it is a similar picture in the rest of Europe. The increased sustainable use of timber in construction is a key market incentive for afforestation, which can make a significant contribution to reducing carbon emissions.

The case study presented in this paper demonstrates the carbon benefits of a Cross Laminated Timber (CLT) frame solution for a multi-storey residential building in comparison with a more conventional reinforced concrete frame solution. Building plan dimensions are approximately 58m long by 14m wide giving a gross internal floor area of 4,154m^2. The building was completed in autumn 2011 to the UK Code for Sustainable Homes Level 4 standard at a project cost of £6 million.

The study considers the question of whether carbon sequestered during the growth of the trees providing the CLT should be credited to timber in a lifecycle assessment, the resulting carbon storage capacity of the CLT frame and the effect of different end of life assumptions for timber on the embodied carbon (E_c) of the building. E_c here is considered to be the ‘cradle to grave’ CO_2e emissions occurring over the whole life cycle of the building, excluding the operational carbon during the building use.

On the basis that CLT utilises short rotation softwood timber sourced from sustainably managed forests and the European area of softwood forest is increasing it is concluded that it is appropriate to consider 100% of the sequestered CO_2, particularly when taken on a life cycle basis where the emissions at end of life are also accounted for.

The study indicates that that E_c of the CLT frame building is 641tCO_2e, 1226tCO_2e lower than the RC frame equivalent with an E_c of 1867 tCO_2e. This is on the basis of 100% CO_2 sequestration and incineration with energy recovery at end of life for the CLT frame.

The effect of five other end of life scenarios for the CLT frame, apart from incineration with energy recovery, is considered: re-use in its existing form; re-engineer the panels into smaller sections and re-use; landfill, assuming 20% of the timber decays and no energy recovery from landfill gas; incineration without energy recovery. The E_c of the CLT for the different treatments considered ranged from -1017tCO_2e for re-use to +153tCO_2e for incinerate without energy recovery, resulting in a whole building Ec differentials between the CLT and RC options ranging from 1756tCO_2e to 586tCO_2e. All treatments resulted in lower total emissions for the CLT frame building.

The choice of treatment at end of life and level of sequestration considered has a significant effect on the E_c of the CLT frame and is important when considering best design options to minimise Ec.

The results of the study show that the total weight of the CLT frame is 734t, which equates to 331t of stored carbon or 1215t of CO_2.

Keywords: Building; timber; carbon dioxide emissions; embodied carbon; life cycle.

A Tool for the Design of Sustainable Building Concepts

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Summary

Background: The term sustainable development is popularized and exploited, especially in building sector. Generally, wrong definitions are in use, where o ly one aspect of development is well considered, while others are ignored. The term was defined by Brundtland Report in 1987 and by the UN Conference on Environment and Development in Rio de Janeiro in 1992. Sustainable development means the development where all four aspects are equally balanced: health, environmental, social and economic. The purpose of the study is to develop a tool for the design of sustainable building concepts, where all four aspects are balanced. **Methods:** Regarding the purpose of our study, the upgraded method of engineering design is used. For each aspect (sub-aspect) we perform four steps: Step 1 - Analysis of real-state conditions, Step 2 - Definition of sustainable indicators, Step 3 - Definition of goals and targets, and Step 4 - Final Assessment (evaluation). In doing so, we cover the whole life cycle of the building. Selected indicators present the platform for the matrix construction. The testing phase includes models, case studies and alterative solutions that are tested through a decision-making model. **Results:** To achieve balance among aspects, we take into consideration needs, interests and requirements. The selected solution represents a variant where all four aspects are balanced with emphasized health and environmental aspect (required by Regulation 305/2011). Th selected solution, an integral efficient system, also fulfils our goal: “Towards near zero energy and at the same time 100 % healthy and comfortable building”. **Conclusions:** The development of building concepts can be sustainable only if all our aspects are balanced. It is mportant that the environmental and health arguments are strong enough; because in reality it often happens that they are crushed by the burden of strong socio-economic arguments.

Keywords: sustainable development; tool; building concepts; indicators.

Three Strategies for Holistic Housing

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Abstract

Vast achievements in the field of sustainable building have been made: A variety of targets, aspects and criteria have been identified that constitute important building blocks of a comprehensive understanding of sustainability in the field of architecture. Assessments and evaluation systems have been developed that help to analyse designs and buildings. Still missing are strategies that could be used to integrate the targets in the design process.

In a two year empirical research project concepts, strategies and methods for designing sustainable residential buildings have been gathered and analysed. Sustainable design is not -merely a technical problem, rather it can be most successful if it accomplishes to bridge the gap between the cultural role of architecture and its technical side. For this reason, the study focused on the design potential that could be derived from the following questions:

- What are approaches and strategies to meet the diverse and sometimes divergent requirements of sustainability in architecture?
- What methods and tools can be applied in the early stages of the design and planning process for new and existing buildings to be planned holistically in order to optimize the design in terms of sustainable construction?
- What is the role the context (in the broadest possible sense of climatic, structural, cultural and social context) plays in respect to the design?
- What are the advantages and disadvantages arising from their implementation?

The study was conducted for a book project that was published with 'Edition Detail' in July 2012 under the title 'Holistic Housing. Concepts, Design Strategies and Processes' [1]. In the book 15 buildings are documented and analysed with special focus on the design process. With the international examples, the study demonstrates how essential aspects of sustainability can be integrated at different design stages. Each project represents a specific response to a given context, the local climate and the user requirements. /
Based on the analysis of the built examples and design processes three strategies were identified, that have been found in the built examples.
The strategies are to be understood as mutually complementary or sequential. None of the investigated buildings can clearly be assigned to one of the strategies exclusively, but in almost all projects a clear focus can be found:

- **Strategy 1: Minimum impact:** Minimize the negative impact of the building for environment and society through more efficiency in combination with the reduction of consumption.
- **Strategy 2: 'Less bad is not good' strategy** [2]**:** Building as a comprehensive design approach which focuses on maximizing positive effect to maximize tangible added value and experience for users and planners
- **Strategy 3: Built utopia:** Planning as a systemicand process oriented approach with the aim of contextualizing our build environment

A central part of the research was the development of an analytical method (building assessment system) that can be used for evaluating sustainability criteria in the wide range of contexts and

system) that can be used for evaluating sustainability criteria in the wide range of contexts and projects. The applied method in this research project is based on the valuation method developed by the Department of Design and Energy Efficient Building of the TU Darmstadt in 2009 called ‘Housing Quality Barometer’ (Wohnwertbarometer [WWB]) [3]. Whereas most rating systems, this system can be used during the design process due to the efficient and phase adapted rating method – beginning with the definition of targets, followed by the analysis of different plots and urban design layouts until the rating of variation studies for different floor plan layouts.

The study has demonstrated that most existing systems are not reflecting the real impact of a building if only approximately. The focus on specific aims and methods often leads to serious limitations in the range of possible approaches in the design processs. A large part of the strategies analyzed in the study would not be covered by conventional assesment. Therefore a re-evaluation of these methods as tools for the design and planning process is based on the following criteria:

- Evaluation of all sustainability-related criteria, to enable a comprehensive reflexion of the qualities and requirements
- Simplified data collection and evaluation to limit time and effort, especially in the important early stages of the planning process does not increase disproportionately.

Fig. 1: Studied buildings (from left upper to right lower): Loblolly House, Taylor Island, Kieran Timberlake Architects, 2008; 20K Houses X, V, VII, VIII, Rural Studios Auburn University, 2008-2011; Quinta Monroy, Iquique, Chile, Elemental, 2007-2009, Lakeside House, Saimaa lake, Finland, NOW Architects 2007; Townhouse, Landskrona, Sweden, Elding Oscarsson Architects, 2009; Wall House, Name: Wall House, Lampa, Santiago, Chile, FAR frohn&rojas, 2007.

Keywords: Strategies, methods and design processes, rating systems, residential buildings, systemic and process oriented, minimum impact, life-cycle-engineering, cradle-to-cradle

A Paradox of Choice in Green Building Labels – Is More Really More?

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Summary

Green Building labels are associated with several benefits. In order to reduce the potential risks of the future markets, clients are anticipating multiple certifications on the same project. Consequently, it became common to certify the same constructed property with a national and an international established label. This results in practice with considerable additional effort and costs. However, it can be questioned if the additional effort and costs add value on the property. To examine this, a case study in Switzerland has been selected, which has been certified with a national and an international Green Building label. The findings are presented through a developed instrument that supports the documentation. The study indicates that multiple certifications are associated with more costs than single certifications with no perceived added value. Nevertheless, it has been also identified that an appropriate instrument can support in controlling the additional costs and keep the costs low.

Keywords: Construction Management, Contractor, Documentation, Green Building Label, LEED, MINERGIE-ECO, Multiple Certification, Switzerland.

1. Introduction

To get the highest profits out of real estate investments and property acquisitions, increasing attention has been paid by the market on sustainability aspects. In addition, it can be demonstrated that there is greater willingness to pay for transactions, which can be related to the gap between demand and supply in the property market. The focus of the property market moved towards the development and application of so called “Green Building” labels.

2. Green Building labels

Previous studies have shown that certified buildings result in added value. The owner’s or the investors associate with Green Buildings a legitimation for higher rent, an increase of the occupancy rate, and a higher resale value. In Switzerland, the most established labels are the Minergie, Minergie-P and Minergie-A labels, but also international labels such as LEED and DGNB / SGNI find significant application. Widely accepted criteria are used to reflect the sustainability themes within these labels. The approaches and structures of the different Green Building labels show a high variety and difference. This results consequently in uncertainty for the owners to choose the appropriate label for their property. Hence, multiple certifications are commonly applied to balance the strengths and the weaknesses of different labels. For the used case study within this paper, the labels LEED and Minergie-ECO have been applied.

3. Case Study - Office Building in Switzerland

The case study is located in Switzerland. It consists mainly on areas for office use. In addition there is also an employee restaurant and a kindergarten. The gross floor area is approx. 40'000 m^2. The focus of this case study is on construction related sustainability issues, e.g. use of ecological materials. The aim is to illustrate the critical differences and to develop a solution which will support the documentation process. To enable the comparison between the used Green Building labels, the criteria are compared in accordance with the respective label methodology. The results are used to develop a documentation tool, which will support the documentation process. In addition it will also support the contractors in receiving the appropriate documents from their suppliers. The key contractors were tracked per trade in accordance with the Swiss Construction Specification (Baukostenplan – BKP) similar to the US CSI (Construction Specifications Institute) Master-Format, which was in line with the LEED requirements. The smooth implementation of the documentation process was facilitated through an internal controlling tool and a calculation tool, which was given to the contractors to assist their process. It was possible to detect similarities between the labels, such as the documentation for recycling concrete, but also crucial differences. One of these differences is significantly visible when dealing with composite wood panels. Another challenge presented to be the documentation of adhesives and sealants in the required format, because of a relevant difference in the metrics for VOC content.

4. Conclusion

The case study was limited to the extent that consultancy for the LEED requirements took place after the submission was completed and assigned to a general contractor. In a following step it is possible to extend this tool with other label requirements, such as DGNB/SGNI or Green Property on the Swiss Real Estate Market

The results of this research indicate that additional expenses arise for using multiple green building labels, even though the requirements of the labels show similarities. The reason for this can be related to the different cultural construction background of the respective label. This is significantly visible for criteria with the same objectives. The research emphasised also that there is a relationship between the project size and the additional costs caused because of multiple certifications on the project or/and life-cycle. For the case of very large projects, it is justifiable to use a national and an international Green Building label, because this will increase the attractiveness and reduce the risk of vacancy. If the appropriate instruments are in place, the additional costs are even negligible for very large projects.

A Comparative Analysis of Emerging Contextual Sustainability Assessment Tools (SATs), Focus on the MENA region

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Summary

For more than two decades, the concept of sustainable development (SD) in general and sustainable architectural design (SAD) in particular has remained the subject of intense debate [1]. Furthermore, existing building sustainability assessment tools such as BREAAM and LEED are mainly proposed for assessing the sustainability in America and Europe. Recently, tools and frameworks have been developed to become sustainability assessment models for the booming cities of the MENA region and Gulf countries, such as the city of Doha in Qatar. In the face of its rapid economic development, population growth and construction boom, there are issues related to the impact of such development on the socio-environmental components of Doha, especially with the upcoming 2022 FIFA world cup. Hence, two of the most important real-estate firms in Qatar; Barwa and Qatari Diar Research Institute worked together in cooperation with T.C. Chan Centre-University of Pennsylvania (USA) to develop 'GSAS/QSAS': Global Assessment Sustainability System formerly known as Qatar Sustainability Assessment System. Based on a comparative evaluation with three other major international and regional tools, this paper aims to investigate the viability, practicability and efficiency of QSAS as a sustainability assessment / EIA model.

Keywords: Comparative Analysis, Sustainability Assessment, Model/Matrix, QSAS, MENA region.

Context:

Based on recent research work conducted by the author and funded by the Qatar National Research Funds (QNRF) under the Undergraduate Research Experience Program (UREP project# 11-026-2-010); this investigation focuses on studying and reviewing emerging SATs such as G/QSAS, while attempting to give answers to the main research question by tackling two main aspects; the first aspect concerns what is measured by the choice of indicators; or the scope of the SA Tool, and the second aspect deals with examining the quality of the system from the perspective of its robustness as a process of appraisal. Sustainability Assessment Tools (SATs) are systems which examine the performance or expected performance of a 'whole building or development' and translate that examination into overall assessment [2]. Hence, the study adopts a comparative evaluation of QSAS versus well-established assessment tools both at the international level (BREEAM in the UK and LEED in the US); and regional level (ESTIDAMA in UAE). This study aims to investigate and review the viability, practicability and efficiency of the Qatar Sustainability Assessment System (QSAS). The research question to be ad-dressed is how fit and adequate is QSAS in its local, regional and international context?

Framework and outcomes overview:

The last two decades have witnessed a maturing of concern and interest in building performance that is increasingly evidenced in building design. Globalization and environmental challenges led to the introduction of emerging rating tools over the past few years in many countries in order to

improve the knowledge about the level of sustainability in each country. It can be argued that the individual characteristics of each country; such as the climate and type of building stock necessitate an individual sustainability rating tool for that country and this may very well be the argument that has led to newly developed green building rating systems in the MENA region, including: Estidama's PEARL system in the United Arab Emirates, ARZ in Lebanon, EDAMA in Jordan, the Egyptian Green Pyramid Rat-ing System (EGPRS) in Egypt and Global/Qatar Sustainability Assessment System (G/QSAS) in Qatar [3]. The strengths and weaknesses analysis is conducted on the basis of the parameters selected in conducting the comparative review against the three other SAT systems, and is developed as follow:
i.Maturity: QSAS is not as mature as BREEAM or LEED**; ii. Scope**: QSAS presents an important development and encompassing a variety of scope at different levels and types of buildings; **iii. Dimensions:** Environmental, Socio-cultural and economic: QSAS is one of the rare SAT that in-cludes (even though at a low percentage) the socio-cultural indicators into account; **iv. Flexibility-Time/Space scales**: QSAS is more flexible in time than in spatial scales; **v. User-friendly**: be-cause of its young age, and lack of maturity QSAS system is still behind expectation to what is called user-friendly system; **vi. Readability,** Results interpretation and Graphic display: results can be hard to read and understand in a snapshot; **vii. Mitigation measures** are lacking in QSAS model.

Initial recommendations:

Rating systems, on their own, are not sufficient to achieve genuine sustainability in the built environment. What is needed are more ambitious sustainability targets than those necessarily assumed by any present building rating system. For countries in general, this means thinking beyond the green building rating systems now used. The challenge for Qatar is to think beyond QSAS, as this on its own may not be sufficient to achieve genuine sustainability for Qatar's built environment.

Including Fuel Price Elasticity of Demand in Net Present Value and Payback Time Calculations of Thermal Retrofits

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Summary

Policymakers use cost-benefit models to evaluate the economic viability and payback time of thermal retrofits, comparing the net present value (NPV) of the benefits expected to be received in future years through fuel savings, with the thermal upgrade costs. However, these models assume that, if the dwelling had not been retrofitted, its occupants would have continued to consume the same amount of heating fuel as previously, despite future fuel price rises. In other words, they fail to include a factor for fuel price elasticity of demand (hereinafter called 'elasticity'). This paper demonstrates how these models can be modified to include this factor. It then tests its effect by calculating the NPV, payback time and CO2 savings of a set of thermal retrofit projects on a large housing estate in Germany.

Most cost-benefit models for thermal retrofits have the general mathematical form:

$$B = Q_1 \times P_1 \times \frac{A^N - 1}{A - 1}$$

Where B = NPV i.e. accumulated benefit through fuel savings (€/m^2); Q_1 = Quantity of fuel saved in first year (kWh/m^2); P_1 = price of fuel in year 1 (€/kWh); N = lifetime of the renovation measures (years); and A = the 'annuity factor'.

In standard models, A = F/D, where F = annual fuel price rise and D = discount rate.

The model can be modified to take account of elasticity. A value G for long-run elasticity over n years is obtained from empirical studies. An equation is derived to translate this into year-on-year elasticity, E, given the annual fuel price rise F during the long-run period:

$$E = \frac{\sqrt[n-1]{1 + G \cdot \left(F^{n-1} - 1\right)} - 1}{F - 1}$$

A further equation is derived for the annual reduction in consumption, H, due to elasticity:

$$H = E \cdot F - E + 1$$

It is then shown how this modifies the annuity factor A so that the NPV model becomes:

$$B = Q_1 \cdot P_1 \cdot \frac{(HF/D)^N - 1}{HF/D - 1}$$

Further, this can be inverted to produce a formula for payback time, the point where B = C, the cost of the thermal up grade measures:

$$N = \frac{\log\left[1 + \frac{C(HF/D-1)}{Q_1 \cdot P_1}\right]}{\log(HF/D)}$$

Finally, the CO2 savings, Y, through a thermal upgrade including elasticity, are given by:

$$Y = Q_1 \times 0.0002 \times \frac{H^N - 1}{H - 1}$$

These formulae are applied to an actual project where 850 apartments had been retrofitted to four different thermal standards which produced fuel savings of 182, 168, 138 and 18 kWh/m^{2}a respectively, for thermal upgrade costs of 314, 187, 122 and 36 €/m^2 respectively. For P_1 = €0.05 (at the time of the retrofits), F = 1.048 (fuel price rise of 4.8% per year); D = 1.02 (discount rate 2%); and G = -0.324 (Hence E = -0.411), the following results were obtained:

For the highest standard (fuel savings of 182 kWh/m^{2}a), accumulated savings were 321€/m^2 under the standard model but fell to 248€/m^2 when elasticity was included, i.e. the retrofit was no longer economically viable. Payback time increased from 24.6 to 30.9 years, and the CO2 saved as a result of the retrofit fell from 0.910 t/m^2 to 0.724 t/m^2.

In all four cases the savings fell by 23% when elasticity was included. Payback time lengthened by 14% for the third highest standard and 29% for the lowest. CO2 savings fell by 20% in all cases and the cost of abated CO2 rose by 25%.

A low discount rate was used in these calculations, but the effects of elasticity are significantly greater with higher discount rates. Further, higher future fuel price rises do not necessarily lead to greater savings, as high fuel price rises cause elasticity to reduce fuel consumption in non-retrofitting homes more sharply (H is smaller when F is larger).

Since fuel price elasticity of demand makes a significant difference to calculations of the benefits of thermal upgrades, policymakers need to consider including it in the NPV models that calculate these benefits.

Keywords:

Price elasticity; economic viability; thermal retrofits; cost-benefit analysis; payback time

Development of an European LCA Rating Methodology for OPEN HOUSE

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1. Introduction

In the last few years the awareness of human influence on environmental effects increased tremendously. The European Union tries to improve the overall environmental impact of Europe by funding research projects that have a focus on energy-efficiency and resource-efficiency. Especially buildings are highly prioritized due to the fact that buildings are responsible for 40% of the total European energy consumption and 33% of the CO2 emissions [4]. In order to utilize this potential savings it is not only important to develop new energy-efficient technologies but also to establish transparency on the building market and make people aware of the energetic and environmental performance of buildings. Due to different approaches and focus areas of existing certification schemes the research project OPEN HOUSE was created to "develop and to implement a common European transparent building assessment methodology, complementing the existing ones, for planning and constructing sustainable buildings by means of an open approach and technical platform". An important part of the OPEN HOUSE building certification system are environmental aspects and therefore Life Cycle Assessment (LCA) results.

2. OPEN HOUSE LCA methodology

The development of a transparent methodology for assessing LCA results of buildings in an European context had to be done based on decisions agreed in workshops and on results from questionnaires in order to get the full picture of opinions and people the possibility to take part. First of all several workshops were held to gather different perspectives on building sustainability and how the sustainability criteria (e.g. LCA) should be included and weighted in OPEN HOUSE. Furthermore questionnaires were developed and sent to the 76 participating case study partners in various countries all over Europe like France, Sweden, Finland, Slovenia, Greek, Cyprus, Czech Republic, Poland, Austria, Denmark, Germany and Italy in order to get a picture of local conditions, legal framework, etc. which are important for the evaluation and for the comparison of buildings all over Europe. Due to the different local circumstances in every country, especially with regard to the different national EPBD methodologies and building regulations, a classification of buildings within different national contexts is a pre-requisite not only for an environmental but a consistent building assessment. Therefore, the „OPEN HOUSE LCA methodology developed, enables comparisons of European buildings on the basis of national ratings. Within the OPEN HOUSE methodology there are two different benchmarks, one for production of the materials, refurbishment of the built-in materials and the specific End of Life and the other one for the operational phase of the building. The "Construction reference benchmark" is based on the average European value of the evaluation of all case study buildings. The "Operational phase benchmark" (Oref) can be assessed in two different ways. If national benchmarks or national defined limited endenergy values are available these values should be used, if not the average European values assessed in the OPEN HOUSE case studies should be used as default values. This two reference values finally are summed up to the total reference value. According to the total reference values for each environmental indicator the building is rated. In the end all indicators are weighted according the OPEN HOUSE assessment and summarized in a global score.

3. Results from the case studies

The case studies helped to spot the main differences between the countries and the most important parameters for building LCA. Special focus is paid to the development of national benchmarks for the construction and use phase for both a „quick and basic assessment“ as well as a „complete assessment“. In order to understand the relevance of certain constructional elements and building materials, sensitivity analysis is performed to verify the necessary of inclusion or exclusion of these elements. As one of the outcomes one benchmark for each environmental impact category and each level of completeness (Quick and Basic, Complete) was developed based on the results of the case study building. For a “Quick and Basic” assessment a construction catalogue with typical European constructions was developed and implemented in the LCA software tool. Some of the building components and their lifecycle stages are until so far excluded due to missing LCA data sets or expected minor relevance. So far some of the information - needed for the inclusion of certain lifecycle stages (e.g. transport to construction side, energy consumption on site, etc.) - is asked for in the LCA questionnaires, but during the project only few case studies were able to provide this information. For consistency reasons this information was not considered in the LCA assessment, but just documented.

4. Outlook

All in all the OPEN HOUSE LCA methodology proofed to provide a consistent methodology that focus on a regional respectively national scale, but at the same time gives a possibility to compare buildings on European level based on a best-in-class approach. On outcome of the case studies is a first step in the direction of European LCA benchmarks. Of course the small number of case studies does not yet allow statistically significant statements, but the average European benchmarks developed within OPEN HOUSE should more or less give a first range. Further research should be taken in this field in order to increase the number of case studies and therefore develop better benchmarks, but also improve the number and quality of the available LCA data sets. Furthermore especially the calculation of the building surfaces and national EPBD versions should be also taken into account in later research projects.

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Sustainable Building Specifier (SBS) in European Research Projects

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1. Introduction

In the last ten years significant progress in the development and implementation of energy efficiency measures in buildings and building equipment were achieved. Before this in the operational phase of a building 80 -90 percent of total CO2 emissions over the lifecycle of the building were related to the operation of the building. The energy- efficient measures and energy saving materials decreased the energy consumption and therefore the overall impact of the use phase tremendously. On the other hand the environmental impacts for the production of the building and the energy-efficient measures increased the importance of the production phase. Due to this a life cycle thinking approach already in the design phase gets in the focus of many architects who are seeking for low impact and sustainable buildings. Due to the fact that there are very little software available which support non-LCA experts to make decisions in very early stages of a project and with very little time effort, LCA came just in place at the very end of projects to state the environmental impacts. Therefore large optimization potential is not used and the overall building quality is often not achieved, because interaction between building materials and technical equipment respectively energy concept is not considered.
In order to support non-LCA experts and decrease the time effort for an building LCA the SBS Building Sustainability was developed and used in two European research projects regarding different goals and scopes to show its applicability.

2. OPEN HOUSE

The European research project “OPEN HOUSE” funded by the European Commission (EU FP7) aims for a benchmarking and building sustainability system in the EU based on transparency and open source technologies. One important part of this building assessment methodology is the description of environmental aspects which are mainly done via a Life Cycle Assessment (LCA). The whole methodology was tested in 76 case studies in countries all over Europe like France, Sweden, Finland, Slovenia, Greek, Cyprus, Czech Republic, Polen, Austria, Denmark, Germany and Italy. This huge number of case studies and the short time scale made it almost impossible to assess all buildings by one company. Therefor the OPEN HOUSE partners were trained to assess the case study buildings by their own. In the end an OPEN HOUSE tailored LCA assessment output Excel file is generated which includes graphs, tables and diagrams to illustrate the LCA results, but also the used input data is included to give user the possibility to transparently check the results.
The Excel format also allows users to use the LCA results and combine them with other results e.g. cost data in order to get a full picture. In the end building LCAs of 76 case studies were created and benchmarks on European and also national level were created in a consistent and automatized way.

3. Cost Effective

Another European research project SBS was tested is “Cost effective”. The objectives of “Cost effective” are to develop and test energy-efficient concepts and technologies which can be installed in the building facade. In „Cost-Effective“ SBS Building Sustainability was used to assess retrofit measures on building level including new energy-efficient components (e.g. façade integrated PV solution). The very unique framework of the research project made it necessary not only to assess newly developed building components which no LCA was done on so far, but also usual building components which common data is available. Therefore it was tested if LCA data from other LCA data software and databases could be imported. For this an import possibility using xml standard was implemented to make it possible to upload datasets. All in all the different concepts and common building parts were modelled directly in the software whereas specific technologies which were not done so far were modelled in GaBi and afterwards uploaded. The Excel output files made it possible to transparently show the results and run automatized evaluations.

4. Conclusions

All in all SBS Building Sustainability helped to decrease the time effort on the one hand side for performing an LCA on buildings and building components and on the other hand for quality checking the model. Also the effort for visualization reduced enormously; due to pre-defined evaluation excel templates. The overall quality of the case studies done by non-LCA experts is quiet good, keeping in mind that they have never done a LCA before. Anyhow the results should be quality checked at the end by a LCA professional.

In future software LCA tools for non-LCA experts can help to increase the number of building LCAs overall and therefor help to develop more representative results (e.g. European benchmarks for different lifecycle stages of buildings). The software tools can also serve as a platform for different LCA data in Europe. So LCA construction databases like ELCD data base, ESUCO or Ökobau.dat can be hosted there, but also national and European EPDs can be included.

A Multilevel and Multiscale Method to Optimize the Sustainable Construction Works

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Summary

The nature of the **sustainabile approach** in the construction management is **complex**, because of the large number of involved components and relationships between disciplinaries, objects, phases of the **life cycle**, aspects and variables of any **project** or **costruction works process**.
The paper reports on the research focused on the development of inductive, logical / operational guidelines, managing the single variables in an integrated vision supported by holistic tools.
The aim is to contribute to the research and the practice to **optimize** the sustainable management of construction works, giving transparent answer to the search of the best technical solutions and design strategies in a large sustainable perspective.
The identification of a **multiscale** and **multilevel** strategy supporting the decision-making process, focused on key targets / criteria / indicators with respect to the energy, environmental, social and economic performances, is applied to “Città Studi Sustainable Campus”. The project is promoted by the Politecnico di Milano and the University of Milan to transform the university district into a model part of the city in terms of quality of life and environmental sustainability. It is also member of the ISCN (International Sustainable Campus Network www.international-sustainable-campus-network.org) and inserted in the European Peripheria framework (http://peripheria.eu).

Keywords: Sustainable construction works; CEN TC 350; Multilevel; Multi-scale; Integrated approach

Introduction

An analysis of the state of the art shows that for the assessment of sustainability of the life cycle in costructions the most commonly used rating systems / multicriteria tools are generally inconsistent one with each other and this represents a barrier the development.
At European level, there is an ongoing process by **CEN TC 350**, in order to develop common rules for the assessment of the environmental, social and economic performance of new and existing buildings within the framework of **integrated performance** of buildings. This is a response to the EC/DG Enterprise standardization mandate M/350 EN “Development of horizontal standardized methods for the assessment of the integrated environmental performance of buildings”.
Complexity is one of the major assumptions of the conceptual model on which the new European **assessment** standards family, still in progress, is based, as well as the **multidisciplinary** approach.
Complexity is one of the major assumptions of the conceptual model on which the new European **assessment** standards family, still in progress, is based, as well as the **multidisciplinary** approach.
Moreover, the future developments are expected to go more and more into the direction of the **integration** of the three major components in the life cycle: environmental, social, economic, as

well as at the international level the discussion on **wider system boundaries,** beyond the building, is going on.
These are sufficient grounds to start managing any case of construction works as an **interdisciplinary** and multi-layer issue, evaluating and planning any action as the integration of a certain number of actions involving many variables and producing cross effects. At this point a **multiscale** and **multilevel** approach becomes indispensable.

Methodology

As indicated by CEN TC 350 standards, the research adopts an inter / trans - disciplinary approach, aided by **multi-level** or **multi-layer** tools in a so-called **integrated** perspective.
And, at the same time, the input to expand, in the assessment, the **boundaries of the system** beyond the building is transposed in a **multi-scale** approach, that examines impacts and performances relating the building and its life cycle to several **territorial** scales. This means to put in relationship the related **sets of aspects/indicators** describing **impacts** and **performances** as identified in respective assessment/reporting systems. The so built system is necessary to compare one to each other a set of options of works on the building case study with the aim to evaluate any option and later to rank them from a sustainable point of view in its own territorial **context**.

The first step has been setting a list of aspects/indicators coherent with the case study, starting from the core indicators identified in the **EN 15643-1-2-3-4 standards** and in the related 7 Framework Program projects (Open-House, SuPerBuildings). A first panel of 43 indicators has so been set, grouped in environmental, social and economic indicators.
Thanks to a further recognition in literature reporting the results of researches validating additional indicators, an additional list of 12 indicators has been selected.
A conceptual model reporting the levels of the building, the campus, the city, the metropolitan area and the national-European framework has been drawn to support the territorial contextualization of the European indicators.

Final remarks

The results of the activities carried on the evaluation systems and indicators applied to the case study show essentially that:

The harmonized European panel of 43 core indicators could be completed with 12 indicators validated at European level but not yet shared to describe the impacts / performances of the building.
Interrelations exist between the indicators belonging to different categories (environment / society / economy).
There is an interrelation between the panel of European indicators of the **building** and the **territory**, namely relations with different scales (building, **campus**-area), due to the relapse of effects (**impacts**) produced by building operations and consequently affecting the territorial **performances** from a sustainable point of view.
The comparison between the panels of indicators (the European one and 3 territorial, plus 2 specific of universitary international ranking systems) highlights such similarities and congruences.
The set up armonization tables are able to support the Politecnico di Milano management staff to plan future strategies creating **synergies** between interventions and policies implemented at different scales.

Integration in Design for Sustainability: Two Brazilian Case Studies

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Summary

The conventional design practice is characterized by a segmented process and isolation across disciplines. The architect usually develops early design work, and then submits the plans for the client's approval. Other design disciplines are added late in the process, when opportunities for significant changes are very limited. The Integrated Design Process (IDP) encourages multidisciplinary collaboration of all agents involved from the design process outset, and the definition of a consensus between client and designers regarding goals, performance targets, means, roles and responsibilities. Full IDP implementation leads to greater efficiency of the process, which enhances the possibilities to achieve more aggressive goals for environmental performance. It was proposed for a research to investigate how IDP can contribute for better environmental performance of buildings, and the extent to which it was adopted in two Brazilian case studies with ambitious environmental goals. As case studies are multi-evidence-based, with more variables of interest than data points, the methodological approach was developed upon previously established theoretical propositions: a theoretical reference consisting of the fundamental elements that characterize IDPs, to guide data collection and design process analysis. This paper positions the case studies in relation to the theoretical reference and discusses the main lessons learned.

The initial research phase synthetized the IDP methodological elements to constitute the theoretical reference as*: Integrated multidisciplinary work; Building Performance Evaluation (BPE); Process management; Energy performance simulation; and Continuous Value Optimization (CVO).* In the second phase, two Brazilian case studies – design processes of buildings - were selected. Both design processes were initiated after competition by invitation letter for the project; and aim at LEED™ NC certification. In the third phase a data collection protocol was created, identifying the types of evidence to be investigated: (a) IDP methodological elements; (b) performance targets; (c) agents; and (d) design solutions.

Obtained results show that, though the studied cases had no predefined agreements to implement IDPs, some methodological elements were actually found, yet at different extents. Continuous Value Optimization was not implemented in neither case. For different reasons, in both projects actual costs overcome the original estimates. Integrated multidisciplinary work was implemented – despite the difficulties experienced – throughout SAP Labs Brazil design development. Integrated project delivery was unfortunately disrupted; despite the efforts to include the construction company in the discussions form the outset and mimic a design-build model. For the CENPES Expansion, a gap during conceptual design review became clear. As rather usual in design-bid-build contracting models, the link with the construction phase was also broken, this time by the subjection to Brazilian bidding legislation. Though the client company had its own team of construction and assembly representatives, it seemed to be insufficient to ensure continuity through the construction activities. Mostly because of the certification pre-requisite, BPE was found in both cases, at pre-design phase, interrupted during conceptual design, and then resumed in construction documents development. Due to company policy and intrinsic risk activities, commissioning is standard practice for Petrobras, greatly differing from the typical Brazilian practice. It is expected that some performance evaluation will be carried out. Still, emphasis is given to industrial installations and laboratories, which have detailed control systems.

Instrumentation of the office area is contrastingly less sophisticated and covers only basic aspects. By the time of writing, BPE during operation had been implemented only in the case of SAP Labs Brazil. The company continuously monitors in-use results of its facilities portfolio worldwide, particularly those with declared environmental goals. A very complete building management system was implemented to assist facility management tasks.

Process management techniques were implemented for both projects. In the case of SAP Labs Brazil, it was more solid and present from design development phase on, harvesting the corresponding benefits. In the case of the CENPES Expansion, management was intensified from development of construction documents onwards. Given the size of the project and of the design & consultancy team involved (140+ people) the management system put in place was considered to be indispensable, but the procedures formalized in the Quality Plan hindered the fluidity of the design development. The system resulted in a large bureaucracy and stiffened the process. Participants stated that, maybe with a little more freedom, the exchange of ideas would be more enjoyable and able to generate more creative results, with greater versatility in the design. The use of energy performance simulation tools was very important in both cases, but seem to have remained underexplored. For the CENPES Expansion, only simplified simulations were performed in the Concept Design phase, due to schedule constraints for delivering the competition material. Likewise, in the case of SAP Labs Brazil, simulations were performed only in the Construction Documents phase, aiming at verifying the compliance with the energy performance pre-requisite for LEED™ certification.

Though the IDP elements detected have remarkably influenced the achievement of the overall targets, the positive results accomplished demanded efforts much superior than those previously estimated. The lessons learned made evident that much of the observed difficulties could have been avoided, or at least minimized, by incorporating the missing elements. In both cases studied, learning form experience was pointed out as possibly the most positive aspect by the agents consulted. This was true not only for the consolidation of new practices on the part of those involved, but also for the development and recording of information to serve as references for other projects and teams. Building design processes are very complex, being characterized by a great number of variables and particularities. Aiming at proposing one single ideal theoretical model to fit and guide all building design processes would be therefore inaccurate. Yet recurring patterns, opportunities and difficulties can be identified and lead to generic propositions and guidelines. Taking due care to consider the particularities of each case, the IDP elements appear as an important reference to guide building delivery processes.

Keywords: sustainability, design methodology, IDP, architecture, construction, management.

Sustainability Performance of Lightweight Aggregate Concrete Masonry

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Summary

In the previous years the strategic sustainability approach was anchored especially in the construction and real estate industry. This sector adopts its key role for a sustainable development more and more. Due to a changed regulatory and normative framework as well as the development and implementation of second generation assessment systems as the German DGNB the building product level becomes focussed on, whereby the importance of sustainability qualities' documentation increases significantly. Environmental Product Declarations (EPD) provide the industry with an instrument to communicate the quality of its building products to the market players. This paper shows the changed framework responsible for the mentioned market dynamic, explains the fundamental methodology of EPDs and describes the sustainability commitment of considerable players of the concrete and precast concrete element industry.

Keywords: Sustainability; lightweight aggregate concrete; masonry; EPD

Extended Abstract

For a sustainable development the construction and real estate industry plays a key role which is more and more adopted by this sector, for instance by the conception and market implementation of sustainability assessment methodologies for buildings. According to the increasing consideration of principles for sustainable construction - due to the demand for above mentioned sustainability assessments - the focus shifts to the environmental impacts as well as the (ecological) sustainability of building products representing up to one fifth of for instance a DGNB-certification performance. This trend's crucial stimulus is moreover the EU Integrated product policy (IPP) which was complemented by the new EU Construction Products Regulation for the segment of building products and furthermore leaded to a changed regulatory framework, accompanied by according harmonisation of relevant and specific standards [1]. The described facts cause a diversified definition of building products quality because the classical two-dimensional demand decision - characterised by technical quality and price - is emerging as a demand triangle completed by the dimension of sustainability.

In this context, Environmental Product Declarations (EPD) have established as a communications format and contemporary instrument. They are based upon a life cycle analysis (LCA) of the declared product, viz. a modelling of all in- and output flows across the life cycle or a specific part of it. In addition and beyond a LCA, an EPD furthermore includes that ecologically relevant information which can be mapped via a life cycle analysis so far [2]. Within the sustainability certification of buildings an analogous LCA at structural level represents a crucial element of the ecological sustainability assessment, at least concerning the German systems DGNB/BNB. Basically it is intended to use a central database which mainly contents generic data. However the usage of producer specific data, as provided by EPD, is explicitly permitted. Often, those specific data have the advantage of accuracy over their generic equivalents: Whereas the generic data outline the average of a plurality of producers and furthermore include a 10% safety factor, EPD-data are able to consider characteristics of a certain producer. Hence producers have to face requests for producer specific data more and more frequently in the procurement process.

The concrete and precast concrete element industry belongs to the early adopters of the trend towards documenting the environmental impacts of building products. In 2008 the *Bundesverband Leichtbeton* developed its first EPD for lightweight aggregate concrete masonry and provides the according sustainability data. Actually the association extends its engagement under a project with *Technische Universität Darmstadt*. A sensitivity analysis of different mixtures of lightweight aggregate concrete masonry should document the sustainability performance on a broad basis and moreover help to identify further potentials towards optimization. The first results (see table 1) verify that lightweight aggregate concrete masonry made of natural aggregates can be characterized by comparatively low environmental impacts or vice versa a high ecological sustainability quality especially due to the manufacturing process without a thermal treatment. And further optimisation is possible by partially substituting the hydraulic binder cement by trass as a natural pozzolan.

Table 1: LCA-results of lightweight aggregate concrete made of natural aggregates

Lightweight aggregate concrete - **Type of brick**	PE [MJ/m^3]	GWP [kg CO_2-eq./m^3]	AP [kg SO_2-eq./m^3]	EP [kg PO_4-eq./m^3]	POCP [kg Ethene-eq./m^3]
Solid block „Vbl leicht" (RDK 0.45)	350	72.5	1.1E-1	1.6E-2	1.1E-2
Solid block „Vbl schwer" (RDK 1.80)	632	119	2.1E-1	3.5E-2	2.3E-2
Hollow block „Hbl" (RDK 0.80)	346	64.1	1.2E-1	1.8E-2	1.2E-2

References

[1] GRAUBNER C.-A., POHL S., „Umweltproduktdeklarationen für Bauprodukte - Ein Kommunikationskanal für ökologische Nachhaltigkeitsqualität", in: BetonWerk International, No. 3, 2012, pp. 116-120

[2] SCHMINCKE E., GRAHL B., „Umwelteigenschaften von Produkten - Die Rolle der Ökobilanz in ISO Typ III Umweltdeklarationen". UWSF - Z Umweltchem Ökotox 18 (3), 2006

Method for Developing and Assessing Holistic Energy Renovation of Multi-Storey Buildings

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Summary

A large part of the Danish building stock is from the post-war era, and thus there is an immense need for renovation within a few years. To secure durable solutions a holistic approach is needed. This paper presents a standardised method for developing and assessing a holistic energy renovation of multi-storey buildings. It is developed as part of a Danish research project on holistic approaches in energy renovation, also considering development of new products or solutions especially for renovation.
The method was successfully tested in the design phase on two buildings in a case study and in one case the output was used in the design proposal for a renovation.

Keywords: Assessment method; building renovation; multi-story buildings; holistic perspective; product development.

1. Introduction

In Denmark around 40% of the building stock is from the post-war era (1950-1979) and many buildings are built before the energy crises in the 1970s. Typically the buildings have not undergone any thorough renovation and thus there is a need for renovation within the next few years. To comply with demands concerning energy savings and to satisfy the need for renovation in general in existing buildings, a holistic approach is needed. As those buildings are typically only renovated every fifty years, the solutions must be thoroughly thought through, in order to secure future-proof solutions with a long lifetime.

2. Method and Assessment Method Development

Development of the method is based on nine overall evaluating criteria, embedded in “people”, “plant”, “profit”, defined in the project “Holistic Energy Renovation” in which context the method has been developed. This was combined with a study of existing methods for building evaluation and registration already used in Denmark today. It was further compared to two case-buildings that were available alongside the development. Those were also used partly for testing the method as a developing method afterwards.

This method combines existing methods that are normally used separately in building renovation and user involvement, which resulted in a method that supports a holistic evaluation of a building renovation. The method is not to asses if one solution is better that the other, but it should be used early in the process to specify focus areas and necessary initiatives to obtain a holistic renovation.

After completing the renovation, it shall be used to make a qualitative assessment of the value added in the performed renovation.
The method comprises an investigation of the following five elements; economy, architecture, technical and social matters as well as user involvement. All elements of the method are equally important; they are not weighted in between. Combining all outputs from the investigations, focus points of a holistic energy renovation can be drawn up. This will not be explicit solutions to specific problems, but focus points that should be treated by the group of consultants connected to the project.
After development of the method, it was tested, to the extent possible, in development of renovation solutions on two multi-story buildings in Denmark. The focus points found were in one case successfully used as underlying basis for the main concept of a renovation.

3. Discussion and conclusion

The output from the developed assessment method, in form of focus points for a holistic renovation can be used as basic input for development of the main concept of a renovation. Especially the strong involvement of the users has led to a broader and more holistic perspective in the development of the main concept.
One can question if there is a need for yet another assessment method and if this method comprise all aspects needed. However we found that no official method existed in Denmark that could do a qualitative evaluation of all the parameters found relevant for a holistic renovation. Renovations have been performed for years, therefore parts of the investigations included in the method already existed and it is believed that a collection and standardisation of the methods will lead to more holistic solutions.
In conclusion the method developed has so far reached the intended aim that is supporting a more holistic approach for renovation of buildings. Future studies will show if the method is also suitable for evaluation of the improvements that follow from a holistic energy renovation.

The Interaction Between Sustainability and Quality in Building – A Systemic Approach

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Abstract

Today sustainability has gained a growing acceptance in the building sector and is seen as a trendsetting part of buildings. On the other hand building processes up until now have (still only) been evaluated through differences in price and marked by the handling of failures and insufficiencies in the construction and erection of buildings. Positive effects of better building quality have not been widely identified.
This paper examines the interaction between and the impact of aspects of sustainability and the criteria of quality in buildings through a sensitivity model.
Firstly the elastic terms of quality in the building context and sustainability are discussed. A sensitivity analysis is produced in order to work out the importance of each aspect and to show their various interactions.
Twenty variables are deduced from the firm establishment of the terms. They constitute the set of variables for a sensitivity analysis from Vester. Based on these results sustainable buildings, which are recognised as exemplary, are examined in order to identify the underlying principals and their correlation. The results of the building analysis are then contrasted with the results of the sensitivity analysis.
An effect system for the creation of sustainable buildings is developed as a cybernetic model. In this model it is outlined which prerequisites are required to develop sustainable buildings.
Aspects, which generate high impact for the whole system, are emphasised and starting points for improvements elaborated.

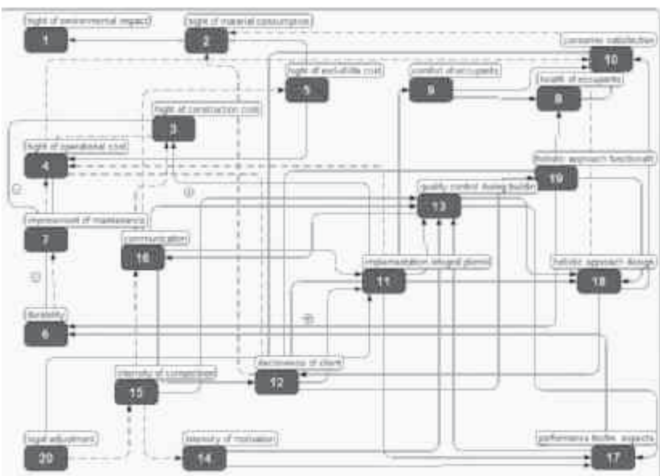

Fig. 1: effect system of interactions between sustainability and quality in buildings

Through the cybernetic model many interactions between sustainability and quality in buildings were shown. True sustainable buildings can only evolve from stronger interactions between the separate disciplines. The first step is to understand the interdependencies and interactions between the variables and then to develop the main factors so that the system changes with the lowest input. In reaching sustainable buildings, design with its complex dependencies has to regain a central position. Client behaviour as well as quality of construction work on site are also fundamental. Motivation of planners and builders and communication between them is highly important.
More training for all parts of the building sector in these issues is necessary. A honest culture of teamwork for the best result rather than only the economic success is fundamental.

Acknowledgement: This paper contains parts of the PhD thesis from the author.

Keywords: sustainability; quality in buildings; sensitivity analysis; interaction

GINGER – The Influence of Gender on User Behaviour in Highly Energy Efficient Buildings

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Summary

This conference contribution presents a study tackling user behaviour and consumer aspects in highly energy efficient buildings taking into account social, ethnical, and especially gender-related aspects, and analyses the building design concept in comparison with the actual energy consumption. The interdisciplinary project team applies new socio-scientific methods to develop innovative solutions for influencing user behaviour, which undergo trial runs in selected buildings. Results will contribute to improving communication measures, design process and product development in order to tap the full potential of energy savings due to user behaviour.

Keywords: gender and diversity, design for all, user behaviour; methodologies and planning tools, holistic planning approaches, highly energy efficient buildings

According to the EU-project „BEHAVE“ (http://www.energy-behave.net/) more than 50% of energy savings are due to changes of energy consumption related user behaviour. The development towards plus-energy-buildings (buildings which produce more energy than what occupants consume) causes a change in the role of consumers: consumers turn to active stakeholders, because their way of using the building will be decisive whether the building actually achieves plus-energy status, or not. It is a precondition to fully understand the motivations and options for actions of consumers, in order to tap the full potential of energy savings related with user behaviour. In this regard, gender-specific aspects have not been considered so far.

The study presented is based on the deep analysis of new and existing buildings which comply with ambitious energy-related criteria and belong to a broad range of building typologies (multi-unit residential buildings, office buildings, schools and kindergartens, educational campus). The interdisciplinary project team applies new socio-scientific methods to develop innovative solutions for influencing user behaviour, which undergo trial runs in selected buildings. The project team investigates the process starting with the early design phase and ending with the present operation of the building. First results will be analysed, and serve as the point of departure for developing innovative solutions and measures to address user behaviour in terms of energy consumption reduction. Selected measures undergo a trial run in selected buildings. Focus is on gender and diversity aspects.

Results will contribute to improving communication measures, design process and product development in order to tap the full potential of energy savings due to user behaviour:
Design process and building construction: Lessons learnt will serve to improve stakeholder involvement during building design. Results will contribute to improve communication and information measures during building operation. Design guidelines: Results provide input to specify standard user-behaviour profiles which are used during building design. Product development: Results will provide information especially for improving building services components and house automation. Stakeholders are actively involved in the project to sensitize them for gender-related issues.

Sustainable Management of Existing Buildings and Portfolios

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Summary

Two of many facts: buildings are responsible for 40% of energy consumption; 80% of the buildings in Germany are older than 25 years. Improving building in-use quality and performance is a must – from an ecological as well as from a financial point of view. It is about the question of how buildings can adapt to changing environmental conditions and the existing respective local economic opportunities; it is about the sustainable management of the building stock.

A possible way to promote sustainability in existing buildings is certification. The implementation of certification systems allows the systematically gathering of information on the building and its operation in order to enhance and protect value as well as contributing to a more sustainable future. One of the certification systems is the “Building Research Establishment Environmental Assessment Method” for existing non-domestic buildings (BREEAM In-Use). Since the beginning of 2012 there is an adopted national scheme for Germany (DE) called BREEAM DE Bestand.

In October 2012 the first pilot projects were labeled with BREEAM DE Bestand. By February 2013 five buildings of the owner Prime Office REIT-AG will be certified – five best practice examples of sustainable management addressing sustainability not only in design but on top in operations. The result: the achievement of high certification levels plus the implementation of strategies to improve the sustainability of the existing buildings as well as of the correspondent portfolio.

Keywords: sustainability; building in-use; certification; performance; portfolio; building operation;

BREEAM DE Bestand Certification

BREEAM DE was launched on the German market by the “Deutsches Privates Institut für Nachhaltige Immobilienwirtschaft GmbH & Co. KG” (DIFNI), located in Frankfurt, in February 2012. In Mai 2012 the first national scheme BREEAM DE Bestand was introduced for the certification of commercial existing buildings (e.g. office, industrial, and retail buildings). The introduction of BREEAM DE Bestand was driven by dissatisfaction of property owners and asset managers regarding the certification of existing buildings, especially of portfolios.

With BREEAM DE Bestand an applicable label exists that is adapted to local standards and local conditions. The main goal of BREEAM DE Bestand is to offer a transparent and practicable sustainability rating system for the assessment of individual buildings as well as portfolios. For existing buildings up to three different certificates can be awarded independently: the asset certificate (Part 1), the building management certificate (Part 2) and the occupier management certificate (Part 3).

BREEAM DE Bestand differs substantially from the known sustainability certificates DGNB (German Sustainable Building Council) and LEED (Leadership in Energy and Environmental Design) in Germany. The certification is based on a questions & answers-catalogue, which allows owners, property- or asset managers to carry out an initial (online) self-assessment followed by the assessment and the audit by an accredited BREEAM DE Auditor. DIFNI is awarding the label after a successful review.

The Prime Office REIT-AG, located in Munich, is a listed real estate company and with a portfolio market value of about 900 million €. Fundamental parts of their corporate strategy are the topics green building and sustainability. Thus, attending the pilot stage of BREEAM DE Bestand was a clear statement. Five buildings of their portfolio were certified until January 2013. The assessment and the audit were carried out by bauperformance GmbH.

Result: The implementation of certification systems allows the systematically gathering of information on the building and its operation. The owner as well as the tenant and facility management is sensibilised regarding possible sustainable improvements for the daily operations. Since the certificate is reviewed annually the "green" value of a building or portfolio is traceable. The "green" value can be protected or even enhanced – supported by a third independent party, an accredited professional of sustainability.


Fig 1 and Fig. 2: T-Online Headquarters (by Prime Office REIT-AG)

Investigations on the Impact of Constructional and Technical Measures on the Energy Consumption of Six Comparable Buildings

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Extended abstract

In Munich's new quarter "Messestadt Riem" have been mounted six identically constructed and oriented apartment buildings (a total of 6 x 8 = 48 apartments) in the year 2010 for treating the questions of energysaving building and modernisation in the future. One of the buildings (House 1D) serves as reference house with the standard equipment of the promoter, a city's housing association. The other five buildings differ in the following features implicating the named desired effects to obtain lower heating energy consumption:

House 2C: Higher thermal protection of the building envelop with better insulated external walls, roof, cellar ceiling and windows
▶ Lower transmission heat losses

House 3B: Intelligent thermostatic valves which close when windows are opened
▶ Reduction of the heating water flow rate during the opening of windows and therefore reduced ventilation heat losses

House 4H: Computer-based central control system for the heating in each apartment which allows a preset of different room temperatures and schedules
▶ Better adaption of the room temperatures to the real need

House 5G: Wall-heating system in order to achieve a higher radiant part in the heat distribution
▶ Higher radiant heat emission of the heating surfaces allows lower air temperatures in the room

House 6F: Decentralised mechanical heat recovery ventilation
▶ Lower ventilation heat losses due to heat recovery

The aim of the monitoring project is to evaluate the potential of different approaches to reduce the energy consumption in residential buildings considering also the impact on the comfort and the investment- respectively operational-costs. There shall be identified cost-efficient, robust and user-friendly solutions for improving the sustainability of residential buildings being built in the future or renovated concerning energy and economic efficiency.
During three winter periods starting in the year 2011 the buildings are monitored with extensive measurement instrumentation for getting informations about thermal and electrical energy consumption, the indoor climate and the local weather conditions. In addition there are conducted tenant surveys in order to get an impression of the user behaviour and the acceptance of the different components.

The results of the analyzed energy consumption of the first full year show some encouraging results especially in view of the applied technical components. With a difference of more than 8300 kWh of annual consumption compared to the Reference House, the building with intelligent thermostatic valves realizes the lowest consumption of 35.0 MWh (46.3 kWh/m²). In second place ranks the house with decentralized ventilation with heat recovery (37.7 MWh or 49.8 kWh/m²).The consumption of the House with the computer-based control system (House 4H) and the wall-heating system (House 5G) accounts with 40.2 MWh (53.1 kWh/m²) and 39.1 MWh (51.7 kWh/m²) in between. The building with the highest standard of insulation (House 2C) shows nearly the same energy consumption as the reference building.

The presented results show that the buildings with modified technical equipment have the lowest consumption. Hereby the equipment that works without of possible interventions of users (Intelligent thermostatic valves, ventilation with heat recovery) performs the best. Especially House 3B, which automatically throttles the heating water flow rate to a minimum when the window is open, turns out to be very effective and indicates the strong influence of the user concerning the ventilation heat losses.

The results show, that further reductions of the energy consumption can be expected in the next winter periods. The following aspects can contribute to an optimization:

- Consolidated mechanical ventilation without of additional ventilation through windows in winter especially in the house with the heat recovery system
- Better adaption of the room temperatures to the requirements
- Better information of the users (information events or further explanation of the possibilities for energy saving measures according the advices in the technical documents that were handed out)

Life Cycle Assessment of Store Concepts

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1. Introduction

Rising greenhouse gas emissions (climate change), air pollution, and the pollution and shortage of drinking water are just a few indications of critical changes in our natural environment. The consequences are already apparent: e.g. shortened periods between floods, storms, droughts and forest decline. Therefore, environmental protection is an important issue in the public sphere and discussions on sustainability are growing ever louder. Also in the retail industry it is becoming more and more important to be sustainable. Through the implementation of a comprehensive environmental sustainability concept for store concepts it is possible to achieve environmental objectives. However, there is no generally accepted environmental sustainability concept for store concepts. For this reason, an approach that attempts to develop an environmental sustainability concept for global stores to optimize future stores effectively by developing a sustainability toolkit is part of a project with a retail company. Conducting the Life Cycle Assessment (LCA) is an important step in evaluating the environmental aspects of the sustainability concept.

2. State of the art

A Life Cycle Assessment (LCA) analyzes the environmental aspects and potential environmental impacts of the product´s entire life cycle. The DIN EN ISO standard 14040/14044 defines the calculation methods of an LCA. In general, the result of an LCA is a quantification of environmental impacts using several impact categories. Two of these impact categories were considered: Global Warming Potential and Primary Energy Demand.
The Life Cycle Assessment of buildings follows given calculation methods as well. These calculation methods are defined in the standard DIN EN 15978. This calculation follows the four phases of the building´s life cycle: construction, maintenance, operation and end of life (e.g. demolition).
The LCA of store areas is considered in terms of certification systems. The English certification system BREEAM (Building Research Establishment´s Environmental Assessment Method) and the American certification system LEED (Leadership in Energy and Environmental Design) currently certify store areas. However, the Life Cycle Assessment portion remains vague and is not yet a major, detailed part of the certification system.
The German Sustainable Building Council ("Deutsche Gesellschaft für Nachhaltiges Bauen", DGNB) incorporated Life Cycle Assessment into its building certification from its inception as a

mandatory instrument for sustainable building assessment. DGNB also develops the system variant “leasehold”.

3. Approach

Due to data availability, the Life Cycle Assessment of the store concept was based on the main characteristics and limited to the DGNB certification system, which includes the LCA over the entire life cycle. The basis of the assessment was the building level.
There exists no applicable or standardized definition for store concepts. Therefore, it was necessary to define the term “store concept”. In general a store concept contains the items such as fixtures and decorative elements like curtains and the non-objective elements like visual systems or the climatic elements. The conclusion is that a store concept comprises three main components (see Figure 1): The design concept contains the building elements of a store. These are the design and technical elements and their color, shape and material, in general the interior fittings. The design concept includes the equipment of a store with fixtures e.g. cash desks and shelves as well.
To calculate the environmental impacts of a store concept only the building elements are important. Therefore, only the design concept had to be considered.

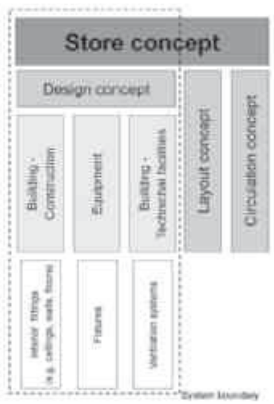

Fig. 1: The store concept

Besides the technical scope it was necessary to define the temporal scope. In DIN EN 15978, the life cycle of a building is divided into modules. This modular division was the basis for defining the life cycle of a store. Adjustments were required to delimit the temporal scope. Due to the fact that the use stage can only be influenced to a certain degree, only the production, construction and end of life stages were evaluated. However, it should be noted that the use phase causes high environmental impacts due to energy consumption for e.g. cooling and heating. It was assumed that the renewal of the interior fittings marks the beginning of a new life cycle.

4. Evaluation

The store concepts were modelled using the software SBS Building Sustainability.
When evaluating the results, it became clear that the wood elements were the key factors. Due to credits in the production, the wood elements affected the results in a crucial way.

5. Outlook

All in all, Life Cycle Assessment of store concepts is in the preliminary stages of development. The methods must be improved to more accurately and comprehensively evaluate the environmental impacts and sustainability of store concepts.

Life Cycle Costing of Energy Storage Technologies for Building Integration

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Summary

In the context of the Energy Performance of Buildings Directive (EPBD), buildings will have to serve both as “energy producers”, “energy consumers” and “energy storage units” in the near future [1]. Efficient buffering of time-related differences between production and consumption of thermal and electrical energy will not only play a major role on district but also on building level. Therefore technologies for energy storage, which can be integrated into buildings in an economic way, are necessary.

Within the European project MESSIB („Multi-Source Energy Storage System Integrated in Buildings“) new technologies for thermal and electrical energy storage are developed, assessed and demonstrated [2]. In addition to the technical feasibility an important issue of the project is the economic assessment which is conducted by means of Life Cycle Costing (LCC) based on technical scenarios. Life Cycle Costing is a method to identify the total costs that occur during the whole lifetime of a product or system. Within MESSIB it will be addressed by using different calculation methods such as dynamic amortisation, retrograde calculations or net present value (NPV).

The presentation will focus on the general approach for conducting LCC assessments of building integrated energy storage systems, demonstrated on the example of a vanadium redox flow battery (electrical storage technology). Emphasis will be given to the methodology of a life cycle based approach and the evaluation of potential cost savings within the operation phase of the technologies. For this purpose, several scenarios are defined, wherein both technical and economic parameters vary. Energetic benefits of the storage technologies are determined by analysing the building energy demand and potential reductions as well as operation strategies to minimize the amount of energy taken from the public grid. This allows for discussing on economic advantages and disadvantages of such energy storage technologies depending on various future conditions and developments.

Keywords: Life Cycle Costing, Energy Storage, Vanadium Redox Flow Battery

Good, Better, Certified? How Green Building Labels Help Planning Sustainable Buildings

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Summary

Water in all of its facets can have a powerful impact on costs and environmental benefits of a new-built office building. As such, it merits more impact across the three main building certification systems.

Keywords:green building certificate, potable water, DGNB, LEED, BREEAM

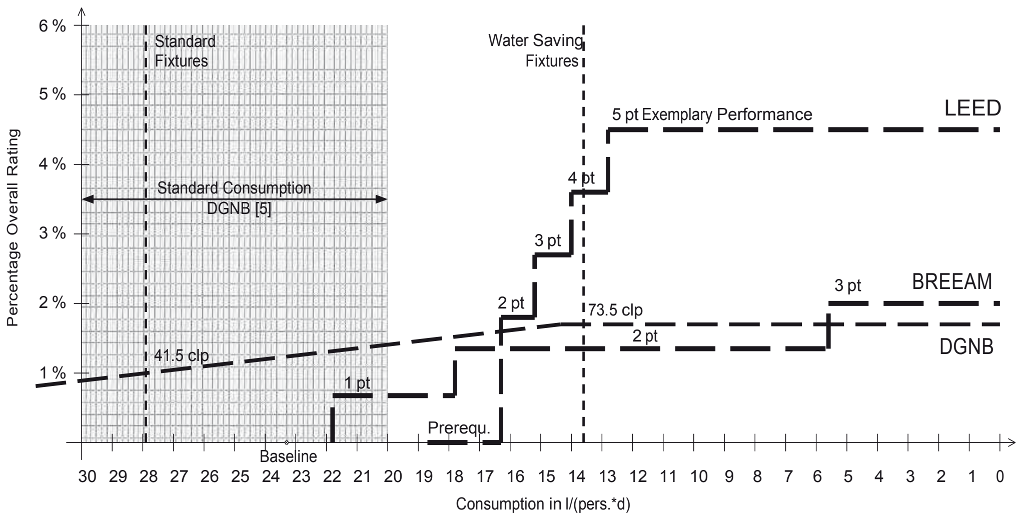
Good, Better, Certified? How Green Building Labels Help Planning Sustainable Buildings

The idea of sustainability is one of the fastest evolving topics in the 21st century. Sustainability governs the ecological, economic and social behaviour of most public and private sectors. Within the building industry, certificates for sustainable buildings help raise awareness for an improved and healthier built environment. Moreover, property owners benefit from increased values of buildings. In Germany the most common building certification systems are DGNB (Deutsches Gütesiegel Nachhaltiges Bauen), LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method).

Although all these systems contribute to a more sustainable built environment, they slightly differ in the way they focus on the different aspects of the building process. As consultants executing all three systems, we know from experience that regardless of a factor's "weighting" within a given system, each factor can have a powerful impact on costs and environmental benefits. In this paper, we will analyse the consumption of potable water and compare how the different systems deal with the topic.

There are a considerable number of differences in the way the three systems approach the water issues. The differences range from the level of detail within the water categories to the way different aspects are merged into one credit. BREEAM and DGNB calculate the actual consumption, whereas LEED defines a baseline and awards points for a reduction in consumption compared to that baseline.
In order to compare the way potable water consumption is calculated, a reference building with a set of comparable parameters had to be defined.

Based on the reference building with average use patterns, we have calculated the typical water consumption in litre per person per day for 2 different scenarios: 1) standard fixtures and 2) high-end water saving fixtures. Typically the actual consumption of an office building would be within that range of maximum and minimum consumption.



Fresh water consumption and corresponding credits

The main results of this study can be summarised as follows:

- The installation of standard fixtures does not lead to any points being awarded in LEED and BREEAM: to achieve points a reduction in consumption is inevitable.
- LEED has the most stringent minimum requirements: Users of the LEED system are obliged to achieve the prerequisite and therefore actively contribute to saving potable water. All LEED certified buildings have a water consumption of at least 20% lower than the benchmark of average consumption, resulting in a reduction of water costs of approximately 33% compared to the water costs with standard fixtures.
- Achieving a label of at least VERY GOOD in BREAAM means realising substantial reductions in the use of potable water: to attain a higher label it is mandatory to reduce water consumption by at least 22% compared to standard fixtures
- Utilising rainwater is not actively encouraged in the three systems: The use of rainwater to minimise potable water consumption is not mandatory to achieve a high building label

Compared to the impact of Energy Efficiency or Materials, the importance of potable water consumption in buildings seems relatively low. Nevertheless, buildings with a LEED or BREEAM label certainly use less water than an average building and therefore contributing to a more responsible handling of a precious resource.

The Role of Renewable Materials in the Building Sector and in the Life Cycle Assessment of Buildings

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Summary

The efficient use of resources is one of the most important challenges of the building sector during the next decade.
In the Research Project "Building with timber – Paths into the Future" (2011) supported by the German Environmental Foundation (Deutsche Bundesstiftung Umwelt /DBU – Project Number 29239), the role of the renewable resources in the building sector and in the Life Cycle Assessment (LCA) of buildings was investigated.
This paper presents some of the results published in the article "Wood-based construction as a form of active climate protection" [1].
Five realised buildings with many components containing renewable natural raw materials have been chosen, for a LCA comparison. For each building, a "standard version" building constructed using conventional construction products – largely created from non-renewable mineral, metallic or synthetic materials – was also modelled.
The analysed "standard version" building is identical to the real building in terms of space, floor area and shape, and therefore has the same energy requirements.
Comparing conventionally constructed buildings - that contain numerous construction products derived from finite resources - with buildings with high portion of building products derived from renewable raw materials shows the significant ecosystem load reduction potentials offered by the latter construction method.

Keywords: Wood, timber, Life Cycle, Life Cycle Assessment, renewable resources

1. Timber and Life Cycle Assessment

The conducted LCA study has taken into account the rules of the certification systems practised in Germany since 2009 [2], [3], [4], [5].
For the LCA comparison, five buildings with many components containing renewable natural raw materials have been chosen.
The life cycle assessments were compiled using information taken from the Ökobau.dat database, the first German building material database for the determination of ecological effects. The LEGEP-tool was used to model and calculate values for the five objects. For each building was also modelled a "standard version", based on conventional construction products (largely created from non-renewable mineral, metallic or synthetic materials). The "standard version" building is identical to the real building in terms of space, floor area and shape, and therefore has the same energy requirements.
The components used in the simulation were taken from the catalogue of elements in the LEGEP database; their construction and materials correspond to many buildings that have already been life cycle assessed. The modelling of these "fraternal twins" reveals the differences made by

changing the construction type.
In the objects presented in this paper, products manufactured by renewable raw materials were used for the load-bearing construction of the outer and inner walls, ceilings, supports and roofs, façade cladding, sun protection, insulation and interior fittings. A large proportion of current conventional buildings (from residential to commercial) could be accomplished using components made from renewable raw materials.
Comparing conventionally constructed buildings that contain numerous construction products derived from finite resources with buildings with high proportion of products derived from renewable raw materials, shows the significant ecosystem load reduction potentials offered by latter construction method. The reduction varies between 10 – 70 %, depending from the chosen indicator.

2. References

[1] Kaufmann H., Nerdinger W., "*Building with Timber – Paths into the Future*", Prestel Verlag, Munich, 2011, pp.18-27.
[2] Bewertungssystem nachhaltiges Bauen (BNB) of the Ministry of Transport, Building and Urban Development (BMVBS, www.nachhaltigesbauen.de).
[3] Deutsches Gütesiegel Nachhaltiges Bauen of the German Sustainable Building Council (DGNB, www.dgnb.de).
[4] Bewertungssystem Nachhaltiger Wohnungsbau (BNW) for residential buildings (www.nawoh.de).
[5] Kohler N., König H., Kreissig J., Lützkendorf T., *"A life cycle approach to buildings",* Detail Green Books, Institut für internationale Architektur-Dokumentation, Munich, 2010.

Estimation of Energy Saving Potentials of Neighborhoods

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Summary

Urban areas are responsible for a large part of the energy consumption in Germany. Due to this circumstance cities take an especially high priority in future objectives of sustainable development and the energy transition. To achieve these goals, cities primarily improve the energy efficiency of their buildings and infrastructure, and then cover the remaining energy needs with renewable energies. To implement these measures, however, first basic information about the energy consumption and the initial situation of cities or individual neighbourhoods is required. In this context the current paper describes a method to estimate the energy performance of residential neighbourhoods and their potential for energy savings and future developments by use of available geodata, building and urban structure types. To estimate the energy performance of buildings, a life cycle analysis was used.

Keywords: energetic assessment, residential neighbourhood, energy performance

1. Introduction

The objectives formulated in the energy concept of 2010 by the Federal Government of Germany shall be achieved by an increase of the energy productiveness, the extended use of renewable energy and a doubling of the renovation rate in the building sector [1]. Due to this circumstance cities take an especially high priority in future objectives of sustainable development. Especially the building sector counts for nearly one-third of the energy consumption [2]. In this context, to reduce the energy consumption cities have to fulfil some key tasks for a future sustainable development [3]. The realized measures towards an eco-friendly energy supply in Germany show some successes. Many other cities developed strategies and action plans to reduce their energy consumption significantly and increase the share of renewable energies. In this context, neighbourhoods in recent years have become increasingly important. With the implementation of measures at the district level, significant savings and efficiency gains through synergies are expected. In this context the paper describes a methodology to estimate the energy demand of residential urban districts. For the paper, four study areas of the town Landau (in der Pfalz) in Rhineland-Palatinate were selected. The town is one of the four sample towns of the research project EASE (Energy Improvement and Urban Development) run at the Leibniz Institute of Ecological Urban and Regional Development, the Halle Institute for Economic Research and the E.ON Energy Research Center at the RWTH Aachen University.

Results

The method presented in this paper serves as a first energetic assessment of urban areas and its possible potential for future development. The energy reference area is determined by using building footprints and a simplified model of the building volume. Based on these building footprints and additional information, which includes the type and size of the building (single- or multi-family house and large or small), the number of full storeys, the height, the roof shape, etc., the building volume was calculated. The demand for energy is determined by using a life cycle analysis of building elements and energy characteristics of buildings. As part of the life cycle analysis inter alia influences connected to the overall historic context were taken into account. These aspects affect the technical and theoretical modernization rates. The method allows on the basis of available geodata, building classifications and with the help of the life cycle analysis of building elements, to estimate the energy demand for space heating for the selected study areas.

Conclusion

With the method described neighbourhoods with various area sizes can be analysed, advantageously in largely homogeneous urban structure types (for example, detached houses, apartment house areas of the perimeter block, etc.). In combination with additional information and methods about renewable energies, it is possible to estimate the potentials of integration of renewable energy techniques in the study areas. As part of the next few steps we are going to improve the calculations for the energy reference area by using laser scanner data from the government of the town Landau. According to these calculations scenarios for individual study areas will be developed, as a part of the project.

References

[1] GERMAN GOVERNMENT, “The Federal Government`s energy concept of 2010 and the transformation of the energy system of 2011”, 2010.

[2] ERHORN-KLUTTIG H., JANK R., SCHREMPF L., DÜTZ A., RUMPEL F., SCHRADE J., ERHORN H., BEIER C., SAGER C., and SCHMIDT D., “*Energetische Quartiersplanung: Methoden - Technologien – Praxisbeispiele*“, 2011.

[3] FEDERAL MINISTRY OF TRANSPORT, BUILDING AND URBAN DEVELOPMENT, “Memorandum “URBAN ENERGIES – Urban Challenges””, 2012.

Advantages and Disadvantages of Cost Optimal Methodology to Determine Energy Performance Requirements for Buildings

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Summary

European regulatory efforts towards increasing energy efficiency of buildings are focusing on a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements, which has been published as a European regulation 244/2012.
The framework of methodology requires that many parameters have to be decided on national level. The paper describe influence of parameters change on final requirements. In the paper the advantages and disadvantages of cost optimal methodology will be presented.
The aim of the paper is contribution of discussion on cost optimal methodology and turning of attention for the needs for further harmonisation of the approach. The presented considerations reflects the works of the IEE project on Market Transformation Towards Nearly Zero Energy Buildings Through Widespread Use of Integrated Energy Design.

Keywords: Cost optimal methodology, energy requirements, LCC

1. Introduction

The Recast of the Directive on the Energy Performance of Buildings (the EPB Directive) came into force on 9 June 2010. The new provisions of directive states, among others, that the minimum requirements of the energy performance of buildings, such as the maximum heat transfer coefficients of the envelope element (U-value) and the primary energy coefficient (EP), should be set by using the cost-optimal calculation . The Directive defines this concept, and the European Commission (EC) determines by regulation a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.

The framework of methodology requires that many parameters have to be decided on national level. The paper describe influence of parameters change on final requirements. In the paper the financial and macroeconomic calculations has been presented for two values of the real discount rate and three different types of fuels.

2. Results

The calculation were performed for four main variants: financial calculation with 3% and 4% of discount rate; macroeconomic calculation with same discount rates. In each variant three heat source has been taken into consideration. It was assumed that the economic lifetime of insulation layer is 30 years and of construction material 60 years (lifetime of a building). For each variant and fuel the optimal U-value has been estimated results are given below.

Table 1: Optimal U-value [W/m^{2}K] for different variants of calculation

Heat source	Financial r=4%	Financial r=3%	Macroeconomic r=4%	Macroeconomic r=3%
Gas boiler	0.200	0.187	0.193	0.180
Coal boiler	0.233	0.227	0.223	0.214
Heat pump	0.215	0.205	0.186	0.171

The results are different between each variant. For both calculation methodologies higher U-value is obtained for higher discount rate, and the difference is about 10-15%. For each heat source and the same discount rate the U-value is lower for macroeconomic calculation, as the prices without taxes and VAT were used. Of course for the cheaper fuel the U-value is higher, as the energy savings cannot cover an extra investment of insulation layer.

The results shows that there are many parameters that has to be considered using cost-optimal calculation for setting building requirements. The choose of one from calculation methodologies may prefer high emission sources but with cheap fuel or high system efficiency.

3. Conclusion

The presented example of application of the comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements suggested by EC for the use by Member States can help to justify any requested value. The range of new U-values defined in different countries in Europe is between 0.3 – 0.15 W/m^{2}K. Assuming that these values have been estimated using the fore mentioned methodology the range is significant and cannot be associated only to climate influence.

Thus, the methodology should be amendment by the examples of determination of the requirements to guide MS trough the procedure.

There are more parameters influencing LCC which were not discussed in the paper: e.g. estimation of residual value, life cycle of the elements and the building, sensitivity on energy prices and investment outlays.

Important remark that can be drawn from the analysis is necessity of consideration of incremental criteria instead of LCC. As the LCC itself can guide us to conclusion that the existing requirements are good enough and there are no needs for their improvements. This is especially important in application of comparative methodology in integrated design process e.g. MATRID project.

Impact of Climate Change on Historic Buildings and Future Energy Demand by Using Whole Building Simulation Tools

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Extended abstract

Climate Change is one of the most critical global challenges of our time. Since many decades a huge number of scientists from all over the world are researching this topic and are developing complex climate models suitable to make future climate projections. Climate change in itself is not the main concern; more important is its impact on the planet. But less certain information is available how the changing climate affects mankind and its environment. Although many studies have been conducted to explore the impact of climate change on economy, biodiversity and agriculture or on fresh water availability, only little is known whether and how climate change influences our cultural heritage. Within the European funded project Climate for Culture running from 2009 until 2014, a multidisciplinary research team consisting of 27 partners from the EU, Croatia and Egypt is performing research to make substantial contributions to estimate the impacts of climate change on the indoor environments in historic buildings and their vast collections in Europe and the Mediterranean.

For this purpose, the CLIMATE FOR CULTURE project has started for the first time ever to couple climate modelling with whole building simulation tools: Completely newly developed high resolution climate change evolution scenarios provide the necessary climate indices for the period from 1960 until 2100. This set of climate indices is used in whole building simulation tools to assess future projections of outdoor climate changes on the indoor environments in historic buildings and its impacts on cultural heritage items in Europe and Egypt. This coupling allows estimates on future indoor climates and energy demands and suitable mitigation strategies can be developed and tested. Valuable collections in historic buildings from different climate zones are included for in situ investigation of contemporary and past problems and for the projection of future demanding issues.

SBToolCZ - Sustainability Certification for Buildings in the Czech Republic

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Summary

The paper presents experience form the foundation of the Czech national building sustainability certification system SBToolCZ. The methodology comes out from GBTool/SBTool developed by the International Initiative for a Sustainable Built Environment. In the paper are described issues related with implementation of the certification system in the Czech Republic.

Keywords: Sustainability assessment of buildings, SBToolCZ, SBTool, Czech Republic, certification scheme

1. Introduction

The reality of these days shows various building sustainability assessment schemes operating across Europe. In some countries the national (or local) tools are competing with the international brands, in other countries these two are living in symbiosis. This paper summarizes lessons learned from the foundation and operation of SBToolCZ scheme in the Czech Republic.

Back in 2005 when building sustainability assessment systems started to emerge across whole Europe, the Czech Republic had multiple choices: to use an existing system, to start a new system from scratch or start on a basis of existing work and develop it further in line with the national and European standardization.

Initially there were attempts to localize the BREEAM methodology. Then there has been done research work and case studies using GBTool and later on SBTool. The team developed a national localization of the SBTool 2010 with further customizations.

2. Implementation

For the successful implementation of a certification scheme there is needed not only assessment method, but also the infrastructure and organization around.

In Czech scenario, it was necessary to cover these issues:

- General methodology;
- Localization for the Czech technical and legislative conditions;
- Customization of the assessment method for multiple building typology;
- Setting of benchmarks;
- Methodology for setting the weights and establishment of expert group;
- Assessment manual;
- Establishment of the legal entity responsible for the operation of certification and implementation into the Czech national system of certification;
- Training of experts and auditors;
- Legal issues concerning the validity of the certificates and registration of issued certificates;
- Public promotion of the certification scheme.

3. Conclusions

New building sustainability tools emerge every year trying to take a part of market. It is important to recognize that establishment of the localized certification scheme complying with the local standards and certification is not a kind of one-man job. It takes several years of work and significant amount of resources to establish working and recognized accreditation scheme, and the operation phase also needs it financing.

Since 2010 the Czech Republic has settled certification scheme SBToolCZ, which has been developed on the basis of international SBTool and fully localized in compliance with all the national and European requirements.

4. Acknowledgements

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Lightweight Envelopes for Energy Efficient Buildings: Energy Saving by Covering Courtyards with Membrane Systems

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Abstract

Within the project “membrane structures for thermal retrofitting of buildings (MESG)” simulations were performed in order to estimate the possible saving of energy in buildings by applying membrane systems. An application with a high capability is the covering of courtyards in order to improve the thermal performance of the bordering buildings and to increase the availability of the courtyard.
Hence this application was investigated in detail with respect to the reduction of heating energy of the buildings which are surrounding the courtyard. The heat from inside the buildings is partially transmitted through the façades which face towards the courtyard. By covering the courtyard, an additional thermal insulation is added, which increases the temperature in the courtyard and subsequently decreases the heat losses of the buildings through the façades.
It was possible to derive the temperatures within the courtyard as well as the heat losses of the buildings with and without membrane roof by an appropriate modeling of the physical situation of the courtyard. Additionally the heat transfer coefficient of the membrane system was calculated considering solid conduction, convection and thermal radiation.
Beside a reduction of the heat losses due to the membrane system an energy gain occurs due to solar radiation which is partially transmitted through the transparent membrane system. Whereas in winter an energy impact by solar radiation is advantageous, this may lead to an overheating during summer. Thus the influence onto the temperature in the courtyard was quantified. Finally the heat transfer coefficient of the membrane system was calculated as input data for the simulations.
Altogether it has been shown that the results of the presented simulations provide a sufficient accuracy. The possible reduction of the heat losses of a building through the façade towards a courtyard lies between 20 % and 60 % if the courtyard is covered by a membrane system. The reduction of the heat losses during winter depend on the heat transfer coefficient of the membrane system as well as on the geometry (base area and height) of the courtyard. During summer the temperatures in the courtyard increase significantly above the environmental temperature due to the membrane covering. Therefore sun shading is necessary to prevent overheating during summer.

Keywords: Textile architecture, energetic reconstruction, thermal insulation, solar gain, building simulation

Torrential Rain Loads on Buildings – Damage Hot Spots, Damage Mechanisms, Vulnerability Criteria

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Summary

The presented research results are based on an on-site-survey in the region of Dresden, where 65 building damage events caused by torrential rain impacts have been analysed in detail by a group of civil engineers. In the outcome of this survey, it is in evidence what a broad variety of construction elements can be affected by torrential rain impacts: steep and flat roofs, roof terraces, balconies, windows, external doors as well as soil-contacted elements. Because of the manifold damage causes and damage mechanisms, it was necessary to assign specific building measures for adaptation to these impacts. Furthermore, the survey results have generated the opportunity for systematic classification of vulnerability criteria for each affected building construction. This classification is going to act as a capable tool for further planning, execution and maintenance of buildings.

Keywords: Climate change adaptation; torrential rain; building damage; damage mechanisms; vulnerability analysis

1. Introduction

In addition to the climate change mitigation activities in building and construction, the adaptation of buildings to external impacts, which are driven by climate change, is an important challenge for the following years. The most important objectives of climate change adaptation for buildings are a) to avoid or decrease building damage caused by intensified impacts and b) to avoid or decrease unacceptable impairments for the buildings residents. Due to this, climatologists have analysed the future conditions within the region of Dresden within REGKLAM, regarding the impacts of summer heat, flooding, torrential rain, hail, storm, and snow. As torrential rain was named as an impact factor with a frequency and intensity likely to increase in the future, a group of civil engineers started an on-site-survey, where a number of 65 building damage events caused by torrential rain impacts were analysed in detail.

2. Results

Building damages caused by torrential rain impacts usually appear in the form of a number of scattered single damage cases, which need to be tackled and settled by a broad variety of different homeowners, homeowners associations and housing companies. Due to this, the public often does not consider torrential rain damages as “major damage events”, in contrast to flood or hail events.

Most of the analysed damage cases caused important refurbishment or repair measures, including respective building costs. Often the affected building constructions needed essential modifications to reduce their vulnerability in future. As a result of the on-site-survey, it is in evidence that a variety of construction elements can be affected by torrential rain impacts. Characteristic damage hot spots are flat roofs, roof terraces and balconies, connections between steep roofs and other building parts, soil-covered ceilings of underground garages, soil-contacted basement walls and bottom plates, as well as windows and external doors. As an example the full paper includes a table with characteristic damage causes for the building constructions “flat roofs” and “roof terraces and balconies”. The investigation results further documented that buildings which belong to specific age groups, with similar construction elements, mostly show identic or at least comparable damage causes and damage mechanisms. The vulnerability of buildings with regard to torrential rain impacts is decisively influenced by 5 different groups of building constructions and by the building services, too. Using this insight, it is necessary to assess the vulnerability features for each affected construction element, which in turn depends on the quality of planning, the quality of construction work and not least on the maintenance conditions. Within the described approach for vulnerability classification the assessing experts need to balance the impacts of different building constructions on the vulnerability of the whole building in a quantitative way, considering the expected damage extent as well as the estimated damage costs.

3. Conclusion

Based on a detailed analysis of building damage caused by torrential rain impacts within the region of Dresden, the authors give an overview of the most frequently affected building parts, of important damage mechanisms and of damage causes. Due to the number of damage cases the results cannot be statistically sound, but they are constructionally accurate. So there are first insights available, which features decisively influence the building’s vulnerability due to torrential rain and which approach can be considered suitable for vulnerability classification. An increasing intensity of torrential rain impacts in future can be taken into account by using modified properties within engineering planning algorithms and testing methods for the affected constructions. In addition to that, the authors present an approach for vulnerability classification of existing buildings, including the differentiation of all the relevant building constructions.

A Framework to Establish Suitable Sustainable Refurbishment Strategies for Residential Buildings

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Summary

Significant effort has been directed to improve the energy efficiency of building facilities as the building sector is the second biggest carbon emitter after the manufacturing industry. In Hong Kong, 56% of final energy is taken up by building facilities, and a reduction in household emissions is undoubtedly the most critical policy direction of many governments for the years to come. One way of achieving a significant reduction in carbon emissions is by improving the energy efficiency of the existing housing stock. However, introducing sustainable refurbishment measures is not an easy task not only because any improvement work would cost but also due to the disturbance that might bring to the occupants. In cities like Hong Kong, it is virtually impossible to vacate all the residents in a multi-storey residential building when sustainable refurbishment work is carried out. As a result, selecting suitable refurbishment strategies to suit the emission goals of the owners and residents would become extremely important. Until now, there is a lack of an agreed mechanism for choosing sustainable refurbishment options for multi-storey residential building. In this paper, a framework to establish suitable sustainable refurbishment options for residential buildings by taking into account the emission reduction, costs and disturbance is proposed. The research is based on a survey conducted in Hong Kong. The findings of this study should help decision-makers identifying suitable sustainable refurbishment strategies so as to maximise the emission reduction at the lowest cost without causing excessive nuisance to the occupants.

Keywords: Carbon emissions; existing building; emission reduction; sustainable refurbishment

1. Introduction

While many nations have proposed ambitious emission reduction target to combat climate change, achieving such goal would necessitate a strong commitment of all parties in the society. A sector presenting a huge opportunity for emission reduction is building and construction. Figures show that residential and commercial buildings account for almost 33% of the globe's GHG emissions (Levermore 2008). Of the total emissions discharged by the building sector in the UK, 99.7% are from existing buildings with the rest attributed by new built (Construction Products Association 2010). This calls for an imminent action to elevate the energy efficiency of existing buildings.

Despite that, the momentum of building upgrading focusing on improving the energy saving is still extremely slow. This is particularly challenging in densely populated cities like Hong Kong as citizens there are usually living in multi-storey apartments with relatively confined living space. Not only would it be difficult to commission a major building overhaul due to the complex issue of ownership, it could also be equally hard to encourage owners and/or occupants adopting any sustainable solutions in their apartments given the nuisance and costs they have to bear.

owners and/or occupants to differentiate which are the most suitable strategies to commensurate their individual emission reduction goal, budget and attitude Without any idea about the amount of emissions that can be reduced, initial and running costs, and degree of disturbance of different sustainable refurbishment options, it would be difficult for owners and/or occupants to respond actively to any emission reduction initiatives.

Therefore, a framework which can help delineate the impacts of each sustainable refurbishment alternative would allow the In this paper, the possible sources of emissions in residential buildings are first examined. It is then followed by identifying the list of sustainable refurbishment options which are relevant to the Hong Kong scenario. The results of a series of semi-structure interviews conducted in Hong Kong are presented. Finally, a framework for establishing the suitability of a sustainable refurbishment option is presented.

Green Ergonomics, Biophilic Design, Sustainable Construction Workplaces and Workers' Performance

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Summary

There is major competition for a quality workforce, which demands the ability to attract and retain a skilled workforce, which requires an optimum environment conducive to worker productivity. Occupational health and safety (H&S) issues, with technological advancement, complex work environments with added workplace stress and H&S issues require new and innovative ways of thinking about the workplace. Given the volume, nature and demands of work with complexity of issues, every strategy and available tools need to be employed. In view of this the issue of ergonomics in conjunction with worker performance and productivity has indicated the need for pro-nature therapeutic measures, to create an attractive, aesthetic and exciting rejuvenative place to work. By incorporating the novel and restorative strategies inherent in biophilic design concept and correlated feng shui principles of workplace interventions on the construction site to green ergonomics derived from the concept of therapeutic garden design to create an orderly dynamic, healthful and energetic sustainable and life giving workplace environment.

Keywords: Biophilia; Feng Shui; Green Ergonomics; Performance; Productivity

Abstract

Purpose:

Drawing on the principles and theoretical justification for the term green ergonomics describing the endeavour that ergonomics should be engaged in ensuring a usable, efficient, healthy and safe intergenerational future which incorporates a pro-nature view to bring the notion of sustainable work systems to emphasise the link between sustainable development and human factors in construction through biophilic construction site interventions drawn from the notion of biophilia; the innate emotional affiliation of humankind to all living organisms; as a sustainable green ergonomics programme for the construction workplace environment, workers' wellness and performance towards enhanced productivity.

Design/approach/methodology:

The research methodology adopted includes an exploratory research involving the critical examination of related literature, interspersed with empirical investigations within the bounds of green ergonomics and pro-nature wellness interventions involving biophilic design concepts. The case study method used involves an evaluation of the effect of a single element introduction of the biophilic design concept on a construction site, adopting pre- and post-intervention observations to determine the impact of the biophilic design concept on the construction site and the effect on work attitude and worker performance on the project. The techniques used included interviews and a focus group study to determine the resultant effect on workers and the organisational level performance matrix.

Result/findings

Findings indicate that managers and their employees benefit both on and off the job when the workplace provides an effective work environment and these effectiveness become strategic management tools

Scope and limitations:

The study is limited to workplace design and evaluation research on a temporary construction site with pro-nature emphasis besides traditional ergonomics literature and ergonomics factors required in designing a suitable biophilic construction site.

Originality and value:

The findings demonstrate the manifest and inherent synergies between natural capital and the greening of construction.

Type of paper:

Research paper

Strategies for Climate Responsive Development in Urban Planning and Architecture in the Middle East

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Extended Abstract

40 years after the publication of the Club of Rome's future scenario "The limits to growth" economic development of the Gulf Cooperation Council countries of the Middle is flourishing based on revenue streams of hydrocarbon exports. Trade assets are now being materialised in even growing skyscrapers and visions of entire cities blooming out of desert sands. The global trend to shifting targets and policies regarding energy efficiency, water reduction and carbon-emissions have been adopted in the GCC as well as the urge to compete in certification systems for the built environment. Therefore platinum credited buildings can be even found in the harsh climate of an arid desert-shrubland although using the same criteria of rating systems based in a temperate forest biome.
The post hydrocarbon boom economy effects the countries in the Middle East with rising population figures that demand development of cities based on fossil fuel driven technologies to control the arid hot climate of the desert for the benefits of human comfort.
An increasing scarcity of resources impedes the supply for the rising demand especially for the consumer giant of the built environment, which contributes to a demand of 37% in the Middle East.

To comply with the global goal to accept environmental challenges of climate change through concepts of sustainability, the dichotomy of resource meagre desert and expanding cities, lead to current phenomena of urban developments in hot desert regions like Masdar City|UAE that proposes to create a "green" city within a desert from scratch for 50000 inhabitant on an area of six square kilometres by 2025.

Since those phenomena depend mainly on technologies and processes developed for other climate regions, this paper aims to research, evaluate and design strategies for climate responsive architecture and planning in the hot arid desert environments.
Conceptual research of passive strategies in traditional settlements of oases towns in Oman of the past are compared to technological-active developments of the present and finally combined with the findings of smart technologies of the future.

Just like desert oases in the past have been perfectly interconnected with all prevalent resources, energy and information inherent to the region. The analysis of oases systems as ecologically adapted urban system within hot arid desert climate zones in the Middle East can lead to the understanding of interconnectedness of all elements of human, nature and the compensation layers of urbanism, architecture and technology.

Traditional practices (pre-fossil power extraction) of constructing cities and inhabitable spaces for an Arabic-Islamic society in the Middle East are often ignored to the point where the initial knowledge which was sensitively adapted to all ecological and social environment is depleting and moreover eradicated by the 'new' and 'modern' tools and technologies introduced by specialists of

further developed countries.
Quantitative compensation technologies driven through specialized experts lead to assessment, rating and certification schemes of the specialist field without relating those expert fields to the bigger picture of the built, natural and human environment, a comprehensive network of disciplines.

The intent of this work is to establish strategies that can be used to determine the comprehensiveness of existing systems of the built environment and of planned environments. This model of interconnections can work as a tool to discover potentials and missing links within the reference system that supports strategies and decision-making processes in planning, policy, and design of the built environment in different levels urban and architectural environments.

A discussion of the proposed strategies of synthesizing ecological systems with relevant technologies results in a trans-clusion of addressing further hypotheses and research areas.

Keywords: Environmental Design; Ecological Architecture; Integrated Urbanism; Sustainable Development; Desert Environment;

Sustainability in Facility Management

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Summary

Sustainability in Facility Management (FM) is more than the reduction of energy consumption during the phase of use. All the supporting services offered by FM shall improve the sustainability of the FM customer. Therefore the share that FM adds to the sustainability of the customer has to be measured in its own system. This system needs good interfaces to existing systems for sustainability accounting, like GRI, LEED, BREEAM, DGNB, etc. Following these demands the GEFMA (German Facility Management Association) working group "Sustainability in Facility Management" intends to publish a guideline on measuring and managing sustainability in the processes of FM.

Keywords: sustainability, Facility Management (FM), phase of use, GEFMA

1. Introduction

For public buildings as well as for private high quality projects in the construction sector it has become a necessity to integrate sustainability into the bidding processes of the construction phase. But how is sustainability to be quantified in the phase of use? Which measures are practicable to be taken in daily routines in order to manage sustainability in operation and maintenance of a building? Or even in secondary processes that are not building related?

The German Facility Management Association (GEFMA) has started a working group in 2012 in order to answer the questions above with defining a guideline on sustainability in Facility Management (FM). The author of this paper is head of the working group. The paper will present the status quo of the draft for standardising sustainability in FM in the sense of a discussion paper.

2. Intended Guideline

It aims at helping FM professionals to manage sustainability in the secondary processes that are bundled in FM. To manage means to measure, to monitor, to declare and to compete on clear KPIs (Key Performance Indicators) for sustainable FM services.

These KPIs shall be used for procurement, in the daily routine of FM performance as well as for potential sustainability reports in FM. Therefore KPIs have to be suitable for communication and also to be practicable concerning documentation and calculation. In addition to that GEFMA expects that a certification shall become possible, as soon as there are enough benchmarks available measuring sustainability in the different sectors of FM.

3. Relation to existing systems of sustainability assessment

The GEFMA guideline will relate to systems measuring the entrepreneurial sustainability, i.e. GRI CRESS (Global Reporting Initiative, Construction and Real Estate Supplement) and ISO 26000 on CSR (Corporate Social Responsibility), and as well to systems accounting the sustainability of construction works. Especially in the versions for buildings in use there are FM-related indicators, i.e. LEED for existing buildings (Leadership in Energy and Environmental Design) BREEAM in use (BRE Environmental Assessment Method), DGNB system (German Sustainable Building Council), etc. Also ISO 15392 and ISO 21929ff: "Sustainability in building construction" will be of importance. The research project "RoSS – Return on Sustainability System" [1] undertook a first attempt to define a specific accounting system for the sustainability of FM industry. It developed a set of 20 KPIs in a process of iterative consultations with FM practitioners [2].

4. First results of discussion process

General principles of sustainability in FM have to be the basis on which KPIs can be stated. A differentiation seems to be necessary in order to address the different context in operative versus strategic management and in technical versus other services. There will be a set of compulsory KPIs complemented by optional KPIs. It is mandatory that FM has possibilities to influence a KPI during the phase of use of a facility. KPIs need to include the supply chain of FM. Most important is that KPIs shall not use square meter or similar units for benchmarking but functional units e.g. fulltime workplace.
The proposed system calculates the share of FM in the achievement of sustainability for the primary process, the staff and the facilities of the FM customer. The contribution of FM is calculated as the difference between the value for the KPI at the beginning and at the end of the period under consideration. The final KPIs to measure the contribution of FM e.g. to the reduction of consumptions, shall follow a national standard (or assessment system) in order to achieve maximal compatibility. The sustainability of the FM provider himself is addressed in "sustainability in the supply chain". There the quality of the provider can be assessed according to GRI or RoSS.

Thus sustainability in FM can be accounted separately from the facility and the primary processes of the FM customer, but with a precisely defined relation to both.

[1] KUMMERT K., MAY M., PELZETER A.: "Nachhaltiges Facility Management", Berlin, 2013
[2] http://ross.htw-berlin.de/RoSSApp

Quality Management and Evaluation of Sustainable Buildings in Germany

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Summary

The aim of the research project "EVAgreen: Quality Management and Evaluation of Sustainable Buildings in Germany" is the development of a methodology for energy and quality management, that consistently includes every lifecycle phase of a building. The innovation is the active management of the relevant processes. The information system is analyzed and optimized during field tests. As the result of the project a workable web-based software demonstrator will be available.

The "EVAgreen" project is carried out by IGS in cooperation with Rotermund ingenieure, energydesign braunschweig GmbH and synavision GmbH. It is sponsored by the DBU (German Environment Foundation) and „proKlima - Der enercity-Fonds". The projekt runs from September 2011 to February 2013.

Keywords: Energy and Quality management; active process control, software demonstrator

1. Introduction

Many standards and checklists have been defined to ensure energy efficiency in buildings. More powerful tools for quality management are our answer to the gap between ambitious goals in the planning and the actual building performance, which often does not meet these expectations.
One of the reasons for this discrepancy is that the target definition and building classifications are neglected and limited to the buildings phases from planning to completion. Down to the present day the approach to look at all work phases including building operation are neither consistently nor effectively implemented.

2. Methodology

The research-project aims at the development of an energy and quality management system for buildings that organizes different processes during the project phases and meets high functionality

and multiple applications.
The starting point of quality management is the specification of the relevant qualities. Secondly, the control procedure or methodology is defined to check the quality at a certain point of time. This is finally followed by, thirdly, the actual quality check. Therefore, continuity between all relevant phases from the draft over to the construction up to the operation is necessary, guaranteeing a consistent technical-economical quality management which can be effectively multiplied on a large scale.

The EVAgreen research project develops a methodology for this approach and tests a software demonstrator created by synavision GmbH called TaskManager. The innovative approach is the application of a web-based ticket system with a highly flexible template generator for process control. The generator allows creating ticket templates and integrating them in usual ticket workflows of assignment and confirmation. Thereby, the numerous contents such as commissioning and inspections for basically all tasks from design to operation can thus be transformed into templates by multiple users similar to an app-store. The documentation of the tickets and their achievement-control follows automatically.
Wikis form a separate information catalogue linked to each Task explaining the target values and their test methods to prevent errors during the quality insurance and to make the results comparable.
Using the TaskManager as ticket system the user can be provided with different knowledge about the quality insurance or else develop his or her own. These checking procedures will be derived from already existing standards (Blower-Door, 12599 etc.).

2.1 Field Test

The practical ability of the TaskManager is demonstrated in field tests of four different projects during the phase of planning and operation. Three of them have been analysed in operation concerning the energy consumption as well as heating, cooling, ventilation and room-comfort.
The test method can be explained in practice by the example of a kindergarten in a passive house construction. The overall power consumption of the building with 40 kWh/(m²a) trespasses the expected targetvalue of 30 kWh/(m²a). Checking the wattage showed, that the air-handling system has the highest share of 50%.
The planning targets of the air-handling system will now be compared in detail with the actual values during operation. Overlong operating time in the reduced night and weekend operation and an enhanced specific ventilation performance could be identified via current measurement of the ventilators.
The control strategies for systems are often inefficient, because they are oriented insufficiently towards the demands of usage requirements. This applies in particular to operating times of air-handling systems and overlong heating operating time. For example, high heating circuit temperatures were measured up until summer. The fundamental problem is the fragmentary documentation of planned and actual control strategies between the technical planners and the building operators. Malfunctions are often not recognized. This corresponds to the central starting point of this project to restructure target-performance comparisons firmly.

3. Conclusion and Outlook

The TaskManager is a powerful concept for the application of energy and quality management in buildings. It also improves the quality in the building industry on a large scale. Positive experiences during first applications in several buildings as well as the huge interest of building operators in the continuation of such an approach, lead us to expect acceptance of the tool in practical work.
In practice, the use of the methodology in pilot buildings leads to an important feedback on the effectiveness of quality assurance across buildings. At the same time the systematic analysis helps to identify typical quality deficits and causes of suboptimal performance that can be tackled beforehand in future projects.

School Goes Green – Extension of the BNB-Certification Methodology for Educational Buildings

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Summary

The development and implementation of a sustainability certification methodology for buildings is considered to be a milestone of establishing principles for sustainable construction. In order to anchor this approach as widely as possible within the construction practice a continual extension of the certification methodology for different types of buildings is necessary. This paper outlines such a process on the basis of the system development and implementation for sustainable educational buildings.

Keywords: Sustainability; certification methodology; educational facilities; new system implementation

Extended Abstract

The construction and real estate industry is regarded as one of the key sectors for a sustainable development. The German Federal Government takes this into account and addresses the sector in its national sustainable development strategy accordingly. For many years the establishment of principles for sustainable construction has been a fundamental part of this strategy, especially concerning public construction projects. Therefore it is necessary to document the ecological, economic and social sustainability performance of buildings transparently and checkable. To realize these requirements the certification methodology *“Nachhaltiges Bauen des Bundes (BNB)”* was developed involving important stakeholders and launched as a basic system appropriate for the typology of office buildings.

But a broad anchoring of the strategic approach requires a certification methodology’s extension for different building typologies. And educational buildings are such a highly relevant typology because the corresponding real estate represents a significant part of the entire public buildings portfolio [1]. This further development of the BNB-basic system is challenging because the different forms of use to be mapped vary considerably and the consequential heterogeneity of the user structure leads to an enormous range of requirements and quality respectively sustainability criteria. Although several assessment criteria of the BNB-basic system could be adopted, a large number of criteria had to be adjusted to specific needs of educational buildings. Furthermore additional criteria had to be developed for the aimed system version “*Nachhaltige Unterrichtsgebäude*”[2]. Thereby the assessment methods and levels had to be configured without advantaging or discriminating one special form of use.

For the last few months the first version of a system draft for sustainable educational buildings has been tested intensively by implementing a phase of initial application. As part of a research project in total seven new built educational buildings of different forms of use were selected as pilot projects assessed by using the system draft for sustainable educational buildings. One of the key findings of the initial application is that the system draft is basically suitable for a sustainability assessment of multiple forms of educational buildings. But secondly particular assessment criteria were not adequately specific to map different forms of use or showed selective blurs in assessment levels. Lastly several assessment methods left inacceptable margins for interpretation by their application [3].

This diagnosis including the identified need for action was subsequently transformed into a strategic approach of finalising the system draft towards an operational market version for sustainable educational buildings. The according measures were to increase the specificity of assessment criteria by considering different forms of building usage within the cluster of educational buildings explicitly as well as to enhance their selectivity through a more precise partition of the assessment benchmarks and a new configuration of quantitative assessment methods i.e. by narrative substantiation. Since sustainability certification methodology always has to be adjusted to technical or scientific progress the system version “Nachhaltige Unterrichtsgebäude” will be subject to a continuous process of developing and updating in the future.

References

[1] FEDERAL MINISTRY OF TRANSPORT; BUILDING AND URBAN DEVELOPMENT (ed.), “Typologie und Bestand beheizter Nichtwohngebäude in Deutschland”, BMVBS-Online-Publikation 16/2011

[2] FEDERAL INSTITUTE FOR RESEARCH ON BUILDING; URBAN AFFAIRS AND SPATIAL DEVELOPMENT (ed.), “Begleitung der Arbeitsgruppe Nachhaltige Unterrichtsgebäude - Endbericht”, www.bbsr.bund.de, 2011

[3] FEDERAL INSTITUTE FOR RESEARCH ON BUILDING; URBAN AFFAIRS AND SPATIAL DEVELOPMENT (ed.), “Bewertungssystem Nachhaltiges Bauen - Erprobung des Systementwurfs Nachhaltige Unterrichtsgebäude - Endbericht”, www.bbsr.bund.de, 2012

Control of Sustainability Processes as an Integral Part of Project Controlling

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Extended Abstract

Sustainability has become an ever-present concern these days. In the real estate industry, too, sustainability constitutes a central aspect in the implementation of a project. While the benefit of sustainability was an object of speculation only some time ago, there is virtually unanimous agreement today that non-consideration of the relevant criteria will have detrimental effects on marketing, operation and utilization/ realization of the property.

The preferred course of action is different for each project, depending on the investor involved. Reliable data describing project processes and tasks of actors concerned are only successively emerging; scientific findings regarding this process still need to be analysed.

Besides the project goals, sustainability criteria will also determine the tasks or services allotted to all units involved in planning, the main project controller and the builder/ developer.

In my capacity as a member of the board of the German Association of project managers (DVP) I have initiated a 'Sustainability' working committee to provide a forum for the discussion of relevant processes under aspects of project controlling. As all parties involved are represented in this working group, it offers an overall view of all aspects, so to speak.

The key objective is to analyse and delimit the tasks to be performed by the project controller on the one hand and the interfaces with other parties involved.

For this reason, the initial objectives and the existing requirements to all participants in the various stages of the project are described from the investor's point of view. Particularly in the early project stage, the investor needs to determine the sustainability goals he pursues.

Depending on the selected certification model, the consideration of sustainability criteria will entail different tasks and processes to be performed in the course of the project. In view of this fact, the task structures of the parties involved in the project will be presented in conjunction with the various milestones in the overall context of the project implementation. As the project sequence is iterative with regard to integrating sustainability goals, it is possible to identify landmarks of sustainability orientation in the progress of the project. A survey of these milestones will be given below, assigning them to the duties of the responsible project stakeholders.

The realization of a project according to the requirements specified in a certification system affects the entire project in each of its subordinate targets. In view of this fact, this topic has an effect on all the services provided by the project controller, who is involved in various areas of intervention, including organisation, costs, quality, time schedules, and contracts. In the following it will be shown which services are particularly related to sustainability. Meanwhile, sustainability advisors who offer special consulting segments (especially in the run-up to project development) have established themselves in the field of project management. Depending on the respective degree of qualification, these services are also offered by project controllers and qualified planning offices. The future will show to what extent this practice will become established. The realisation of sustainability criteria in planning and execution also affects the scope of services provided by the project planners, whose performance profiles need to be reviewed with regard to supplementary services.

These emerging services and newly introduced project participants associated with sustainability issues also require new legal classifications. For instance, if sustainability targets were not achieved, the question of liability for any damages occurred has to be discussed.

Project management as a discipline in the context of project planning and implementation is a suitable tool to optimize the efforts and expenses of all parties involved by following structural approaches.

Compared to the time required for the project stages of preparing, planning, and executing construction works, the useful life of a building is many times longer. It is therefore all the more important to reflect carefully on the aims of the project and their underlying principles, and to diligently document planning processes. It is only in this way that sustainable properties may be accomplished. Unfortunately, project-relevant boundary conditions do not always consider this crucial but trivial insight. Generally, there is a growing tendency towards accelerated planning and building. This is particularly true for projects initiated by private investors. To achieve these goals as efficiently as possible, it takes a clear division of responsibilities and process modelling among all parties involved. The basic structures need to be analysed individually for each project. The presentation will give a survey of sustainability-relevant time schedules and milestones.

The Pareto Principle for the Energy Assessment of Heterogeneous and Complex University Buildings - A Comparison

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Summary

The Pareto principle can be used as a basis for novel energy assessment methods for complex buildings, e.g. university buildings. An energy-related comparison between two simulation models of the same building with different level of details is assessed. Both models are calculated based on a well-established building energy simulation software (EnergyPlus). The simplified method uses characteristic values and almost correlates with the detailed method. The Pareto principle is applied in the selection of representative rooms to determine the building energy demand and the thermal behavior. The choice of selecting representative rooms reduces the amount of the input data. The associated waiver of a whole 3D model for a multi-zone building leads to a significant reduction of the simulation run-time.
Based on the results a rating for a building stock is done. The relative and absolute differences are calculated according to the energy demand. Both differences built an own rating. Using only one difference as a parameter causes a loss of information. The combination of the absolute and relative difference allows to evaluate the real energy saving potential (absolute diff.) and to consider the individual building character (relative diff.). Energy efficiency and energy costs have to be considered in order to draw up a priority list for the retrofit of the buildings. With the new information it is possible to create a rating regarding both parameters and individual priority.

Keywords: Non-residential buildings; Energy assessment; EnergyPlus; Pareto principle; Benchmarking; Rating; Characteristic value

1. Introduction

The directive 2010/31/EU of the European Parliament and Council describes the goals and lays down the formal energy performance requirements of buildings [1]. The directive could be seen as a direct request for the universities to assess and to improve their building stock while using the existing methods. Furthermore, the future energy supply of the universities is affected by rising costs of fussil fuels and by national and European requirements to reduce the energy demand of buildings. The university building stock involves huge challenges and opportunities, notably

- the size and quantity of its buildings
- the large variety of buildng types with regard to age, construction type and facade design
- the different HVAC systems for different functional requirements
- the heterogeneous occupancy, especially with regard to seminar rooms, lecture halls and laboratories
- the field of expertise and the research activity of the faculty or chair.

For a comprehensible energy assessment these points have to be taken into account.

2. Method

An energy-related comparison between two simulation models of the same building with different level of details is assessed. Both models are calculated based on a well-established building energy simulation software (EnergyPlus). The first calculation method (M1) uses the Pareto principle and the second one (M2) describes the building completely as a 3D model in EnergyPlus. The intent of the first calculation method is to reduce the calculation run-time while keeping the individual character of the building and the high information quality of the whole building simulation. The Pareto principle is applied in the selection of representative rooms to determine the building energy demand and the thermal behavior. The choice of selecting representative rooms reduces the amount of the input data. The associated waiver of a whole 3D model for a multi-zone building (>50 zones) leads to a significant reduction of the simulation run-time. The additional information of the dynamic simulation engine improves the knowledge on the overall performance of the building and allows the evaluation of the necessary measures for the refurbishment.

3. Results

The presentation will show first results and the process of this approach. Applying characteristic values for the building energy assessment appears as a suitable and promising tool for the evaluation of complex buildings, e.g. university buildings. This method allows determining a characteristic value for a building under consideration of its unique function and space partitioning. The very low time demand, the unique characteristic value and the better view into the energy behavior of the building are notably the strengths. Based on this information a benchmarking is done more easily. The absolute or relative difference between energy consumption and demand commonly used to receive a rating for the building improvement. Using only one parameter leads to a loss of information and can occur in an unsuitable rating with less performance regarding increasing energy efficiency and decreasing energy costs. Energy efficiency and energy costs have to be considered in order to draw up a priority list for the retrofit of the buildings, which considers the individual character and the energy saving potential. The combination of both differences offers the opportunity to evaluate a building stock in a more comprehensible way.

Sustainable Outdoor Spaces and Facilities – A Chance to Improve the Building Sector

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Summary

The core aspects of two consecutive research projects were the development, subsequent testing and the introduction of an assessment system for the topics of sustainable outdoor spaces and facilities on federal office buildings properties in Germany. These projects were contracted by the Federal Ministry of Transport, Building and Urban Development (BMVBS) and the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR).

As a new module to the well-known BNB-system it needed to be tested as a whole, and each of the comprising 27 criteria profiles needed to be reviewed by evaluating selected Federal projects. Based on these results the previously established assessment system was adapted and amended.

A brochure, entitled “Sustainably planned outdoor facilities on Federal property“, was prepared, reviewed and published in Feb. 2012, which is now compulsory for federal public projects.

Keywords: Landscape architecture, sustainability, evaluation methods, assessment system, outdoor space, outdoor facilities, urban design, life-cycle costing

1. Introduction

It was the goal of the two mentioned research projects to unite the very complex, heterogeneous sometimes opposite, even contradictory or conflicting topics in just one assessment system for sustainable outdoor spaces and facilities.

Among existing outdoor spaces there are some projects that essentially show an implementation of sustainable aspects: Some rely on the integration of rooftop-gardening and the rainwater-management system others focus on the *Design for all*.

In this context some garden and landscape projects set ambitious targets in view of the protection of resources. But nonetheless there is a tendency at other projects to consume further resources than to protect and improve natural resources or maintain bio-diversity. Widespread is a lack of information regarding the long-term effects to the environment, ecological-balances, life-cycle cost calculations and an absence of efficient and practically applicable planning instruments.

2. Results

The present catalogue of the new BNB-assessment-system-module offers an appraisal of 27 criteria, divided into six main groups of qualities such as ecological, economic, social, location and technical quality and procedural requirements.

The subsequent breakdown of these 27 main criteria into sub criteria is using carefully chosen methods - both appropriate and innovative measurement - the detailed characterizations, features and media data were described in the profiles. Measurable characteristics comprising the sustainable topics of an outdoor spaces planning through clearly defined guidelines and checklists - in terms of quantity and/or quality – guarantee sustainability in the future.

At this stage the use of the present guidelines is limited to outdoor spaces and facilities on federal office building properties in Germany. Even this limited range of application offers various types of outdoor spaces, such as near natural landscapes, gardens, stylish inner courtyards, planted or paved forecourts, spaces for pedestrians and cyclists etc. In case of a possible future extension of the evaluation system for example for municipal outdoor spaces and facilities, the inclusion of various other types of outdoor space is recommended.

Assessing outdoor spaces and facilities detached from their location and context affects the results. Unlike building evaluation, advantages or problems of the context contribute to a larger extent to the qualities of outdoor space, such as, for example, inundation areas, where specific paving materials have to be chosen, or plantings, that must be adapted to the peculiarity of outdoor space of urban and suburban areas and typologies.

Topics of sustainability are triggering a whole array of positive development effects. Consideration of environmental, ecological and building interrelations leads to questions of the efficiency of outdoor space in relation to the size, to questions of maintaining and preservation of biodiversity and the protection of resources.

3. Conclusion

The development and improvement of the rating system for sustainable outdoor spaces and facilities fill in an indicated information gap regarding the assessment, aims and criteria, long-term effects on the environment, social and functional qualities, eco-balances, life-cycle cost calculations.

Accordingly, both the results from the practical application and hints from project participants and the accompanying board were taken into consideration. Thus, the contents of the criteria could be developed, adapted and formulated more precisely in the future.

Using the system can optimize buildings and their surroundings, in terms of, for example, the local environment, rainwater management, microclimatic conditions, the attractiveness and welcoming qualities of outdoor space like forecourts, courtyards, roof gardens, pedestrian or cyclist zones.

Evaluation of Criteria for Sustainable Housing Development: Results from a Preference Analysis among Different Stakeholders in Housing Development and Occupancy

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Summary

The building sector is regarded as one of the key factors for reaching climate and energy objectives in European policy. Analyzing only energy aspects in the building sector, however, has been frequently criticized of falling short of assessing the whole impact the building sector has on the environment. For the purpose of evaluation of “sustainability of buildings” some voluntary certificates were established that are based on a multidimensional comprehension of sustainability and that go beyond the one-dimensional methods of some of the mandatory evaluation tools, such as EnEV.

Background

These voluntary certification systems, the DGNB, WWB, BREEAM, LEED, and ESI, attempt to cover a large set of indicators, differently weighted for each certificate. Neither the indicators, however, nor their weighing nor their emphasis on results are standardized. The results of the available institutional and commercial certification systems, therefore, are not consistent with each other, and applying a different certification to the same building possibly leads to different results.

Methodology

This study aims at conducting a critical comparison of certification systems that are presently available for the purpose of evaluating the sustainability of residential buildings and investigated these systems from the viewpoint of key stakeholders in housing development: architects, project developers, the financial sector, home owners, tenants and local authorities. To do so, a list of indicators was gathered from different certification systems to be evaluated by the identified stakeholders in a questionnaire. The survey was conducted on some 250 interviewees in 2011.

Results & Conclusions

Our results show that different stakeholders evaluate a number of indicators in a similar way, but also that some important differences were discovered with statistical significance. From the 65 criteria, evaluated by all stakeholders interviewed, 31 were evaluated differently with statistical significance. We conclude that this heavily influences an unbiased and generally accepted evaluation of sustainability of housing development. This study identifies “areas of conflict” with regard to indicators used by most of the certification systems investigated and also identifies stakeholders who have a different opinion in respect of the evaluation of sustainability of residential buildings.

Sustainable Laboratories – Development and Piloting a New Assessment Method

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According to the national Sustainability Strategy the German Federal Ministry of Transport, Building and Urban Development (BMVBS) published the first Guideline for Sustainable Building. In March 2011, the reworked Guideline for Sustainable Building was introduced by the German Federal Ministry of Transport, Building and Urban Development (BMVBS). Thus the Federal Building Authorities were obliged by edict to evaluate Office and Administration Buildings, using the Assessment System for Sustainable Buildings (BNB).

On initiative of the Building Ministry a research project was founded in October 2011, in order to supply an additional module of BNB that would meet the needs of Research Buildings and Laboratories. The scientific team, ee concept gmbh, receives support by a working group, representing relevant experts, in cooperation with the German Sustainable Building Council (DGNB). The scientific work was sponsored by the Research Initiative “Future Building” of the BMVBS and based on former results of the DGNB. The Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) was responsible for the research management.

The working group had several meetings and discussed the interim results of the current research project. The experts delivered intensive scientific support for these project, particularly with regard to their practical experience in planning and building laboratories.

Research Buildings and Laboratories are distinguished by a great variation of utilization - the assessment of some important criteria - as LCA, LCC or energy performance - therefore based on a so called “Reference Building”. This calculating model defines the quantitative benchmarking for the evaluation of the real building. This new method represents the substantial difference compared to other existing building categories in the BNB-System. Moreover the system will be able to react to the usual mixed- use in research buildings and laboratories, where besides different forms of laboratories, also offices, workshops and conference rooms are to be found.

According to the Assessment System for Office and Administration Buildings, the System or Research Buildings and Laboratories is organised in 50 criteria files. The notations of the criteria correspondent broadly to the criteria for Office and Administration Buildings, but the content matter has been adapted to the special requirements of the considered building variation.

In the following pilot phase, the developed assessment method was applied to selected laboratories in completion, among them five projects from the public sector. During this process which lasted several months, three workshops were organised to discuss the practicability and consolidate the methodology. Evaluating the results BNB- Laboratories will be finished the second quarter of 2013.

In the following pilot phase, the developed assessment method was applied to selected laboratories in completion, among them five projects from the public sector. During this process

which lasted several months, three workshops with the participating auditors were organised by the researchers to discuss the practicability and consolidate the methodology.

On the part of the public sector five projects participate in the pilot phase:

Zentrum für Präklinische Forschung (ZPF), Deutsches Krebsforschungszentrum (DKFZ) in Heidelberg
Experimental Research Center (ERC), Max-Delbrück-Centrum für Molekulare Medizin (MDC) in Berlin
Max-Planck-Institut für Biologie des Alterns (MPI), Max-Planck-Gesellschaft in Köln
Labor- und Bürogebäude (IEK-4) Geb. 10.14, Institut für Energie- und Klimaforschung Plasmaphysik (IEK) in Jülich
Photovoltaik Technikum, Institut für Energie- und Klimaforschung Photovoltaik in Jülich.

Further participating projects are supervised by the German Sustainable Building Council (DGNB).

Evaluating the results BNB-Module Research Buildings and Laboratories will be finished in the second quarter of 2013. The Assessment System will be implemented into the practical work of the Federal Building Authorities. The publication is carried out with the Information Portal Sustainable Building “www.nachhaltigesbauen.de”.

Keywords

Sustainability; Assessment; Laboratories; Federal Buildings

Automated Design Space Exploration for Improved Early Stage Decision-Making

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Summary

This paper addresses today's challenges in creating a building design. It focuses on the criteria of sustainable design and how it can be integrated into the conceptual design stages of office and administrative buildings. The conceptual design stages are of extraordinarily high importance because they have a profound impact on the later costs and performance of the resulting building. A careful investigation of the different design options is accordingly required. As the combination of the diverse design options usually results in a very large design space which can hardly be explored manually, designers can obtain considerable assistance from computer tools that are able to perform an automated design space exploration (ADSE). If they are to be of use, however, such tools need to be intuitive, helping the designers in the decision-making process without impeding creativity. This paper contributes towards the development of such tools by investigating the boundary conditions in place. To illustrate the concept, the paper presents a prototypical software tool which assists building designers in the creation of load-bearing steel and steel composite structures for a roughly defined building layout.

Keywords: conceptual design; structural feedback; performance predictions

1. Introduction

Architectural design is a complex process, which cannot be described as a linear sequence of individual steps or the result of a mathematical equation, but must be understood as an iterative approach instead. There are a number of different influences and various stakeholders, such as technical guidelines, legal regulations or specifications issued by the clients that limit the potential design space. During the course of the design process the concept therefore evolves from a conceptual, three-dimensional idea into a result that combines all aspects, from stakeholders as well as guidelines and other constraints.

In the analysis of the guidelines, it is very important to adjust the influence they exert at each design stage in order to define the scope of the design space. This adjustment is necessary because, on the one hand, designers run the risk of limiting the design space too early in the process without taking alternative solutions into consideration. Alternative solutions are an important step where designers get to know the spectrum of three-dimensional variations and how the individual aspects influence each other. On the other hand, the definition of the benchmarks has to be precise enough to transfer the designed space to the next design step without departing from the main idea of the original concept. Thus, it is always of particular importance to repeatedly check the given applied constraints, such as financial constraints, input by the clients or technical standards, in the different alternative designs.

Even with their experience-based typological knowledge and individual creativity, designers have to struggle with increasingly complex, specific and, above all, technical aspects in the design process. Designers need to work together with specialist engineers in this regard. Ecological and economic issues in particular (for example LEED or DGNB certifications for office buildings) become more and more relevant.

However, these specialist engineers are often involved at a fairly late stage in the intricate design process. Wherever possible, designers and architects have to think ahead and consider their relevant aspects well in advance in order to recognize the consequences and dependences for the design. To assess ecological or economic issues accurately early on in the design process, years of experience on the part of the architect or an extremely high time investment are necessary to emulate the knowledge of specialist engineers adequately.

Contemplating the consequences of individual decisions at an early stage of the building design process is an important work step for architects designing the three-dimensional concept. Most of the constraints designs are not well defined at this point, because there is no clear description of the model in a designer’s mind before the final design has emerged [1]. However, some quick, automatically generated feedback on the initial conceptual ideas offers designers the chance to increase the number of validated conceptual designs and at the same time reduce the time effort. The feedback can be related to the main supporting structure and the associated information on material quantities, production costs, sustainability, etc. These results help designers early on in the design process to obtain further decision criteria for or against alternative solutions and to optimize solutions without the need for specialist engineering knowledge. The more different structural solutions can be created, the more the designer can explore the design space for optimal solutions.

Automated Design Space Exploration (ADSE) accordingly has the potential to act as a valuable tool to assist the designer in this situation. In order to generate more than one optimum solution, it is necessary to make use of an assessment that provides several well-performing solutions. This is of importance, because the optimal solution may not correspond to the stakeholders’ original design intentions. It is vital to provide a means of comparing these results and choosing the one that appeals most and matches the intended purpose of the design best.

To illustrate the ADSE approach, this paper presents an implementation of the methods available with a software tool that supports the traditional sketch-based line of thought employed by designers. This lifts the draughtsman’s approach from the drawing-board and physical models to computer-aided volumetric models generating early proposals for steel and steel composite supporting structures.

Insulation Versus Installation – An Exploration Towards Maximization

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Summary

In this research the optimal energy efficiency improvement in the renovation of a social housing dwelling in the Netherlands is investigated using different methods. In the investigated case, the dwelling has been renovated in a number of energy-efficiency improvement steps using different insulation packages and installation packages.

Keywords: Building envelope - Embodied Energy – Operational Energy – Embodied Land – Energy Efficient Renovation

1. Introduction

Worldwide, extraction of energy resources is increasing significantly to maintain, and even improve, our standards of living. About 40% of our energy consumption takes place in the built environment. Based on global developments such as depletion of these resources, environmental issues and social-economic issues, there is a need to realize higher energy efficiency and energy savings in the built environment. These developments have led to numerous initiatives, mainly focusing on energy efficiency in the operational phase of buildings. Examples of energy efficiency improvement strategies are passive houses, active houses and zero energy houses. The objective to realize a more energy efficient built environment is embedded in European policy through the Energy Performance Building Directive (EPBD) in which all new built objects within the EU have to be nearly zero energy by 2020. To reach this objective, an increasing amount of building materials is consumed, for instance for insulation and energy generating devices.

In the Netherlands, about 1% of all building objects are renewed each year, making the existing building stock a logical target for realizing energy efficiency. By concentrating on only new developments, it would take 100 years to realize an energy efficient built environment. In the Netherlands, about 33% of the dwellings in the existing building stock are social housing dwellings, owned by social housing corporations. Various initiatives are realized to improve the energy efficiency of this existing stock.

The counter effect of focusing mainly on energy efficiency in the operational phase might be a disproportional energy and material consumption in the realization phase, which on its turn might contribute even more to resource depletion.

The aim of this research is to generate insight in the balance between the energy aspect and the material aspect in a renovation project to be able to determine optimal energy saving and energy generation packages based on a number of calculation strategies. The two aspects can be translated in the energy consumption in the operational phase (operational energy) and energy consumed in the realization phase of the building object invested in materials to reduce and generate energy (embodied energy). Current methods to assess the balance between the operational and realization phase of building objects do not take into account possible depletion and the physical possibilities and boundaries of the system. Current methods are based on weighted comparisons between the material aspect and the energy aspect, and there is a lack of a scientific based solid corresponding unit for both energy and materials. A possible method to incorporate both aspects is to calculate the total impact to the physical possibilities of our system; time and land. The hypothesis is, that if all components are calculated with a corresponding unit, focusing on only the energy aspect leads to a sub optimization of the total system.

2. Methodology

The research is conducted by calculating the environmental impact and energy aspects of different insulation packages and installation packages for an energy efficient renovation of one of the most numerous and basic dwelling types in the Netherlands. The selected dwelling type, built between 1946 and 1965, accounts for around 478.000 dwellings (7% of all dwellings in the Netherlands). For the energy calculations the Dutch Standard Energy Performance calculation program [1] is used, for the embodied energy the ICE database of the university of Bath is used [2], and for the calculation on time-space a tool under development of RiBuilT (MAXergy) [3] is used in which embodied energy is translated into land-impact. In the calculations, the dwelling has on one hand been insulated in 3 phases to the level of a passive house, and on the other hand, the installation package consists of solar photovoltaic panels for electricity and a ground heat pump for heat.

3. Results

Regarding mass impact, the lowest impact is logically with no addition of mass whatsoever. But when looking at mass impact during the lifespan of the building, due to the fact that a lightweight insulation package is used and the installation has to be renewed at least once in the 50-year lifespan, there is a minimum impact with minimal insulation. The energy calculations show that concerning embodied energy minimal insulation has the lowest energy impact. But, taking embodied energy versus operational energy into account, the lowest total energy impact is calculated with maximum insulation. With this package, the amount of embodied energy is nearly equal to the amount of operational energy, implicating that further insulation would be less effective. When translating both the energy and the material aspect into embodied land, the lowest impact is reached again with minimal insulation.

4. Conclusions

This research has generated insight in the offset between mass for the installation and insulation, and in the offset between embodied energy and operational energy to the level of embodied land. The results indicate that different impact calculation tools show different optima. The insight can be used to determine optimal insulation and installation packages considering environmental impact. In further research the chosen methodology to calculate impact to the level of time-land has to be refined and the financial aspect could be taken into account.

“Greener” Procurement of Construction Works for Contracting Authorities

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Summary

Previous research and practice initiatives concerning ecologically sustainable infrastructure projects have predominantly focused on the operational phase. Environmental aspects during the construction phase, however, have not sufficiently been considered. As a result, a gap in holistic life cycle considerations occurs. This article generally describes strategic basics as to how to implement environmental aspects into the construction contracts of public infrastructure projects. Appropriate framework conditions need to have been predetermined during the tendering stage for an ecological orientation of the construction process. In particular, the application of an environmental award criterion is proposed, thereby improving the construction process in an environmentally sustainable way, in order to fill the gap in sustainability considerations. This paper presents the current state of research for procuring a “greener” construction phase and provides a new strategic approach.

Keywords: Infrastructure projects; environmental aspects; green public procurement, strategy, construction phase

1. Introduction

Public large-scale infrastructure projects are often initiated due to environmental issues as a basis for a modern living environment, e.g. for the restoration of waters and industrial landscapes or for the improvement of underground infrastructure. During the construction phase, however, the construction process temporarily causes effects upon the environment. In addition to temporary “invisible” environmental impacts because of energy consumption, air pollution and greenhouse gas emissions, construction processes tend to have an impact upon the human environment and nature. Thus, it is not only necessary to focus on the operating phase of buildings, but also to make the construction processes more ecological. Besides the client’s key construction project objectives of “cost”, “time” and “quality”, the objective “environment” should be a new dimension in a holistic and environmentally oriented construction project management. A fundamental change in the construction sector must be achieved. Since the construction methods, applied technologies and the organization of the construction processes are determined by the contracting authorities, measures have to be taken as early as the public procurement process. After awarding the contract, efforts towards environmental protection and resource economizing are difficult to influence. Due to the fact that awarding authorities have to conform to strict organized awarding procedures, approaches of a strategically correct implementation of environmental aspects have to be studied.

2. Aims of the Paper

This publication demonstrates the results of a theoretical study about the strategic basics of implementing environmental aspects into the German public tendering procedure. The study has two aims: {1} To analyse the statutory framework in the public procurement process regarding the specific situation of environmental aspects in civil engineering projects, and {2} To identify strategic approaches within the tendering procedure contributing to improvements in the environmental performance during the construction phase. The paper is an outcome of an ongoing research project concerning practicable opportunities and solutions for the embedding of environmental aspects in public procurement of underground infrastructure construction works. A review of published German and international literature in environmental management, construction management and green public procurement has been carried out. The findings and results have been discussed and validated in interviews and expert workshops. Representatives from several departments of a major German contracting authority discussed the legal, technical, and commercial perspectives of green procurement by focusing specifically on the feasibility of environmental awarding criteria in the public procurement process. The procurement phases and tender elements were analysed to identify possibilities to implement environmental aspects.

3. Results

As a result, the application of environmental preferences in German public tenders for construction works is possible if the legal framework is observed. The definition of award criteria turns out to be especially qualified in this context. Besides taking account of legal aspects, technical, economic and ecological issues all have to be considered. The application of an “Environmental Concept” as an award criterion seems to be a feasible way of implementing environmental preferences into the procurement procedure. Both quantitative criteria, such as fuel consumption or greenhouse gas emissions, and qualitative statements, such as descriptions of planned environmental measures, can be inquired by applying the proposed criterion. The contracting authority thereby demonstrates high environmental ambitions for the processing of the project. The tenderer’s capabilities of managing environmental issues during the project are evaluated. Incentives for a “greener” construction industry are created.

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Pilot Applications of the German Rating System for Sustainable Building in China

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Summary

This paper reports experience of first pilot applications of the German rating system for sustainable building (DGNB/BNB) in three projects in China. First the current situation of energy-efficient and sustainable building in China will be described. Following the paper will discuss the local Chinese rating system (Chinese Green Building Label) in relation to its application in building projects in China. The German rating system for sustainable building, which was recently introduced to the Chinese market, will then be presented and its appropriateness and applicability will be analyzed. Parts of results presented are derived from a research project funded by the German Ministry of Transport, Building and Urban Development, which was conducted to develop a local representation of the German rating system in the Chinese Market able to represent the required qualities based on Chinese standards and local professional processes. Then experience from the first three project applications of the DGNB system will be presented. It was found that the required technical quality can be achieved in China, but that some of the technical categories must be adapted to the local conditions due to climate and the user requirements. The largest need for adaptation and the largest mismatch between the requirements of the German rating system and the praxis in China was identified for the category “process quality”. Processes of comprehensive project preparation, integral design and comprehensive building design, as required by the rating system, are currently not present in the Chinese building delivery process. The paper at the end will discuss the contribution the German system can make to the Chinese building market and the future chances for its application in China.

Keywords: sustainable building rating, DGNB, CGBL, 3-star System, China, local context

Introduction

Among the strategic goals set in current Chinese 5-year plan there are many objectives that directly relate to a sustainable and resource efficient built environment. With the construction industry being a large part of the Chinese economy as such and thereby accounting for a large part of the Chinese resource consumption, sustainable design and sustainable building is promoted in China as an effective contribution to achieving these strategic goals.
After some years in which “low carbon” has been high on the agenda, now more and more sincere interest can perceived in a more comprehensive approach to sustainable design and building. In the past years, and up-to now, various certification schemes for sustainable building have been applied in building projects and the knowledge on green design is growing among Chinese construction professional and the clients in the Chinese market. Among the certification schemes

applied the American LEED framework and the National Chinese Green Building Label are most widely known. While the international schemes are perceived as more reliable and prestigious, the Chinese Green building standard is strongly promoted by governmental policies, incentives, financial subsides, and not at least by growing self-confidence of the Chinese stakeholder. After being applied in a large number of projects, the American LEED system has lost its reputation and is often considered as not appropriate for the Chinese conditions, as it is largely based on American Standards. On the other hand the LEED framework is structured and openly available to be applied easily in building projects worldwide.
There have been attempts to introduce the German Rating System for Sustainable Building (DGNB) and it has recently received some attention by local professionals, researches and policy makers. The DGNB framework is said to represent a more complete set of aspects relevant for China than for example the American LEED framework. On the other hand the DGNB System is believed to be too complex and too involved for the application in China. Also the information policy by the German Green Building Council, not to disclose the system openly, hinders the wider application.
The author has been working on energy-efficient and sustainable building projects in China in the last 5 years. He and his team of energydesign in Shanghai have been working on LEED projects, on projects certified with the Chinese Green Building Label and on the first DGNB applications in China. The author has performed an analysis on the application and the local adaptation of the German Rating System for Sustainable Building for the application in China.

Conclusion

A large part of the qualities required by the German Rating System for Sustainable Building (DGNB) is applicable and relevant in the Chinese construction market to achieve an advanced quality compared to the current praxis. The energy-efficiency and resource-efficiency required supports the overall national goals, formulated in the 12th national 5-year plan, directly and indirectly through the better resource utilization in buildings of higher ecological, functional and economic performance.
By defining a comprehensive catalogue of sustainability aspects the system guides project teams, during project definition, concept, design and construction, into the phase of handover and operation.
The technical, economic and functional aspect of the DGNB system can be achieved in building projects in China; however the current process organisation does usually not support the integral and comprehensive design and building process.
Some of the technical aspects, such as building physical aspects and comfort aspects, need to be adapted in order to be relevant for the local climate and the local context. For the systematic life-cycle impact assessment a confirmed database is missing, so that the evaluation and design development has to be performed based on a European database. The energy calculation requires further careful review, to be applicable by Chinese building professionals on the one hand, and to represent a similar scope as the calculation according to the German standard. The local adaptation of the German Rating System for Sustainable Building is currently being developed in collaboration with local experts and German sustainability council based on the experience made in the first project applications.
The German Rating System for sustainable building provides a comprehensive framework of measureable and relevant criteria for sustainable building projects in China. Through its structure and scope, it has the potential to remediate short comings in the current green building praxis in China.

A Systematic Approach to Energy Efficiency Improvements in Buildings Based on Enterprise Modeling Method

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Summary

Energy consumption of buildings accounts for almost 40% of the global energy use, and improving energy efficiency in buildings becomes a major priority worldwide. Retrofitting of existing buildings offers significant opportunities for reducing building energy consumption. Innovative energy efficiency technologies are widespread today and there is then a vast “trade space” for the design options that can be undertaken. But retrofits are still done in a disintegrated way and the decision to retrofit for energy efficiency has become extremely complex given the conflicting objectives of the building stakeholders. Thus, finding an optimum for the energy efficiency retrofit is a truly hard problem.

Enterprise modeling technology has been considered playing a very important role in variety of information systems used to support enterprise management and integration. This paper employs the modeling method of enterprise about process industry as reference to provide a structured investigation of energy efficiency retrofit processes. The framework will integrate the building stakeholders’ requirements and provide a systematic view of how energy efficiency measures can be employed, facilitating the integration of various facets of the whole process. A decision support system, which handles the trade-off among a range of energy related and non-energy related factors, will be implemented to recommend an optimal set of energy efficiency decision-making actions. As the study is still at its early stage, this paper aims to provide an outline of the new methodology, in which the process integration and information integration will be discussed.

Keywords: energy efficiency; systematic approach; enterprise modeling; CIMOSA; decision support system; building retrofit; integrated project delivery

1. Introduction

The overarching aim of this study is to address the gap between the vast energy efficiency measures and the systematic energy efficiency solutions in retrofit projects. The research in this project will determine how the various requirements of the different building stakeholders affect the energy efficiency solutions and the relevant objectives of building retrofit projects and their constraints. The systematic approach taken will support identifying, determining and implementing feasible energy efficiency measures for retrofitting existing buildings. This study will treat buildings as complex systems like enterprises and take energy efficiency improvements such as retrofits of existing buildings as enterprise engineering activities. The modeling method of enterprise about process industry will be employed as reference to provide a systematic information-based approach to improving the design process of energy efficiency retrofit.

2. Problem statement

Decision problems about a building's energy efficiency solutions are usually unstructured and ill defined. Existing building usually have conflicting subjective preferences and fragmented expertise, and frequently conflicting requirements. Moreover, energy consumption relates to almost every subsystem of buildings and different facets of building design. The subsystems in buildings are highly interactive. Different energy efficiency measures may have different impacts on associated building subsystems due to these interactions, requiring for a complex combination of energy efficiency technologies. This leads to finding an optimum solution for the energy efficiency retrofit truly a challenge. Therefore, decision support plays an important role, and a systematic approach to identifying, determining, and implementing an optimum of energy efficiency measures is needed, which takes all stakeholders and factors into consideration.

3. Development of the new methodology

The development of an integrated energy efficiency retrofit management system can be defined as a set of procedures that analyses and segregates a complex building retrofit task into simpler manageable sub-systems while maintaining their links and interdependencies. The process of segregation, analysis and generation of solutions should lead to the development of energy efficiency retrofit management system. This study makes reference to one reference model of enterprise modeling method, CIMOSA, as primary architecture and adopts its concept to establish an integrated energy efficiency retrofit framework. The primary reason to have an enterprise modeling framework is to provide an overall, high-level design that could addresses stakeholder needs, shows how those needs will be satisfied, and explains the trade-offs required to meet those needs. The modeling framework communicates the system design vision to all stakeholders and energy efficiency solutions could be comprised depending on the stakeholders' priorities. The realizations of models mapping rely on a set of modeling languages supporting every phase in a hierarchical way. The models of various phases in the modeling framework are evolved step by step in the model-driven way from up to down.

A Strategic Package Approach to Energy Efficiency in Buildings

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Keywords: energy efficiency gap, best available technologies (BATs), good practice, cost effectiveness, cost reduction, minimum energy efficiency standards, holistic design, (ultra) low energy buildings, zero-/plus energy buildings

1. Introduction

The project "bigEE – Bridging the Information Gap on Energy Efficiency in Buildings" presents comprehensive information for energy efficiency in buildings and the related policy on the international internet-based knowledge platform bigee.net . Numerous studies (e.g., Ürge-Vorsatz et al. [1]; Laustsen [2]; WBCSD [3]) are confirming that enormous energy saving potentials – up to 90% – can be realised by improving building and appliance energy efficiency, and that most of the available improvement options are cost-effective from a life-cycle perspective as long as they are done in new built or in line with normal reinvestment cycles. Yet a consistent methodology in rating these highly energy efficient buildings does not exist. Therefore, the bigEE team developed a strategic two-level approach to energy-efficient building design in a consistent manner for the four main climate zones in the world. The two levels are (1) an 'Easy Efficiency Approach', which can reduce primary energy consumption by 40 to 60 % compared to conventional new building standards and focuses on low-cost options, mainly passive options, and (2) an 'Advanced Efficiency Approach', with savings up to 90% as soon as possible to avoid lock-in effects. In verifying this approach simulations with low-energy and ultra-low-energy buildings of different types (single family, multi family, high rise) were carried out in close cooperation with project partners. This data has also been verified through an empirical database of built examples both for energy consumption as well their economic soundness.

2. Results

The Strategic Approach of bigEE aims to alleviate this lack of methodology by defining ranges of energy consumption, which are determined by a common set of parameters in combination with the climatic conditions.

In the framework of the bigEE project as well as the Strategic Approach the energy consumption in buildings is described as the specific primary energy consumption of new residential buildings for heating, cooling, ventilation and hot water. The energy consumption for lighting and for appliances is not included because - as a rule - both end uses are not building integrated but come as a procurement of the habitants.

The bigEE Strategic Approach aims to offer ranges as guidelines for various climate zones to help the decision maker, cf. Table 1. It also provides recommendations for a holistic design that enables achievement of these ranges.

Table 1: Specific primary energy consumption levels, for heating, cooling, dehumidification, ventilation and hot water, of the bigEE Strategic Approach according to Climate: values recommended for closed new building concepts

	Cool (e.g. Helsinki) $kWh/m^2_{TFA}yr$	Temperate (e.g. Shanghai) $kWh/m^2_{TFA}yr$	Hot and Humid (e.g. Mumbai) $kWh/m^2_{TFA}yr$	Hot and Arid (e.g. Khartoum) $kWh/m^2_{TFA}yr$
LEB	40 – 80	40 – 80	100 – 150	50 – 100
ULEB	20 - 40	20 - 40	50 – 100	25 - 50
nZEB	0 - 20	0 - 20	0 - 50	0 -25
PEB	++	++	++	++

(TFA : Treated floor area)

In the context of this paper, the Strategic Approach will be described through the example of new residential buildings. The Strategic Approach follows the premise of first implementing load-reducing “Passive Options” for building design, followed by energy-efficient “Active Options” for thermal conditioning and ventilation as needed and then fine-tuning building operation through “User Behaviour and Energy Management”. This integrated three-step process can reduce the primary energy demand of a building to low or even ultra-low levels. Adding on-site renewable energy technologies for heating and cooling can turn the primary energy balance of a building to the positive side, with the building becoming a net producer of energy over the year.

3. Conclusion

With the strategic approach to energy-efficient building design, bigEE has created the first worldwide consistent approach to defining Low-Energy and Ultra-Low-Energy Buildings in different climate zones. This goes further than previous attempts for Net Zero Energy or Plus Energy Buildings, which are relatively easy to define, and the Passive House Institute’s definition, which only covers closed building concepts of Ultra-Low-Energy Buildings.

Our approach also differentiates target value ranges for the specific primary energy consumption by climate zone, in order to allow comparable efforts, whereas a single energy target range would require too high efforts in the hot climates. On the other hand, the target ranges should be seen as maximum values. There are “lucky climates” in the temperate zones (such as in Lisbon) or in some regions of the tropics that allow real Zero-Energy Buildings using the Easy Efficiency Approach.

Looking at policy targets, countries starting efforts to improve building energy efficiency should at least start with the Easy Efficiency Approach to Low-Energy Buildings and aim to advance to Ultra-Low-Energy Buildings as soon as possible. However, as far as possible, leapfrogging to very high energy efficiencies of whole buildings or components, building on the experiences of others, would even be more preferable, given the need to limit global warming and cope with limited oil and gas resources.

As it is the first worldwide consistent approach to defining Low-Energy and Ultra-Low-Energy Buildings in different climate zones, our results leave room for further improvement. We consider extending the number of climate zones to provide for better differentiation of target values and design recommendations. Also, we hope that more built good practice examples confirming the design and results will become available during the next years. Currently, particularly in the hot climate zone, many energy-efficient buildings are still prototypes with the corresponding high costs. As more experience is gained also in these climates, cost-effectiveness should improve further.

Testing OPEN HOUSE Methodology in Former YU Countries

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Summary

This paper is dealing with testing FP7 OPEN HOUSE methodology for sustainable assessment of buildings on case studies in Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Macedonia and Montenegro. The aim was to evaluate the applicability of the set of indicators in these countries and to investigate the status quo and future trends in development of the favourable conditions for deployment of sustainable building. The above countries used to be part of former YU market. In spite of existence of independent national building codes the construction sector in these countries had common roots in former principles of planning, project development, design, construction and quality control mechanisms, in common JUS standardization as well as in building technologies used in the area. Through the detailed testing of 30 core indicators out of the full list of 56 OPEN HOUSE indicators the applicability, feasibility and benchmarks for ranking of particular indicators were investigated. The differences in the implementation of EU common market rules are relevant for the applicability of the OPEN HOUSE methodology as well as for penetration of sustainability principles in built environment.

Keywords: OPEN HOUSE; sustainable building; assessment methodology; indicators; case studies; testing

1. Introduction

The scope of the FP7 OPEN HOUSE project was the development of a European building assessment methodology (www.openhouse-fp7.eu). The methodology is based on the standardization of ISO TC 59/SC 17 and CEN/TC 350, international initiatives, like iisBE or SB Alliance as well as on European and international sustainability assessment methods, like LEED, BREEAM, HQE or DGNB. Within the project the baseline OPEN HOUSE methodology was tested on 52 case studies in 34 countries all over geographical area of Europe. The in depth testing of OPEN HOUSE methodology on 8 case studies in former Yugoslav countries Slovenia (SI), Croatia (HR), Bosnia and Herzegovina (BA), Serbia (RS), Macedonia (MK) and Montenegro (ME) not only provided the feedback from case studies and the information about country specific weights and benchmarks; it also enabled an insight in the influence of the status of transposition of EC legislation and CEN standardisation on the applicability of the OPEN HOUSE methodology.

2. Results

30 core indicators out of the full list of 56 OPEN HOUSE indicators were tested against the applicability, feasibility and benchmarks for ranking of particular indicators in the national context. Although the method was very positively evaluated there were some important barriers identified.

In general the environmental and economic indicators were evaluated as quite complex. Country specific benchmarks for evaluation of particular indicators are not easy to provide. Neither complex simulation of some indicators nor detailed monitoring of parameters foreseen in the OPEN HOUSE method is binding in the former YU countries. The applicability of OPEN HOUSE environmental, social/functional and economic indicators in SI-HR-BA-RS-ME-MK countries did not differ from EU wide opinion of respondents from all 34 countries. Although contemporary LCA and LCC methods are known and they are entering the market via relevant EN and ISO standardisation they are far from being binding or frequently used in building sector. The LCA indicators can only be used if the relevant data bases of building products with environmental product declarations (EPDs) existed.

Slovenia as an EU member state has implemented EU Directives related to energy efficiency of buildings as well as EU policy related to green public procurement in the building sector. In other countries this is still an ongoing process. Croatia which will soon complete accession process has implemented the core elements of EPBD but has not yet imposed green procurement rules. Macedonia, Montenegro, Bosnia and Herzegovina and Serbia reported about preliminary and more advanced activities towards implementation of EPBD based calculation methods and building energy indicators.

3. Conclusion

By the early 1990-ties *SI-HR-BA-RS-ME-MK* countries used to be part of former YU market, with common elements of building codes, common standardisation, design and construction practice, although each of the countries had also independent, country specific national building legislation. These countries had common roots in principles of planning, project development, design, construction and quality control mechanisms, as well as in building technologies used in the area.

However, in the last 20 years, the development of the construction sector became country specific and mostly oriented towards transposition of EC legislation and CEN standardisation. Criteria for sustainable building are not yet transparent. Particular aspects may be defined in green procurement rules, but above all the understanding of building sustainability differs from country to country. The implementation of EC directives, the use of harmonized CEN standards for building products and the integration of CEN based calculation methodologies for assessment of environmental indicators into national building codes (i.e. CEN-EPBD standardisation and standards of CEN/TC 350) differ between EU member states, accession countries and candidates. The differences in the implementation of EU common market rules are relevant for the applicability of the OPEN HOUSE methodology, where the core idea is an EU wide use of equal indicators with country specific benchmarks and weights.

Stochastic Approach for Useful Energy Performance Calculations

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Summary

Paper presents new ways how to use the energy performance calculations as a base for qualified discussion on building energy policy. An extra attention is given to possibilities how to use the stochastic methods as a real design supporting tool. Corresponding examples of calculations are presented and discussed.

Keywords: energy demand of building, space heating, stochastic methods, passive buildings, integrated design process, energy policy, cost optimum

Introduction

It seems to be very useful to have an instrument allowing the observation of energy demand problem "from above". This can be used for overall assessments, for studies on tendencies in particular typological group of buildings, for setting of targets and policy making in general. Moreover, such approach can be used as a real design supporting tool – advantageously in one package from the very early stage of the design to final delivery of the project.

Calculation procedure and input data

The calculations using steady state monthly method [1] are repeated automatically for large amount of combination of input data (typically several hundred up to thousands). Stochastic principles for selection of input data and for expression of the results are used. In general, all input data can be set in different modes:

- exact value, if available,
- reference to standard or legislative requirements (upper limit or lower limit, as interval),
- most realistic default values created automatically within the software tool.

The results are expressed in the form of statistic evaluation of all calculations done for generated data sets (overall distribution, minimum and maximum for 90% of results, mean value, probability of reaching usual targets). A sensitivity analysis describing the importance of input data in can be used for "fine-tuning" in the next step of the building design.

Examples

Several types of examples are presented in the paper. The energy demand expressed in primary energy (non-renewable part) for middle size apartment building was studied together with overall costs in the life cycle period of 30 years [2]. For random selected combination of input parameters the calculations were performed for 3000 combinations divided in 3 groups according the building quality. Energy prices consider the situation in 2011 increased by 4 % from year to year. Results are expressed graphically as a function of primary energy (non-renewable part) and global costs for natural gas as main energy carrier (Fig. 1). The overlapping “clouds“ illustrate the situation very clearly: There is no significant difference among the building quality group in the global costs if the long time perspective is used.

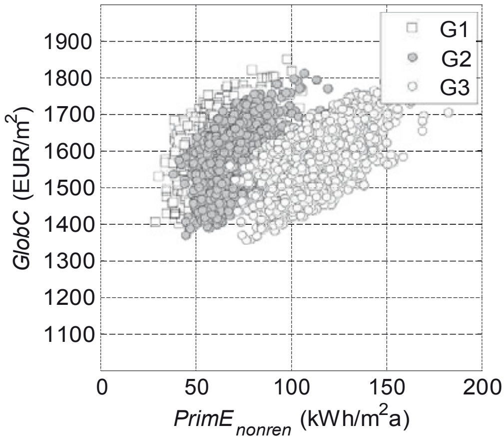

Fig.1 Study on relation primary energy – total costs for medium size apartment buildings (G3 usual solution, G2 low-energy building, G1 passive building)

References

[1] EN ISO 13790 Energy performance of Buildings – Energy use for space heating and cooling

[2] Commission delegated regulation of 16.1.2012 establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements

Optimization Geopolymer Binder for Sustainable Concrete Design

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Summary

This paper shows the potential of using FT-IR and solid state ^{29}Si NMR for (semi)quantitatively evaluating the quality and performance of secondary resources with the aim of applying them in sustainable geopolymer concrete for energy savings and CO_2 reduction. Four fly ash types with slightly different chemistry and their respective geopolymers were investigated.

Keywords: sustainable concrete, secondary resources, geopolymer, fly ash, FT-IR, ^{29}Si-NMR

1. Introduction

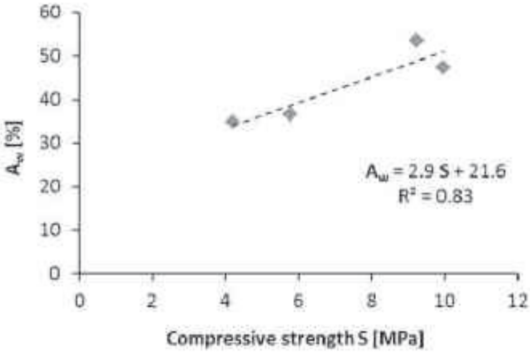
Replacing clinker cement with secondary resources can significantly reduce energy consumption and CO_2 footprint of concrete as the manufacturing process of cement clinker in a cement kiln is responsible for at least 5% of the worldwide CO_2 emission. Geopolymers are a type of inorganic binder that can be used for cementless concrete and generally consist of an aluminium-silicate precursor with an alkali activating solution. These precursors are often secondary resource materials such as fly ash and blast furnace slag. If geopolymers are to be used for sustainable concrete on a large scale or for particular unique applications, a screening method for linking the variable secondary resource materials to the quality and performance of geopolymers is needed to enable successful and efficient concrete design.

In previous studies FT-IR and ^{29}Si-NMR have been used for qualitatively evaluating and comparing different types of aluminium-silicates in materials such as fly ash. However, these data were not quantified and could not be linked to performance (strength) of geopolymers through a uniform relationship for different source materials. This paper shows the potential of using FT-IR and solid state ^{29}Si NMR for (semi)quantitatively evaluating the quality and performance of secondary resources with the aim of applying them in sustainable geopolymer concrete. Four fly ash types with slightly different chemistry and their respective geopolymers were investigated.

2. Results and conclusions

It is found that for secondary resources such as fly ash, the higher the amount of framework silicates with a medium to high amount of aluminium in their structure, the stronger the geopolymer binders (Fig. 1-2). Consequently, FT-IR and ^{29}Si-NMR can be useful screening tools for efficient geopolymer concrete design and optimization. ^{29}Si-NMR has the advantage of giving detailed information of different types of aluminium-silicate species. As such, more complex deconvolutions and accurate quantifications can be done for ^{29}Si-NMR spectra compared to FT-IR spectra.

The advantage of FT-IR is that it is much faster and less elaborate than ^{29}Si-NMR, and even though the FT-IR deconvolutions are less detailed, the relative areas of the peaks give a clear correlation with strength. Therefore, FT-IR has the potential to be a quick and user-friendly quality control tool of secondary resources for enabling cement replacement in sustainable geopolymer concrete and reducing CO_2 emissions and energy consumption related to cement production.



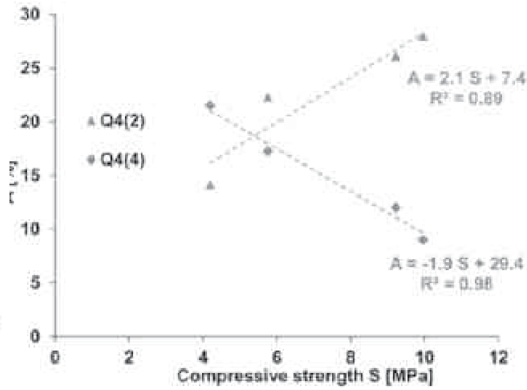


Fig. 1: Graph of S (compressive strength) of the geopolymer paste versus A_w (relative area of aluminium-rich silicate peaks (850-1000 cm^{-1}) of the fly ash source divided by the liquid solid ratio of the paste) as obtained by FT-IR quantification.

Fig. 2: Graph of S (compressive strength) of the geopolymer paste versus A (relative area of Q4(2) and Q4(4)) of the fly ash source as obtained by ^{29}Si NMR quantification.

NaWoh: Sustainable Quality for Housing - A Compendium and a New Certification System for New Multiple Dwelling Buildings

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Summary

Management decisions in the housing industry emerge from competing social, environmental and cultural requirements of the residential construction and the necessary economic efficiency. These various dimensions are to equilibrate and none of the dimensions can be maximized at the expense of another. The description and measurement (in terms of benchmarks) of sustainability makes sustainable action visible and transparent. But sustainable quality is not the result of a certification but of sustainable planning and design. The lecture will present the quality label for sustainable housing "NaWoh" and its use for planning and design and it will introduce in some aspects in a more profound level.

Keywords: sustainability, housing, compendium, label, certification system, new multiple dwelling buildings

1. Introducrion

"Lived sustainability" is part of the normal management of resources by housing companies:

- within the framework of urban development and urban renewal, the neighbourhoods are continuously adapted to future needs,
- resource conservation and energy efficiency are ever present in the construction of new residential buildings, modernization and management of dwellings,
- the active involvement of residents, attractive services and social management maintain social peace in culturally diverse neighborhoods and promote neighborly living together.

The implementation of all these activities in the context of economic viability is genuine lived sustainability.

2. Sustainable quality for housing

These various dimensions are to equilibrate and none of the dimensions can be maximized at the expense of another. Sustainability certification in a narrow sense makes the lived sustainability visible and transparent. Nevertheless, a sustainability certification for residential buildings is also to be critically examined. There are questions to social policy and housing matters because of the high social importance of housing. The home is an economic as well as an environmental and a social asset. The home is the centre of human life. Behind indicators of sustainability there is always a socio-cultural system of values. One must always be aware of this. There is no detached "objective sustainability". And: sustainable quality is not the result of a certification but of sustainable planning and design.

As the result of discussion a tailor made compendium for planning and certification of sustainability for new multiple dwelling buildings was developed by a working group "sustainable housing" with support from the Federal Ministry of Transport, Building and Urban Development and with scientific assistance of the Chair of Economy and Ecology in Housing, Prof. Dr.-Ing. habil. Thomas Lützkendorf.

On the basis of the new certification system for new multiple dwelling buildings "sustainable housing" (NaWoh) the Association for the Support of Sustainability in Housing was founded. For interested residential building owners the opportunity to provide newly constructed residential building with a sustainability label of quality was created. First the system or scheme should serve as a checklist or compendium to the sustainable approach. The association recommends the criteria for use as a guide in planning and for documentation. A consideration from the beginning of the planning is seriously supposed. In the system and the quality label interested can find all information on www.nawoh.de.

The lecture will picture the sense of the sustainability system for the housing industry, details of the system, common elements and differences to other systems like economic sustainability for the housing company..

Identifying the Relevance of Construction Products for Building Certification

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Summary

The certification of sustainable buildings is one of the relevant drivers for current discussions concerning sustainability in the construction sector. The quality of a certification depends on various factors, one being the choice of the materials and construction products used. The importance of the choice of the right material is frequently emphasised, yet rarely proven or quantified. Quantitative information on the performance of products with regard to sustainable buildings certification, however, forms the basis for the selection of objectively best performing products, as well as for further optimization of construction products.
Methods are required that allow the evaluation of the influence of construction products on the sustainability certification of buildings. The presented work contains such a method to specifically address technical properties of construction products and their implications on the assessment results of specific certification schemes.
In Germany, two systems for the certification of sustainable buildings are widely recognized, one for public buildings (abbreviated BNB) under the realm of the Federal Ministry of Transport, Building and Urban Development (Bundesministerium für Verkehr, Bau und Stadtentwicklung, BMVBS) and one for the private construction industry of the German Sustainable Building Council (Deutsche Gesellschaft für Nachhaltiges Bauen, DGNB). These systems use indicators to define characteristics and requirements for sustainable buildings across all pillars of sustainability. The impact of building products on the sustainability rating of buildings is currently not systematically assessed. The understanding of this impact, however, is required to allow for optimization of construction products. Within the presented work – the author's dissertation [1], methods are developed to quantitatively link construction products to the sustainable building assessment.
For this purpose, mechanisms are developed to identify sustainability indicators that are affected from construction products. On this basis, the magnitude of influence through individual properties of construction products is assessed. For this, mechanisms are laid out that use indicator models to systematically link construction product properties to the assessment results for individual certification indicators. With the use of parameter variations that follow defined rules, the magnitude of influence of single construction product properties on indicator results on building level are assessed.
The assessment differentiates four cases of application:

- the assessment of product optimisation (both, including and excluding indirect effects),
- the assessment of the sensitivity of a building rating due to properties of individual construction products and

- the assessment of reverse effects of changing single product properties.

Depending on the case of application, different conclusions may be drawn from the assessment approach. Such conclusions may include the identification of priority indicators to be investigated further with regard to individual construction products or the identification of product related strategies to improve a building's overall sustainability rating.

The use of the method is demonstrated by applying it to the certification system of the German Sustainable Building Council (DGNB), discussing the influence of one specific construction product, being a wall-mounted acoustic absorber.

The results of the case study highlight the relevance of specific indicators for the product. They indicate, on which product properties the focus of future product improvements should lie. Additionally, a thorough understanding of the systematics of the underlying certification system can be extracted from the application of the method.

The method reflects a basis for further systematic analyses of the principles and mechanisms of building certification systems. It also provides a scientific foundation for an impartial discussion on the relevance of construction products or product categories for building certification. On this basis, further product developments and product innovation, as well as objective product choices by planners, may be anticipated.

Keywords: Building Certification; Construction Products; Relevance of Building Products

References:

[1] WITTSTOCK B, *"Methode zur Analyse und Beurteilung des Einflusses von Bauproduktеigenschaften auf die Nachhaltigkeitsbewertung im Rahmen der Zertifizierung von Gebäuden"*, Stuttgart: Fraunhofer Verlag, 2012 und Stuttgart: Universität, Dissertation, 2012. ISBN: 978-3-8396-0486-1.

Embodied Energy and Embodied CO2 Associated with the Building Industry in Japan

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Summary

The building sector in Japan is responsible for a significant portion of the country's energy consumption and CO_2 emissions. This study quantifies the embodied energy and embodied CO_2 associated with construction buildings, and provide reference data for project planning of new construction and reconstruction project.

The energy and CO_2 emissions associated construction buildings were calculated by using combination of an Input and Output table and actual construction data. The energy intensity and CO_2 intensity table is calculated, which is based on 2005 I/O tables in Japan. Industrial sectors in a country are very closely related, and the input or output of one industrial sector has repercussions on all other industrial sectors. Environmental loads caused by an economic demand value of 1 million yen (1 Euro=137yen) for an industrial sector can be derived from the I/O and quantity of material tables.

In the intensity table, intensities of energy consumption and CO_2 emission are shown as values of MJ and kg-CO_2/million Yen, and each values are shown as based on producer's and purchaser's prices. It can be possible to calculate embodied energy and CO_2 emissions due to constructions of various buildings in Japan. Margins in intermediate sectors and purchaser's are calculated and compared between whole industries and building industry.

Margin of purchaser's prices are shown in Japanese IO table, therefore energy consumption and CO_2 emissions due to transportation from the factories to building site can be also calculated. Building industry is adjudged to be large CO_2 emission industry concerning transportation compared with the value of production.

Keywords: EMBODIED ENERGY, EMBODIED CO2, BUILDING INDUSTRY, TRANSPORTATION

Conclusion

This study analysed the IO table in 2005 and obtained energy intensity and CO_2 intensity, and compared the circulation margins of building sector and other industry sectors. Following results are summarized,

1) Energy intensity and CO_2 intensity per million Yen of building sector and other industry sector are obtained as the table. IO table in 2005 provides the circulation margins and it applied purchaser margins for the building sector in this study.

2) After dividing the circulation margin into the middle margin and the purchaser margin, and analysing it, the middle margin of the building sector is small with 35% of all industry average, but the purchaser margin is large with 1.8 times, and it is suggested that the effect of the local production for local consumption are large.

3) The ratio of the CO_2 emission of transport shows that both general industry and building industry are same, but, as for the CO_2 emission of transport per amount of production in building sector is about 2-4 times of other industry. It is suggested that building sector is the type of industry that consume much energy and emit CO_2 of transport.

Multiple Flow Solutions of Convective Heat and Pollutant Removals within a Slot-Ventilated Building Enclosure

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Summary

Air conditioning and ventilation in the commercial and industrial buildings actually occupy the majorities of urban building energy consumptions. Unfortunately, air flow motions in these slot-ventilated large building spaces were currently poorly understood, particularly concerning their special flow behaviours – multiple steady flows, i.e., two or more flow solutions will be obtained with the same boundary conditions and different initial conditions or load perturbations. The multiple flow behaviors essentially complicate the convective transports of air, heat and species. In this paper, combined natural and forced convections in an industrial building space for welding process will be investigated. The multiple flow mechanism and their transitions between different solution branches will be disclosed by the numerical methodology of computational fluid dynamics. Effects of ambient air temperature, indoor heating loads, and welding shifting on the multiple flow motions will be discussed. Finally, suggestions of multiple ventilations in the large space will be presented.

Keywords: Large space, slot ventilation, flow instability, computational fluid dynamics

One Goal two Paths - Practical Experience and Findings in Applying the DGNB System in Hungary and Bulgaria

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Summary

The paper illustrates the worldwide unique experience with the international application of the German DGNB Sustainable Building Certification System used in two different projects in Sofia, Bulgaria and Szeged, Hungary. The emphasis is put on the different applicability of the 'DGNB International' scheme on one hand and the adapted DGNB-System of the Bulgarian Green Building Council (BGBC) on the other hand. Both systems led to a Certification in Gold, even though the rating methodology differs. The Paper explains the key differences in both paths and tries to point out whether a direct comparability of the certificates is given.

Keywords: DGNB, Certification, International Applicability, Hungary, Bulgaria, Best Practice

1. Introduction

The first DGNB certificates for office and administrative buildings in Germany were issued in January 2009 at the 'BAU' conference in Munich. These first rated buildings took part in the so-called 'pilot phase' and were already completed when the assessment took place. The interest in the real estate industry was awakened and soon working groups were established in order to further the development of the rating system - especially in regard to other building types. The first new schemes to be developed were for industrial buildings as well as shopping centers and retail buildings. Following this development, the first certificates for these building types were issued at the Exporeal conference in October 2009.

Simultaneously to the development of the DGNB rating system and its new schemes the work on its internationalization for worldwide applicability began. The rating methodology was designed to be flexible and adaptable since the beginning. Therefore adaptations on different levels can be made according to the given climate or cultural conditions. One of them is the so-called 'impact factor' which can be easily adapted for the suitability of single criteria hence shifting the different weightings inside a rating scheme.
This adaptability on the one hand, along with the strong interaction with the current and coming European standardization led to a growth in appeal throughout Europe to the point that, in the summer of 2009, the first cooperation agreements were signed with the Austrian ÖGNI and the Bulgarian BGBC. Both countries began with the adaptation of the rating system in accordance with the national building standards and in May 2010, the first certificate could be issued by the ÖGNI on the basis of the modified system. One year later, the Bulgarian Green Building Council was able to report their first successful implementation of the Bulgarian system.

While new cooperations (among others from Denmark, Switzerland and Thailand) have been activated, a demand for a universally applicable rating system which is developed and run by the DGNB Germany came to mind. After the first successful implementations of the German system outside of German territory (e.g. in Luxembourg) it became clear that especially for smaller markets, there needed to be a standardized system which allows to consider local standards and circumstances without the need for a new designed system through a localized scheme operator. This led to the decision to develop a universally useable 'DGNB International' system which allows the assessment to consider regional and local specifications while guaranteeing transparency and comparability on an international level.

2. Results

The unique position of the authors allows an experience report of the international applicability of the DGNB rating system in two real projects: One project certified with an adapted DGNB-System in Bulgaria, the other with the DGNB International System in Hungary.
Both projects are very similar in usage and both buildings are coming from the same developer. These similarities in both projects enable to focus the gained knowledge on the differences between the two rating methodologies; the shopping center project 'Serdika Center' in Sofia, Bulgaria, certified in 'Gold' according to the BGBC rating system and the project 'Arkad Szeged' in Hungary, certified in 'Gold' with the DGNB International scheme for retail developments. Both projects were respectively the first of their kind to be assessed with those certificates and are up to today unique in the industry.

The aim of this paper is to identify the particularities of the certification process in both projects. Besides the final rating of the assessment, this analysis aspires to outline the differences between both systems. Further insight in the BGBC system adaptation process is provided and the understanding of the technical as well as cultural differences and their impact on the rating methods is explained. In this context, for example, besides the typical change in number of bicycle-spaces to be provided in Bulgaria's capital Sofia, there was also a discussion about the overfulfillment of noise insulation coming to the point, that obviously in Bulgaria a little more noise is not only accepted but even desired.

Whereas the Bulgarian system founded its building energy consumption rating upon a national calculation method, the DGNB International System used an alternative evaluation method. Since there was no national calculation methodology in place in Hungary, the rating took place on the basis of a DGNB-defined method (energy simulation). For a better understanding and for further proofing, the calculation has been made also in accordance with DIN 18599 as required in the original German DGNB system. Interestingly, the result of both studies vary broadly whereas the percentage improvement over the so-called 'reference building' is very similar.

The projects show that both strategies – the adapted national scheme and the DGNB International scheme – can be successfully applied. Nevertheless the numerous differences in the details, lead to the question if both strategies deliver comparable results, because finally comparability and transparency in these building ratings remain a key factor for the success of sustainable building certificates all around the world.

The Decision Support for Facilities Managers about Sustainability: Life Cycle Performance Costing

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Summary

To realize the formulated high sustainability ambitions in the built environment, such as an energy- neutral environment in the year 2050, new approaches need to be developed. Increased sustainability is a major task for the built environment. Sustainability is a way to reduce energy consumption and reduce operational cost as well. Therefore conducting (sustainability) performance based assessments of buildings operation is of great importance and should be considered right from the early design phases [8]. No longer only the architects and the engineers of the design team should have a huge influence, on the design decisions also facilities managers must have a great role in the decision process. Facilities management, as a profession, became latched onto the sustainability agenda, as a result of the increasing environmental awareness and legislative pressures Currently most important decisions about the building sustainability are made by applying sustainability assessment tools. However these tools are not really optimal for considering the (environmental) performance of buildings during their whole life cycle. New design tools, to support design decisions are necessary to asses and monitor the environmental performance of buildings. With the Life Cycle Performance Costing tool, facilities managers involved in the design process, can determine the most cost effective sustainable solution over the whole life cycle of the building. Optimizing comfort for occupants and its related energy use is becoming more important for facility managers. Presently however HVAC installations often do not operate effective and efficient in practice, because the behaviour of occupants is not included. This result in comfort complains as well as unnecessary high energy consumption. As the end-user influence becomes even more important for the resulting energy consumption of sustainable buildings, the focus should be how to integrate the occupants in the building's performance control loop. Comfort can be related to productivity. When people are comfortable, they have higher a production than when they are not feeling comfortable. This leads to the need for new approaches which enable to include occupant's behaviour in the life cycle costing and building's performance: Life Cycle Performance Costing. This makes it possible, to include the human comfort and related productivity in the facility management loop and so to help facilities managers operate and maintain their sustainable buildings more efficiently.
Well-being, health and productivity of office workers are highly related to the indoor thermal conditions. Due to individual human differences, it is not possible to satisfy the perceived comfort of all office workers with the same indoor thermal conditions. There is clear need for more individualized provided thermal comfort strategy: the human in the loop. In theis strategy the human is the centre of the process control. This promising innovation, the human in the loop process control and personalized conditioning, was investigated to see to what extent this concept would be attractive for the market. If insight

of the added value of these kind of innovations could be provided at the early stage of innovation, the market would see the benefits of innovations.

This could accelerate the adoption of innovation in the built environment. Economic benefits are very important motives in the decision making process. Innovations general induce higher investment costs, where the development and research costs are majorly presented in the investment. To make the innovation financial attractive it should therefore be recouped on the short term through lower operating costs, such as reduction of the energy costs. By using a structured and systematic approach, decisions can be made lifecycle based.
Benefits in productivity are not included in traditional considerations about climatization concepts. Since much research is done towards influences on productivity, it is however possible to deter- mine the benefits and include them in the lifecycle approach. With a quantitative analysis the in- crease in productivity is determined of the human-in-the-loop approach. Compared to the standard system this will be increased with 2.0%. The benefits of an increase in productivity were included in
the lifecycle performance costing, which showed that the benefits of the increased productivity are much higher than the effects of the additional investment costs. Including performances in the LCC, decision process, thus applying LCPC, will lead to another decision than just based on LCC. Cur- rent environmental assessment methods, e.g. Energy Performance and BREEAM and economical validation methods, e.g. LCC, do not fully show the benefits of innovation, for example the new human in the loop approach. To accelerate the innovation process and so reduce the time to mar- ket these benefits should be made clear using the valuation methods that are used in common
practice by the market and its different stakeholders. This is possible by applying Life Cycle Per- formance Costing in the decision process.

Keywords: Life cycle performance costing; human in the loop; accelerated innovations

Life Cycle Costing- Proposal for Organisation of Information Based on the Feedback of the European Project OPEN HOUSE

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Abstract

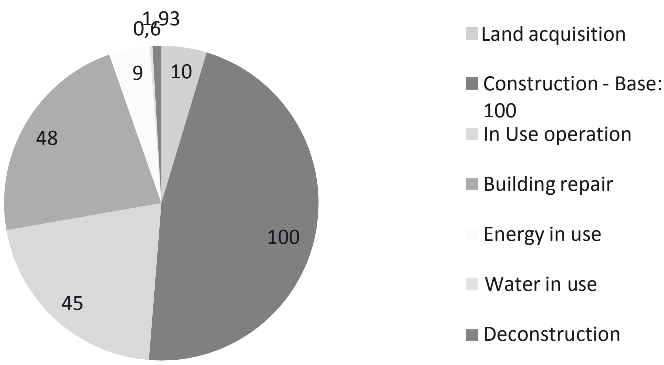
The European OPEN HOUSE project aims to propose a methodology for assessment of the sustainability of the building sector. 67 buildings, mainly office buildings, have been assessed in 2012. The paper focuses on the economic aspect and on the tool developed for the OPEN HOUSE project to support the quantification of the Life Cycle Costs.

Feedback from the analysis of the different assessors considers both 'Life Cycle Costs calculation' and 'Value stability' as core indicators. Difficulties arose from the non homogeneous information arising from the quantification of the buildings and operational costs (maintenance, energy, water). 'Value stability'

From this feedback the OPEN HOUSE calculation tool has been refitted in order to:
- refine the presentation of the results alternatively on the total value or on the valuation expressed per functional unit (e.g. per m² and per year)
- propose the valuation of the costs for the different life stages with reference to the initial investment costs
- propose default value for maintenance, lifetime of products and systems and demolition costs
- propose default value for disaggregation of the investment costs depending on the type of structure for the assessed building (concrete, steel, and wood).

Figure 1 illustrates the new presentation of the results. The results are issued from a concrete structured building (final energy used : 19 kWh/m²).

Figure 1 – Example of the cost repartition for a low energy office building



The choice for presentation was made accordingly to different modules describing the life cycle of the building (construction, in-use, end of life). For the in use stage the information have been separated for 'cleaning/maintenance' which are mainly influenced by human costs, 'repair' which is linked to the lifetime of products and 'energy and water use'..

For practical reasons a base 100 has been considered for the initial construction costs. Land acquisition and connection to external services for energy and telecommunication has been separated from initial costs as a large dispersion is observed for this category of cost.

In-use operation costs cover maintenance and cleaning whereas repair covers the replacement of products that are changed during the period of calculation (50 years).

Life Cycle Costs calculation is just a part of the economical analysis as the perception given by the economic impacts is driven by different objectives depending on the stakeholder's point of view [5], [6] and aims to:
- identify the added value for sustainable buildings
- handle with the risk of decreasing the value property
- quantify the benefits due to the selected design options of alternative policy for maintenance, repair and choice of products.

In the OPEN HOUSE methodology, the indicator dealing with **'value stability'** merges the intrinsic aspects (accessibility, conversion feasibility, performance of the envelope, benefits due to site location,..)

With such refinement of the Life Cycle Costing tool, it is now possible to propose a valuation of the costs and to assist stakeholders in the decision making process for design of buildings.

5. Technologies, Material and Product Innovations

Increasing Resource Efficiency within the Building Industry

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Summary

The building industry is one of the world's largest consumers of resources. In Germany for example it uses 85 % of the countries extraction of mineral raw material and produces more than 50 % of the countries waste accumulation [1]. To overcome this problem it is essential to analyse and reduce the resource consumption over the life cycle of a structure e. g. by selecting less resource intensive building materials. As an example the contribution of the selected material for the supporting structure shall be analysed.

Keywords: Resource efficiency; life cycle analysis; embodied energy; greenhouse gas emission; recycling; supporting structure

1. Introduction

Due to its large resource consumption the building industry is one of the focal points of the German Resource Efficiency Programme [2]. Its key indicator, the raw material productivity, directly addresses the large consumptions within the building sector. So far the discussion on sustainability is focused on the large energy consumption of buildings during their use aiming to achieve energy efficiency. Starting the discussion of resource efficiency however the view has to be widened towards material efficiency and a complete life cycle analysis. This incorporates also the construction and demolition period. Based on the life cycle analysis the following four indicators for resource efficiency of building materials can be derived:

- type of raw material,
- embodied energy,
- greenhouse gas emission during production,
- options for disposal.

2. Results

These indicators have been applied to compare wood, reinforced concrete and steel as possible materials for a supporting structure. Due to its large mass and volume the supporting structure plays a central role for resource efficiency and is a good starting point. In the given example the three materials have been used to form a 3 meter high column that is loaded with 100 kN. The necessary data on the embodied energy and the greenhouse gas emission has been extracted from the German database Ökobau.dat 2011 which lists nearly all in Germany available building materials [3]. Regarding the first indicator, i.e. the type of raw material wood stands out as a renewable material whereas concrete and steel are of mineral origin. For steel the use of recycling material is positive. The non-renewable embodied energy varies largely between 118.4 MJ for reinforced concrete, 185.0 MJ for wood and 835.4 MJ for steel. An even larger variation in values can be seen for the greenhouse gas emission during production which ranges from a negative value for wood (-52.4 kg CO_2-eqv.) to 17.2 kg CO_2-eqv. for reinforced concrete to 60.6 kg CO_2-eqv. for steel. The options for disposal of wood and steel have to be evaluated positively as wood applies for material and thermal utilisation and steel can be fully recycled. The disposal of reinforced concrete is improvable as most of it is reutilised for lower-grade purposes and some of it is landfilled while only a small proportion is recycled.

3. Conclusions

Aiming for resource efficiency beside the substitution of resource intensive materials another valuable approach is to improve the reusability of materials. Here the sorted demolition of buildings and infrastructure plays a major role in order to gain for example recycling aggregates for the production of concrete. Some European countries have already proven their great potential for resource efficiency and it is estimated that in Germany they could save 11 million tons of raw material aggregates in 2020 [4].

4. References

[1] BUNDESMINISTERIUM FÜR UMWELT, NATURSCHUTZ UND REAKTORSICHERHEIT, „Deutsches Ressourceneffizienzprogramm (ProgRess)“, 2012, p. 74.

[2] FEDERAL MINISTERY FOR THE ENVIROMENT, NATURE CONVERSATION AND NUCLEAR SAFETY, “German Resource Efficiency Programme”, URL: http://www.bmu.de/en/service/publications/downloads/details/artikel/german-resource-efficiency-programme-progress/?tx_ttnews[backPid]=1742

[3] INFORMATIONSPORTAL NACHHALTIGES BAUEN, “Ökobau.dat”, URL: http://www.nachhaltigesbauen.de/oekobaudat/

[4] SCHILLER G., DEILMANN C.,: „Ermittlung von Ressourcenschonungspotenzialen bei der Verwertung von Bauabfällen und Erarbeitung von Empfehlungen zu deren Nutzung“, UBA-Forschungsvorhaben (FKZ 3708 95 303), Leibniz-Institut für ökologische Raumentwicklung, 2010, URL: www.umweltdaten.de/publikationen/fpdf-l/4040.pdf

Carbon Footprint in Construction Product Life Cycle

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Summary

The carbon footprint analysis for construction products plays significant role for producers, but especially for environment. The EU Emissions Trading System sets obligatory fees for carbon dioxide emissions. This paper presents EU and Polish policy in context of CO_2 and other greenhouse gasses emissions reduction. Additionally paper describes on the basis of carbon footprint analysis the method and scope of ITBs procedure concerning self-declared environmental claim on the basis of PN-EN ISO 14021.

Keywords: Carbon footprint; greenhouse gases emission; LCA; concrete, EPD

Introduction

Growth and evolution of civilization causes increase of influence on human surroundings. Territorial expansion, aggressive consumption and production are not neutral to Earth and its climate changes. The factor, which is said to be directly connected with climate changes is Global Warming Potential (GWP), which also is one of Greenhouse Gases (GHG) among: methane, nitrous oxide, fluorinated hydrocarbons, perfluorocarbons and sulphur hexafluoride (Table 1). In terms of low carbon economy which sufficiently uses natural resources and increased environmental concern, construction products carbon footprint analysis, which verifies its negative environmental impact during whole life cycle is becoming more and more popular.

Table 1. GWP for specific substances (according to IPCC 2007)

Substance	Lifetime in the atmosphere (years)	GWP_{100}
Carbon dioxide (CO2)	50-200	1
Methane (CH4)	12	25
Nitrous oxide (N2O)	114	298
Trifluoromethane (HFC-23)	270	14800
Perfluorocarbon (CF4)	50000	7390
Sulphur hexafluoride (SF6)	3200	22200

According to EU regulations introduced by Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, all Member States are obliged to implement obligatory payment concerning carbon dioxide emissions. Due to that regulations producers are forced to search for possible decrease in CO_2 and greenhouse gases emissions in their products. Polish Regulation on the assessment of the effects of certain public and private projects on the environment regulates the permissions and declarations of CO_2 emissions, art.2 of this regulation lists a branch of industry, in which gas emission allowance is obligatory.

ANALYSIS AND DISCUSSION

The paper consists of example of carbon footprint analysis and comparison between standard and specific concrete assessed for one of leading cement producers in Poland. The works were to verify producers one parameter self-claim concerning minimization of carbon dioxide content in its products. Assumption was based on standard PN-EN ISO 14021:2002/A1:2012, which characterize Type II environmental declaration. Due to clinker replacement by ash, slag and calcaire and assumption that these products have no carbon footprint the CO_2 reduction per cement functional unit has been achieved.

The main reason for CO_2 emissions is use of non-renewable energy resources at production stage, transport or in other processes concerning use of fossil fuel. The factor that indicates the level of carbon footprint, the negative environmental impact is an equivalent of CO_2 per functional unit of product (kg CO_{2e}/FU), which occurs in product life cycle. There are few standards for carbon footprint analysis for example EN ISO 15804:2012, LCA based for construction products, where one of the indicators is Global Warming Potential GWP shown as CO_{2e} and PAS 2050 British specification publicly available.

Carbon footprint is also an element of LCA, which is Type III Environmental Declaration known also as Environmental Product Declaration (EPD) regulated by EN ISO 15804:2012. In July 2013 enters into force new CPR regulation (Construction Products Regulation 305/2011/EU), which will implement new 7^{th} Basic Work Requirement – "sustainable resource use". It focuses around the design, construction and dismantling of building.

European Emission Trading System (EU ETS) is based on awareness that payment for carbon emissions is the most profitable method for reduction of global greenhouse gases emissions. The system was introduced by Directive 2003/87/EC and approved by EU Member States and the European Parliament is based on four fundamental principles: cap and trade system, obligatory participation by industry sectors covered by system, strong mechanism to obey rules, it covers also other participants outside the EU which ratified Kyoto Protocol.

CONCLUSIONS

The meaning of carbon footprint in the construction sector is increasing. Through implementation of EU ETS the producers are not forced to reduce their production and the environmental advantage is visible through CO_2 and other greenhouse gases reduction. ITB is an expert among other representatives in CEN and provides life cycle analysis in its standard procedures (EN ISO 15804:2012)

Acoustic Comfort and Energy Efficiency of Air Conditioning Systems

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Dedicated to Prof. Dr. Gerd Hauser *on the occasion of his 65th birthday.*

Summary

Noise and acoustic environment conditions affect health, well-being and performance inside and outside of work and living spaces. Therefore, standards have to be met in buildings just as for the other room features light, climate and air quality. While energy-saving lamps and energy-efficient air conditioning systems are obvious considerable reserves still exist in the sound-absorbing components. They are obstacles to the air transport and the effort to overcome this resistance has to be provided in terms of energy by increased power of fans. Thus, in its optimized configuration lies potential for energy savings while improving the acoustic quality. At the investment decision, measures to reduce energy consumption are clearly established with payback. The cost of noise reduction, however, is considered to be 'only' cost-intensive. The assessment is often reversed at a later stage during operation. Users of ventilated rooms may be aware of their energy efficiency, but the disturbance of ventilation noise is acute and chronic.

Nowadays all types of buildings are equipped with fans for air supply and they represent also the essential sound source whose noise occurs at the air intakes and outlets. Fig. 1 (left) shows the typical noise frequency range of fans, focusing at low frequencies. For comparison, the picture shows (right) also the attenuation capacity of conventional silencers, which reaches its maximum at mid and high frequencies. Applying these silencers the low-frequency sounds emerge even at low levels, which are in turn considered very disturbing. To achieve sufficient attenuation with this type of muffler, thick and long splitter silencers with almost closed air gaps in between are installed, resulting in a corresponding high pressure drop.

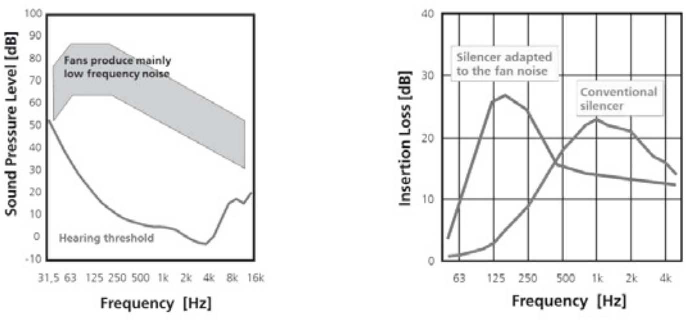

Fig. 1: Typical spectrum of fan noise (left) and attenuation spectra of conventional as well as adapted (innovative) silencers (right).

Thus, silencers with an attenuation spectrum adapted to the low-frequency noise of the fan as also shown in Fig. 1 (right) could better fulfil not only the acoustic requirements. They can also improve the energy efficiency of the system in a slimmer version and with larger air gaps. Distributed soundproofing installations along the duct and its bends lead into the same direction as an improved acoustic effect is obtained with the same material effort. Furthermore, the variation of both the aerodynamic and acoustic effects influencing factors of silencers (splitter and air gap width), shows a very different sensitivity. A small variation of the air gap width between typical splitters results in a large change in electric energy consumption whereas the acoustic effect is almost negligible.

Integral and adapted solutions are needed and provided by innovative resonance silencer whose attenuation can be adjusted to a required noise spectrum. Either mass-spring-systems or hollow chambers (such as Helmholtz resonators) are used, still allowing the application of different constructions. Due to their higher acoustic efficiency, leaner silencer with lower pressure drop and energy consumption can be used at the same noise reduction. Different calculation tools for classical as well as innovative silencers have been developed already at Fraunhofer IBP. But, their application and the design of complete air supply systems require new design concepts and tools that are to date only partially available.

As a kind of a flagship project example serves a painting facility of the Daimler AG in the Düsseldorf plant: Only through the exchange of conventional by innovative silencers in a large industrial air conditioning system as illustrated in Fig. 2 it was possible to reduce both noise pollution and to achieve an annual energy savings worth more than € 500 000. In this way, innovative silencers link high, appropriate attenuation effects to low flow resistance, expressed by the pressure loss. The high amount in this sample system is certainly exceptional due to the plant dimension, but also on a small scale systematically and cost-effective synergies can be achieved.

Fig. 2: Design of the 20 m-long resonance silencer in the exhaust duct of a plant component.

As a conclusion of today's approach, the integral analysis of acoustics and energy efficiency is not a standard in the planning and operation of HVAC and process air systems. Just this synergy offers enormous potential for further energy savings with enhanced acoustic quality in the sense of sustainable buildings and production facilities. In the end, the optimization of energy costs has to be proven by comprehensible before and after comparisons in more pilot plants. This allows moving the previously sole focus on investment to the savings of operating costs through new technology.

Keywords: Silencers; noise control; energy efficiency

Energy Issues and Environmental Impact of Membrane and Foil Materials and Structures - Status Quo and Future Outlook

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Extended Abstract

In the last years and together with different partners from industry and research institutes, Hightex has successfully developed and investigated a broad range of new technologies for foils and textiles (membranes) for building construction with regard to energy issues. Selected key words are:

- Innovative transparent flexible thermal insulation for membranes, i.e. Aerogels
- Embedded flexible thin-film photovoltaic for foils and textiles
- Innovative functional coatings on textiles and foils (selective, low-E)

A large research project "Membranen für die energetische Sanierung von Gebäuden" (MESG) funded by the German parliament (through BMWi: EnOB) has explored the potential of membrane structures for improving the building stock. Also, new concepts of modular design and construction for membrane structures have been followed up. In 2011, the author has launched a European working group on the topic of life-cycle-assessment (LCA) for membrane materials (via the "TensiNet"-association platform, www.tensinet.com). A broad range of research institutes, universities, and industries from the membrane sector are involved.

Increasing energy efficiency in the operation of buildings is a major challenge of our time. At first glance this refers to energy demand of a building on the one side (primary energy, non-renewable) and to the quality of the building for the user (and the owner, and the society...) on the other side. The latter is reflected by the indoor comfort conditions achieved for example. For both aspects, the opportunities of textile architecture (building envelopes made from technical coated textiles and polymer foils) have been studied extensively in the past years. This refers for example to the use of flexible thin-film PV on membranes or optimising passive solar performance including the use of high-performance translucent thermal insulation.

But next to energy demand of the building usage period and the achieved quality, we also have to focus on the energy consumption ("grey energy") and environmental impact of the materials and structures used for our buildings - with regard to their full life cycle, from the production to recycling or disposal. It is important to understand that the effects of our planning decisions extend deeply into the future. Most buildings are meant to last for decades. Our industry is proud to also offer this perspective to our clients when they embark on our materials and structures. In parallel, the planet's resources are shrinking and get more and more contested and hard-fought. Compared to other industry branches, the building sector is still lacking efficiency in the use of materials and rationalisation, the overall recycling rate is very low.

With regard to the membrane industry we see a Janus-faced discussion: One the one hand we apply polymers that use of the enormous amounts of energy for their production. They contain a high amount of primary energy in relation to their mass and emissions from some of the materials can represent dangers for the environment and users. On the other hand, they have an undoubted potential for generating resource and energy savings through forms of construction that utilise these materials very efficiently. Membrane material's mass per area is very low.

Keywords: Membranes; PTFE/glass; ETFE Foil; PVC/PES; Photovoltaics (PV); Life Cycle Assessment (LCA); Textile Architecture; Environmental Impact, Grey Energy, Environmental Product Declaration (EPD)

Shopping Mall Dolce Vita, Portugal
© FG+SG (Photograph)

BC Place Stadium, Vancouver, Canada
© Grant Mattice (Photograph)

The Energy Efficiency Centre: Smart Building / Lightweight Construction with Smart Technology

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Energy efficient buildings of the future have to be efficient in respect to energy consumption for construction and operation. There is also the tendency and the need to provide users of buildings a comfortable environment. Lightweight buildings with integrated smart technologies could meet such ambitious goals. In 2010 ZAE Bayern started with the realization of the research and demonstration building 'Energy Efficiency Center' (EEC) in Würzburg within a public funded research project funded by the German Ministry of Economy and Technology. It is the first building of the new district 'Hubland' of Würzburg with corresponding high visibility. The EEC comprehends innovative know-how from the involved research partners from science and industry in order to share experience and exchange ideas. The main objectives are the implementation of energy efficient cutting edge technologies, to optimize their interaction for maximum energy efficiency and to demonstrate the efficiency technologies. The involved innovative technological approaches are lightweight highly insulating facades with vacuum insulation and the textile translucent roof construction with subjacent translucent aerogel modules. This construction improves the utilization of daylight and improves the overall energy efficiency. The lightweight concept is completed by the integration of innovative HVAC low exergy technology with implemented heat and cooling storage systems (PCM components, passive infrared radiation and open adsorption cooling technology) and an adaptive high-level control system, which ensures the most efficient interaction of the smart building technologies with changing environmental influences. The combination of research, demonstration and dissemination of knowledge in one place will generate the necessary boost for the fast implementation of energy efficient technologies in the building sector. Therefore the EEC will be a highly dynamic innovation driver and this approach has the potential to achieve maximum market impact and public visibility and accelerate innovation processes.

KEYWORDS:
Textile architecture; energy efficiency; smart materials; high level control system; smart materials

CONFERENCE TOPIC:
Topic 1: Political Frameworks for a Sustainable Built Environment

Energy Optimization in Ice Hockey Halls I – The System COP as a Multivariable Function, Brine and Design Choices

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Summary

Implementing methods for saving energy and reducing operational costs is a major challenge for the actual research on sustainability. In particular, indoor ice hockey halls are large buildings afflicted by very high energy consumption, due to refrigeration, heating and air conditioning.
Considering refrigeration, energy saving can be accomplished in several ways. For instance, literature on mathematical models for heat transfer in the ice rink has recently flourished, thanks also to the fast development of computational tools. These methods focus on an accurate study of heat transfer in the concrete slab, and/or on the ice surface, sometimes also including the effect of ventilation and lighting.

Here we discuss a complementary approach that is already employed in the theory of control and neural networks, under the name *functional optimization* (FO).
The basic idea is the following: focus on the quantities of interest to energy efficiency, and investigate their behavior in function of design parameters. A simple yet rigorous mathematical analysis is then performed and complemented by technological and cost-related constraints. This gives an optimal configuration, that eventually provides with practical indications for the optimization of the system.

By this method, we can thus find the best design configuration of a system *a priori*, still at the design stage. Through a simple analytical maxima/minima study of a multivariable function, one is able to estimate the best design configuration, reducing expensive preliminary empirical tests.

This approach is so general that it can be used not only in heat transfer studies, but also in other areas of interest to engineers, and even in architecture. Just single out the quantities which are most important for energy saving, case by case, then write down their expressions in function of the system parameters, and finally study these functions to obtain the more performing configuration.

As a specific example, consider the already existing ice rinks. We show in this paper how one can determine the most important quantities for the optimization of the cooling process, and the characteristics of the more energy-friendly secondary coolant.

To minimize the energy consumption during operating conditions, this result should then be coupled to control methods on the brine pumps and cooling tower. Our current research is indeed pointing in this direction, to obtain a full detailed knowledge of the physical processes, which complements this analysis based on *functional optimization*. By agreement with construction companies, we are going to apply our results to both existing and future ice rinks in Finland.

More into detail, in this paper we apply FO to the Coefficient Of Performance (COP) of the *entire* cooling system (chiller, condenser fans, compressor and brine pumps). The COP here is viewed as a multivariable function of the system parameters (e.g. volumetric flow, pipe length, brine physical properties…), and can be maximized by an appropriate choice of parameters.
We consider this quantity because a low efficiency of the cooling system (low COP) is a primary source of energy and money waste. Therefore the challenging topic of energy saving should also include maximization of the COP, among the other possibilities.

Our theoretical model is based on measurements taken at an ice hockey hall built in 2009 in Leppävaara (Espoo, Finland), that contains two average sized ice rinks (28mx58m each).
The COP is written in function of the system variables, by using both theoretical formulas and experimental data of the refrigeration system in standard operating conditions. The according expression is thus automatically validated.
We find first of all that technically acceptable values of the volumetric flow do not affect appreciably the system COP. We show indeed that the pumping power required to overcome the pressure drop in the two ice tracks, accounts for only 7% of the total electric consumption. The brine pumps, the chiller, compressor and condensers are instead much more relevant, since they correspond to the remaining 93%. Thus optimization of the COP cannot be achieved by acting only on the pumping power (that is, by changing only the volumetric flow).

Choosing an optimal brine fluid (the secondary refrigerant) is instead crucial to achieve a higher COP. We find indeed that the COP, through the cooling power, is particularly sensitive to the *specific heat* of the fluid. Moreover, we show that it is maximal for a critical value of the density, independently of the specific brine chosen.
By means of these results, we compare ammonia and ethylene glycol, two of the most common secondary coolants. We find that ammonia gives a higher COP than ethylene glycol, the latter to be preferred in any case at concentration between 20% and 34%.

The pipe size and depth inside the concrete slab are instead irrelevant to the COP, however by performing simulations with COMSOL Multiphysics we show that they certainly cover a role in the general cooling process. First of all, we confirm the well-known practical result that the pipe size and depth do not enhance the process appreciably.
However, increasing the pipe number by 1/3 (from 150 to 200) provides with a more uniform temperature profile at the ice surface. Even taken into account the according price increase, this might be a viable option in the context of control study of the cooling process.
This possibility will be therefore investigated in our future works in this series, concerning analytical solutions of heat transfer in the ice pad and control methods of the whole system ice track-cooling devices.

Keywords: energy saving, sustainability, system optimization, theoretical models

Bamboocrete – Prototypes for Reinforcement of Structural Building Parts with Bamboo

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Summary

The focus of the grass-roots research presented here is on strategies for affordable building parts for small-scale residential or public buildings, trying to substitute steel in structural parts by renewable materials – namely bamboo – with the aim to reduce cost as well as the embodied energy. Different types of lintels were produced and tested, with the aim to come up with reliable structural building parts, using mainly left-over or inferior raw material, while high quality harvest is put to more sophisticated use. The results of the study will be the starting point for more detailed research on natural fibre reinforced concrete within the East African region.

Keywords: fibre-reinforced concrete; bamboo; material testing; alternative construction; low embedded energy

1. Introduction

In many countries of the so-called ‘Global South’, mutually reinforcing developments of rapidly growing populations and increasing urbanisation with the resulting need for affordable housing, have led to a dramatic increase of the energy demand for construction. In many rural or peri-urban regions, the construction cost of small-scale residential or public buildings are dominated by surging prices for imported, industrialised building materials like cement and steel, which have almost completely replaced traditional, cheap but less durable building materials.
The focus of the grass-roots research presented here will be on strategies for affordable building parts, trying to substitute steel in structural parts by renewable materials – namely bamboo – with the aim to reduce cost as well as the embodied energy of the construction. The first step of this research deals with the use of bamboo as reinforcement in concrete slabs and lintels, and is based on material testing of prototypes.
An increased use of renewable materials in construction does not only have a positive effect on the amount of energy used for the production of building parts. It is also an ecological income generating measure helping to increase local added value. With harvesting cycles of about three to five years, which are much shorter than those of timber, bamboo also has great potential for fast reforestation of abandoned agricultural land. Research initiatives by the Kenya Forestry Research Institute (KEFRI) are directed to this end but have not yet had great impact – due to some extent to the fact that there is no reliable commercial basis for the use of bamboo in construction [1].
The underlying assumption of the research presented here is that beside technically sophisticated uses it will be necessary to find applications for low-grade material, which can be used without a high degree of know-how.

Simulation Study of a New Type of Solar Combi System with a Sorption Heat Pump for Solar Heating and Cooling of Residential Buildings

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Summary

We present a simulation study of a solar combi system for domestic hot water, heating and cooling, which could be beneficial for use in retrofitted residential buildings. The key difference to other 'solar combi plus' concepts is that in our system, the sorption unit is used not only for solar cooling in summer, but also as a gas heat pump during the heating period. The solar storage or the solar collector are used as low temperature heat sources, and no additional (ambient) heat source is needed, although it is possible to integrate exhaust air of a ventilation system as a heat source.
The solar collector is used as the driving heat source in the cooling case and for direct heating or supplying the evaporator of the heat pump in the heating case. The sorption unit is modelled by means of a generic thermodynamic model.
Our focus is on the integration of the solar storage into the system and on the use as a heat source for the gas heat pump. We analyse the solar fraction for heating and cooling compared to a reference system without sorption unit. A hybrid photovoltaic and thermal collector (PVT) is analysed as an additional variant, which turns out to be suitable to achieve low energy standards in this kind of application.
On the building side, we investigate three different retrofit variants of the same building shell for the climate of Freiburg, Germany. The required supply temperatures to the building are modelled depending on heating and cooling curves, thereby strongly coupling the retrofit standard of the shell and the supply system. We show how this system can help to create sustainable buildings with high comfort levels and low primary energy demands.

Keywords: sorption, heating, cooling, retrofit, PVT, gas heat pump, building simulation

1. Introduction

Since solar combi systems usually are equipped with thermal storages, large heat demands and relatively high supply temperatures force solar combi systems in such buildings to operate in the temperature range between 30 through 35°C (return flow from heating system) and 95°C. As the efficiency of a solar thermal collector decreases with higher supply temperatures, solar combi systems are less efficient in supply systems with high operating temperatures.
In our model system, the sorption heat pump can discharge the storage down to lower temperatures such as 5°C, thereby increasing the effective storage size by about 35%. The capacity factor of the solar thermal collector increases due to the operating temperatures being lower on average, which is particularly beneficial for increasing the yield from PVT collectors, as not only the thermal yield increases, but also the electrical yield due to lower module temperatures.

The solar thermal collector and storage are used for direct heating. If the supply temperature decreases below the temperature level required by the heating system, the – in this case gas fired - sorption heat pump will use the remaining thermal heat from the storage as environmental heat source and will supply the building with high enough temperature for heating. For the sorption heat pump, the coupling scheme decreases the temperature lift required for heating to provide sufficiently high enough temperatures for heating and domestic hot water compared to other additional heat sources.
If the sorption heat pump can be designed reversibly, this 'sorption combi system' can help to provide very high comfort standards by supplying the building with cooling during summer.

2. Hydraulic scheme

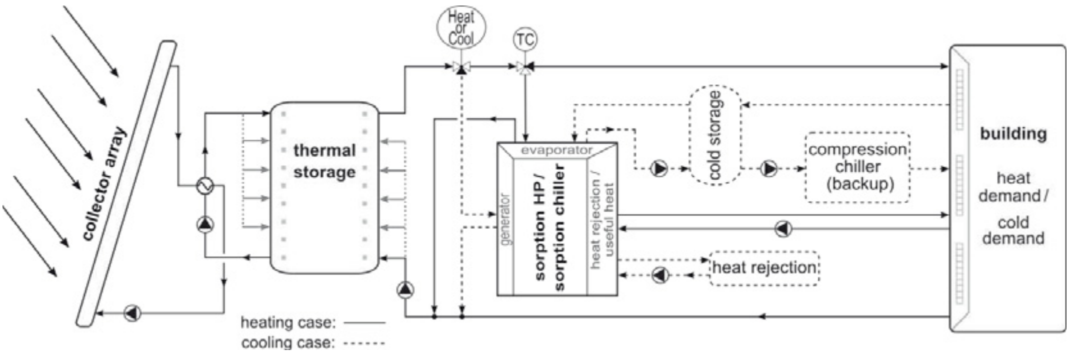

Fig. 1: Hydraulic scheme (simplified)

Carbon and Energy Profiles as Eco Cfficiency Descriptors of Key Brazilian Building Materials

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Summary

Carbon footprint and embodied energy are indicators that, referring to buildings, measure, respectively, the intensity of CO_2 emission and energy use during the manufacture of building materials and components, in transporting these to the site, and during the construction process itself. They can further include the measurement of energy and CO_2 emission incurred during renovations and replacement of components, as well as those resulting from demolition, waste and reprocessing at the end of the building service life.

There is active debate on the validity of reducing the scope from complete environmental life cycle studies to carbon footprint monitoring, with passionate advocates at both sides. On one hand, there is the risk of excluding critical impacts from the overall picture. On the other hand, such consideration seems very tempting as it could save research time and investment that might be considerable in some contexts. Also, from the designer/specifier practical perspective, ranking building materials based on embodied carbon/energy enables impact-based specification and balance of materials aiming at agreed upon CO_2 emission/energy budgets.

In this paper, life cycle embodied energy and embodied $CO_{2eq.}$, normalized per unit of built area (m²), are proposed as environmental descriptors at the building material level and calculated to assess material ecoefficiency of Brazilian case study buildings. Cradle-to-gate LCAs were performed using SimaPro 7.3 software and followed ISO 14040:2006 methodological guideline. Input data for materials/components modelling were collected from national literature or adapted from international literature or from Ecoinvent database. Obtaining of embodied $CO_{2eq.}$ figures was assisted by CML 2001 v.2.05 environmental impact analysis, which presents equivalency factors for all greenhouse gases in the global warming impact category, and expresses results in mass of $CO_{2eq.}$ per functional unit. The studied typology is basically comprised by low-rise (up to 3 floors), low window-to-wall ratio, reinforced concrete-framed, masonry façade and partitions, and ceramic or metallic roofing buildings. Total usage of material/components was quantified for four case studies - according to the functional unit previously defined – then divided by the total built area, and corrected by national estimates for construction waste. Portland cement and ready-mixed concrete are here expressed considering three amounts of ground granulated blast furnace slag (ggbs) as clinker replacement, consistently with Brazilian standards (5% in CPI-32, 30% in CPII-E-32, and 66% in CPIII-32).

For the studied typology, results for computed embodied energy and embodied $CO_{2eq.}$ were around, respectively, 1.030 MJ/m^2 and 128 kg $CO_{2eq.}$/m^2. The top six contributions (Portland cement CP III-32, ceramic brick, steel rebar, sawn timber planks, plywood and PVC tube) respond for over 80% of the total embodied energy computed. Analogously, over 80% of the accounted embodied $CO_{2eq.}$ was related to cement, steel rebar, ceramic brick and PVC tube and conduit. For the studied building typology, a core database encompassing twelve building materials and components

provides a very reasonable (over 97%-coverage) description of the accounted embodied energy and $CO_{2eq.}$ profiles altogether, which can possibly streamline indicators monitoring scope.

Identification of key materials which effectively define a building's impact profile have important implications not only on research time and investment, but also on understanding by designers and successful implementation of such concepts in their daily specification practice. Ranking building materials based on embodied energy and $CO_{2eq.}$ and its disclosure to designers empower the material selection process, enabling more efficient, impact-driven specifications and materials balance. Disclosure of impact profiles to the general public can also provide the grounds for societal pressure for mitigation and technological improvement of the related industries, as well as advise public and sectorial policy-making.

Keywords: embodied energy; embodied $CO_{2eq.}$; life cycle assessment; building material; indicators; eco-efficiency

Indicators to Support Sustainability and Performance-Based Selection of Structural Frame Alternatives in Concrete: Preliminary Validation at Element Level

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Summary

Life cycle-based studies show structural frames and envelopes as major contributors to building's environmental loads. Such contribution is however not always precisely stated or described across literature. Data on integrated sustainability performance of building parts completely lack in the Brazilian building sector. Using a case study approach, we address this research gap and preliminarily validate a set of life cycle-based indicators - integrating functional, environmental and economic performance requirements - to assist selection of the top performing concrete structural element alternative. Concrete column design proposals were therefore compared.

Keywords: indicators; LCA; performance requirements; sustainability; structural frames; columns.

1. Introduction

Research initiatives for next generation assessment protocols state that buildings sustainability should always be described and assessed with the help of relevant indicators. Environmental, economic and social performances are all important dimensions to make a good sustainability assessment at the building level. However, advancement in all three dimensions of the sustainability tripod is not equally balanced. Literature review has pointed out many unsolved difficulties regarding integration of social aspects to environmental life-cycle assessment. Most sustainability assessment systems therefore currently offer a number of indicators to be used in different life cycle phases of a building, however, without specifically targeting structural frames.

Durability decisively influences a building's life span, maintenance requirements and resources consumed, ultimately defining its environmental, social and economic performances. Nevertheless, service life and durability are seldom addressed by sustainability assessment systems. Driven by *(1)* the major and increasing role of the structural frames in the overall building environmental burden; *(2)* the scarcity and difficulty of selecting data to evaluate social indicators; and *(3)* the lack of attention given by existing buildings assessment systems to structural frames, we address this research gap and preliminarily validate a core set of life cycle-based indicators, integrating functional, environmental and economic performance requirements, to assist selection of the top performing concrete structural element alternative.

2. Approach

The set of functional indicators shown in this paper refers to stability, fire safety and safety in use, flexibility and durability requirements, and is based on ISO and the Brazilian Performance Standards. The selected environmental indicators, basically resource intensity indicators, are based on ISO/TS 21929-1:2006, mainly associated to resource management. They measure structural frames environmental performance in accordance with ISO 21931-1:2010 methodological guidelines. Life cycle costs and local economy support were the economic indicators considered for this study. Six column design alternatives comprising four concrete columns with different concrete strengths and two types of structural steel columns for a ground floor of medium-rise building under typical residential loading are analyzed. Typical concrete mixes were designed for a Brazilian coastal region utilizing CP III-32, with characteristic strengths (fck) ranging between 30 and 60MPa, following 10MPa increments. Calculation of LCA-and-LCC-based indicators used Life-365 software for service life prediction and LCC estimate, as well as cradle-to-gate LCA results performed via SimaPro 7.3 for reinforcing steel, structural steel, plywood formwork and the different concrete strengths mixes.

3. Results and Conclusions

Results highlighted service life as a convenient and relevant functional unit. Despite being frequently found in literature as a whole-building level indicator, the local economy support indicator assessment output was not consistent for isolated structural elements. Findings also revealed that designing by the Brazilian concrete structural design code does not ensure compliance with the relatively recent national performance standard. Brainstorming during LCCA yielded alternatives to achieve compliance, simulating maintenance/repair schedules, and concrete protection strategies to increase reinforced structures' service life. Analytic hierarchy process will be applied for relative importance attribution across indicators, to generate single scores to streamline selection. Ongoing case studies focus on concrete flooring systems and on the concrete superstructure as a whole. It is expected that a refined set of indicators evolve into a multidimensional performance framework to support sustainability consideration during the structural design decision-making of concrete framed buildings.

Höllentalangerhütte – A case Study for End of Life Reuse and Recycling Methodologies

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Abstract

In consideration of sustainable buildings closing life cycle loops becomes more and more important. Up to now reuse and recycling of existing buildings is not examined widely. This paper discusses the theories, methods and practicalities of buildings´ end of life with a main focus on the instruments planning and managing reuse and recycling of existing buildings and their structures. Aim is a realistic estimation of theoretical scenarios for end of life with a case study.
Here the methods of building survey, material classification and documentation for reuse, recycling and disposal of existing constructions are presented. Exemplary investigations and calculations are done on an existing cottage in the Alps, which is located in a sensitive natural environment. Here the ecologic most beneficial disposal phase of the old alpine hut is main objective.
The existing fabric of the cottage does no longer fulfil today's technical and functional requirements. Additionally it lacks protection from avalanches, ergonomic work environment, spatial and architectural potential to reuse the existing substance in its actual state. Hence as much material and components should be reused and selected for recycling on-site. Critical questions arise from the quality of the material (dry, chemical treatment, moulder, etc.).

Fig. 1: Höllentalanger cottage.

The existing cottage was used as a case study for end of life evaluation because it was devoted to rebuild and thus has to be dismantled and demolished in a planned way. Used methods for that were: research with existing planning material, survey on site to measure exact sizes and construction detailing, as well as the technical status of the material. Material samples were taken to examine the content of the construction.
Overall result was, that mostly massive timber from which the cottage was built nearly a hundred years ago is reusable and available in reasonable sizes. For future planning the reuse and recycling of existing buildings has to be integrated quite early in the planning process to be able to use the materials in the best way. With existing building documentation fictive mass calculation could be produced which then can be updated by partial surveys. In future architects contracts have to be enlarged to include also reuse of material in early planning stages.

Keywords: Life cycle; end of life; reuse; recycling; material flow; survey

Sustainable Concrete for Sustainable Buildings

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Summary

Concrete is the most used man made material. Buildings are responsible for 30-40% of total energy consumption, CO_2 emission and the same proportion of waste generation. Concrete is used in almost every building, in most of them in significant measure. The paper will show and discuss sustainability advantages of concrete structures when used in building construction. Following aspects will be mentioned: (i) thermal mass contributing to energy savings associated with cooling and heating, (ii) acoustic properties – improving air-born sound insulation, (iii) fire resistance, (iv) long term durability, (v) structural safety, including high resistance to natural effects during exceptional effects like natural disasters and others. These advantages could be significant when used in sustainability-optimized structures and using new types of high performance concretes in optimized more effective structural forms and technologies.

Keywords: Sustainable buildings, High performance concrete, Environmental impact, Life Cycle Assessment

1. Introduction

During last decades the term sustainable construction penetrated into consideration of the most experts. Today hardly anybody doubts about a sense and importance of approaches, methods and technologies leading to construction of sustainable buildings – i.e. buildings with high quality of functional performance, reduced environmental impacts and high quality of social and economical parameters.

One of the basic sustainability targets specified already in Agenda 21 for Sustainable Construction is reduction of non-renewable raw material consumption. Current development of concrete production technology and development of concrete constructions during last twenty years have lead to quality shift of technical parameters and also of related environmental impacts. Many research results and building realizations have proved it. New types of concrete have significantly better characteristics from the perspective of mechanical resistance, durability and resistance to extreme loads. They enable to realize structures with diminished material and energy consumption. Concrete gradually becomes building material with high potential for expectant environmental impact reduction. Important factor influencing larger utilization of environmentally effective concrete use is recently increasing number of international activities in the field of standards, recommendations and other legislative documents.

2. Examples of sustainable concrete buildings

Paper presents several examples of environmentally effective buildings constructed during last decade in the Czech Republic – such as office building Main Point Karlin (Fig.1) awarded by platinum LEED, National Technical Library in Prague (Fig. 2) awarded by Czech architects Grand Prix 2010 and prize Building of the year 2010, passive house from light subtle RC frame and low energy residential house X-LOFT awarded by silver SB ToolCZ certificate.

Fig.1 Main Point Karlin

Fig.2 National Technical Library in Prague

3. Conclusion

Taking in consideration the amount of produced concrete and number of realized concrete structures (after all concrete is used practically in every contemporary construction) it is obvious that optimization of concrete structures represents great potential for increasing the complex quality of buildings from the perspective of sustainable development. Already implemented realizations give clear signal that in the forthcoming era when designing and implementing concrete structures it will be necessary to take into account new requirements and criteria following from global aspects on sustainable development.

A New Dawn Rising - New Options for Windows, Facades & Walls with Vacuum Glass and other Integrated Building Innovations

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Summary

Historical Reflection
Let me start with a short historical reflection. Glass companies have been searching for over 20 years for a new option for Insulating Glass, mainly due to intense competition, poor price-cost ratio and to improve the energy saving performance. Unfortunately most investigations did not result in a new generation of innovations, only small improvements in a few areas following standard technologies.

Big demand for new solutions

Many notable companies turned to Vacuum Glass as an Alternative, but no one was able to discover a marketable industrial solution. The only Company was Nippon Sheet Glass starting in 1997. Their development is based on research at Sydney University under the direction of Professor R. E. Collins who worked with a partner, Professor Jianzheng Tang, a Chinese. who had been living in Australia for a number of years. NSG acquired 1995 the rights on these patents. Professor Tang left Australia in 1998 and made - unnoticed by Western states - his own research with new patents and started within a new company in 2001.

Initial production

The developing company - owned by an governmental real estate holding in Beijing - trusted the long term success and had been producing a small automated line of Vacuum Glass for some time and sold VIG to Chinese governmental projects from 2004 onwards as shown in the report.
In the past twenty years a series of **technical difficulties need to be conquered** in order to mass produce high-quality vacuum glazing. High-quality means high performance and long-life. Due to promotion of energy saving and emission reduction, both subjective and objective conditions for industrialization of vacuum glazing are now ready, and a continuous automatic production line for vacuum glazing is soon starting in Beijing.

Requirements for vacuum glass production

In regards to equipment and in general this is discussed in this report. To achieve market recognition, the most important thing is to ensure the quality of the product, and then reduce the cost.

New Advantages – market options

Glass Companies compare VIG price today with triple insulating glass with 2 coatings considering similar windows and facades production. With Vacuum Glass the door is wide open for complete new solutions and advantages in window, façade and wall construction. Architects, who come more from a holistic approach and the performance side, balance costs for investment against utilization and operational costs.

Missing innovation of windows and facades

If one considers the frame development for windows, it is easy to see that there is a lack of new solutions for energy saving and it was more a development of steady growth of the cross section. Frames have taken more and more surface area on a window. We can use the former space of IG especially for triple IG as an excellent opportunity to build, for example, a new box-type or counter-sash windows replacing the triple IG, but with the option to integrate other functions. We are only at the beginning. Very few experts and companies have shared their thoughts on these aspects. But we do need less independent actions; we need more integrated vertical teams to find new solutions.

Energy Plus Houses with vacuum glass - the future of building

There is so much to do and so much to achieve. This industry should have a general concept to utilize vacuum glass in order to satisfy the present architectural requirements and future expectations.

Keywords: Advanced insulating glass, Vacuum Glass, Energy Plus Houses, Active Plus Houses, Adaptive Glazings

vaku^{tex} - Vacuum-Insulated Textile Concrete Facade Elements

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Summary

In the next few years, the ecological and energetic requirements for building envelopes will be further tightened. The use of conventional materials would cause wall constructions to become increasingly thicker. To counter this development, new types of construction involving micro- or nano-structural materials facilitate slimmer building elements due to their high-grade properties regarding the reduction of thermal conductivity and the increase of stability, thermal capacity and quality.
Since March 2010, the research project 'vakutex - Vakuumgedämmte Fassadenelemente aus Textilbeton' ('vakutex - vacuum-insulated textile concrete facade elements') at HTWK Leipzig (Leipzig University of Applied Sciences) has been dedicated to the development of building envelopes made of extremely lightweight and energy-efficient exposed concrete, maintaining the design possibilities of contemporary concrete architecture.

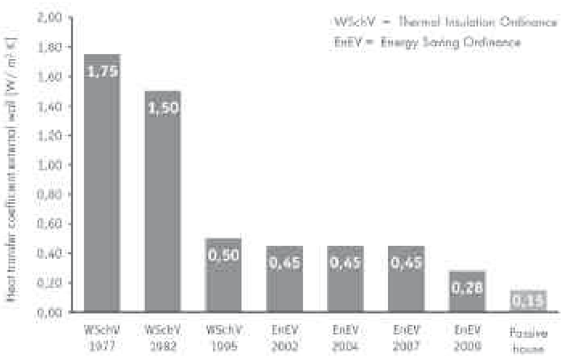

Fig. 1: Development of the requirements of thermal protection

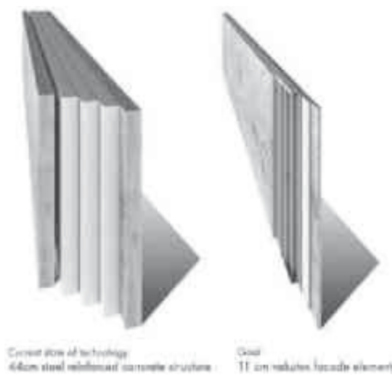

Fig. 2: Comparison of a reinforced concrete facade with a vakutex-facade

The result of the two-year research project is a prototype of the vakutex facade with the dimensions 1,50 m x 3,20 m as a nonloadbearing curtain wall façade, combining innovative composite materials, such as textile-reinforced concrete, vacuum insulation panels (VIP), phase-change materials (PCM) and glass fiber reinforced plastics (GRP). With a total thickness of 11 cm, all static, constructional, and building physical requirements regarding its structure, airtightness, thermal insulation, acoustic insulation, and fire safety can be met. The element can be designed in many different colors and structures and possible panel dimensions range from small to large formats. It is durable, low-maintenance, and equally high-quality.

The light appearance through the thin walls increases the quality of inhabitation of the spaces, accompanied by higher daylight and solar energy gains. Using vakutex facade elements can generate more usable floor space from the same gross floor area, which especially adds economic value to buildings in upscale inner city locations. Moreover, the developed vacuum-insulated textile concrete facade elements make a considerable ecological contribution to sustainable concrete architecture.

Fig. 3: Axonometric drawing of a facade detail

Fig. 4: Building extension, Paratex project

Keywords: facade; vacuum-insulated; composite materials; exposed concrete; textile concrete

Hygrothermal and Biohygrothermal Studies on Walls with Insulation from Straw

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Summary

The durability of components consisting of straw bales depends substantially on its moisture-proofing. Due to its suitability to serve as a substrate for fungal cultures, the integrity of straw can be compromised if a sufficient amount of water accrues in the material. In that case, fungal spores are able to germinate and decompose the straw, which is why appropriate measures must be adopted in order to prevent the attainment of a critical threshold for fungal growth.

Keywords: straw, moisture proofing, growth of mildew, hygrothermal, biohygrothermal

1. Introduction

The durability of components consisting of straw bales depends substantially on its moisture-proofing. If a critical huge amount of water accrues in the material over a longer period, fungal spores are able to germinate and decompose the straw. Therefore, it must be prevented by appropriate measures, that the thresholds for fungal growth are attained. On comparing the results of simulations based on common hygrothermal calculation methods with measurands of actual building elements, one can notice significant deviations concerning the water content within straw-insulated constructions, which is why a realistic evaluation of those constructions is possible only to a limited extent.
Based on the scientific works of Künzel [1] and Sedlbauer [2], it is intended to develop a technical dampness evaluation method for straw-insulated constructions. For this purpose, selected building elements in a climate system are investigated and compared with simulations based on the WUFI simulation program for hygrothermal analyses. On this basis, an approximation of calculated and measured results is to be achieved by applying adjustments to the properties of the material. The results of the simulations shall additionally be validated on constructions freely exposed to the weather. The requirements for the growth of mildews within the constructions are determined by the evaluation method depicted in [2] (if necessary, the substrate categories are adjusted for this purpose). Based on the results of this procedure, a reference method with an adequate reliability as to the growth of mildews for components consisting of bales of straw shall be developed

2. Basic principles

Generally admitted criteria for the assessment of the moisture proofing of devices consisting of bales of straw are not yet available. Until now, only indicative results of exemplary investigations in [3], metrological examination results of real building projects [4] and suggestions for the erection of walls [5] exist.

3. Examination method

In order to determine the water transport process within an insulation made of straw, metrological investigations are conducted on chosen constructions under laboratory conditions. Based on the results, an approximation of calculated and measured results is to be achieved by applying adjustments to the properties of the material by using the WUFI program. Hereby, a reference method for the valuation of the protection against moisture and the risk of mildews in constructions being insulated with straw shall be developed.

4. Results of the examination

The results show, that there are high discrepancies regarding the comparison between the measurement and the simulation with the material characteristics from literature. Through the increase of the sorption isotherm of the material straw of $10 kg/m^3$, the variances between simulation and measurement decrease. It is recognizable, that the variations of relative humidities at lower temperatures (10℃) are considerably higher than at temperatures above 10℃. Consequently through the increase of the sorption isotherm, the variances can be reduced.
The validation of the adapted material data is effected by the comparison with the construction in chapter 2, which is really exposed to the weather. The results show a good compliance between simulation and measurement in the months of winter and summer. However, especially in spring there are still variances in the range of decreasing moistness.
Because of this fact, it is perceptible that the deviations emerge, if there are modifications concerning moistness, especially in the range of desorption.

5. References

[1] KÜNZEL H.M., “Verfahren zur ein- und zweidimensionalen Berechnung des gekoppelten Wärme- und Feuchtetransports in Bauteilen mit einfachen Kennwerten.” Dissertation Universität Stuttgart (1994).

[2] SEDLBAUER K., “Beurteilung von Schimmelpilzbildung auf und in Bauteilen.” Dissertation Universität Stuttgart (2001).

[3] DANIELEWICZ I., FITZ C., KLATECKI M., KRICK B., KRUEGER N., KRUS M., MINKE G., OTTO F., SCHARMER D., TEUBER W., “Grundlagen zur bauaufsichtlichen Anerkennung der Strohballenbauweise - Weiterentwicklung der lasttragenden und Optimierung der bauphysikalischen Performance.” DBU Abschlußbericht (2008).

[4] JOLLY R., “Strawbale moisture monitoring report”, Canadian mortgage an housing (2000).

[5] RÜGER B., “Putzoberflächen auf Strohballenwänden”, Fachverband für Strohballenbau Deutschland e.V. (2004).

Solar Absorbers and Shading on Large Glazed Facades

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Keywords: building envelope; solar absorbers; shading; thickness insensitive spectrally selective paints

Use of solar radiation in buildings represents one of key factors in reaching the goal of zero energy buildings as well as a keystone of bioclimatic architecture. Solar radiation in buildings can be used either as direct gains through transparent part of the building envelope or indirectly through solar absorbers or photovoltaic systems. Additionally to energy potential, solar radiation provides internal living spaces with daylight which is probably a single most important factor in creating quality living and working environments. Harvesting of solar energy can become problematic in buildings with large glazed surfaces, which can result in overheating and consequentially in the application of shading elements that block the unwanted radiation. Although beneficial from the view point of reducing overheating, shading can reduce the full potential of a building to utilize the available solar radiation.

In the present paper a concept of an innovative shading device with integrated solar collector is presented. The proposed system enables the use of direct solar gains (when desired), indirect use of solar gains through solar absorbers integrated in the shading elements as well as shading and daylight regulation. A key element in the design of such an absorber is the application of thickness insensitive spectrally selective paints (TISS) that enable simpler and more robust applications than the thickness sensitive spectrally selective (TSSS) coatings used in conventional solar collectors. Compared to solar collectors based on TSSS paints the TISS solar absorber exhibits lower solar absorptance (TISS: a_S=0.84 to 0.88, TSSS: a_S=0.90), as well as higher emissivity (TISS: e_T=0.37 to 0.48, TSSS: e_T=0.30), but at the same time it does not require additional protection (glazing) from atmospheric agents. Additional benefits of TISS paints are also a wider range of architecturally pleasing colours, simplified application due to thickness insensitivity of the paint and the potential of using a non-metallic base for the absorbers, as the paint itself already incorporates metallic particles. The proposed shading device integrated solar collector is of a relatively straightforward design consisting of an absorber surface covered with a layer of TISS paint, a honeycomb water distribution system and a backing thermal insulation for reducing heath losses. Individual elements are linked into a rotational or fixed louvered shading element that is integrated into a building-wide closed loop of pressurized water circulation system. Coordination between daylighting and solar gains (direct as well as indirect) must be executed by an advanced automated control system.

Although TISS paints are not equal in efficiency to conventional TSSS coatings, they do offer advantages that outweigh their lower efficiency and make them attractive for use in buildings. The proposed shading devices with integrated solar collectors based on TISS paint coats enable greater flexibility in harvesting of renewable solar energy even at times when direct gains are unwanted (e.g. summer) and on the parts of the building envelope that are currently unsuitable for the application of conventional solar collectors (e.g. glazed facades). The proposed concept extends the multifunctionality of the building envelope as well as contributes to the lowering of the building energy demand and as such represents a step towards reaching the goal of net zero energy buildings. Nonetheless, further research is necessary to obtain more data on the speed of degradation of TISS paints when exposed to the atmospheric conditions as well as in the field of practical application of such a system.

Recycling of Autoclaved Aerated Concrete

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Summary

In the present paper, a reuse strategy for Autoclaved Aerated Concrete (AAC) demolition waste into the ongoing production of AAC is described. Xella has randomly analyzed AAC demolition waste from various recycling facility operators. Regarding the purity, strong variations were observed. Some sample-sets revealed a rather low purity and are, thus, improper for the production of high-quality AAC. Others exhibited satisfactory purity and were analyzed in more detail. Critical contaminations with organic compounds or heavy metals were not detected. In test series, class P4-0.55 AAC could be produced by admixing 10 % w/w of recycled AAC-split. The crucial step for the described high quality recycling of AAC is the accessibility of unmixed waste material.

Keywords: Autoclaved Aerated Concrete, AAC, waste material, deposition, recycling

1. Introduction

To date, the majority of Autoclaved Aerated Concrete (AAC) demolition waste is dumped into local landfills. Landfill capacities for waste class I, which is obligatory for AAC, significantly dropped during recent years. As a consequence, costs for its acceptance steadily increased. According to the European Waste Framework Directive 2008/98/EC, recycling, recovery and preparation for reuse must be achieved for 70 % of discarded non-hazardous construction- and demolition-waste by 2020. Thus, the establishment of high quality recycling ways constitutes an important and inevitable sustainability strategy for manufacturers of construction materials.

2. Results

Xella has randomly analyzed AAC demolition waste from various recycling facility operators. Regarding the purity, strong variations were observed: Some samples showed contaminations by tiles, ceramics, corrosion protection, gypsum, plaster, styrofoam and bitumen. Such material has to be regarded as non-suitable for the production of high quality AAC. Other samples displayed high sorting accuracy and were analyzed in-depth. Leaching tests of granular material according to DEV-S4 showed sulfate-concentrations which fulfill the assignment criteria of RC3 [1]. The content of polycyclic aromatic hydrocarbons (PAH) was found to be below the detection limit. Detected amounts of total organic carbon (TOC) were far below applicable limit values [1]. According to X-ray fluorescence analysis (RFA), no contaminations with the heavy metals vanadium, chromium, nickel, strontium, copper and lead were detectable. Such AAC waste has a high potential for high quality recycling ways.
In test castings, class P4-0.55 AAC was produced by using 10 % w/w of crushed AAC from demolition waste. Detected $\lambda_{10,dry}$-values were meeting the demands of a λ_D = 0.14 W/(mK). Equilibrium moisture contents were below 3 % w/w. Shrinkage-values according to EN 680 were below the limit value of 0.2 mm/m (according to the German DIN 1053-100).

3. Conclusion

Xella's long-term perspective is to establish a largely closed recycling circuit for AAC: AAC-demolition waste is collected and assorted by contracted recycling facility operators. The resulting mono-fraction is further processed (drying, milling) and subjected to random analytical investigations. Having passed an internal approval, the material is conveyed into the ongoing production of AAC.

With regard to process technology and product quality the production of class P4-0.55 AAC with AAC from demolition waste was shown to be feasible. Future experiments will have to demonstrate whether other our strategy is expandable to other quality classes of AAC, too.

As the bandwidth of the chemical composition of AAC-returns is not statistically evaluated, yet, its long term monitoring is inevitable. The accessibility of unmixed material is crucial for high quality recycling ways. Additional aspects of Xella's future work concern the establishment of internal test- and approval-procedures, infrastructure, and, last but not least, significant mass flux from recycling facilities towards AAC-production sites.

4. References

[1] Länderarbeitsgemeinschaft Abfall (LAGA) - Eckpunkte für eine „Verordnung über die Verwertung von mineralischen Abfällen in technischen Bauwerken", 31.08.2004

Renewable Façade Retrofit for Existing High-Rise Buildings in Central and South Europe

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Extended abstract

Keywords: LCA; Façade retrofit; Façade-integrated renewable components; High-rise-buildings; Sustainability

1. Introduction

Contributing to improve the overall efficiency of buildings and encouraging the use of renewable energies as well as reducing the use of fossil resources for building operation, is one major target of the European Energy Performance of Buildings Directive (EPBD). For existing buildings, this implies to apply retrofit measures that increase the overall building energy efficiency tailored to specific building types or special building characteristics. Within the European project "Cost-Effective" innovative components and concepts have been developed to convert facades of existing high-rise buildings into multifunctional, energy gaining entities, aiming to have a substantial effect on the energy conservation potential in the EU-25 and the associated CO_2 mitigation. Such technical concepts for façade retrofit take into account measures for the building envelope, the heating, cooling, ventilation and air-conditioning (HVAC) technology and the building operation. Apart from an economic investment and an energetic analysis for the operation phase, life cycle assessment (LCA) studies have been performed.

2. LCA approach for integrated retrofit concepts

The system boundary for LCA is set on modernization activities which are regarded at for production, maintenance and End-of-Life as well as the building operation of the existing building. Three references have been defined: one representing the building before modernization without any "Upgrade", one representing the building after modernization/retrofit with "Upgrade" and one representing the applied integrated concepts and the building after modernization/retrofit with "Upgrade", e.g. improved building envelope and HVAC technology as well as applied façade-integrated new components. The concepts are analyzed in two different climate zones: South Mediterranean and central Europe. The assessment focusses on the question, if higher environmental impacts within the production phase can be amortized while building operation (and within what period) and if the application of new developed, façade integrated energy generating components makes sense from an environmental point of view. The studies are conducted on a "Cradle to Grave" basis and following ISO 14040/14044. Extensive questionnaires on data collection for the building layout, the constructional elements (e.g. exterior walls, windows, heating, cooling, ventilation and air-conditioning) and building operational data (e.g. on renewable electricity and heat production by applied façade-integrated components) are the basis for environmental assessment.

3. Results, discussion and Conclusion

The most sensible parameters for the overall environmental impacts are the energetic performance of the buildings, the energy carriers used or substituted and the actual share for the renewable components to assist in covering the building final energy demand. The results indicate that approximately one half of all assessed concepts show up to be evaluated as environmental beneficial, meaning that production-related environmental impacts can be amortized during the use phase within 15 years (and thus equalling the financial investment horizon in such concepts or façade-integrated technologies) and that overall life-cycle based impacts (sum of production, maintenance, operation and End-of-Life) can be reduced for all environmental topics assessed. Furthermore concepts with focus on “heat supply“ tend to show up less potential for reduction as concepts focusing on “electricity supply“ due to underlying environmental profiles for substituted energy carriers (European electricity grid mix versus European gas condensing boiler). The potential for reductions seems to be higher if concepts are applied in hot or Mediterranean climates due to higher solar irradiation. In particular cases of concepts with „heat supply“: A potentially increased electricity demand may lead to less reductions in environmental impacts (especially with regard to acidification, eutrophication, summer smog and ozone depletion) even if conventional heat generation is substituted via solar heat.

4. Acknowledgement

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Sustainable Building Materials

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Summary
The issue of sustainability gains more and more importance for the building sector. Therefore all branches work on improving their solutions in terms of sustainability. As one example for the building material industry, Xella is leading several projects in this field.
Not only by providing environmental product declarations, but also by carrying out intensive investigations about material behaviour and by cooperating with different partners in the certification process for sustainable buildings. Together with trainings for employees and external experts, all these activities are bundled in the new sustainability strategy for the company.
An overview for these activities shall be given in the present paper.

Keywords: sustainability, environmental product declaration, material behaviour

1. Introduction
The importance of environmental and climate protection has been rising in the last decades more and more. This lead to a wide range of measures especially in the field of energy saving and recycling. In the last years this was expanded to a new approach called sustainability.
The building sector and as a part of it, the building material industry has been working on this topic, finding new economic and ecologic solutions with an optimum in energy performance, low influences on environment, and fulfilling all demands resulting from their application (like structural design, fire safety and others).
But sustainability in the building sector is not only related to the development of materials. There is a wide range of projects dealing with that. Some examples shall be shown in the following chapter.

2. Results
To improve the situation for the sustainability of building materials and houses a bundle of projects have been set up. Not only to develop materials with high energy efficiency, low impact on the environment and with high quality and optimised processes referring to protection of resources, reduction of energy consumption and emissions.
One of these projects is the development of Environmental Product Declarations (EPD). The first EPD’s on the market were issued for AAC products. Such declarations (containing an eco balance and other relevant information about production, use and recycling of building materials) are the basis for certifying buildings in terms of sustainability. Xella received these declarations for its entire building material portfolio. The new product, Energy+ got a cradle to cradle declaration which gives relevant data for the whole life cycle of the product.
Projects dealing with recycling of waste and finding new ecological methods to produce energy also belong to this field.

Another important part of this topic are different investigations for increasing knowledge about the sustainable properties of building materials. There are activities in the fields of durability, constant physical properties and long term behaviour under real conditions. Furthermore the impact on the environment resulting from use of buildings or measures after use are deeply investigated.
Educating employees and external experts all over the world has an important factor. Examples for this are cooperation with colleges to support them with knowledge, trainings for sales people to become certified energy advisers or instructions for experts in various technical topics to support their work.
The building industry has an active part in the certification process for sustainable buildings. For example the new Xella headquarter in Duisburg (Germany) has been certified in compliance with the German seal of DGNB ("Deutsche Gesellschaft für Nachhaltiges Bauen"). As part of a cooperation between the German Federal Ministry of Transport, Building and Urban Development (BMVBS) and the Technical University of Munich, a Chinese office building in which AAC materials have been used got a sustainability certification based on German standards. The results were presented during the EXPO in Shanghai in the course of the Week of Sustainability in the German Centre.
The efforts of Xella in the field of sustainability were recognised by winning the German innovation award for climate and ecology in 2011 for a project of developing a new method to produce synthetic gas to reduce the use of fossil fuels and to improve CO_2 balance in building industry.
Together with several partners from science, society and politics, Xella joins different initiatives like the German Industry Initiative for Energy Efficiency and the 2° foundation.

3. Conclusion

Sustainability of buildings is a complex topic which is beyond daily activity of building material producers. But the industry can give positive input by finding new approaches for building products with better ecological properties and joining and leading projects to improve the sustainability of buildings like shown in the present paper.

Dynamic LCA applied to Buildings and Urban Districts

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Summary

Existing Building LCA tools are based upon a static method, considering yearly average processes and impacts. This paper presents a dynamic method that has been developed to evaluate electricity-related impacts in buildings. Results on case studies show important discrepancy between the static and dynamic methods. This study is a first step towards the introduction of consequential LCA parameters in life-cycle assessment of buildings.

Keywords: Buildings, Electricity production, Dynamic Life-cycle assessment, Consequential life-cycle assessment

Extended Abstract

Most building life cycle assessment tools are based upon a static method, i.e. no temporal variation is considered for processes and corresponding impacts. The present study addresses the validity of such a simplification in the case of buildings. Electric heating, heat pumps and air conditioning induce seasonal demand, during which the production mix may differ from the yearly average. Professional and domestic activities influence weekly and hourly patterns. Local renewable electricity production, e.g. using a photovoltaic system, is also variable.

A dynamic LCA model has been developed to account for such temporal variation, in order to evaluate more precisely the environmental impacts of electricity consumption and production in buildings, which is useful in order to compare e.g. plus energy and standard buildings.

The French electricity grid manager provides hourly production values for nuclear, hydro-electricity, thermal plants, and other types. Based upon these data, the model evaluates the production mix in terms of an average temperature in France and several periodic functions corresponding to variation frequencies identified by a Fourier analysis. In a second step, specific production mixes are derived for different uses: heating, cooling, domestic hot water, domestic appliances and office appliances. This model is then integrated in a building LCA tool. The model requiring hourly energy consumption data, the LCA tool is linked to dynamic thermal simulation.

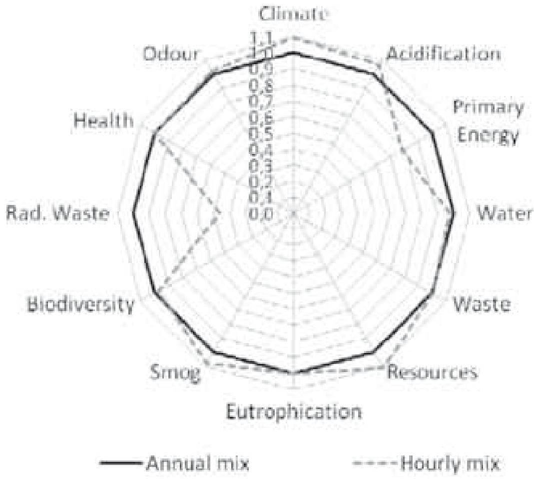

Figure 1: Evaluation of Low-Energy Neighbourhood using the annual and hourly models

Comparative results between the static and the dynamic method show a discrepancy up to 50% for radioactive waste, 22% for cumulative energy demand, 10% for climate and resources. Using a more precise model based upon use-specific hourly mixes instead of a constant annual average is therefore justified.

The Building LCA tool has been extended to the scale of urban districts, integrating several building types as well as streets, public spaces and networks. In order to illustrate the capabilities of this tool, a new project in France has been compared to passive blocks of Quartier Vauban in Freiburg. This allowed the performance of this project to be evaluated against best practice.

A Cross-Sectional Analysis of using the Ground as Heat Source and Heat Sink

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Summary

Within the research project EnOB:MONITOR (research for energy-optimized construction) a large number of buildings standing out due to an energy efficient planned, innovative system concept get subsidized and analyzed in a monitoring process. Nearly 30 percent of these demonstration buildings use the ground soil as heat source and/ or heat sink. (The name EnOB is an abbreviation of the equivalent German term Energieoptimiertes Bauen.)

The following article shall give an overview of commonly used geothermal systems and of their performance in praxis. The analysis deals with questions of energy efficiency, performance and fatigue of the ground of the different system types, such as geothermal probes, geothermal collectors or water well systems. Besides, aspects will be pointed out which should be considered while planning a geothermal system and which led to problems or complications in the past. The analysis refers to scientific studies of new buildings as well as existing ones that were measured in a monitoring over several years.

Keywords: Geothermal energy; ground heat; monitoring; EnOB; ground temperatures.

Abstract

The EnOB demonstration buildings are presented on an internet platform and shall illustrate, how innovations in building materials and system engineering work in practice. For this purpose, measurements are performed in the buildings, which will later be analyzed and finally summarized in a publicly available report.

By means of this information accompanying research teams undertake cross-sectional analysis focusing on special issues. One of these accompanying research teams is the department of building physics of the University of Kassel. The topic of one analysis made by the department is the ground soil as heat source and heat sink. The aim is to demonstrate which systems are applied nowadays in order to heat or cool buildings with the aid of the ground and how these systems prove themselves. The following contribution will show results of the cross-sectional analysis and present experiences from the monitoring research.

In the beginning of the article the main principle of geothermal systems and some basic knowledge will be explained. The content refers only to the near-surface geothermal energy, because the deep geothermal energy beginning in a depth of 400 meters is rarely applied for technical building services. Afterwards, a short overview of possible and commonly used geothermal systems follows. The overview contains geothermal probes, geothermal collectors, geothermal heat exchangers, ground contacting building components and finally water well systems. The main function of these systems is presented as well as some pros and cons.

In a further part of the article some planning aspects will be pointed out that should be considered when planning a geothermal system. Here, the importance of preliminary inspections is e.g. mentioned, as well as the choice of a suitable heat transferring system and medium with the focus on using antifreeze or not.

The following part outlines the practicability of the different systems and how they proved themselves in the existing buildings. This information was filtered out of the reports of several buildings applying a geothermal system. The practicability of the system types is shown and aspects like the influence of the users´ behaviour and the fatigue of the ground are discussed. The results of the monitoring research create the impression that a lot of malfunctions of the system engineering were caused by mistakes or defects in the controlling technology or by unpropitious control strategies. What can also be a problem is the wrong behaviour of the users, especially in residential buildings.

A following short section will take a closer look the efficiency and summarize the advantages and disadvantages of geothermal systems in general. The efficiency turned out to differ a lot from system to system. This can be traced back to the high dependence on the dimensioning and on the control system. Moreover, every building has different conditions due to the location and the design of the building itself. But overall, good performance factors can be achieved with geothermal systems, especially for the cooling of buildings. Here, the ground soil temperature can often cover the demand for cooling or at least, in combination with other measures, achieve a comfortable indoor climate.

The last part of the article shall draw a conclusion from the main results of the cross-sectional analysis. Here it has to be mentioned, that the monitoring often helped to find defects or malfunctions, which proves that it can be a useable instrument. Another important aspect is that the malfunctions are often caused by the attached system technique of the geothermal system and that the efficiency of the systems varies quiet much. This makes clear, that an integral planning of buildings is of high importance in order to avoid an incorrect dimensioning or a malfunction of the system technique. Thus, all planning sectors should cooperate well and a transfer of knowledge by members of all planning phases should be made possible for eventually achieving the planning targets.

Towards the Industrialization and Sustainability of Social Housing Projects in Colombia

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Summary

In accordance with the Inter-American Development Bank (IADB), 59 million people in Latin America and the Caribbean have no housing or their houses do not have sufficient conditions for habitation. The National Bureau of Statistics (*Departamento Administrativo Nacional de Estadística,* DANE) of the Republic of Colombia has indicated that the quantitative deficit of households in 2005 was 12.37%, equal to 1.307.620 homes. In 1993, it was 850.471 homes. Therefore, from 1993 to 2005 the deficit increased by 457.149 housing units. According to the Colombian Chamber of Construction (*Cámara Colombiana de la Construcción,* CAMACOL), a total of 250.000 new homes are begun each year but only 150.000 houses are built, 70% of which correspond to social housing. According to these figures, the quantitative social housing deficit increases by some 70.000 units each year in Colombia.

Additionally, construction costs in Colombia grow at a rate of 6.5% per year according to measurements made by the Index of Housing Construction Costs (*Índice de Costos de la Construcción*, ICC). The Colombian Government has planned the construction of one million new social dwellings between 2011 and 2014, equivalent to 250.000 new houses per year. This goal will barely be accomplished due to the variability of construction costs in the country and the slow speed of construction using traditional building systems. Even in this context, public and private investment has confirmed its commitment to continue building social housing.

According to the building tradition in the country (which has used cast concrete *in situ* for the construction of houses and other buildings) and the availability of raw materials, precast concrete could improve efficiency, production and installation times, control quality and reduce costs through dimensional coordination processes to avoid wasting materials and reprocesses that arise in traditional construction systems in Colombia. Despite the availability of resources, this system has not been sufficiently explored in the country for the architectural design and construction of social housing projects. Steel structures, which can also be specified for prefabrication, are produced in insufficient proportions in Colombia to attend the construction of this number of dwellings, these structures could be up to 40% more expensive than structures in traditional poured-concrete systems in the country and construction could take a similar amount of time compared to construction in precast concrete.

The question leading this investigation is how to improve efficiency in designing and building social housing in Colombia through the use of precast concrete in order to decrease the quantitative housing deficit in the country.

In this research, the meaning of efficiency is the optimal utilization of available resources to get desired results. Therefore, we can say that architecture for social housing in Colombia is efficient when it is capable of obtaining desired results (quality control, less time and lower costs) through the optimal utilization of available resources (space, materials, labor and equipment).

The four basic activities considered in this investigation in the prefabrication process are design, production, transport and installation.

During the design stage, the urban and architectural spaces, along with the materials to be used, are planned. Designs are conceived through the principles of modular coordination with the precast elements to avoid waste and the repetition of activities in the construction process that generally arise in traditional construction systems in the country.

During production, the use of materials can be reduced and pieces can be standardized for their optimal use. The precast elements can be lightened through pre-stressed alveolar parts that reduce the quantity of materials. The precast elements may also have lower costs due to the use of other materials that reduce the volume of costly materials -such as cement- in the mixture, which in Colombia cost on average 175 Euros per ton, according to information from the Colombian Chamber of Construction (*Cámara Colombiana de la Construcción,* CAMACOL).

In transport, efficiency and construction times can be improved through the construction of field factories adjacent to the social housing projects to decrease processes, reduce distances and resolve difficulties that arise in transporting large-format elements from factories to projects, generally located in the outskirts of the cities and in mountainous topographies.

In the installation, it is possible to improve efficiency through less complex coupling systems or assemblies between the precast parts, the standardization of units and the use of machinery and equipment in shorter time frames.

This research also aims to associate the architectural design with industrial production processes to obtain maximum efficiency in cost and time with the highest quality. The standardization of precast concrete pieces with the least amount of variants and maximum flexibility also contributes to increased efficiency in the production, transportation and installation of elements in the construction of social housing. This research connects the activity of the architect as designer and technical coordinator of the production of parts that conform the building.

Decreasing construction times could reduce the general and financial costs without sacrificing construction quality. Social housing projects tend to be urgent because they provide solutions in terrains that are currently and informally occupied by people, leaving them without any kind of housing for a period of time. Reducing construction time is also a desirable social aspect. This panorama of current needs and almost immediate opportunities in Colombia awakens the interest of public and private sectors to improve the efficiency in designing and constructing social housing. The use of precast concrete to industrialize the production of replicable modular elements is another possibility for the construction of social housing in Colombia during the coming years.

Keywords: Industrialization, efficiency, sustainability, precast concrete, modularity, social housing.

Improving Thermal Insulation of Façades through Optimized Anchorages, here: Brickwork Support Brackets

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Summary

Fixings of Brickwork Façades usually are provided by Support Brackets which are connected to the support structure. These brackets are to be fabricated in stainless steel due to missing options for inspection or maintenance. An insulation which is positioned between support structure and the brickwork cladding will be penetrated by the brackets. This thermal bridge can be reduced either by using insulating material or by optimizing the shape of the brackets.

Keywords: Thermal insulation; façade constructions; anchorages; Energie Einspar-Gesetz, Brickwork Support Brackets

1. Introduction

Raised requirements towards energy efficiency of buildings are stipulated widely, for example in Germany it is the Energie Einspar-Gesetz (EnEG) which is implemented through the Energie Einspar Verordnung (EnEV). Affecting a building's energy efficiency, façade constructions play a decisive role. Among the influencing factors are the following parameters: structural design, layer thickness and thermal conductivity of the used materials.
In order to connect façades to buildings or support structures, reliable systems of fasteners and anchorages are required. Regulations for cladding for external walls with ventilated space can be found in DIN 18516. This standard deals with claddings built in steel, in natural stone, manufactured stone or glass. Fixing systems are regulated there as well. For masonry façade systems, ancillary components such as ties, tension straps, hangers and brackets are regulated in DIN EN 845.
Since anchorages (generally fabricated in stainless steel) need to penetrate the façade construction and especially the insulation layer in order to transfer loads securely, they act as a thermal bridge that needs to be evaluated and minimized.
Fig. 1 shows the usual assembly of a façade: The bearing construction, which can consist of a concrete construction or a masonry wall, the insulation layer, either with or without ventilated space and the masonry façade.

The here shown steel bracket provides a safe fixture of the masonry façade to the bearing construction.

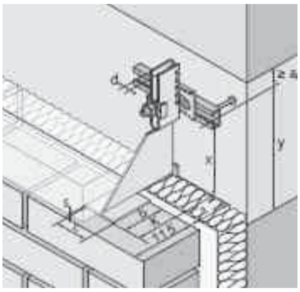

Fig. 1: Brickwork Support Bracket

Fig. 2: Finite Element Mesh for Thermal Calculation

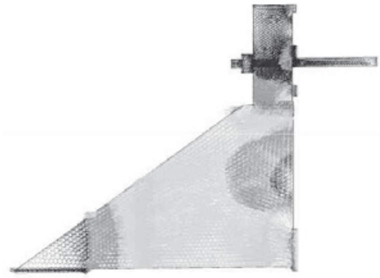

Fig. 3: Result of Thermal Calculation

2. Results

To determine the heat transfer of a Support Bracket, calculations using Finite Element Method provide reliable results to verify thermal bridges and to compare insulation methods. Fig. 2 shows a FEM mesh displaying the support structure, the insulation, the brickwork façade and the bracket. The heat transfer of such a setup is shown in figure 3. The illustration of the potential fields shows the principal direction of the heat flow.

3. Conclusion

This paper gives an overview of the calculation methods and test methods to provide results for the heat transfer and the static resistance of a façade anchorage. Load bearing capacities are confirmed by means of test results as well as calculations. Some essential technical developments are presented and explained. Results are provided to show the effect of optimization of the anchorages, here: Brickwork Support Brackets. The design rules are explained and the results are illustrated.

Environmental Benefits of Advanced Load Bearing Structures Based on Earth and Straw

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Summary

One of the approaches towards sustainable building is increasing of usage of raw natural materials. Natural materials have a high potential of environmental quality for example in following criteria: embodied CO_2 and SO_2 emissions, embodied energy, using renewable sources, easy recycling, etc. They are many possible approaches to use benefits of those materials. On one hand low-tech approach and self-made technologies enable taking advantage of wide range of social benefits; on the other hand advanced technologies as prefabrication etc. enable wider using of those materials and decreasing of technological risks.

Earth and straw belong next to wood and timer structures among the most used raw natural materials for contemporary environmental friendly structures. Their usage increases permanently and brings to the structures new quality from the sustainable building point of view.

They are many possible ways to use benefits of those materials. On one hand low-tech approach and self-made technologies enable taking advantage of wide range of social benefits; on the other hand advanced technologies as prefabrication etc. enable wider using of those materials and decreasing of technological risks.

The paper outlines results of experimental research of load bearing structures based on prefabricated rammed earth panels and load bearing straw bales. Environmental assessment of load bearing wall based on prefabricated rammed earth elements is presented and structural development of those elements and technological process is described.

Straw can be used in energy efficient building as a thermal insulation but can be also used for simple load bearing structures. Crucial properties from this point of view are load bearing capacity, thermal properties and fire resistance. These properties have been investigated within the research project mentioned in the paper. Also results of fire resistance of load bearing straw bale based structures carried out in the in accredited fire testing laboratory PAVUS in Veseli n/L are mentioned in the paper.

Main technological disadvantage of higher amount of human power can be used as the main advantage for alternative approach as low cost and self-made structures with all economic and social benefits. From this point of view the main disadvantage as complicated technological process, higher need of human power, etc. can be used as social and economic advantage. It is obvious that economical potential of alternative “green” technologies is limited but it can solve the problems in specific and extreme social cases as shown below. Also other industry branches above all agriculture which needs in EU strong governmental support and subsidies can profit from this process.

There are many historical examples of social impact of building sector. It is obvious that the social aspects were not the most important in history but from our point of view also social impact should be taking into account.

Contemporary low technologies based on earth and straw enable today also their using within special projects with wider social or social-economic impact. Those projects can be divided into following groups (i) social programmes for developing countries, (ii) special programmes in disaster areas, (iii) social programmes for unprivileged and social eliminated people. From this point of view can “green”, low-cost and low-tech approach bring wider benefits and can contribute to solve specific social problems. There are many examples using this approach but always technical quality of the structures, durability and should be taking into account.

The topic of sustainable building covers wide range of issues including environmental, socio-cultural and economic criteria. All building material and used technology should be assessed not only from the point of view of the technical quality of the building, quality of internal microclimate etc. but also from the point of view of using local human sources and encouraging local economy. Specific approach can be used by using low-tech and self-made technologies (straw bales, rammed earth, etc.) within special project focusing on social issues like building in development countries, housing for homeless people, building in poor areas, solving problems of long term unemployed people etc. Earthen and straw bale based structures represent one of possible approaches to meet the needs of positive social impact of building sector in specific cases.

Keywords: rammed earth; straw bale structures; prefabrication; sustainable building, low-tech materials; natural based materials

Biomimetic Architecture, The building as an Organism, Biomimetic Approaches for Build Systems

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Summary

The present study explores the possibilities of biomimetic applications on buildings by analyzing the functional parameters of the building shell in a context of an organismic building definition.

Keywords: biomimetic architecture; organismic architecture; building shell

Abstract

Over 3.8 billion years of evolution, nature has developed and introduced specific systems to accomplish the most various tasks. These efficient biological mechanisms [1] [Bar-Cohen 2005] offer models for optimization and innovation with potential applications on manmade technologies [2] Considered in the context of this work are ecological energetic aspects, organismic parameters, as well as building specific parameters (what is today`s requirement in terms of comfort related energy and material).
Organisms are integrally hierarchically organized and target-oriented systems. This analysis considers - from an architectonical point of view- the building as an organismic unit. Applying organismic properties to buildings empowers buildings to be an interconnected system that is able to interact within themselves and in their environment [11]. Thus, buildings can potentially be capable of self-regulating, adapting and interacting in a symbiotic way with their controlled inside climate and with the outside.
Biomimetic offers an important pool for information transfer and a high potential of innovation. The organismic approach intends to look at a building as an integrated complex system incorporating varied aspects of biomimetics.

In order to deal with this high potential of innovation, this paper structures the organismic building concept around three main parts: Biomimetics, sustainability and building specific parameters. While biomimetics describes the transfer of information in between biology and technology and the possible interdependencies in between different system functions, sustainability covers the elaborated and rational use and design of materials and energy. The building specific parameters describe in a general way, the functions the building shell should be able to perform today. After defining these concepts, an analysis concentrates on the functions of the building shell, dividing it into three layers (outer-, middle-, inner-layer) serving as a support for positioning the 29 functional properties of the building shell.

Results

The analysis in this paper focuses on some energy and some comfort related functional properties of the layers of the building shell. Due to interdependencies, they cannot be discussed entirely separately. On one side the “Variable Air and Heat Permeability” and on the other side the “Sun Radiation Variable Control”. Both are highly relevant in the context of energetic regulation. The first group of functional properties regulates the energy loss and air quality, the second the energy gain form IR-radiation.

Conclusion

The use of biomimetic approaches on the building shell offers a wide range of possible applications. The interdependence of these applications shows potential to integrate energetic and material saving.

Recycling Options for Masonry – Identifying Sustainable Solutions

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Keywords: Sustainability; LCA; LCC; LCWE; Recycling; Demolition material

1. Introduction

Every year, over 50 million tons of construction waste occur in Germany. These masses, which consist of concrete, insulation material, gypsum, plaster, tiles, wood, steel and plastics, but also of different types of stone-work like lime-sandstone, red brick, aerated concrete and lightweight concrete, have to be disposed. With regard to a sustainable recycling management, demolished masonry should be recycled.

The AiF (German Federation of Industrial Research Association) project "Sustainability Analysis for the Recycling of Masonry is supported by the Federal Ministry of Economics and Technology. Within this research project, the sustainability of different recycling options for masonry will be assessed. By using the methods of Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and Life Cycle Working Environment (LCWE), environmental, economic and social aspects are considered and evaluated.

2. Project "Sustainability Analysis for the Recycling of Masonry"

2.1 Recycling options for masonry and required recycling processes

In a first step, different recycling options, necessary technologies and regulations concerning material composition and the proportion of contaminated material are identified and described. The results are compiled in an excel-tool, which shows recycling options depending on the material composition of the construction debris and the needed processing steps. Therefore, it is necessary to specify the proportions of the different types of stonework – lime-sandstone, red brick, aerated concrete and lightweight concrete – and the proportions of foreign matters like plastics, wood, paper, ferrous metal and insulation material. Afterwards different technologies to brake and separate the material fractions can be selected. In dependence of the chosen sorting system and the resulting material composition, the recycling material can replace primary material like gravel, sand, pumice or expanded clay.

2.2 Approach for a Sustainability Assessment

With the help of the software system GaBi 5 the identified recycling options and technologies are modelled and evaluated concerning environmental, economic and social aspects. Within the evaluation system boundaries are: the transportation of demolished material, processes of the recycling facility and end-of-life credits for replaced primary raw material or foreign substances (e.g. reinforced steel parts) that have been sorted out. The production of lime-sandstone, red brick, aerated concrete, lightweight concrete and other materials, their integration into masonry and the on-site demolition of the masonry are not considered. The functional unit for the assessment is one tone of demolished material. Industry as well as literature data is used for the inventory modelling. For the recycling of masonry, several processes were modelled. The demolished masonry, transferred by truck to the recycling plant is feed into the feed hopper by an excavator. By going through a crusher, a primary screen and a screening plant, the demolition material is crushed into smaller grain sizes and separated into different grain sizes. Plastics, wood, insulation material, paper and ferrous metal is sorted out via sorting machines and/or a magnetic belt.

For the end-of-life of plastics, wood, insulation material and paper, a waste incineration plant is estimated resulting in credits for on-side steam and power generation. Credits for the broken masonry can be accounted for the amount of gravel, sand, pumice or expanded clay production. In case of very heterogeneous demolition material, further sorting systems are necessary to achieve credits for replaced primary raw material production. New technologies like a jigging machine, an air classifier and a colour sorter are modelled. These technologies are able to separate smaller parts of lightweight material (paper, insulation material, plastics, etc.) but also lightweight and aerated concrete or red brick. In dependence of the material composition and the requested replaceable material, the sorting technologies can be chosen within the GaBi 5 modell.

The parameterized processes of the LCA model enable the assessment of individual recycling plants: All modelled processes can be switched on or off - the nominal power, the delivery rate, the sorting efficiency and the transportation distance are modifiable. Additionally, the replaced primary raw material and the power source can be specified.

The results are provided within a web-tool, which allows an easy using for operators of recycling facilities and for demolition companies.

3. Conclusions

The excel-tool shows which possibilities do exist for the recycling of construction waste and which processes are necessary. Within the parameterized GaBi 5 model several questions about the recycling of masonry can be responded. Therefor different technologies are modelled and can be specified individually. The model identifies the important environmental, economic and social benefits and the processes posing the largest potentials for improvements. Also other questions could be discussed: Should the material be sorted for achieving higher recycling levels? Is a selective deconstruction worthwhile?
Answering all of these questions will help to avoid landfilling and support using demolished masonry for manufacturing recycling products, thus enhancing sustainability in the construction sector.

4. Acknowledgement

The IGF-project 17022 N "Sustainability Analysis for the Recycling of Masonry" of the registered research association Porenbetonindustrie e.V., Berlin was funded through the German Federation of Industrial Research Associations (AiF) by the Federal Ministry of Economics and Technology as part of the programme to promote Industrial Collective Research (IGF).

LifeCycle Tower – the Natural Change in Urban Architecture

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Extended Abstract

More than 50% of the world's population today lives in cities and the trend is increasing. The urbanization of the world presents an enormous challenge to the future of mankind. As we move into an era of climate change compounded by either diminishing resources and/or resources that are expected to continue to have extreme price volatility, resource efficiency is a crucial factor.

Global construction industry today accounts for 40% of today's energy, CO2 and resource consumption, and 40% of waste production. In the past, urban architecture has been based predominantly on conventionally produced prototypes with long, complex and resource-intensive construction work. Today, resource efficiency combined with renewable energy and energy efficiency should be part of every community's planning, projects and budgets and should be considered for all construction projects. Therefore, sustainable construction techniques are of immanent importance. The orientation towards high-rise green buildings that offer many people an urban living environment with environmental and resource-friendly building materials is much more than just a global trend by now.

The changing global construction scene was the trigger that spawned a research project over several years. An extensive research process by knowledge leaders from all professions in the building industry, such as architecture, structural engineering, building physics, building services, process management, marketing etc. resulted in an innovative solution for sustainable construction.

The vision of our product reflects the aim: LifeCycle Tower (LCT) – a skyscraper out of wood. Therefore, we developed a market-ready hybrid timber building system for high-rise buildings up 100 m and 30 stories. Cree as a subsidiary of Rhomberg is set to demonstrate the versatility as well as the feasibility of this modular construction system. Three main objectives were pursued:

Large-volume building:
As a result of the global trend towards urbanization, efforts were made to develop a solution for use in an urban context. The objective was the development of a high-rise building solution capable of reaching up to 30 stories or 100 m in height.

Resource efficiency:
The shortage of resources and the associated rising prices of raw materials turn the intelligent use of material goods into an enormous competitive advantage for the building industry. Therefore timber, a renewable and local resource, was chosen as the basis for the development of the new building system. Its reduced "ecological backpack" is only half that of conventional buildings. Moreover, wood as a material has the potential to improve the CO2 balance by 90% and reduce the weight of the building by 50%.

System building:
A further objective of the research was to develop a standardised universally usable modular system containing a significant proportion of building technical services (heating, cooling, ventilation,…). The individual elements should, as in the automotive industry, be capable of being prefabricated in a factory and modular to the extent required by the client. The concept of serial off-site production was intended to ensure economies of scale, consistently high quality and rapid erection of the building on site.

The first research project "8+" investigated the technical feasibility of buildings in wood construction. The results showed that it was technically feasible (from a structural engineering point of view) to erect buildings 80 metres or more in height. The research did not consider the commercial marketability or the likelihood of obtaining statutory construction approval of the final concept. It was therefore not possible to construct a building based on principles of the "8+" research project.

The second "LifeCycle Tower" research project extended the findings of the "8+" project and developed a new building system modified to suit the requirements of the modern real estate market. Industrial prefabrication and special consideration of fire safety in the design led to the new product becoming ready for the market. The eight-story prototype “LCT ONE” that has been constructed in Dornbirn, Austria and the first customer project IZM being built in Vandans, Austria demonstrate the proof of concept.

Embodied Carbon through Building Products' Supply Chain

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Extended Abstract

Due to technology improvement, the intensity of operational carbon in building is expected to decrease over the life time of buildings; however, over the same duration, materials that have gone into buildings will not change their embodied carbon. Therefore the share of embodied carbon will steadily increase over time. In the longer term, when zero (operative) carbon emission buildings become popular, the carbon emissions of the elements that go into buildings will be our key concern in carbon reduction. The knowledge of carbon emissions attributed to building products should help us target where and what innovations can be prioritized to reduce carbon. Based on this context, this paper is intended to provide a process-based method to quantify the embodied carbon of any building product for the purpose of hot spot analysis in the product.
In this paper, we present the importance of embodied carbon for buildings and building products. And also this paper suggests a method of evaluating embodied carbon in building products considering their supply chain. The proposed method provides two capabilities for the improvement of product design relating to carbon reduction: (1) quantification of embodied carbon; and (2) identification and analysis of hot spots within the direct control of the manufacturer of the final product. From the perspective of the embodied carbon quantification, the cradle-to-factory gate system boundary includes all stages in the product's life cycle from extraction of materials, through processing, transportation and manufacturing. From the perspective of performing hot spot analysis on the production of the product, the method restricts the embodied carbon modelling and analysis to the realm of influence, in which production related activities, can be direct controlled or influenced by the manufacturer of the final product.

As an illustrative example, a typical aluminium window system was selected having size of 600 (mm) high and 600 (mm) wide, as an illustrative example assessment in this case. The key materials for this are aluminium, glass, PVC rubber, butyl rubber and powder coat. The assessment was performed on a 0.36m2 (600mm x 600mm) aluminium window in a manufacturing plant located in Victoria and supplied in within Australia.

The consideration of carbon management is not only due to the concern about climate change impacts but also due to the concern about increasing energy and carbon costs in product and supplier systems. The embodied carbon of a building is a small part of building's life cycle, but it is increasing its significance due to energy efficiency of buildings during their operation. This paper has outlined the importance of embodied carbon, illustrating static vs. dynamic carbon intensity of electricity for the production and operation of buildings. This paper shows when considering the dynamic projections of carbon emissions associated with electricity generation, embodied carbon will play a more significant role in carbon reduction as it becomes a higher proportion of total carbon emissions over the life time of the building.

This study intends to identify an opportunity to reduce embodied carbon in building product supply chain and suggests a methodology to evaluate the embodied carbon in the supply chain of a building product brand. Though a manufacturing process can be optimised for least carbon emission, the total carbon may not be decreased, if high carbon products are supplied for their assembly or manufacture from upstream. This is well illustrated in the case study in the paper. This study has shown that the embodied carbon management in product supply chains has the potential to effectively reduce carbon, because it can identify hot spots (or key materials) of carbon emission in the manufacturing process as well as in the supply chains.

Through the case study, this study demonstrates embodied carbon in building product supply chains can provide useful information to assess the real value of design decisions that reduce energy and carbon emission through improved supplier chain and/or selecting alternative options (e.g., through selecting local suppliers and avoidance of transportation of raw materials or adopting alternative products which have less embodied carbon upstream (adopting recycled aluminium or replace aluminium product with uPVC which has less embodied carbon).

Fluid Glass Façade Elements: Energy Balance of an Office Space with a Fluid Glass Façade

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Abstract

Since transparency is an important element of architecture, also large-scale buildings often are equipped with a high proportion of areas with transparent façades. This can lead to major problems from an energetic and comfort point of view, especially in high-rise buildings, where conventional external overheating protection cannot be used due to the wind loads.

In this paper a glass façade system is proposed, which controls the energy flows within the transparent building envelope [1]. Two fluid-filled layers are set into the glass façade. The inner fluid layer keeps the inside surface temperature just below or above room temperature for heating and cooling, while the outer, dyeable liquid layer controls the energy transmission by absorption of the solar radiation. The inside and outside fluid layers are thermally separated by a commercial insulating glazing unit [2]. Three standard types of glazing are adopted as benchmarks for the fluid glass: a double glazing unit (DGU) with an overall heat transfer coefficients (U-value) of 2.6W/m²K, a solar-control glazing unit (SCGU 0.7) with a U-value of 0.7W/m²K and a solar-control glazing unit (SCGU 0.4) with a U-value of 0.4W/m²K. Yearly energy consumptions of an office space are calculated in Munich and Dubai as illustrated in *Fig.1* and *Fig.2*, respectively. The dimensions of the room are 3.0 x 3.5 x 5.0 meters (height x width x depth). Two fluid glass scenarios are considered: one with adjustable transparency (fluid glass dyed) and one with constant properties of a clear fluid (fluid glass clear), both with U-values of 0.44 W/m²K.

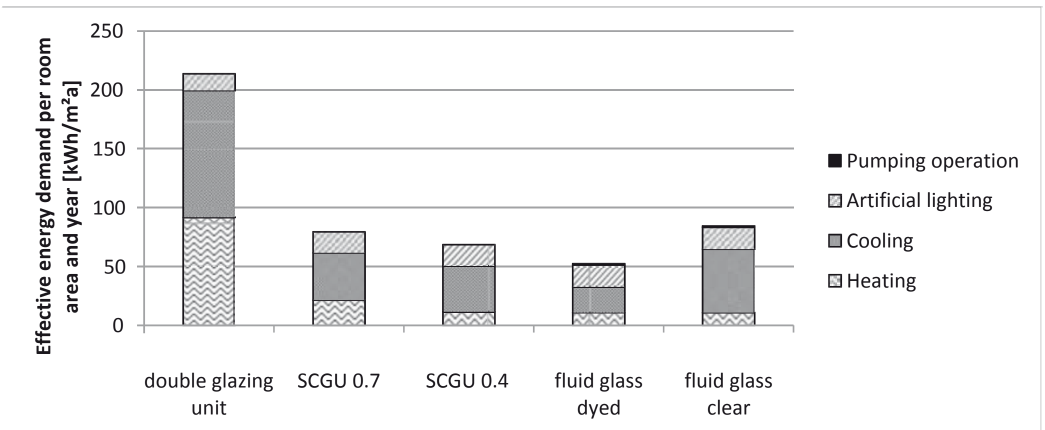

Fig. 1: Munich south-west orientation: Yearly effective energy demand for five different glazing scenarios.

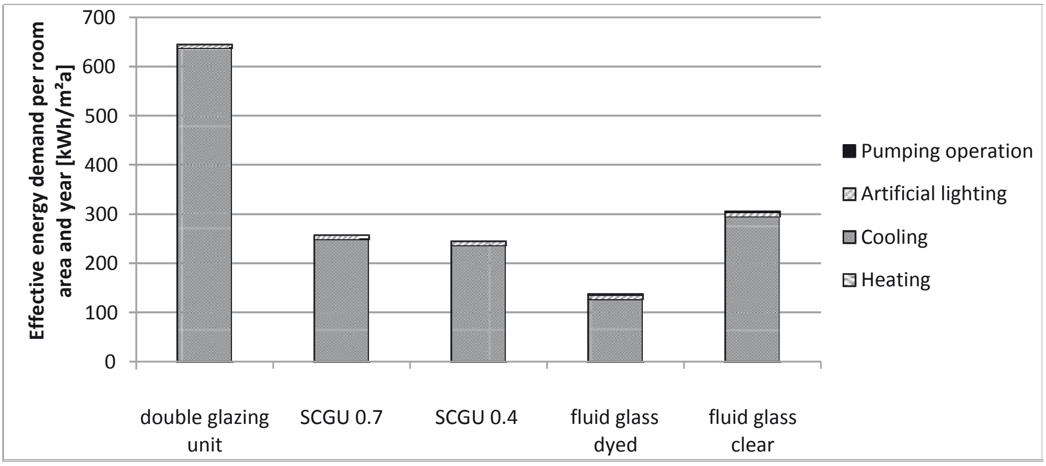

Fig. 2: Dubai south-west orientation: Yearly effective energy demand for the five different glazing scenarios.

The office space is calculated with a theoretical glazing share of 100% within the façade area. The cooling demand is strongly connected to the g-value of the glass unit. Without coloring the fluid, the cooling demand with fluid glass is approximately 39% higher than with SCGU in Munich, and approximately 25% higher in Dubai. While colored fluid glass nearly halves the cooling demand compared to SCGUs. Colored fluid glass show an overall saving in the energy demand of approximately 23% in Munich, and approximately 44% in Dubai, compared to the SCGUs. Thus, using dye to control the solar transmission is crucial for successful implementation of the fluid glass concept. By coloring the outer liquid layer, a huge fraction of the solar radiation is absorbed in the fluid. As a result, the temperature of the liquid layer rises, but not the room temperature. Since the energy is absorbed at an elevated temperature, it can be transferred to the environment without the need of active cooling. The stagnation temperature of the fluid rises up to a maximum value of 61°C in Dubai. Both for the heating and the cooling operation of the colored fluid glass, the temperatures of the inner fluid layer are very close to room temperature. In Munich, for example, the highest fluid temperature for heating purposes is 25°C. In combination with a heat pump, a highly efficient heating system can be obtained, resulting in low primary energy demand.

The current study showed the high potential of fluid glass façades for reducing the energy demand of an office space, mainly for cooling purposes.

Keywords: Solar energy, renewable energy, energy efficiency, building envelope, energy consumption, adaptive facades

1. References

[1] Patent WO 98/51973.

[2] GSTOEHL D., STOPPER J., BERTSCH S., SCHWARZ D., „Fluidised glass facade elements for an active energy transmission control“, World Engineers’ Convention 2011, Geneva, 2011.

Demand-Side-Management with Heat Pumps for Single Family Houses

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Abstract

The dynamic expansion of renewable energy production, especially solar and wind power, will accelerate the transformation process from a fossil fuel based energy supply to a sustainable energy supply in the energy sector. However, the fluctuation of the renewable energy supply represents a new challenge for the system during the implementation of this transformation process. Generally, photovoltaic panels and wind turbines feed electric power into local power grids independently of demand. The power generation from renewable energy sources mostly depends on local weather conditions, and for this reason it is difficult to adapt the power generation to the power demand from local power grids. This instability makes it clear that we must change our energy supply and consumption systems from demand-oriented energy generation to generation-oriented energy consumption. Achieving this primarily requires demand side management (DSM) and intelligent storage technologies. With these technologies, the share of fluctuating electricity from renewable energy sources can be compensated and the consumption of surplus electricity will be more flexible. In this context, the building sector has huge potential, as the building sector accounts for about 40% of final energy consumption in Germany. In total, more than 70% of the final energy consumed in households is used for space heating and hot water in Germany.

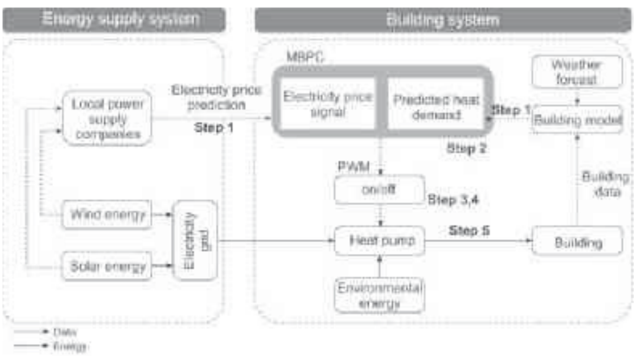

Fig. 1: Basic control concept for the model based predictive control of heat pumps

The objective of this study is to evaluate the fraction of residential heat demand which can be expected to be covered by using electric heat pumps coupled with an underfloor heating system as

variable loads. The main aim is to improve the utilization of surplus electricity from renewable energy sources in space heating and to stabilize the indoor temperature within a given comfort interval. In order to achieve this, this study is aimed to develop a heat pump control system for single family houses which takes into account heat storage capacity of building elements, predictions such as weather conditions—which allow an explicit prediction of heat demand of buildings for a certain period of time, as well as wind and solar power generation. In this study we have estimated the electricity consumption and generation, from photovoltaic panels and a planned wind farm (10MW), of the city of Wolfhagen in Northern Hessen, Germany, in order to investigate local surplus electricity. For the detailed simulations of the building model coupled with a ground source heat pump system, dynamic thermal simulation with TRNSYS was chosen as a tool. The heat pump model is based on the standard product data files, containing catalog data for the capacity and power draw, and was connected to the building model (single family house). In the simulation, the load of the heat pump and the power surplus can be matched through the control system with DSM, in the best case, more than 76% of the time with minimal influence on operative room temperature. Accordingly, the primary energy demand can be reduced by up to 50% compared to a conventional control system. This means that most of the residential heat demand, in the context of widespread use of heat pumps with DSM, can be covered by surplus electricity from renewable energy sources, thus also replacing heat generated for fossil fuel based heating system. From a user's perspective, the control structure in combination with DSM provides significant energy saving potential by heat pump operation coupled with under-floor heating systems. However, this kind of energy saving is only possible if the slight temperature fluctuation is by user- allowed. At the same time, the load shifting with heat pumps has a positive effect on grid stabilization.

Keywords: heat pump, Demand Side Management, energy storage, under-floor heating

A High-Tech Curtain Wall System for 21st Century

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Summary

In this paper we would like to present our innovative and completely new curtain wall system, Qbiss Air. Qbiss Air system, envisioned to be used for every type of skeleton buildings, can fulfil future demands on the market of high-tech energy efficient curtain wall systems. Curtain walls are used in more than 80% of high-rise buildings. However, high heat transfer (U) values are associated with such systems. Average U values of below 1 W/m^{2}K appear hard to achieve due to architectural and glazing limitations. Nowadays, some national codes for efficient energy usage require U values to be lower than 0.3 W/m^{2}K. We, Trimo d.d. and CBS institute d.o.o. developed an energy efficient curtain wall panel which consists of multi chamber gas filled insulation core covered with enamelled glass (outer plate) and appropriate glass or gypsum (inner plate) of maximum size 4000x1250mm. Prefabricated Qbiss Air panels are manufactured in a semi-automated assembly line. The U value of the raw gas filled insulation core is as low as 0.17 W/m^{2}K, at thickness of 100 mm, and the U value of complete Qbiss Air system together with integrated all necessary load bearing profiles and gaskets can be as low as 0.25 W/m^{2}K. Sound impedance is at least 45 dB in the basic version and can be pushed up to 60 dB.

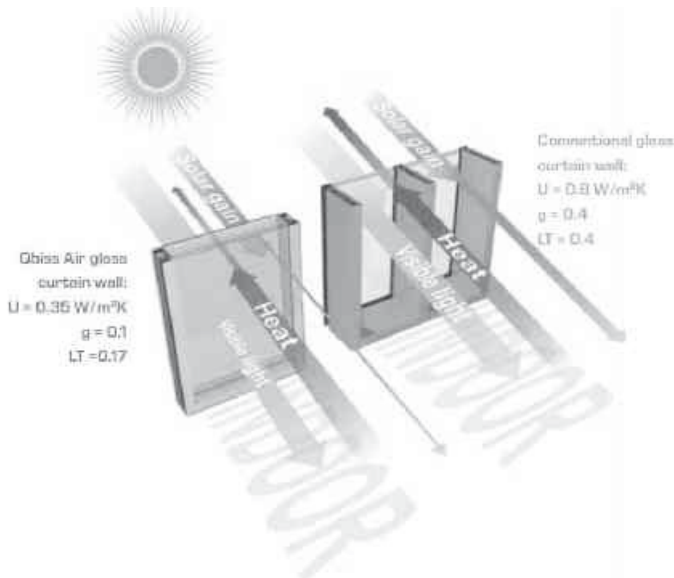
Keywords: Curtain wall; gas-filled insulation; energy efficiency.

Qbiss Air curtain wall system

Qbiss Air curtain wall system is envisioned in a way that it can be used for every type of skeleton building and can also fulfil future demands on the market of the high-tech energy efficient curtain wall systems. Curtain walls are used in more than 80% of high-rise buildings. However, rather high heat transfer values (U) are associated with such systems. Average U values of below 1 W/m^{2}K are hard to achieve due to architectural and glazing limitations. Nowadays, national codes for efficient energy usage require U values to be as low as 0.3 W/m^{2}K. Our answer to demanding market of energy efficient and green buildings is a complete novelty in curtain wall systems: Qbiss Air. Qbiss Air is a gas-filled panel curtain wall system. The basic idea was to produce insulation material which can offer best price performance ratio regarding thickness with as low as possible environmental effect. We found several attractive options amongst modern refrigerant gases (R32, R23), inert gases, CO_2 and others. We chose CO_2 and argon to be used as an insulation gas mainly because of economical, ecological and engineering reasons. On the basis of experimental work we proposed two different types of Qbiss air elements:

1. Qbiss Air opaque with five gas partitions with 20 mm gaps for use with either argon or CO_2. The gas chambers are delimited with thin aluminium foils, which together with insulation gas allow low U value (U=0.17 W/m^{2}K at thickness of 100 mm).

2. Qbiss Air transparent or translucent with four gas partitions with 18 mm gaps for use with argon and one 18 mm air partition. The gas chambers are delimited with 3 thin glass panes and one expansion glass pane which together with insulation gas enable low centre of glass U value ($U=0.29\ W/m^2K$ at thickness of 100 mm)



Qbiss Air transparent in comparison with standard solution

6. Special Forum

Special Forum Fraunhofer-Allianz Bau

Nachhaltigkeit von der Theorie auf die Baustelle - geht das heute schon?

Organiser: Fraunhofer-Allianz Bau

Date: 26.04.2013

4 Impulsvorträge (à 15 Min.) von 11:00 – 12:15

Podiumsdiskussion von 12:15 – 13:00

Session Chair: Prof. Dr. Klaus Sedlbauer (Fraunhofer IBP)

Nachhaltigkeit ist seit langem in aller Munde.

- Doch was kann Nachhaltigkeit im Bauwesen bewirken?
- Wie kann man Nachhaltigkeit im Bauwesen vorantreiben?
- Wie ist sie in der Praxis umsetzbar?
- Was sind die aktuellen und vor allem die nachhaltigen Trends am Bau?

Sprecher

Nachhaltige Perspektiven am Bau
Prof. Dr.-Ing. Klaus Sedlbauer, Institutsleiter Fraunhofer IBP

Zertifizierung als Motor für Nachhaltigkeit
Prof. Dr. Dr. E.h. Werner Sobek, Werner Sobek Gruppe, Leiter des Instituts für Leichtbau Entwerfen und Konstruieren, Universität Stuttgart

Bauqualität als wesentliche Säule der Nachhaltigkeit
Dr. Eike Messow, Leiter Nachhaltigkeit, Sto AG

Nachhaltigkeit – Vergesst den Menschen nicht!
Mag. Dr. Heimo Scheuch, Vorstandsvorsitzender Wienerberger AG

Kommt die Nachhaltigkeit auf der Baustelle an?
Dipl.-Ing. Daniel Georg Keppel, Leiter Gebäudediagnose / Green Building, HOCHTIEF Solutions AG

Podiumsdiskussion
Nachhaltigkeit von der Theorie auf die Baustelle – geht das heute schon?
Moderation Prof. Dr.-Ing. Klaus Sedlbauer

Special Forum BMVBS

Nachhaltige Beschaffung von Gebäuden durch die öffentliche Hand
Sustainable procurement of buildings by public authorities

Organiser: Bundesministerium für Verkehr, Bau und Stadtentwicklung

Thema
Das Special Forum **„Nachhaltige Beschaffung von Gebäuden durch die öffentliche Hand"** findet im Rahmen der **internationalen Sustainable Building Conference München (SB13)** statt. Die nachhaltige Beschaffung ist ein zentrales Thema in den öffentlichen Verwaltungen. Die Bundesregierung unterstützt diese Entwicklung. So stellt das Bundesministerium für Verkehr, Bau und Stadtentwicklung mit den aktualisierten Leitfaden Nachhaltiges Bauen eine wesentliche Grundlage für die nachhaltige Beschaffung von Gebäuden im Bereich des Bundes zur Verfügung. Mit dem Bewertungssystem Nachhaltiges Bauen (BNB) liegt zusätzlich ein praxisbezogenes Instrument zur ganzheitlichen Nachhaltigkeitsbewertung für Gebäude des Bundes vor. Im Workshop werden Grundlagen und Hilfsmittel zur nachhaltigen Beschaffung vorgestellt und diskutiert. Es ist in besonderer Weise an die Abläufe und Bedürfnisse der öffentlichen Hand angepasst und kann daher zur Unterstützung einer nachhaltigen Beschaffung aber auch im Rahmen des Planes und Bauens durch Länder, Kommunen und sonstige öffentliche Bauherrn eingesetzt werden.

Topic
*The Special forum **"Sustainable procurement of buildings by public authorities"** takes place in the context of the **international Sustainable Building Conference Munich (SB13).** The sustainable procurement is a central topic in the public administrations. The Federal Government supports this development. So the Federal Ministry of Transport, Building and Urban Development provides with the updated "Guideline Sustainable Building" an essential basis for the sustainable procurement of buildings in the area of the federal government and administration. The Assessment System for Sustainable Building (BNB) can now serve as an additional practical instrument for an integral sustainability assessment of federal buildings. It is adapted in a special way to the processes and needs of the public authorities and can therefore be used for the support of a sustainable procurement as well as in the context of planning and construction of buildings by the federal states, communities and other public institutions. In the workshop basics and tools are introduced and discussed for the sustainable procurement.*

Programm / Program

Prof. Dr.-Ing. habil. Thomas Lützkendorf
Lehrstuhl Ökonomie und Ökologie des Wohnungsbaus (ÖÖW)
Karlsruher Institut für Technologie (KIT), Deutschland
Einführung
Introduction

Dipl.-Ing. Nicolas Kerz
Leiter der Geschäftsstelle nachhaltiges Bauen im Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR), Deutschland
„Leitfaden und Bewertungssystem Nachhaltiges Bauen als Instrument zur nachhaltigen Beschaffung öffentlicher Gebäude"
"Guideline and Assessment System for Sustainable Building" as an instrument for the sustainable procurement of public buildings".

Dr.-Ing. Günter Löhnert
sol i dar planungswerkstatt berlin Deutschland
„Auf die Prozessqualität kommt es an: Planungsbegleitung mit dem Bewertungssystem BNB zur Optimierung des Planungs- und Bauprozesses"
„It depends on the process quality: Attendance of planning with the sustainability assessment system "BNB – Sustainable Building" for the optimization of the planning and construction process"

Til Bolland
Umweltbundesamt, Deutschland
„Auswahl und Bewertung von Bauprodukten im Sinne einer nachhaltigen Beschaffung"
"Choice and assessment of construction products according to a sustainable procurement"

Dipl.-Ing. Sabine Erber
Beratungsservice für Energieeffizientes und ökologisches Bauen Energieinstitut Vorarlberg, Österreich
„Servicepaket Nachhaltiges Bauen in Gemeinden"
"Service package Sustainable Construction in Communities"

Nicolas Kerz (BBSR)

Leitfaden und Bewertungssystem Nachhaltiges Bauen als Instrument zur nachhaltigen Beschaffung öffentlicher Gebäude

Umweltgerechte Produktauswahl und energieeffiziente Gebäude stehen im Bausektor als Synonym für eine nachhaltige Beschaffung der öffentlichen Hände. Bei dem zu beschaffenden Gut, handelt es sich in der Regel um bauliche Leistungen oder Bauprodukte, die durch unterschiedlichste Leistungspositionen unter Berücksichtigung einzelner Aspekte der Nachhaltigkeit beschrieben werden. Umweltgerechte Ausschreibungen, direkte Materialverbote, die Berücksichtigung sozialer Fragestellungen bei der Vergabe, das wirtschaftlichste Angebot etc. finden dabei heute schon Berücksichtigung und werden in Verordnungen bzw. Richtlinien umfänglich geregelt.

Impliziert die Summe vieler nachhaltiger Produkte aber auch gleichzeitig ein nachhaltiges Gebäude? Aus Sicht des Bewertungssystems Nachhaltiges Bauen müsste man die Frage wohl mit „Nein" beantworten, da viele entscheidende Nachhaltigkeitsfragen oberhalb der Produktebene angesiedelt sind.

Ganzheitliches betrachten und bewerten im Sinne eines nachhaltigen Handelns erfolgt in weitaus größeren Dimensionen / Systemgrenzen. Das BMVBS hat sich deshalb bewusst entschieden, die Nachhaltigkeitsbetrachtung auf Gebäudeebene zu führen. Mit dem Leitfaden Nachhaltiges Bauen 2013 und dem Bewertungssystem Nachhaltiges Bauen liegen die Regeln und Instrumente für den Neubau, den Betrieb und die Modernisierung des Bestandes nunmehr vor.

Guideline and Assessment System for Sustainable Building as an Instrument for Sustainable Procurement of Public Buildings

Environmentally responsible product selection and energy-efficient buildings are in construction sector a synonym for sustainable procurement of public authorities.

The procured goods are usually engineering services or construction products, which are described by different tender positions taking into account individual aspects of sustainability. Environmentally responsible procurement, direct material bans, integration of social questions in the award, the most economic offer etc. find it already taken into account and are regulated in regulations or directives.

Implies the sum of many sustainable products as well a sustainable building? From the perspective of a sustainable building assessment system the question probably would have answered with "No", because many key issues for sustainability are located above the product level.

A holistic look at and the evaluation as an idea of sustainable action, follows in much larger dimensions / system boundaries. As a result the Federal Ministry for Transport, Building and Urban Development make the decision to lead the sustainability assessment at the building level. With updating the Guideline Sustainable Building 2013 and the Assessement System Sustainable Building, the rules and instruments for new construction, operation and modernisation of the building stock are now available.

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DEUTSCH

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“Auf die Prozessqualität kommt es an: Planungsbegleitung mit dem Bewertungssystem BNB zur Optimierung des Planungs- und Bauprozesses“

Die Qualität der Planung erlangt eine immer größere Bedeutung, da sich sowohl der Umfang der Planungsbetrachtungen als auch das Potenzial der Einflussnahme auf die spätere Performance des Gebäudes bzgl. Energie- und Kosteneffizienz sowie Komfort und Nutzungsqualität in frühen Planungsstadien am größten ist.

Gegenüber dem traditionell linearen Planungsansatz ist die iterative Vorgehensweise eine unbedingte Voraussetzung hin zum integralen Planungsprozess, der eine Planungsoptimierung durch ganzheitliche Betrachtungen und interdisziplinäre Bewertungsmethoden gewährleistet.

Der Beitrag adressiert Potentiale und Störungen im Planungs- und Umsetzungsprozess aufgrund einschlägiger Erfahrungen aus projektbegleitender Beratung sowie Qualitätssicherung und Zertifizierung von Projektbeispielen und liefert Empfehlungen zur Konfliktvermeidung und Verbesserung der Prozessqualität durch Planungsmanagement.

ENGLISH

Dr. Günter Löhnert, sol·id·ar planungswerkstatt berlin

“Design process quality is the challenge: Planning support by using the BNB assessment system to optimize the design and construction process“

Quality of planning obtains more and more prominence, since both the scope of design issues and the potential exerting an influence on future building performances such as energy and cost efficiency as well as comfort and functionality are most significant in very early design stages.

Opposite to the traditonal linear design approach an iterative procedural method is an inevitable prior condition towards an integrated design process which ensures a design optimisation by holistic considerations and by means of cross-disciplinary assessment methods.

The contrubution addresses potentials and troubles during the design and constructuion process based on relevant expert knowledge experienced from numerous projects facilitated as well as from quality assurance and certification activities. Moreover the contribution provides recommendations for conflict avoidance and for enhancing design process quality by planning management.

Landeshauptstadt München Baureferat

SWM Stadtwerke München

Special Forum - City of Munich

Municipal Strategies for Climate Protection and the Expansion of Renewable Energies

Speakers:

Rosemarie Hingerl

Dr. Florian Bieberbach

Lectures: **Climate Protection Strategies and Measures for Municipal Buildings**

Rosemarie Hingerl, Governing member of the City Council and Head of the Department of Public Construction, City of Munich

Munich's renewable energies expansion campaign: 100% green electricity by 2025

Dr. Florian Bieberbach, CEO, Stadtwerke München GmbH

The Bavarian state capital Munich has been engaging in climate protection for many years and set out the ambitious goal to reduce its CO2 emissions by 50% compared to 1990 levels by 2030 at the latest. In 2008 the City Council of Munich brought about the decision of principle on the "Integrated Action Program for Climate Protection in Munich" – IHKM (*Integriertes Handlungsprogramm Klimaschutz in München*).

The IHKM pools several projects and measures of the City of Munich on climate protection. The new interdepartmental organization supports the coordinated development of measures and bundles existing projects and measures. The results are updated and presented regularly as a worked out climate protection program to the City Council for resolution.

Lecture Rosemarie Hingerl:

Climate Protection Strategies and Measures for Municipal Buildings

Munich's Department of Public Construction is playing a key role in reducing energy consumption, expanding the use of renewable energies in municipal buildings, and electrical transport infrastructure. In 1997 the City Council assigned central energy management to the Department of Public Construction and has intensified the ongoing work through numerous resolutions since then. In this context, the Department of Public Construction developed building and energy standards as well as energy concepts and implemented those for the planning, building, refurbishment, and operation of municipal buildings.

The "Climate Protection Program 2010" – KSP (*Klimaschutzprogramm 2010*) was the first package of measures which was approved within the framework of the IHKM. The Department of Public Construction focused on building refurbishment to improve energy-efficiency. After its implementation the KSP was assessed and the follow-up program KSP 2013 was established. In order to maintain the scope of the building refurbishment works for higher energy efficiency financial means to the tune of €47.2M were granted for this project. In addition to the refurbishment project further measures on energy saving and expanding the use of renewable energies are implemented with an additional investment volume of €5M. Preparation works for the follow-up program KSP 2015 have already started.

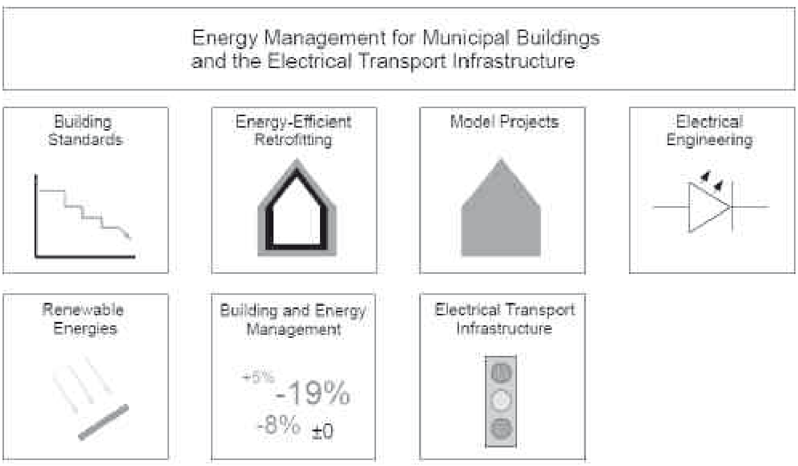

Fig.: The 7 main topics of the IHKM at the Department of Public Construction

Lecture Dr. Florian Bieberbach:

Munich's renewable energies expansion campaign: 100% green electricity by 2025

Stadtwerke München GmbH (SWM) has concertedly forged ahead with the expansion of renewable energies for many years now and has set itself an ambitious goal: By 2025, SWM want to produce enough green electricity in their own production facilities to meet the electricity requirements of the state capital's private households and companies, which is as much as 7.5 billion kilowatt-hours. This would make Munich the world's first city of more than a million inhabitants to achieve this goal. By then, SWM will have invested some € 9 billion in renewable energies.

As far as technology is concerned, SWM will be opting for a broad-based portfolio of renewable sources of energy such as wind, hydro, solar, biomass and geothermal. The overriding premise for all projects is always economic viability. Meticulous identification and reviewing of suitable projects is guaranteed by SWM's participation management. Particularly with large-scale projects such as an offshore wind park, SWM do not generally take on the role of the developer or operator. The demands SWM places on the credibility and experience of their business partners are therefore commensurately high.

Wherever possible, SWM give priority to local projects in Munich and in the region provided, of course, that they fulfill SWM's requirements. However, the expansion potential within the Munich region is far from sufficient to allow SWM to achieve their ambitious objectives. SWM's supra-regional commitment therefore leads SWM to where the winds are stronger and blow more consistently, and to where the sun shines more frequently and strongly.

Special Forum DBU 1

Planning resources and strategies for supporting optimal energy efficiency during the planning, operation and completion of buildings and urban structures

Organiser: Deutsche Bundesstiftung Umwelt

Date: 24.04.2013 from 16:00 – 17:30

Session Chair: Sabine Djahanschah (Deutsche Bundesstiftung Umwelt)

Session language: German with English PowerPoint - texts

1. Workshop Wednesday 24.04.2013 16:00 to 17:30

Philosophy of sponsoring of the Division “Architecture and Building”

Sabine Djahanschah, Head of Division “Architecture and Building” of the Deutsche Bundesstiftung Umwelt DBU

Strategies for climate neutrality in the building sector up to 2050

Dr. Burkhard Schulze-Darup Schulze Darup & Partners (architects)

Passive houses for different climate zones

Dr. Jürgen Schnieders Passive House Institute

Quality management and evaluation of sustainable buildings in Germany

Stefan Plesser Institute of Building Services and Energy Design, Technische Universität Braunschweig

This workshop will deal with the relevant planning resources and strategies for optimal energy efficiency in the planning, operation and completion of buildings and urban structures. During the introduction, Sabine Djahanschah, architect and head of division of the Architecture and Building division of the Deutsche Bundesstiftung Umwelt (DBU) will explain the role played by energy policy, climate protection and energy efficiency in its funding activities. How can greater energy efficiency be achieved by developing planning resources, methods and strategies? How are sustainable processes over the entire life cycle of buildings and urban structures created in so doing? What policy does the DBU follow and what are the current funding criteria and subject areas? The three contributions that follow will give further insight into specific funding projects and their results. Dr. Burkhard Schulze-Darup will explain the strategies to achieve climate neutrality by 2050. Using the discussion around the framework conditions and standards necessary for this, a possible route for achieving climate protection targets will be described by means of practical examples from projects and urban concepts, ranging from broad impacts to local climate protection strategies. Dr. Jürgen Schnieders from the Passive House Institute in Darmstadt will present a study in which the adaptation of the passive house concept will be analysed and described for 5 relevant climate zones worldwide. Can the passive house concept be applied on a global scale? What are the opportunities and limits of applying the passive house concept on a global scale? Stefan Plesser of the Institute of Building Services and Energy Design at the Technische Universität Braunschweig will explain the project results in terms of quality management and the evaluation of sustainable buildings in Germany. What are the properties of sustainably planned buildings? What are the opportunities offered by quality management and monitoring of buildings in view of achieving the defined objectives? How can optimal use be sustained in the long-term, even after the monitoring phase has been carried out?

Special Forum DBU 2

Sustainable construction of schools – two pilot projects in energy efficiency, a healthy indoor climate and the role of optimal material selection in the life cycle

Organiser: Deutsche Bundesstiftung Umwelt

Date: 25.04.2013 from 11:00 – 12:30

Session Chair: Sabine Djahanschah (Deutsche Bundesstiftung Umwelt)

Session language: German with English PowerPoint - texts

Philosophy of sponsoring of the “Architecture and Building” division

Sabine Djahanschah, Head of Division “Architecture and Building" of the Deutsche Bundesstiftung Umwelt DBU

Integrated development including monitoring of a sustainable nearly-zero-energy school-analysis of project execution

Hanns-Peter Kirchmann kplan AG, Dr. Jens Kuckelkorn ZAE Bayern

Integral planning process including pedagogics, timber construction and healthy building materials for a Plus-Energy Gymnasium Diedorf

Prof. Hermann Kaufmann, TU München

The role of renewable materials in the building sector and in the Life Cycle Assessment of buildings

Holger König, ASCONA

This workshop will present two pilot projects relating to the sustainable construction of schools and the attendant processes in integrated planning, implementation and evaluation. In the opening presentation, Sabine Djahanschah, DBU, will explain funding philosophy in the context of current focal points in the sustainable building of schools. How can sustainable school construction be kick-started through the promotion of integrated planning processes? What are the funding criteria and subject areas? What makes for sustainable school construction according to the DBU? The three contributions that follow will give further insights into specific development projects and their results. The example of a vocational school in Erding focuses primarily on the subject of a passive house school with optimal electricity consumption and primary energy demand within a healthy indoor climate. Is achieving this energetic quality within the bounds of comparable construction costs for school buildings possible while at the same time sticking to the energy-saving regulation? What are the initial results of the ongoing evaluation carried out by the ZAE? The second project undertaken by the Plusenergie Gymnasium in Diedorf includes further sustainability objectives, in addition to energy efficiency and comfort. These include the development of adapted spatial and technical concepts for new forms of learning, the comprehensive use of renewable resources and optimised material selection. How can new educational concepts be incorporated into the planning process, and what does this mean for architects and expert planners? What advantages and new solutions-based approaches does timber construction offer for the sustainable building of schools? In the final contribution, the role of renewable raw materials, life cycle analysis and experiences in the reduction of high-risk building materials will be discussed on the basis of both pilot projects. How can the risk of incorporating materials which present a clear danger to human health be reduced? What is the relevance of the enhanced use of renewable raw materials in construction? What are the potential results of integrating life cycle analyses in the planning process?

Special Forum DBU 3

Pilot projects for sustainable renovation strategies for (listed) post-war buildings and innovative system solutions for timber construction

Organiser: Deutsche Bundesstiftung Umwelt

Date: 25.04.2013 from 16:00 – 17:30

Session Chair: Sabine Djahanschah (Deutsche Bundesstiftung Umwelt)

Session language: German with English PowerPoint – texts

Philosophy of sponsoring of the "Architecture and Building" division

Sabine Djahanschah, Head of Division "Architecture and Building" of the Deutsche Bundesstiftung Umwelt DBU

Refurbishment of buildings of the post-war period listed as monuments with the example of the Berlin "Siedlung am Schillerpark"

Winfried Brenne Brenne Architects

Building with wood up to the high-rise height limit

Arthur Schankula Schankula Architects

Gymnasium Baesweiler energy-saving refurbishment with passive house standard for new buildings

Prof. Ludwig Rongen RoA Rongen Architects GmbH

Opportunities via renovation of existing buildings dealing with the GDR (German Democratic Republic) pre-fabricated building types

Prof. Martin Wollensak Hochschule Wismar

The sustainable renovation of our existing building stock is a central component of our energy policy. The ways in which it may be applied in practice is demonstrated by three examples of pilot projects already carried out. Is it possible to retain historically valuable buildings in spite of modern energy efficiency regulations and interior comfort requirements? Is it possible to demonstrate synergies between climate protection and listed monument protection by means of in-depth planning and the accompanying research? An example is given for illustration, namely the Berlin Siedlung Schillerpark. Owing to the ever-increasing need for housing in urban centres, new buildings are still in demand. How can they be built in such a way as to require few resources and yet remain socially palatable? What role can timber construction play in this market segment?

Examples of sustainable renovation concepts are also in demand for public buildings. The large portion of post-war building stock will be part of the first wave of renovation. What energy standards should be applied and may reasonably be achieved? Is a structural upgrade of our existing buildings possible with the planned energy renovation? The first school building renovated and certified according to passive house standards demonstrates economic, ecological and artistic potential. A further example of renovation of a post-war kindergarten demonstrates the new use options which go hand in hand with cost and energy-efficient renovation. Can user satisfaction be palpably influenced by this? Is the potential of our existing building stock undervalued

Young Researchers Session

Organiser: Students of the Technische Universität München

Jonas Biet, Ahmed Khoja, Simone Magdolen

Date: 23.04.2013 from 09:30 – 17:00

Location: Oskar von Miller Forum München

Oskar-von-Miller-Ring 25, 80333 München

Session language: English and German

Undergraduate and graduate students in the sphere of sustainable construction and development are invited to the Young Researchers Session. As Part of the Sustainability Conference sb13 munich it will be held on the 23th of April 2013 in Munich.

Young researchers is given the opportunity to present their projects, dissertations, etc. to an interested audience. Following the presentations a discussion between all the participants will take place to identify the chances and the barriers facing the implementation of sustainability. The result will be presented in the sb13 munich closing statements.

Programm:

09:30-10:00 • Entry and welcoming

Young Researchers Session Organising Team

Holger Wolpensinger/Prof. Wolfgang Rid (NSE Network Sustainable Urban Development)

10:00-10:30 • Keynote

Nils Larson (iisbee)

10:30-12:00 • Presentations Block 1 (Young Researchers)

12:00-13:00 • Lunch and poster presentation

13:00-14:00 • Keynote

Dipl. Ing. Alexander Schwab (Bavarian Chamber of Architects)

Nils Klabunde & Zizheng Zhoung (TUM Graduate School)

14:00-15:30 • Presentations Block 2 (Young Researchers)

15:30-16:00 • Coffee break

16:00-17:00 • Final discussion

Speakers:

Block 1

- Shaikha Abdulattef Mubarak AlSanad
  The risks associated with the implementation of green construction practices in Kuwait
- Anderson John
  Life-Cycle Assessment of Induced Impacts in the Built Environment
- Georgi Georgiev
  Cattail-reinforced clay plasters in historic buildings preservation and new constructions: Sustainable building and spatial planning
- Emiliy Nault
  Solar potential and interactive design in the urban context
- Leopoldo Saavedra
  Biomimetic Architecture. The building as an organism. Biomimetic approaches for build systems
- Maryam & Mitra Mesbah
  Feasibility of PV cells in Residential Housing Design in Cyprus

Block 2

- Botzenhardt Julia, Matjeschk Benedikt & Päätalo Juha
  Angemessen sanieren? Die Suche nach Antworten an einem 50er-Jahre-Bau in München
- *HaidhausenLisbeth Fischbacher & Daniel Hoheneder*
  Flissade. Der wandelbare Raum
- Dominik Ganterer & Philipp Heinz Kölsch
  Die adaptive Fassade
- Amelie Lesser
  Erarbeitung eines Modells der gesamtenergetischen Entwicklung in Wohngebieten unter Berücksichtigung verschiedener Sanierungsszenarien
- Maria Sideri, Michael Vollmer & Florian Grindinger
  Lebenswerte Stadtquartiere – Untersuchung von Nichtwohngebäuden der Nürnberger Weststadt für einen zukunftsorientierten Stadtumbau

More Information: www.sb13-munich.com

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DBU OSKAR VON MILLER FORUM NSE e.V. Netzwerk Nachhaltige Stadtentwicklung

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