REPORT 9

SUSTAINABLE CONSTRUCTION
IN THE NETHERLANDS

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION

1.1 Methodology

The approach used in this study is to analyze the long-term goals and targets set by the national government and other bodies in the Netherlands and to derive from these a national agenda for the year 2010 (what do we want to achieve?). This normative framework is then used in conjunction with a definition of sustainable construction to identify the major issues and challenges facing the construction industry. These challenges, relating to socio-economic factors, technologies, and process management, are further elaborated at several scale levels: urban settlements and infrastructure, buildings and materials/components.

Full use is made of available future studies in the Netherlands to draft the outline of the present national report. A round-table discussion was held with experts in various fields to solicit their opinions and to define priorities. For those not able to attend the round-table discussions, drafts of the report were circulated for comments.

Moreover a limited number of face-to-face interviews were held with experts to identify the most important issues and their priorities. Taking the agenda for 2010 as a starting point ensures that the scenario used reflects a realistic, economically and politically backed approach towards sustainable construction in 2010 as viewed by Dutch society.

1.2 Scenario

The scenario adopted for 2010 is a policy target-based approach. It retains the direction and relative dynamism of the economic and political changes observed during the past years, including trends recently recognized. It involves a considered balance between environmental objectives and economic sustainability (CIB scenario 3: considered sustainment). Long-term goals and standards are set by government. Policy will keep relying on the principle of self-regulation in which the government sets realistic targets and directions, with target groups being responsible for meeting these goals. Partnership and consultation remains an important environmental policy tool. Where targets are not met, regulation will be enforced by government.

However, it is realized that the environmental problems of the future will have an international dimension. The increasing use of fossil fuels, lack of space and bio-diversity all relate to questions of resource redistribution on a global scale so that a quantum leap forward can only be made in a strong together scenario.

1.3 The Netherlands: concerns for tomorrow

Demography

The Netherlands has the highest population density in Europe (499 inhabitants per km^2 projected to 2010). As everywhere else in Europe, life expectancy is on the increase and is projected to reach 76 years in 2010. In 2010, those over 65 will make up 24.1% of the population. This ageing population, together with an anticipated decline in total population after 2025, will have a significant impact on the demand for housing and infrastructure. Careful planning of supply and demand will be needed in order to ensure that the housing supply remains adaptable to future needs as well as to prevent overcapacity.

A large proportion of the population (roughly 90%) live in urban settlements and some 30% of these people complain about nuisance from noise and odours.

Mobility and transportation

Dutch society owns 5.7 million cars and 0.6 million trucks which means 185 road vehicles per km^2. Of the total amount of freight within the Netherlands, 98% is transported by road. Road traffic alone is responsible for 22% of the national CO_2 emission. Because of the Netherlands' favourable geographic location with respect to the European hinterland and the opening up of new markets in Eastern Europe, its role as a transit country will only increase. Projections indicate a 70% increase in road transport kilometres between 1986 and 2010. Other modes of transport (rail, inland waterways and sea) urgently deserve attention.

Land use

Urbanization, the transport network, water catchment areas and recreation will increasingly compete for the limited space available. Growing conflicts concerning land use are expected between the demands for mobility, agriculture and urbanization. The problem of allocating space is not restricted to the Netherlands itself but also has a global dimension. The Netherlands uses up to five times its own surface area in other countries for the production and import of food, livestock fodder and timber.

Another point worth mentioning is that the highly populated western areas of the Netherlands are characterized by unstable soil conditions requiring large quantities of foundation materials (sand, gravel, concrete). Although natural resources for these materials are abundant within the country, their extraction causes large-scale permanent changes in the landscape which increasingly meet opposition from society.

Energy use

Energy consumption and economic growth are closely related. For the Low Countries, the effects of CO_2 emissions on the global climate are of particular importance in view of a possible rise in sea level. In this complex global issue the Netherlands aims at increasing the efficiency of energy use with an expected stabilization of CO_2 emissions by 2020. As the country's natural gas reserves, mainly used for domestic heating, are used up in the coming decades, the energy economy will change considerably, with much effort put into the search for alternative forms of energy and a possible reappraisal of nuclear energy.

Water management

Water management is of extreme importance. Much energy and infrastructure is needed to keep the ground water table at levels acceptable both to agriculture, the built environment and recreation. As fresh water of sufficient quality to be used for irrigation and drinking water becomes scarcer, water conservation and the prevention of soil dehydration will become key issues in the coming years. Coastal and river defences in the delta area of the Netherlands will require large quantities of raw materials for strengthening in order to cope with an anticipated rise in sea level due to global warming.

2. SUSTAINABLE CONSTRUCTION, AGENDA 2010

2.1 Definition of sustainable construction

Sustainable construction must be seen as a special case of sustainable development aiming at a specific target group (i.e., the construction industry). The construction industry is defined as all parties that develop, plan, design, build, alter, or maintain the built environment and includes building material manufacturers and suppliers.

In the Brundtland report (1987), sustainable development was originally defined as: "leaving sufficient resources for future generations to have a quality of life similar to our own". Later, the Advisory Board for Research on Nature and Environment in the Netherlands described it as follows: "sustainable development implies that the environmental impacts of human activities stay well within the limits of how much environmental impact the biosphere can absorb" **(RMNO 1994)**. This introduces the notion of "environmental utilization space" which is a complex concept involving resource availability, depletion indicators, pollution indicators and insight into the resilience of the biosphere at different levels of scale. The need to make choices and the introduction of value judgements becomes inevitable, and one of the difficulties is how to allocate the environmental space amongst the various sectors of industry and the developing countries. However, the attractiveness of the concept is that it allows taking a clear normative position on global equity.

By the year 2040, the world population will have increased to between two to two and a half times its current level. With an annual economic growth of 2.5% in the industrialized countries and 3.5% in the developing ones, the pressure on the environment per unit of wealth will have to be reduced by a factor 5 so as not to exceed the level of 1990. Taking into account that natural resources and wealth should be shared equitably throughout the world, an extremely ambitious 20-fold reduction in resource consumption by the high-consuming countries is needed (Sust. Res. Manag. RMNO). Extrapolating this figure to the year 2010 means a reduction by a factor of 10 in the consumption of resources.

The official Dutch definition for sustainable construction is: "a way of building which aims at reducing (negative) health and environmental impacts caused by the construction process or by buildings or by the built environment"(**1990 NEPP+**). The following principles were adopted:

- integral life cycle management (closed cycle of raw material use, retention in the cycle through life-time extension, prevention of waste, prevention of emissions);
- reduction in energy use;
- quality improvement (materials, buildings, built environment).

In the Netherlands, long-term government policy is based on the identification of three closely interconnected sustainability variables (or key resources):

- energy (energy efficiency, controlled growth of mobility)
- mineral resources (efficient use of raw materials and water)
- land use and bio-diversity (stringent planning of land use)

Energy is essential for all economic processes. It involves two environmental aspects: the environmental impact of the use of fossil fuels (CO_2, NO_x), and the energy needed to keep nonrenewable raw materials available (extraction and recycling).

Mineral resources including **water** are used in large quantities in the built environment. Most of these resources are nonrenewable and require an efficient use combined with closed-loop recycling.

Competition for **land use** will probably become more intense in the Netherlands than in other countries with lower population densities. The availability of space which is suitable for use is rapidly diminishing. Land is needed for buildings and infrastructure, availability of natural resources (biomass, water, minerals), conservation of viable biotopes and production of renewable energy. The concept of "land use" requires the integration of environmental policy and physical planning.

Bio-diversity involves maintaining the natural growth of renewable raw materials and the conservation of the life support function of nature including the biochemical processes essential for life (decomposition, regeneration and oxygen production). Construction work has a direct impact on bio-diversity through fragmentation of natural areas and ecosystems.

Many of the long-term goals and targets set by the national government or other bodies are related to these resources. They also offer a framework for defining an operational concept of sustainable development. A **more precise definition** of sustainable construction might be: "the reduction of the use of natural resources and the conservation of the life support function of the environment by construction processes, buildings and the built environment under the premise that the quality of life be maintained"

The definition involves 3 primary key verbs: reduce, conserve and maintain. The issues involved and the principles involved are summarized in Table 1.

The boundaries of the system to which this concept applies can be defined at different levels of scale: building components, buildings, the urban network, the country as a whole, or even the global system. The higher the level, the more influence is exerted by physical planners and designers.

At the level of buildings, a sustainable building can be defined as a building that:
- consumes a minimum amount of energy and water over its life span;
- makes efficient use of raw materials (environmentally friendly materials, renewable materials, enhanced life cycle, possibility for disassembly);
- generates a minimum amount of waste and pollution over its life span (durability, recyclability);
  uses a minimum amount of land and integrates well with the natural environment;
- meets its user's needs now and in the future (flexibility, adaptability, site quality);
- creates a healthy indoor environment.

SUSTAINABLE CONSTRUCTION		
CRITERION	**RESOURCES**	**PRINCIPLES**
1 Reduce	. Use of energy sources . Use of mineral resources . Use of water resources . Use of land	Minimize depletion through: - reuse - recycling - use of renewable resources - efficient use (extended lifespan of products, energy and water efficiency, multi-functional use of land)
2 Conserve	. Natural areas . Bio-diversity	Conserve through: - prevention of toxic emissions Restore through: - remediation
3 Maintain	. Healthy indoor environment . Quality of built environment	Maintain through: - low-emission materials, (energy) efficient ventilation, compliance with occupants' needs - provision of amenities, transport, recreation, security - abatement of noise, pollution and odours Restore/improve through: - renovation, rehabilitation

Table 1 : Principles of sustainable construction in the Netherlands

2.2 Agenda 2010

In order to effect lasting large-scale changes, long-term goals and standards are set by the government. These national environmental policy targets can be used to define the issues for 2010 within the adopted scenario. However, it should be realized that these targets are still well outside the boundaries of the "environmental utilization space". Not only does the question remain in regard to how far we must reduce the pressure on the biosphere (the prognosis is for a 10-fold reduction by 2010), but also: who should be responsible for reducing this pressure taking account of the global equity principle? This touches the roots of current economic thinking in the industrialized countries, and an open question remains as to whether it is politically achievable. Therefore, the agenda 2010 is a policy target-based one and not one based on taking maximum account of the global equity principle. Agenda 2010 for the Netherlands, together with the key issues for the construction industry, are presented in the Table 2.

The main driving forces for the coming decades will be energy, mineral resources and land/water management. The general issue centres around the question: how can we do more with less (or the same amounts of) resources within a viable economic framework? The challenges for the construction industry can be summarized as follows:

Socio-economic factors

It is anticipated that concern about the pressure on the environment due to human activities will lead to full acceptance of the sustainability concept and that this concept will be fully integrated into decision-making processes. To mediate this, the government will have to adapt the tax system by integrating environmental costs. Environmental performance standards will be included in the building regulations. For the construction industry, the most important issues will be life-cycle thinking, re-engineering of the building process, and education and training (social engineering).

Energy

In a "business-as-usual" scenario, CO_2 emissions would increase by 60% by 2020. The reduction targets will still lead to an increase of 10% by 2020 and represent a compromise between economic growth and environmental impact. Agenda 2010 aims at substantially increasing energy efficiency through the increased use of renewable energy (solar and wind energy, waste/biomass burning) and by reducing mobility. The energy factor will become very important in physical planning and design processes.

Mineral resources and water

The management of material flows in the economic processes will focus on the principles of less "in" and "out" and on "retention," meaning a reduction in the use of nonrenewable raw materials in favour of renewable ones, closed-loop recycling and extending the life cycle of products. The issues for the construction industry as a whole focus on efficient designs, life cycle flexibility, and strategies to extend the service life of existing buildings. A tremendous effort will have to be put into upgrading the existing housing stock to the standards of 2010. The increasing use of fresh water for irrigation, industrial purposes and the preparation of drinking water will result in the large-scale introduction of water-saving technologies into the built environment.

Land use and bio-diversity

The struggle over land and the sustenance of bio-diversity will result in less space being available for the built environment. This will have a major effect on physical planning and use of land, and will involve issues such as long-term decision-making, multiple land use - including underground construction - and the total quality of the built environment.

Key sustainability issues	Agenda 2010 (goals)	Key issues for construction industry
1 General (socio-economic factors)	Incorporate sustainability into decision making; Environmental performance standards in building regulations.	Decision-support systems, information technology, interdisciplinary cooperation, re-engineering of building process, incentives for innovative technologies.
	Incorporate environmental costs in the tax sy-stem or in prices.	Life-cycle costing, full cost pricing.
	Full acceptance of the sustainability concept.	"Social engineering", education.
2 Energy	30% Increase in overall energy efficiency (1995 to 2020).	Embodied energy, energy use and supply, urban planning.
	Increased energy performance of buildings (23% in 2000).	Insulation, intelligent building services, alternative energy sources, maintaining healthy indoor environment.
	10% Renewable energy (2020).	Optimal use of solar energy and biomass.
	35% Reduction in mobility.	Physical planning, public transport, energy-efficient transport systems, tele-conferencing, tele-working.
	Energy taxes.	Energy-efficient production.
3 Mineral resources	Decreased use of nonrenewable raw materials (annual use of 1% of established reserves).	Lean design, durable products.
	Increased use of renewable raw materials (20%).	Use of biomass.
	Closed-loop recycling (90%).	Infrastructure for recycling/reuse, product stewardship.
	Water conservation (25% reduction in household use by 2010).	Efficient use of drinking water, prevention of water pollution.
	Extended service life of buildings; Management strategy for existing building stock.	Life-cycle flexibility, regeneration of existing building stock, sustainable design and site quality.
4 Land use and bio-diversity	Conserve open areas.	Use of third dimension, land reclamation, compact building, multi-functional use of land, right use in right place.
	Interconnected wildlife areas, buffer and compensation zones.	Physical planning of infrastructure, reconstruction.
	Conservation of ecosystems.	Emissions of building products in use, management of river systems, remediation of soil/water pollution.

Table 2 : Agenda 2010 and key issues for the construction industry

3. MAIN CHANGES EXPECTED IN THE BUILDING AND OPERATING PROCESS BY 2010

3.1 Introduction

In order to clarify the level of decision making throughout the building process, the main changes are classified according to levels of scale: Urban network and infrastructure, buildings, and materials and services. For each level, a table summarizing the main changes is presented which also indicates the process stage in which the main decisions have to be made. To make the allocation of these decisions and their interactions easier to understand, the stages of the building process and operation process are clustered into four levels:

Process level 1: Development, planning and design (decisions in this stage are highly interrelated)

Process level 2: Construction and deconstruction (mainly technical issues following the design)

Process level 3: Operation (main question: how to adapt the existing building stock to the standards set for 2010 -maintenance, refurbishment, renovation, demolition-).

Process level 4: Material supply (development of sustainable materials and components)

3.2 Urban framework and infrastructure

Urban development meets two areas of concern which cannot be separated easily: the upgrading of the existing urban fabric, and compliance with the housing needs within the current city limits. Both are faced with the problems of availability of space and transport infrastructure. At the scale of towns, the sustainability principles of conserving natural areas and maintaining the quality of the built environment are becoming increasingly important and will place the emphasis on urban and spatial planning. Strict adherence to the policy of limited urban extension reduces the possibilities of starting new developments beyond currently built areas.

As many cities are confronted by an ageing infrastructure, high noise and pollution levels, and a lack of social cohesion -factors that are all conducive to urban decline-, urban renewal projects will become increasingly important.

Land use

The rigid urban fabric puts restrictions on the amount of space available. In addition to high-rise buildings, underground construction will increase, particularly for use as shops, parking lots and transport infrastructure. This will create opportunities for redesigning the above-ground fabric and for creating new green areas. Infill within cities will be characterized by high-density building requiring special attention to the 'social' sustainability (noise pollution, security, privacy) of these compact quarters. Building densities may be as high as 60 dwelling units per hectare.

Infill should be combined with "outfill": the creation of new open spaces such as small squares, parks and playgrounds.

Compact building allows less flexibility in future planning. Some of the city districts may be designed as light constructions (not requiring heavy pile foundations) allowing easy removal, e.g., by land or water, in anticipation of future patterns for the use of space.

Much space in densely populated areas is occupied by so-called "nuisance zones" (areas around industrial complexes or highways where building is not permitted because of the high noise levels). Increasingly, these spaces will be filled by utilizing new designs in which the building façade facing the noise source functions as a sound-reducing wall.

For new developments, the original fabric and ecological structure of the site should be retained or restored as far as possible. Existing water structures are to be incorporated in the plan. The infrastructure plan will be an integral part of site development.

Construction sites in urban areas always cause minor (and sometimes major) disruptions in function. For infrastructure works, new underground drilling techniques will offer promising possibilities since they will cause no interruption to above-ground activities.

Renewal or refurbishment projects in buildings will need new construction and demolition techniques that minimize disruption of building services and reduce nuisance to occupants and surroundings.

In order to cope with existing soil pollution in cities, advanced in-situ remediation technologies are required that combine speed with efficiency.

Energy/water

Site planning should take account of the availability of local energy sources (excess heat from power plants and refuse incinerators) to be used for district heating. Water management will rely on the use of closed systems. Pavements and roofs will be designed in such a way that rainwater directly infiltrates the soil, thus safeguarding ground and surface water systems. Surface water supplied to buildings by a service pipe other than the one supplying processed drinking water can be used for toilet flushing and gardening purposes.

Looking further ahead, a future trend might be the creation of selfsufficient communities that are relatively independent of centrally provided services due to the use of renewable energy sources and on-site treatment of domestic waste combined with energy recovery. Such resource-efficient communities will help create a more stable society that is less vulnerable to interruptions in services, and even to a depletion of resources.

To reduce urban traffic, priority must be given to public transport and good connections with parking facilities at the city rim. The traffic infrastructure will be an integral part of site development in order to effect a systematic reduction in car use.

Materials

Ageing underground infrastructures such as sewage systems, ducts and cables will need repair or replacement. For the repair of these systems existing, in-situ diagnosis and repair techniques will require further development. When replacement is inevitable, new integrated systems will be used that are easily serviceable and can be repaired without interrupting the functioning of the above-ground structure.

The ever-increasing amount of urban waste and the limited possibilities for residents in a compact city to separate waste into recyclable fractions will require new building-integrated and user-friendly systems for collective waste disposal. In the near future, residential waste could be transported via underground ducts to local collection points.

3.3 Non-urban infrastructure

The demands being made on non-urban infrastructure will increase in the coming decades. The main issues involved will be the creation of environmentally-friendly modes of transport and the safeguarding of the land from flooding. Both require linear infrastructure with its inherent problem being the fragmentation of natural areas and large-scale use of raw materials. Making the maximum use of existing infrastructure to meet future needs should receive carefully consideration as a first priority.

Land use

To reduce taking up land for new transport infrastructure, information technology can be used to make optimal use of existing capacity. Efficient land use can be achieved by combining transport corridors (roads, rail, cables, ducts). Since many public and private parties will be involved in susch projects, the construction industry could take the lead by offering complete concepts for combined transport including their exploitation.

New underground drilling techniques will offer challenging opportunities for new types of underground transport infrastructure, such as the container transport of goods. The experience gained in the Netherlands with land reclamation can be used to create new land in the coastal areas for types of infrastructure incompatible with densely populated urban areas. This may involve airports, sea terminals, storage of hazardous materials, wind energy parks, etc.

Water management and materials

The management of our large river systems and sea defences requires much effort. It not only requires large quantities of sand and clay to reinforce our dikes, but much energy is also used in transporting these materials to the proper locations. A better understanding of hydrological processes may favour new concepts like building with nature, i.e., combining man-made interventions with the natural action of water. Examples include using breakwaters to enhance natural sand suppletion in coastal areas, extending the flow capacity of rivers through the selective removal of containing dikes, etc.

3.4 New buildings

In the specification and design of new buildings, three key issues will play a dominant role: land use, energy efficiency (in combination with a healthy indoor environment), and reduction in the use of raw materials and water.

Land use

Land use restrictions will promote the use of the third dimension. High-rise construction may increase, but new conflicts will arise (problems of solar shading, energy use and lack of public appreciation). It is more likely that underground construction will become popular, particularly for storage and shops. This will create possibilities for redesigning the above-ground structures for new buildings and recreation. In addition to these two options, new buildings will increasingly be built over or integrated into existing infrastructure (roads, railways). For this type of double land use, several issues relating to safety aspects, legal implications and public/private ownership will still require solving.

Creating multi-functional buildings, particularly office buildings, can reduce the problem of unoccupied buildings and prevent taking up more land for new construction.

The highly popular slanting roofs in the Netherlands may well be redesigned as flat roofs allowing rooftop space for recreation or even car parking. It is even foreseeable that buildings will be designed to be transportable to other locations in anticipation of future patterns of spatial use over time.

Energy

The energy efficiency goals can be met through improved designs incorporating the optimum use of passive and active solar energy. This may lead to innovative roof and façade designs including solar panels, passive lighting systems and translucent insulation. Insulation and recirculation ventilation will become quite critical from the point of view of maintaining a healthy indoor environment. Heat recovery systems for ventilated exhaust air will be used rather than recirculation. Electrical heat pumps will gradually replace gas-fired central heating systems, the additional advantage being that no gas supply net is required. Low-temperature heating systems (floor or wall heating) can significantly improve the energy efficiency of buildings. For larger building complexes, heat and cold storage systems in the subsoil can be applied.

The ever-increasing mobility leads to more attention to the combination of living and working. Tele-working may lead to smaller office buildings and changes in the lay-out of dwellings. Living and working may also be combined in one building situated at a favourable location.

Water

Technologies to reduce the spill of high-quality drinking water need to be integrated into the building fabric.

Materials

Efficient use of raw materials can be achieved through several means, including lightweight constructions that use a minimum of raw materials, and the use of renewable or recyclable materials. However, a more significant reduction in material use is possible by designing buildings that can be used much longer than the buildings presently in use. This requires design for flexibility, creating buildings that are adaptable to the changing needs of owners and occupants.

In order to keep the raw materials within the building cycle after buildings have reached the end of their service life, jointing and assembly should be designed to allow easy disassembly for reuse or recycling of components (reversible building process).

The increasing amount of domestic waste and the separation into recyclable fractions will require new building-integrated collection systems or the design of user-friendly communal systems for waste collection.

3.5 Management of existing building stock

At the current rate of new construction, only 15% of the building stock in 2010 will consist of buildings built after 1995. The majority will be older buildings that do not meet the standards set for 2010. In addition, demographic trends indicate that large percentages of the housing supply will have to be adapted to the needs of the elderly. This may involve splitting of dwellings, adding new services and improving horizontal and vertical access. A tremendous effort will have to be put into upgrading the existing building stock. Sustainable renovation or even reconstruction will become increasingly important. The agenda for 2010 will confront us even more with the dilemma of whether demolition and building anew, or upgrading an existing buildings, is the best solution from the point of view of sustainability.

Land use

To reduce taking up land, vertical or horizontal extensions to existing buildings will be added without affecting their support structures. This requires lightweight construction technologies, possibly incorporating passive or active solar energy systems.

Regeneration will also involve the reallocation of old utility buildings for new functions such as housing.

Energy

Building owners will be required to improve the energy efficiency of their buildings. Retrofitting of installations will become a major issue. By using new heat recovery systems, the energy use of existing buildings can be reduced by 25%. An additional energy-saving measure for old buildings without cavity walls is the application of external insulation. New installations that can be easily retrofitted into the existing building fabric need to be developed.

Materials

The environmental impact due to the conservation of building components (paints etc.) and maintenance activities is still too large. There is a need for durable coating systems which can be applied to traditional building materials.

Ultimately, one can expect that the support/infill modularity developed for new buildings can also be used when existing buildings are renovated or reconstructed, thus creating a highly flexible and adaptable building stock.

3.6 Materials, components, building services

At the level of materials, components and building services, many of the issues discussed previously for buildings are equally important. The goals set for the use of natural resources as well as current trends indicate that the building material industry needs to reconsider the environmental performance of its products. Important issues are: embodied energy, durability, low emissions in the use phase and recyclability.

Land use

To reduce further degradation of ecosystems, the emissions of products in use have to be reduced. This will mean the development of environmentally friendly coatings and pretreatment of building materials in the workshop.

Energy

The embodied energy of the products must be lowered by improving the energy efficiency of production processes and by using renewable raw materials and low-energy recycling methods. Increasing durability and technical life expectancy of building components also results in the use of less energy and raw material per unit of time.

In the fields of heating, cooling, ventilation and lighting, the energy-reduction targets offer ample opportunities for innovative products. New technologies include: heat recovery and storage systems, small-scale CHP units, electrical heat pumps, photo-voltaic cells, glass fibre technology for passive lighting, translucent insulation, flexible underfloor air conditioning, advanced sensor technology, etc.

For buildings exposed to high external noise levels (e.g., near airports, highways, industry) new soundproofing materials and techniques which can be easily retrofitted to existing buildings will be required.

Water

Reduction in the use of drinking water can be achieved through the storage and utilization of rain water for sanitary, washing and gardening purposes, the cascade-use of drinking water, and the use of water-saving equipment. Many water-saving techniques are proven technologies which only need reinventing and modification for incorporation into the building fabric.

Materials

Infill components and systems should be made readily exchangeable through standardization of dimensions and connections (plug-in systems), taking into account the different life expectancies of these components. Components should be easily disassembled and repaired, bringing a halt to the "throw-away society." In this scenario, designers and building material manufacturers will have to cooperate closely in developing new concepts.

Specifiers of building materials and components will increasingly take into account the recyclability of these materials as well as the possibilities of returning products to the manufacturer at the end their useful life cycle.

URBAN FRAMEWORK AND INFRASTRUCTURE	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND	**Sustainable city**:		**Sustainable city**:	
	Optimum public transport (commuter)	1	Compact living and working infrastructure to reduce mobility	1
	On-site treatment of urban solid/liquid waste	1	Integrated physical planning of urban and rural areas, design for future value (flexibility)	1
	Control of noise and air/water/soil pollution	1,2	Create and maintain attractive and safe living quarters, individual-choice housing	1
	Conservation of cultural heritage	1	Reduce dependence on resource-intensive infrastructure	1
	Creation/conservation of green areas	1		
	Sustainable renewal:		**Sustainable renewal**:	
	Infill within cities, high density building	1	Site quality and inhabitant security	1,3
	Construction/demolition techniques which minimize interruption of functions and nuisance to occupants and surroundings	2	Integrate existing and new fabrics	
	Underground construction (infrastructure, shops, storage) and redesign of above-ground areas	1		
	Isolation/encapsulation of existing soil pollution	1,2		
	Renewal engineering for ageing urban infrastructure:		**Renewal engineering** for ageing urban infrastructure:	
	In-situ reconstruction (sewerage)	2	Safety of components and systems	2
	Accessible and adaptable multiple-use systems for underground infrastructure	1	Minimal disruption of function	1
ENERGY	**Energy management**:		**Energy management**:	
	CHP applications, district heating, heat pumps	1	Integrate town planning and energy management	1
WATER	**Drinking water management**:		**Drinking-water management**:	
	Split sewage systems	1	Public health aspects	1
	Split systems for water supply	1		
	Treatment of grey water at the source, and reuse	1		
MATERIALS	**Management of urban waste**:		**Management of urban waste**:	
	User-friendly central collection points	1,4	Develop logistics	1
	Local treatment and energy recovery	1,2	Public health aspects	1

Table 3 : Major challenges facing construction industry (Urban and infrastructure development)

Numbers indicate the process levels were decisions have to be made

NON-URBAN INFRASTRUCTURE	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND	**Sustainable mobility**:		**Sustainable mobility**:	
	Optimum use of existing capacity (IT)	1	Cost benefit considerations for parties involved (public/private partnerships)	1,3
	Combined transport corridors (roads, rail, cables, ducts)	1	Corridor analysis (environmental impact assessment)	1
	Increased transport by waterways	1		
	Underground transport systems	1,2		
ENERGY	see mobility			
WATER	**Climate change**:		**Climate change**:	
	Regeneration of coastal and river defences to meet future rise in sea-level	1		
	Constructing with nature	1,2	Understanding the basic principles	1
	River and water system management:		**River and water system management**:	
	Water buffering systems, controlled infiltration of water, water capture areas	1		
	Pollution control (preventive/remedial)	2,3		
MATERIALS	**Construction using the minimum of raw materials**:		**Raw material extensive construction**:	
	New technologies for river containment (dike reinforcement using a minimum of raw materials, building with nature)	2		
	Optimal use of recycled materials in infrastructure works (techniques to prevent water/soil pollution)	1,2	Performance criteria and functional requirements	1,2,3

Table 4 : Major challenges facing construction industry (non-urban infrastructure)

Numbers indicate the process levels were decisions have to be made

NEW BUILDINGS	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND	**Land use-efficient building** (using third dimension):		**Land use-efficient building** (using third dimension):	
	Underground construction, tunnelling techniques in soft soil	2	Legal implications of double land use	1
	Building over road/rail systems	1,2	Safety aspects	1,2,3
	Ground surface-free buildings	1,2	Cost/benefit considerations for parties involved (public/private partnerships)	1,3
	Flat roofing systems for recreational use or parking	1,2	Environmental impact assessment reports	1
	Extend service life of buildings:		**Extend service life** of buildings:	
	Design for flexibility, open building	1	Understanding needs and requirements of future users, consumer participation	1
	Durable and repairable components	1	Tools for assessment of life cycle costs	1,3
	Removable/transportable buildings	1		
ENERGY	**Energy-efficient buildings** (zero-energy buildings):		**Energy efficient buildings** (zero-energy buildings):	
	Integrated design for passive/active solar energy (roof and facade design), electrical heat pumps, subsoil energy storage and retrieval, low-temperature heating, passive lighting systems, building management systems	1,3	Integrate into building design	1
WATER	**Minimize water consumption**:		**Minimize water consumption**:	
	Cascade use of drinking water/grey water	1	Integrate into building design	1
			Health and safety aspects	1
MATERIALS	**Recyclable/reusable constructions**:		**Recyclable/reusable constructions**:	
	Design for disassembly and recyclability	1	Design and demolition process	1,2
	Prefabrication, industrialized assembly techniques	2	Life-cycle costing and flexibility	1,3
	Raw materials-efficient buildings:		**Raw materials-efficient buildings**:	
	Constructions using a minimum of raw materials, lightweight constructions, renewable materials	1	Reduction in building volume, taking into account work station rotation and tele-working (office buildings)	1

Table 5 : Major challenges facing the construction industry (development of new buildings)

Numbers indicate the process levels were decisions have to be made

EXISTING BUILDINGS	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND	Save land by **re-destination of non-functioning buildings**: Stripping and retrofit techniques	2	Safe land by **re-destination of non-functioning buildings**: Decision support (demolition/renewal)	1,3
ENERGY	**Upgrading energy performance of existing building stock**: Heat recovery systems External insulation	3 3	**Upgrading energy performance of existing building stock**: Safeguarding indoor environment	1,3
WATER				
MATERIALS	**Regeneration of existing building stock**: Refurbishment technologies (adding vertical or horizontal extensions; lightweight constructions) Integration of lightweight constructions/ components with passive and active solar energy Smart construction techniques allowing occupants to stay in the building	2 1 2	**Regeneration of existing building stock**: Decision support (demolition/refurbishment) Set performance environmental standards for buildings that will be renovated Understanding needs and requirements of future users, consumer-oriented renovation	1 1 1

Table 6 : Major challenges facing construction industry (management of existing buildings)

Numbers indicate the process levels were decisions have to be made

MATERIALS, COMPONENTS, BUILDING SERVICES			Challenges facing the construction industry	
RESOURCES	**Technical issues**		**Process-related issues**	
LAND				
ENERGY	**Embodied energy of products**:		**Embodied energy of products**:	
	Renewable raw materials	4	Energy-efficient production techniques	4
	Low-energy recycling	4		
	Extend service life; demountable and repairable components	4		
	Energy-efficient installations, energy-saving materials:		**Energy-efficient installations, energy-saving materials**:	
	Heat recovery, small-scale CHP units, heat recovery systems, electrical heat pumps, active solar energy	4	Integrate into building design	1
	Advanced sensor technology, building management systems, individual climate control	4		
	New passive lighting systems	4		
	High-performance insulation materials	4		
WATER	**Water-efficient installations**:		**Water-efficient installations**:	
	Water-saving equipment, reuse of water	4	Integrate into building design	1
	Rainwater catchment systems	4		
MATERIALS	**Resource-efficient products**:		**Resource-efficient products**:	
	Renewable raw materials (biomass)	4	Craddle to grave responsibility of manufacturers	4
	Closed-loop recycling	4	Exchangeability through standardized dimensions	4
	Recyclable products	4	Logistics for reuse or recycling	4
	Lightweight, non-monolithic structures	2,4	Measuring tools to predict structural service life of components and for condition assessment	1,4
	Improved performance and durability	4		
	Exchangeable components:		**Exchangeable components**:	
	Prefabrication and dry connectable components,		Exchangeability through standardized dimensions	4
	Plug-in infill systems	2,4	Develop design guidelines	1,4
	Low-emission (in use) products:		**Low-emission (in use) products**:	
	Pretreatment, advanced coating systems	2,4	Design for disassembly and repair/re-coating in the factory	4

Table 7 : Major challenges facing construction industry (Building material supply)

Numbers indicate the process levels were decisions have to be made

4. MAIN CONSEQUENCES TO THE CONSTRUCTION INDUSTRY

4.1 City planners and the built environment in 2010

Urban planning

The economical use of space is of increasing importance for purposes of town extension, industrial development and new infrastructure. In the Netherlands, the physical planning policy is aimed at preventing the further fragmentation of the countryside by suburbanization, new industrial sites, and new transport corridors. The main challenge to the physical planners will be to adapt and regenerate the built environment within the existing urban fabric and to involve environmental issues in the planning process at the earliest possible moment. This requires concerted decision-making at all levels and optimization of the management of energy, water and waste. For urban planners, this means integral thinking, optimally combining the existing and new urban fabric.

Integral decision-making must involve:
- Efficient use of land, combining underground and above-ground constructions.
- Taking into account the availability of local energy sources (excess heat from power plants and refuse incinerators) for district heating.
- Water management relying on the use of closed systems (direct infiltration of rainwater into the soil, split service lines for drinking water and grey water) and incorporating existing water structure into the city plan.
- Waste management (residential waste to be transported via underground ducts to local collection points).
- Maintaining excellent quality by creating a flexible living and working environment in order to make cities again competitive with suburban developments (offering services and recreation, accessibility and social sustainability).

Environmental impact reports now required for very large projects will in future also be required for smaller scale developments, forcing planners to look at alternatives with reduced environmental impact. These reports should address sustainability issues such as energy supply and transport needs in relation to building density, water management on the site, and the future value of the development taking into account demographic trends.

An important issue will be how to create self-sufficient communities that are, to a considerable degree, independent of centralized resource-intensive utilities through the use of renewable energy sources and energy recovery from domestic waste. Such resource-efficient communities may significantly reduce energy demand from conventional sources.

Non-urban infrastructure

To maintain environmentally friendly modes of transport and to safeguard the land from flooding, careful planning of linear infrastructure is required. This will involve making maximum use of the existing infrastructure to meet future needs. Information technology will become an important tool for optimizing the existing capacity of transport infrastructure.

The combination of roads, rail, cables, and ducts into single transport corridors reduces the amount of land taken up and offers promising possibilities for underground construction and drilling techniques. This will require careful physical planning of underground and above-ground land use.

A better understanding of hydrological processes will favour new concepts like building with nature for creating new land in coastal areas and enhancing sand suppletion to reinforce river and sea defences. Infrastructure incompatible with densely populated urban areas may well take advantage of this newly created land. This may involve airports, sea terminals, storage of hazardous materials, wind energy parks, etc.

4.2 Building and operating processes in 2010

4.2.1 The building process

Thinking in terms of life cycles, one of the key elements of sustainable construction, is, compared to other production processes, severely hampered by the fragmentation of the building process. Currently, the processes of procurement and contract negotiation in the building industry are broken down into separate entities with separate responsibilities, all of which discourage cooperation and the feeling of having a common responsibility for the end product.

Of all consumer goods, buildings have the longest service life while strategic planning does not look ahead but a fraction of that time. The initial costs of construction still play a dominant role. Risk and liability factors not only form a barrier to innovative process management but also to technological innovation.

Many of the sustainability issues ensuing from Agenda 2010 can only be effectively addressed by construction companies through re-engineering of the building process and the adoption of industrialized construction techniques. Design and build and/or Build, Operate and Transfer (BOT) contracting will not only significantly improve the construction process as a whole (reduction of project delivery time), but may also facilitate the adoption of the principles of life-cycle sustainability.

4.2.2 Initiative and design

Clients play a crucial role in the end quality of a building product. A common saying is "the quality of a building reflects the quality of the client". Adopting new sustainability concepts is often perceived as taking risks. Ways to increase awareness should be developed which lead to a better understanding of costs, benefits and risks. Thinking in terms of life cycles will be the key phrase. Design, build and operate contracts will enhance the notion of life-cycle costing and the future value of real estate.

Long service-life and the flexibility of buildings are not new ideas, but have gained renewed interest through sustainability principles. The major barrier to their application lies in our economic principles, e.g., the economic versus technical life span of buildings and the split responsibilities for initial costs and maintenance costs. A solution might be to split the write-off costs according to the individual building components or to draft lease constructions for building components with life spans shorter than that of the load-bearing structure.

A precondition for life-span flexibility is consumer orientation, i.e., understanding the changing needs of owners and occupants and beyond that, insight into future housing and work demands.

To enhance design for flexibility, a set of rules for interfacing between support and infill should be developed that takes into account the different technical life expectancies of the various components. The support system should be designed for a building's life span, and infills should be designed for easy repair and disassembly (reversible building process).

Energy-saving measures should focus on the construction components that have the longest life span and are least easily changed (e.g., the supporting construction) rather than focusing on the building installations (e.g., heating systems). Support structures must be designed in such a way that houses can be split up or enlarged, and so that utility buildings can be transformed to serve other functions. On the reverse side of the coin it can be shown that for houses to be really multi-functional, their floor space has to increase by 15% compared to current standards. To save nonrenewable raw materials, construction methods utilizing a minimum of raw materials should be developed, and renewable materials should be used as much as possible.

In view of our ever-increasing mobility, those taking initiatives need to give more attention to combining living and working. Tele-working may lead to smaller office buildings and changes in the lay-outs of dwellings.

4.2.3 Construction and decommissioning

In the traditional building process, construction companies do not have much opportunity to influence decisions involving sustainability. Since many public and private parties are involved in the construction of infrastructure works, construction companies could take the lead by offering complete concepts for combined transport facilities under build, operate and transfer (BOT) contract. It is anticipated that the larger companies will start taking this option while the smaller companies will specialize in specific market segments or special trades like renewal engineering.

Product accountability will emphasize the introduction of total quality management systems. In order to insure against environmental and other risks related to buildings, certification systems for buildings will be required in 2010.

Assembly techniques minimizing construction waste can be found in prefabrication and industrialization. Much of the construction work will be taken away from the construction site to the factory leaving the construction site as an assembly site only. Technical solutions must be found in the standardization of support systems and flexible infill technologies, including the use of durable and repairable components. Dry jointing systems for interfacing support and infill should be developed that facilitate disassembly when components have to be replaced or a building has to be demolished. By applying jointing and assembly techniques, construction companies should keep in mind that dismantling will remain feasible.

Logistics are still open to improvement, particularly with respect to return systems for packaging materials and used building materials.

The demolition process will be closely linked to the recycling process so that disassembly and separation into reusable and recyclable waste fractions will be optimized.

Renewal projects involving housing estates will require new construction and demolition techniques that minimize the interruption of functions and limit the amount of nuisance to occupants and surroundings (construction without nuisance). For the renewal of ageing underground infrastructures (sewage systems, ducts and cables), existing in-situ diagnosis and repair techniques that do not interrupt the functioning of the above-ground structure must be further improved.

In order to cope with existing soil pollution in cities, advanced in-situ remediation technologies are needed that combine speed with efficiency.

4.2.4 Operation

The widening gap between the environmental performance of the existing building stock and new buildings puts much emphasis on renewal engineering. Decision support systems will be needed for the purpose of assessing, within an economic and ecological context, the environmental benefits of decommissioning versus regeneration.

To prevent a depreciation in value resulting in a high tenant turnover or vacancy, housing corporations will have to adapt their housing estates to future requirements. This involves identifying tenants needs and demographic trends, and concerted actions on the part of government, municipalities and housing corporations to match supply and demand at the relevant scale levels.

Sustainability policies will put pressure on building owners to adapt or convert buildings rather than to demolish existing buildings that no longer fulfil their original function. Recommissioning for new functions (e.g., converting a hospital into a court house) saves land and minimizes use of raw materials. If demolition is inevitable, consideration must be given to stripping the building and leaving the support structure for incorporation into the new building.

4.3 Building material suppliers in 2010

Materials, components, building services

The goals set for the use of natural resources indicate that the building material industry must improve the environmental performance of its products. Important issues are:

- reducing the embodied energy of the products (renewable raw materials, low-energy recycling, increasing durability and technical life expectancy);
- low emissions from products in use (environmentally friendly coatings, pretreatment);
- reparability (design for disassembly and repair in the factory) and recyclability (used products to be returned to their producer; product stewardship).

In this scenario, designers and building material manufacturers will have to cooperate closely in developing new building concepts (lightweight components and new jointing and assembly techniques). Moreover, a better cooperation with related industries (e.g., plastic manufacturers, building services manufacturers) will promote the development of a new range of function integrated building components.

To assist in the selection of building materials, environmental labels will be introduced to identify such factors as expected service life, embodied energy, composition and recyclability.

The energy-reduction targets offer ample opportunities for innovative products in the fields of heating, cooling, ventilation, lighting and thermal insulation.

Soundproofing of buildings exposed to high external noise levels (e.g., locations near airports, highways, industry) will require new noise-reducing materials and techniques which can be easily retrofitted to existing buildings. Water-saving targets offer challenges for new technologies and building-integrated equipment.

4.4 Human resources and skills needed in 2010

Working conditions and ergonomics on the building site will profit from off-site prefabrication and new mechanized assembly techniques (robotics, computer-driven tower cranes). The workforce on the building site will evolve into multi-skilled (permanent) crews specialized in assembly techniques. Repair and maintenance will assume increasing importance and require other types of multi-skilled operators trained in nondestructive disassembly techniques and in the handling of both new and old materials.

Incorporating sustainability into the decision-making process requires new education curricula for architects, designers and construction engineers with the emphasis on: interdisciplinary education to overcome professional barriers, making full use of information technology for communication and for decision support, gaining insight into a building's performance over its entire life span (thinking in terms of life cycles), and developing technologies for adapting the existing building stock for future needs.

4.5 R&D themes until 2010

Although there is an increased awareness into sustainability issues, financial incentives are mostly lacking. This requires a whole new way of thinking in terms of costs and returns on investments.

Assessment tools are needed to demonstrate to decision-makers the returns on investments when sustainability principles are incorporated into the planning and design processes, and when facility life-cycle costs and the future value of buildings are taken into account. If environmental costs are truly to be incorporated in the economic system, the following issues will become increasingly important:

- conversion of environmental impacts into environmental costs (making ecological costs and benefits more transparent);
- integrated decision support systems based on monetary principles (weighing investment and exploitation cost against environmental costs).

The high (and still rising) costs of dumping or incineration of building and demolition waste in the Netherlands already show that benefits can be obtained through waste prevention over the life cycle of a building.

The building process itself is open to improvement. Research should focus on the feasibility of procurement combinations like design, build and operate contracts and their benefits in terms of reduction of life-cycle costs. Integrating the design and construction process will significantly improve productivity. Construction enterprises adopting these new production concepts will not design on a project-by-project basis but will offer a number of highly flexible building designs that are readily adaptable to specific consumer needs.

In the technical field, many R&D themes emerge. The most important are:

- Integral physical planning requires more insight into the impact of human activities on ecological systems and the conditions under which these systems can function in a sustainable way.
- Performance-based environmental standards for new and existing buildings, including measurement methods, need to be drafted and incorporated into the building codes
- Tools to make the environmental life-cycle performance of buildings measurable and certifiable need to be developed.
- Development of predictive models for the service life of construction materials and systems under real life situations.

- Underground drilling and constructing in soft soils needs to be studied to understand the dynamic behaviour of these constructions and their impact on the subsoil environment (e.g, ground water transport, soil settling)
- Renewal engineering methods involving non-destructive condition assessment, in-situ engineering and construction techniques, and procedures minimizing disruption of functions need to be developed.
- Energy-efficiency goals can be met through improved designs incorporating the optimum use of passive and active solar energy as well as heat/cold storage and recovery. Upgrading the energy performance of existing buildings requires new products that can be easily retrofitted into the building fabric (energy-efficient retrofitting).
- Research is needed to understand the phenomena of natural sand transport by sea water and river systems in order to take full advantage of 'building with nature' for land reclamation and sea and river defences.

5. STRATEGIC RECOMMENDATIONS

The main issues for sustainable construction are: efficient use of land (both above-ground and underground), efficient use of energy (an integrated approach), and efficient use of raw materials (service life, system repair and retrofit, improved quality of materials, components, and services).

In order to meet these requirements, the following strategic recommendations for the construction industry are given:

Area 1: Public and private policies

Draft measurable performance standards based on sustainability principles at the levels of both urban development and building design, and set long-term targets for a step by step approach for future development.

Incorporate sustainable building principles into the curricula of training courses for architects, designers and construction engineers, and promote interdisciplinary training in design, construction and exploitation processes.

Area 2: Management and business practices

Develop an integrated approach to sustainable life-cycle management that can be used by all stakeholders in the building process. For planners and developers, this means integrated decision-making tools and flexible responses to consumers needs. For building owners and managers, this involves tools to support decisions (in regard to the maintaining, repairing, refurbishing, and demolishing of buildings).

Project life cycle management offers construction companies the option to re-engineer their processes by offering their clients design/construct or build-operate-transfer projects.

Area 3: Design technology

New design standards should be developed for designers for the purpose of integrating sustainability aspects into their decision-making. The attention of designers should focus on the exploitation stage during functional design (long service-life and flexibility of the building during its use). Technical design should focus on the durability of components, as well as the reparability and (de) constructability components by adopting open systems and advanced jointing and assembly techniques.

Area 4 Construction

Efficient production in construction should be met by open industrialization and by making decisions (setting requirements) at different scale levels (open building). This creates a controlled process that is beneficial to sustainability in terms of better quality, less squandering of raw materials, and less building and demolition waste.

Large companies should take the lead by re-engineering their processes and by developing complete consumer-oriented (flexible) concepts that use standardized production methods that are universal applicable, independent of project type or size. A strong balance should be established between demand-side (user requirements) and supply-side (production techniques).

Small companies should specialize in market segments (e.g., renewal engineering) or specific trades (e.g., drilling techniques, assembly techniques), and should seek a competitive edge by standing out in terms of sustainable construction.

Area 5 Materials and systems

Designers, construction companies and manufacturers should co-operate in creating new designs (jointing/assembly technologies, flexible engineering and system modularity) for new building designs as well as for renewal projects. Co-operation with related industries (e.g., plastic manufacturers, electronics) should be attempted to develop new function integrated building components. Manufacturers should improve the durability, repairability and retrofit ability of their products.

6. APPENDIX : BEST PRACTICES OF SUSTAINABLE CONSTRUCTION IN THE NETHERLANDS

CONTENTS:

- **Urban planning project**
- **Office building**
- **Eco-balance dwellings**
- **Tools:**
  - **Eco-Quantum**
  - **National Package Sustainable Construction**

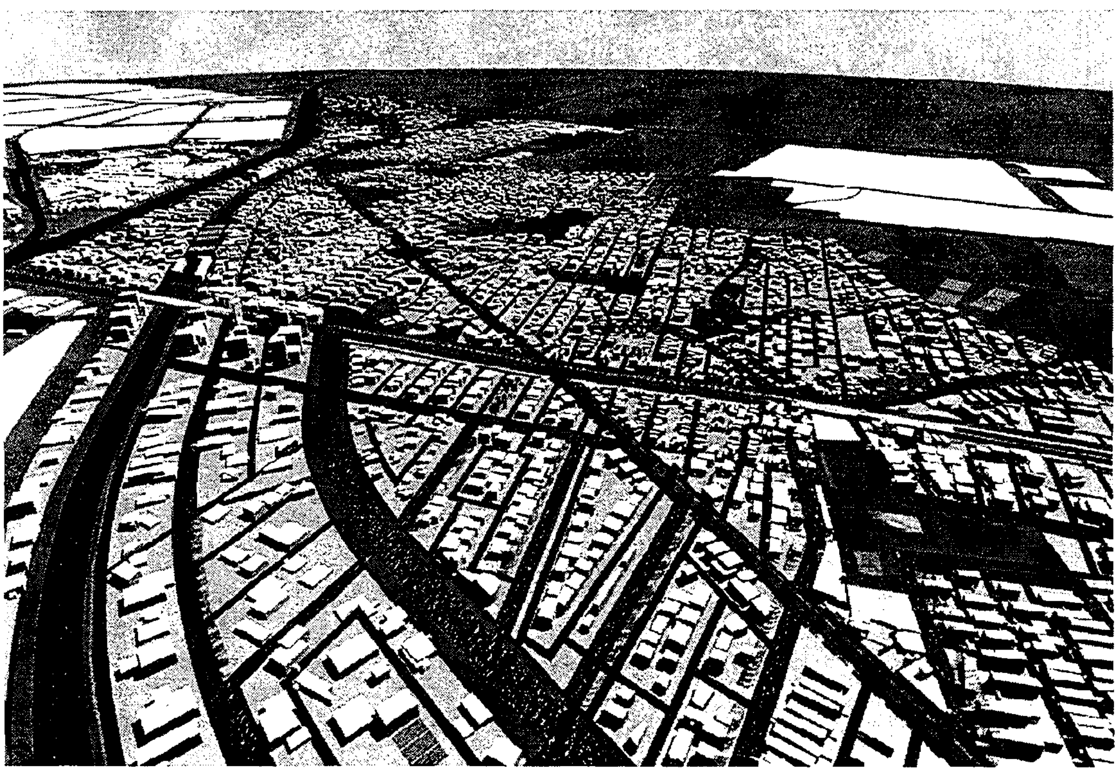
LEIDSE RIJN: development of a new medium sized town.

Description

Leidse Rijn will be a new residential district of the city of Utrecht. The area is still predominantly agricultural, but is also very diverse. The new residential development will consist of 30,000 homes, which will house about 100,000 people. In effect, it means that a medium-sized town will be created out of nothing.

Project planning

The urban planners have adopted a new approach in Leidse Rijn. The first map drawn up by Rients Dijkstra, an architect and urban planner from Rotterdam, showed all the environmental zones and sources of environmental nuisance. During the preparatory stage, the project consultant also drew up a quality map, showing all the locations which were of value to someone or other. A multidisciplinary committee then assessed all the claims, rejecting about 5%. The various members of the project team went to all the public meetings, armed with the maps. "A great deal of attention was focused on communication in the project. Listening and explaining was a very important part of the design process. The team, only two-thirds of which were local government officials, all worked together in one room, which is very unusual. Working in this way increased the range of options.



Use of land

Two international motorways pass through Leidse Rijn area, which together create a high-noise zone 17 kilometres long and 600 metres wide. At the Oude Rijn intersection, one of the largest in the country, the zone is nearly twice as wide. An essential part of the project, the bringing the motorway underground, was a result of this co-operation. It is typical of the kind of creative solutions the project hopes to generate. This is the first time in the Netherlands that motorway builders and urban planners have successfully overcome their mutual mistrust and worked closely together at the design stage. The underground motorway uses a method never used before. Because tunnel tubes are relatively light, they can be pushed upwards by the groundwater. The solution found was to leave the tube free to 'float' on the groundwater, with the result that the tunnel will require less use of raw materials and will be two and a half times cheaper than normal."
The most important effect of the underground motorway is that it brings the ideal of compact development a lot closer. It means that there will no longer be a no-man's land around the motorway, automatically cutting Leidse Rijn off from the rest of Utrecht. There will be more cycle traffic around the motorway than in the rest of the city, because the area is especially designed for it.

The space saved in Leidse Rijn by running the motorway underground can be used to build a large park in the middle of the district and an area of greenery and watercourses alongside the motorway to Amsterdam. Existing landscape features of the area and buildings already present will be preserved in the fabric of the new city plan.

Energy

The energy performance of the dwellings will be 40% better than the current legal requirements

Moreover district heating will be applied.

Transportation and mobility Another point of attention was the concurrent development of a high quality public transportation system. The transportation system will realised simultaneously with the construction of the housing blocks.

A transferium will be built between Leidse Rijn and the old city allowing motorists to switch over to public transportation. The transferium will hold parking place for 4000 cars.

Water

A 50% decrease in the consumption of high quality drinking water will be realised by using a double water supply system. One system supplying drinking water quality and one system supplying lightly treated surface water for washing, toilet flushing etcetera. The sewage system is only designed to transport domestic waste water. Rainwater is infiltrated in the groundwater or discharged in the existing waterways.

ECO-OFFICE in Bunnik

General description

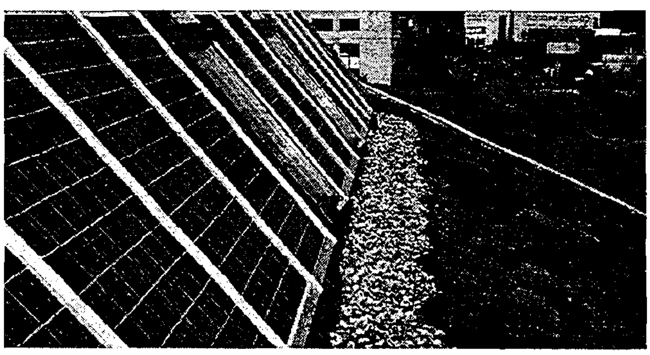
In the design of the eco-office building all the principles of sustainable construction were incorporated in a very early stage. Compared to a standard office building the eco-office use 50% less electricity, gas and water. The building was commissioned in May 1996. Building costs: 810 ECU / m2. Extra costs to incorporate sustainability principles: ± 8%.

Energy

Energy performance is 45% better compared to legal requirements. The building mass is optimised requiring no mechanical cooling during summer time. Natural ventilation is used over night to cool the building.

During winter times heat is recovered from the mechanical ventilation air.

Hot water supply relies on a solar boiler combined with 10 m2 of photo voltaic cells.



Further energy savings is accomplished by optimised use of day lighting and day light controlled energy saving fixtures.

Water

Rain water is collected on the flat roof , filtered and stored in the basement for use as toilet flushing. Any excess water is transferred to the atrium to create a small waterfall. This adds to the humidification of the indoor air.

Part of the roof construction is covered by vegetation.

Materials

As an experiment flax is used as insulation material in the north facade. Window frames are made from Oregon Pine. All drainage tubing and electricity conducts are made from poly-ethylene.

During construction, building waste was separated into five fractions. The pantries are fitted with boxes for separate collection of waste.

The parking lot is constructed with a foundation of lava stone which absorbed any oil spills from parked cars.

ECO BALANCE DWELLINGS in Nieuwland- Amersfoort

Introduction

The Eco Balance dwellings in Amersfoort have been designed to incorporate the best available technology currently available. Many measures adopted form also part of the National Package Sustainable Construction.

The main emphasis leis on energy saving and water saving (numbers refer to figure on the next page).

Energy

Thermal insulation:

- Facade: Rc = 5,0 m^2K/W
- Floors: Rc = 3,5 m^2K/W
- Roof: Rc = 5,0 m^2K/W

Glazing: U = 1,4 W/m^2K.

Glass rooms facing south (4) provide additional passive solar heating.

Photovoltaic cells (31) coupled to the mains and a solar heater for hot water supply (32) are incorporated in the roof construction. The orientation and the slope of the roof construction is optimised for solar energy collection (south orientation and slope 45°).

Vessels for storage of hot water (40) with a total capacity of 1300 litres are situated in the basement. A heat pump (42) connected to a heat exchanger in the subsoil (43) adds additional heat to the storage vessels.

Room ventilation is by means of a balanced system with heat recovery. A low temperature wall heating system (12) fed by the heat storage vessels (40) is the primary heat source during wintertime.

Water

Rain water collected in a vessel (46) in the basement is used for toilet flushing and the washing machine. The latter is of the hot-fill type. Grey waste water is stored in a vessel (41) and can be used for gardening purposes after being led through a bio-filter bed.

All water consuming equipment (toilets (51), taps (48), shower heads (47)) is specially designed for water saving.

Materials

A large raking coping (15) protects the facade. For roof and facade insulation cellulose fibres are applied. To a high extent domestic timber is used to save non-renewable raw materials. Examples are window frames (19), door frames and doors (24) floor construction of the first floor (21), stair case (26), facade cladding (27)..

The flat roof is covered by vegetation (30)

For more information, contact:

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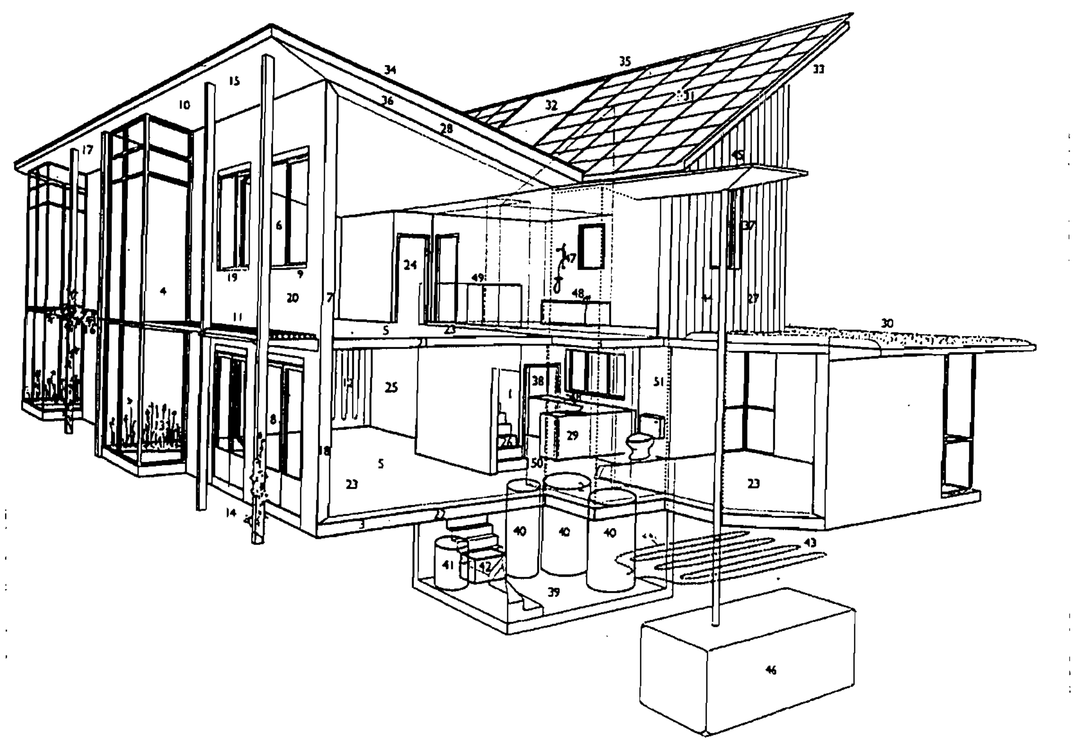


Eco-balance dwelling Nieuwland-Amersfoort

ECO-QUANTUM: DEVELOPMENT OF LCA BASED TOOLS FOR BUILDINGS

Introduction

In order to provide architects and project developers with an instrument to measure the environmental performance of buildings, the Dutch government and other organisations financed the development of Eco-Quantum (EQ). EQ is a calculating method on the basis of LCA which serves actors in the building sector with quantitative information on the environmental impact of buildings as a whole. The environmental effects during the entire life cycle of the building are taken into account: from the moment the raw materials are extracted to the final demolition or reuse. This includes the impact of the energy use, the maintenance during the use phase, the differences in the durability of parts or construction needs, like adhesives and nails. EQ also takes into account the possibility for selective demolition or renovation. The method can be used for both dwellings and non-domestic buildings.

Eco-Quantum is based on the method of life cycle assessment of products as developed by the Dutch CML (Heijungs, 1992) and the outcomes of the CCI project 'Environmental Ratings in the construction industry'.

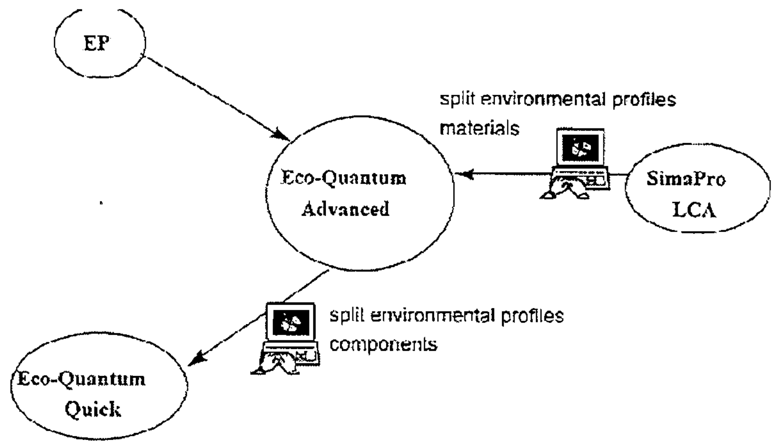
The EQ project was commissioned by the Dutch government, the Steering Committee for experiments in public Housing (SEV), The Dutch Building Research Foundation (SBR) and Stichting Milieubewustzijn. Eco-Quantum is widely accepted in The Netherlands because a steering committee, with representatives of the government, universities, consultants, industry and designers, is involved in the project.

The Eco-Quantum tools

Because of the different applications there are two customised tools: Eco-Quantum Advanced and Eco-Quantum Quick. EQ-quick is a tool for designers, with this instrument they are able to include environmental consequences of designing and of materials in their designs of dwellings and non-domestic buildings.

A customer can use EQ-quick to set (environmental) performances at the start of the design process, and to assess the design at the end of the process. Meanwhile the designer can use EQ-quick as a quick scan to determine the environmental correctness of his design. During the design process EQ-quick can be used to communicate on sustainable designing and building, for example between the customer and the designer as a means for evaluation of alternatives

EQ-advanced will be used by building consultants, (environmental) researchers and large design offices to analyse their building concepts and to reduce the environmental impact of their designs.



The tools EQ-quick and EQ-advanced can be used separately, although they are connected (see figure). EQ-advanced generates indicators for EQ-quick. These indicators are made up to date regularly.

The Dutch Energy Performance standard (EP) is applied to determine the energy consumption during the phase of use of the buildings. In The Netherlands it is obliged to measure the energy performance of a building, otherwise one doesn't receive a building permit. Because of this the data for energy use are available for every building, these are imported in both EQ-advanced and EQ-quick.

In these programmes the environmental effects caused by the production of various energy sources is calculated and added to the rest of the environmental impact of the building. The LCA programme SimaPro is applied to generate and automatically supply the environmental information of processes related to building materials, energy and transportation. Concerning building materials the environmental profile is calculated for the phases of production, use, waste treatment and recycling per kg of each building materials. These environmental profiles are automatically transferred to EQ-advanced

In EQ-advanced design data are translated into material and energy flows. Therefor Eco-Quantum comprises an extensive database *Components* which consists of materialised components of the building, with information about the life span, materials needed and maintenance. The environmental information from SimaPro is connected to the components information. Various outputs can be presented. In order to make a practical instrument EQ-advanced supplies EQ-quick with environmental profiles of various components and with other building information. The information is automatically transferred to EQ quick. The most important difference with EQ advanced is that the user of EQ-quick can adapt much less parameters. He can only adapt the parameters, which he can influence by his design. This makes the input easy and protects the user from not realistic output. The input is on the other hand made extra easy by offering, if possible, defaults and choice options.

How the tool works

The most important user group, the designers, makes a number of great demands on EQ-quick. If the instrument does not meet these demands, it won't be used in the designing process. An important demand is that the input and the output has to follow the language of the user. The next demand is that the input has to be simple. Only information should be asked which is available to the user at that moment. To obtain the input of EQ-quick, the designer hardly has to make extra effort. The data have to be collected already for the calculation of the costs.

The most important designing decisions are made in the first phases of the designing process. The problem is that the necessary information is only available in the 'Specification-stage' and at the end of the 'Final design-stage'. Namely in these design stages the entire materialisation of the building takes place. For that reason EQ-quick has more levels. By working with defaults and aggregated data it is possible to obtain results in an early phase of designing, without knowing all details of the design.

The user of EQ-quick can influence the results by varying the life span, the shape of the building, the installation concepts (energy, water) and the choice and life span of the building components. It is also possible to choose per component a more profitable waste scenario. The obligated (minimal) input consists of building sizes, energy use during the use phase (this is the result of an EP measurement) and the choice of the sizes of the components.

EQ-advanced uses the databases of SimaPro: environmental profiles per kg material. EQ-quick contains a database with data which are even more aggregated, namely the environmental profiles per unit component, which are generated with EQ-advanced. This database is also updated when changes occur in EQ-advanced and SimaPro. By this the consistency between the different instruments is guaranteed.

Developments

In Europe there is an urgent need for tools and methods which assess the environmental impacts of buildings and building materials and indicate the environmental profit of improvement options. Companies, designers, producers and clients need a common environmental language to provide each other with environmental information. While there has been no uniform and easy accessible tool and method to provide this information, building actors disagreed on the environmental performance of building and building components.

In the future it is expected that more building actors can use the 'communal environmental language Eco-Quantum'. Producers and suppliers of building products, can use EQ-advanced to determine :
i) the impact of their building products, ii) the contribution to the total environmental burden of a whole building and iii) to implement environmental improvements.
Government policy makers can use EQ-advanced to establish quantitative targets for the environmental performance of buildings, like is done with energy performance standards.
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NATIONAL PACKAGE FOR SUSTAINABLE BUILDING

More and more, sustainable building is becoming a normal part of the building process. We have made great progress in our knowledge of sustainable design methods, constructions and materials. More and more public authorities and commercial enterprises now have experience of sustainable building.

This state of the art was compiled in a national package for sustainable building drawn up by the building industry. It is aimed mainly at the residential market. The State Secretary for Housing, Spatial Planning and the Environment has added a recommendation that should give substance to the principle of sustainable building in 1996.

Why this package?

The initiative for the national package for sustainable building came from the building industry association NVOB. The organisation had noticed that there was growing confusion about the measures required for sustainable building. A product or measure that might be called 'sustainable' in one instance, would be regarded as unsustainable in another. The NVOB concluded that one uniform package was needed to put an end to all the confusion. A building research organisation, Stichting Bouwresearch, was asked to identify all the different packages in use throughout the country, and create one standard package. A wide range of organisations in the building industry have helped in the production of this package.

The following organisations were involved in drawing up the national package for sustainable building:

- The Federation of Dutch Contractors' Organisations (AVBB)
- The Association of Netherlands Architects (BNA)
- The National Housing Council (INWR)
- The Dutch Christian Institute of Housing (NCIV)
- The Dutch Federation of Building Constructors (NVOB)
- The Dutch Association of Builders & Developers (NVB)
- The Dutch Association of Construction Industry Suppliers (NVTB)
- The Association of Dutch Consulting Engineers (ONRI)
- The Real Estate Council of the Netherlands (ROZ)
- Stichting Bouwresearch
- The Steering Group on Experiments in Housing (SEV)
- The Union of Dutch Local Authorities (VNG)
- VGBouw

The national package for sustainable building consists of some 160 voluntary measures. The involvement of many trade associations and the clear nature of the package mean that it should become standard for everyone. Sustainable building is therefore also to be incorporated in the Housing Act. Those who decide to work with the national package now will therefore have an advantage in terms of experience and know-how when the measures become mandatory.

How to use the package

The national package for sustainable building is used for a wide variety of purposes. For example:

- a municipal approach to sustainable building. When planning new housing projects, all the partners involved can agree that the national package should apply to all plans;
- programme of requirements for new housing plans. A principal may incorporate the measures from the national package in his programme of requirements;
- marketing. A principal can design a house and use the national package to arouse the interests of potential tenants and buyers;
- advice during the building process. Architects and advisers can advise their clients of the environmental aspects of certain design options, using the national package.

High-quality package

Many leading trade associations and umbrella organisations were closely involved in drawing up the national package, and they therefore fully endorse its contents. This broad support means that those who use the package can rest assured that the measures meet a number of important conditions:

- they are perfectly suited for application on a large scale;
- they match traditional methods in terms of quality;
- they have a definite positive environmental impact;
- they are not too expensive, and can therefore be used in all sectors of the housing market, including the subsidised sector.

Structure

The national package deals with all phases of the building process- It contains 160 measures, arranged according to the phase and environmental theme they relate to. Some of the measures concern the immediate living environment (such as the choice of paving), but the main concern is the home itself. The measures are divided into fixed and flexible measures.

Fixed measures can be adopted as standard, irrespective of the specific nature of the project. Just how the flexible measures can be put into practice will have to be decided on a project by project basis, depending on the preferences of those involved, the availability of the materials and the type of location.

Sustainable building in 2000

Our knowledge of sustainable building is developing apace. Manufacturers regularly launch new sustainable products onto the market. Legislation and regulations relating to building and the environment are also being amended.

Life-cycle analyses constantly provide us with more information about the environmental aspects of building materials, so the national package will be updated once a year. Any changes will be decided in consultation between Stichting Bouwresearch, the trade associations and the Ministry of Housing, Spatial Planning and the Environment. Measures will also be added in the near future for the renovation and maintenance of the existing housing stock.

'An acceptable extra investment'

Stichting Bouwresearch has also worked out the costs associated with the measures. On the basis of these costs, the State Secretary for Housing, Spatial Planning and the Environment concluded that ,most of the measures can be applied with an extra investment of 1.500 ECU'. He has therefore made the following recommendations:

- apply all the fixed measures- The extra costs associated with this lie between 750 ECU and 1.000 ECU;
- apply all further measures that cost no extra or lead to investment savings;
- choose from the remaining measures a package that is tailored to the specific features of the project, so that the total extra investment is 1.500 ECU.

With this small investment it should be possible to build a sustainable home. The State Secretary plans to use the package and further recommendations in future arrangements with partners concerning the locations designated under present Dutch spatial planning policy, and in the Ministry's other activities.

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