Zukunft Bau

STRUCTURE / SHORT REPORT

CDP // Energy

Computer-based planning for urban development context considering energy and indoor climate aspects urban development context considering energy and indoor climate aspects

Initial Situation

Energy and indoor climate aspects for urban planning in the decision making phase are insufficiently considered. The reason for this is the insufficient of user friendly interface and software solutions. In order to resolve this discrepancy, requirements for analysis methods for energy consideration in creative planning phases have been investigate - based on this, solution approaches were conceptually developed and prototypically implemented.

Subject of the Research Project

The project was carried out in an interdisciplinary team between the Chair of Building Technology and Climate Responsive Design (Prof. Thomas Auer) and the Chair of Architectural Informatics (Prof. Frank Petzold). The research team of Prof. Auer explored methods for calculation and analysis of relevant energy and room climate aspects on a scale of 1: 500 on the basis of which the definition of conceptual requirements for calculation models was carried out. The team of Prof. Petzold focused on the computer-based implementation of the defined methods based on the existing infrastructure in the form of the CDP // Collaborative Design Platform. The research focus was the development of efficient, but still accurate algorithms, as well as suitable application and visualization concepts. The work steps are subdivided as follows:

1. Determination of relevant calculation and simulation methods
Appropriate calculation and analysis models were defined for the investigation of the supply options with district heating networks and for determination of the renewable energy potentials (solar and geothermal energy) in early urban planning phases. The challenge here lies largely in the data availability which is vague and incomplete in these planning phases. Therefore, approaches had to be investigated and methods developed for real-time prediction of energy aspects and effects based on available data.

2. Extension of the CDP // Collaborative Design Platform with additional plug-ins
Based on the defined calculation models and methods, several new Plugins were developed and implemented in the existing design platform CDP // Collaborative Design Platform. The focus here was on the implementation of the following analysis tools:

- **Plugin for the analysis of the supply possibilities with heat networks**
  The basis of this plugin is the automatic, optimized route laying on the basis of the road / path network. Based on this, the heat consumption per meter of network path per segment is calculated. Two methods were designed and implemented: Method 1 calculates the supply potential in the network for a manually placed heating system. Method 2 automatically evaluated the entire planning are for the location quality of the heating system.

- **Plugin for calculation and analysis of the solar potential**
  The solar potential calculation plugin includes the analysis of all buildings in the planning area, as well as planned developments. Based on the calculation of the solar irradiation on

the roof surfaces the producible amount of electricity from photovoltaic is determined for each building and compared to the statistical power consumption of the building.

- **Plugin for analysis of the geothermal potential**

With this plugin, maps for the use of geothermal energy from WMS servers can be visualized in the CDP. In addition, a method was developed for the building-specific calculation of the heat potential from geothermal energy.

- **Plugin for daylight simulation**

At the threshold between exterior and interior areas, this plugin provides a daylight simulation to determine the daylight factor values for an analysis room inside a building.

- **Plugin for thermal simulation**

The goal of this plugin is to implement a dynamic thermal simulation to determine the energy demand and the thermal comfort conditions of the selected analysis room. The methodology for this was defined and a first implementation incorporating TRNSYS was tested.

Strategies for information visualization and consideration of corresponding degrees of abstraction

The embedding of the analysis results into the planning process requires appropriate methods of information visualization and the representation of the simulation results. Within the scope of the project, appropriate strategies for the individual plugins were investigated, designed and implemented within the framework of the plugins. The focus was mainly on the presentation of the results in real time, as well as possible forms of depiction of trends reflecting results.

Conclusion

Within the scope of the project CDP // ENERGY, methods for the energy analysis of urban planning in early stages of decision making were investigated, analyzed and prototypically implemented. Based on indoor climate and energy aspects, requirements analysis for district heating, renewable energy potential as well as daylight and thermal simulations at building scale were developed. Taking into account these requirements, 5 calculation methods were developed within the scope of the project and implemented on the basis of the CDP // Collaborative Design Platform.

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Key Data

Short Title: CDP // Energy

Researcher / Project Lead: Prof. Dr.-Ing. Frank Petzold, Prof. Thomas Auer
Project Manager: Dr.-Ing. Gerhard Schubert
Research Members: Dipl.-Ing. Cécile Bonnet, Ata Chokhachian, M.Sc., Ivan Bratoev, M.Sc.
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PICTURES/IMAGES:

5 - 7 Printable image data as a separate file (*.tif, *.bmp, …) with a resolution of at least 300 dpi in the image size (e.g. width 10 – 20 cm). Images are free of third party rights.

Image credits:

Image 1: cdp_energy.jpg
Caption: CDP // Energy – interactive heat network calculation in real time

Image 2: heatnetwork_single_sim.jpg
Caption: Automatic generation and evaluation of the heating network depending on the position of the heating plant (physical object on the table surface - marked in red)

Image 3: heatnetwork_full_sim.jpg
Caption: Analysis for identification of the most favorable positions to place the heating system

Image 4: solar_potential_with_streets.jpg
Caption: Representation of the energy consumption covered by solar radiation as a percentage; buildings marked in red are not part of the analysis

Image 5: daylight_full_with_streets.jpg
Caption: Daylight availability for a selected analysis room including magnification of the visualization

Image 6: 3d_prespective_shoe_box.jpg
Caption: Selection of the analysis room - the geometry with a depth of 6 m is constructed directly from the hand-drawn sketch, assigned to the building and positioned and referenced in the 3D model