EUROPEAN INSTITUTE FOR ENERGY RESEARCH

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Näher dran.

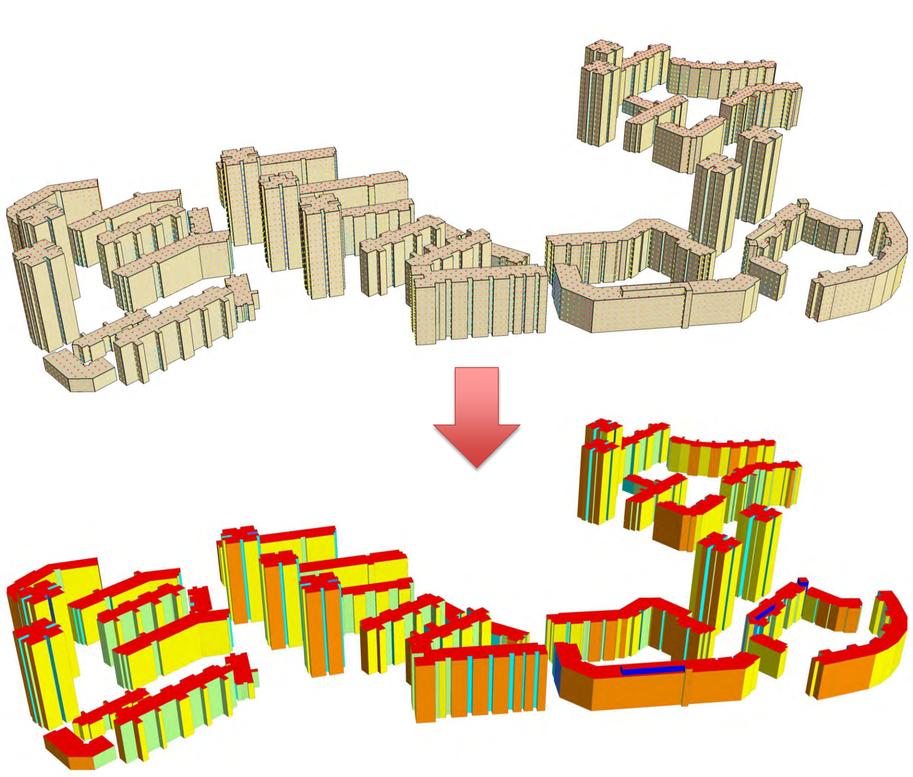
Computing Solar Radiation on Buildings at an Urban Scale

Development and Implementation based on CityGML and 3D City Database for PostGIS

Introduction

Solar radiation plays an important role for the planning of sustainable city structures and the development of energy models related to urban areas. For this task, detailed information about the spatial distribution of solar radiation with respect to building structure and urban morphology is of high importance.

In this thesis, a Python application has been developed for city wide computation of solar radiation received by building's wall and roof surfaces contained in a 3D city model. The underlying building data is gathered from CityGML files and stored in a PostgreSQL database with PostGIS extension.



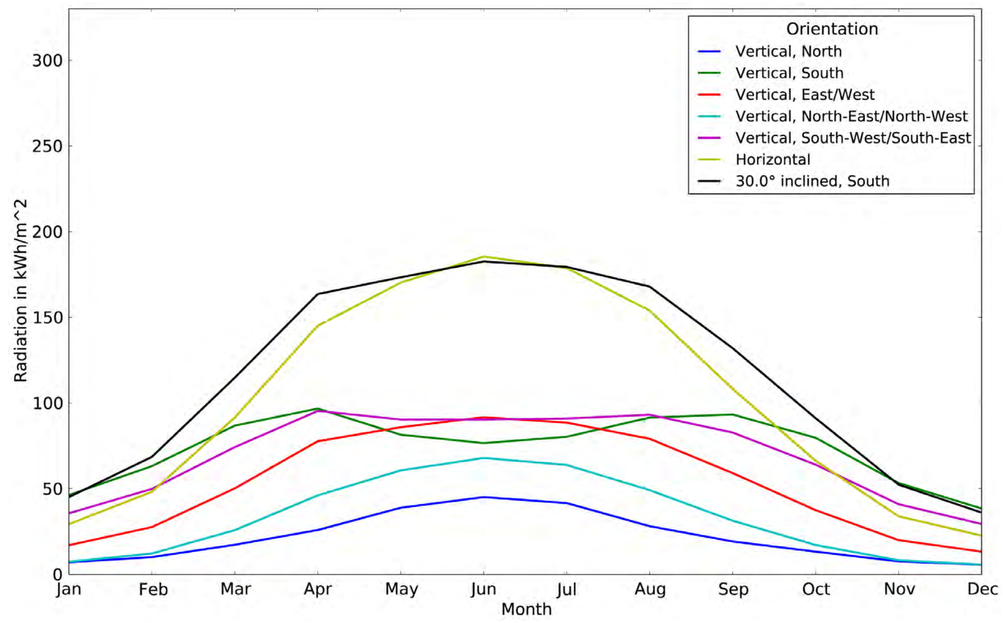
Solar radiation per square meter in one month received per point (top) and per surface (bottom)

Methodology

1. Establishing a point grid on roof and wall surfaces of buildings
2. Determination of shadowing
3. Computation of solar irradiance for each surface point
4. Aggregation with respect to time interval and surface area each point represents

Results

Monthly values for beam and diffuse component of solar radiation received by building surfaces have been computed for clear-sky and overcast conditions with respect to measured climatologic parameters such as global horizontal radiation. The required orientation of individual surfaces and the determination of shadowing by surrounding buildings have been extracted from 3D city models containing geometry in Level of Detail one or two.



Solar radiation per month for surfaces in various orientations in Karlsruhe

A validation against commercial thermal simulation software for energy performance assessment of buildings has been undertaken, which revealed that the results of the implemented computation model correlate with the given reference values.

Conclusion

The developed application can be incorporated into further energy models and analysis dedicated to the assessment of buildings' wall and roof surfaces of 3D city models stored in the CityGML format.

For instance, the resulting solar radiation values have been used in this thesis to compute passive solar heat gains of residential buildings.

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