

# An approach to model the thermal demand of buildings

## A case study using two districts of Graz

Author: Stefan Mayer, UniGIS Msc 2011

### Abstract

The current paper deals with an approach to model the annual heating and cooling demand for buildings, using two districts of the city of Graz as case study. The main objective is to gather the demand patterns within different parts of the city and to localise demand hotspots. A determination of the heating and cooling demand of buildings is carried out via the calculation of the heat balance of individual buildings. The practical implementation consists of the generation of a building model and the proper demand calculation, which is performed with the Python programming language. Thermal gains and losses of buildings are calculated separately. This master thesis shows in detail which kind of effects have to be considered when determining the heating and cooling demand of buildings. While qualitative and quantitative statements can be made about the building quality and the demand patterns, also the interactions of building geometry, age and type are revealed. Moreover, the significant influence of climatic conditions is highlighted. The approach chosen for this paper could be enhanced by considering an advanced building model or a higher level of temporal resolution. By considering the warm water heating demand and the integration of the HVAC-system into the model, the final energy demand can be calculated.

*Keywords: Thermal Demand, Energy, Hotspot, Heating, Cooling, Building, Specific Demand*

### 1. Introduction

The report from the European Environmental Agency about “Urban sprawl in Europe” (EEA, 2006) points out that more than a quarter of the European Union's territory is directly affected by urban land use. Moreover, approximately 80 % of the Europeans will be living in urban areas by 2020, in some countries the share will be by 90 %. Nowadays, the challenge for cities lies in the development of strategies to reduce greenhouse gases (GHG) and to increase the energy efficiency.

The potentials for implementing efficient strategies are available, as in cities a lot of individual measures can be obtained in different sectors like: energy production, energy networks, energy-efficient buildings but also urban design, transport, water and waste. Until now, all different elements have not been implemented in an integrated system, which helps to understand the city as a complex

framework with interacting components and all its consequential processes, due to governmental barriers. This thesis can be seen as a starting point towards an energy mapping tool, which tries to find an appropriate method to visualize the thermal energy demand for cities or city districts, by considering the demand of buildings only.

The main objective is the mapping of the heating and cooling demand according to the quality of the building envelope in order to assess potentials for energy saving measures and planning optimization as well as to develop supply scenarios. The focus of this thesis will be placed on the spatial distribution of thermal demand within urban areas and various demographic structures, using two districts of the city of Graz as case study. The final representation of the thermal demand will be visualized through raster format (125x125m).