DETERMINING THE SPATIAL-TEMPORAL HEATING DEMAND FOR SECTOR-COUPLED OPTIMISATION MODELS

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Motivation

Space heating accounts for approximately 65 % of the total residential energy consumption in EU households, but still relies mainly on fossil fuels [1]. According to the European Green Deal emissions in the building sector must be decreased by 60% by 2023 compared to 2015 [2]. Some examples to achieve this are retrofitting with heat pumps or biomass boilers or the expansion of district heating networks. However, a priori it is not clear where to implement which technology, since these decisions depend on many aspects, such as availability of (waste) heat, the linear heat density, (hourly) electricity costs, etc. To determine the most cost-effective and most sustainable solution, optimisation models, which are well established in the electricity systems [3], will play a key role. Such optimisation models require reliable input parameters: among others, the heating demand with spatial (where) and high temporal (when) resolution. A plethora of different methods for heating and cooling demand estimations exists [4], but most of them focus either on the yearly heating demand or the load profile of existing district heating systems. We, therefore, propose an integrated method that determines the heating demand on a building level and aggregated hourly load profiles, based on geo information system (GIS), cadastre, weather and occupancy data. By applying the developed approach on a case study of Puertollano in Spain we lay the foundation for investigating the waste heat usage potential of electrolysers by means of sector-coupled optimisation models.

Methodology

The procedure for data acquisition and aggregation is subdivided into two main steps: Spatial distribution and temporal profiles. **Spatial distribution:** starting with GIS data from Open Street Maps (OSM), the location (GPS coordinates) of the buildings in the desired region can be identified. Those geodata allow to request information for every building from the official cadastre (depending on the country). By that, the size, type of usage, year of construction, and other data can be acquired. Based on the (historic) national legislation on energy building performance and typical building standards in different decades a specific heating demand can be estimated for every building. **Temporal profiles:** The hourly heating demand is mainly determined by two factors: outside temperature and the setpoint of the temperature control during the day. While temperature with temporal resolution is readily available, the setpoint can only be estimated by occupancy statistics: when people are at home and active a higher, when not, a lower temperature will be set. This stochastic approach is based on activity data from the Time Use Survey, which gives insight into typical activities of people during the day. In addition, the thermal losses and thermal storage capacity of the buildings are estimated from the specific heating demand and incorporated into the simulation.

Case study: waste heat usage potential of an electrolyser for residential heating

In Puertollano/Spain a 20 MW electrolyser, powered by PV (installed capacity: 100 MW) produces green hydrogen [5]. One research question deals with the usage potential of electrolyser waste heat for district heating. To tackle the complex interplay of the electrical with the thermal sector, a sector-coupled optimisation model will be designed. As input data, this model requires valid spatial-temporal resolved heating demand profiles. According to the procedure described in the previous section, the heating demand was determined for the City of Puertollano on a building level (see Figure 1). Additionally, an aggregated heat load profile can be seen in Figure 2.

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Conclusions and Outlook

We found that the approach works well and that the determined total heating demand is in good accordance with data from other sources [6,7], as well as the temporal load profile matches with measured demands from district heating networks. In the next step, the model will be validated by applying it to a district/region where measured heating demand data is directly available.

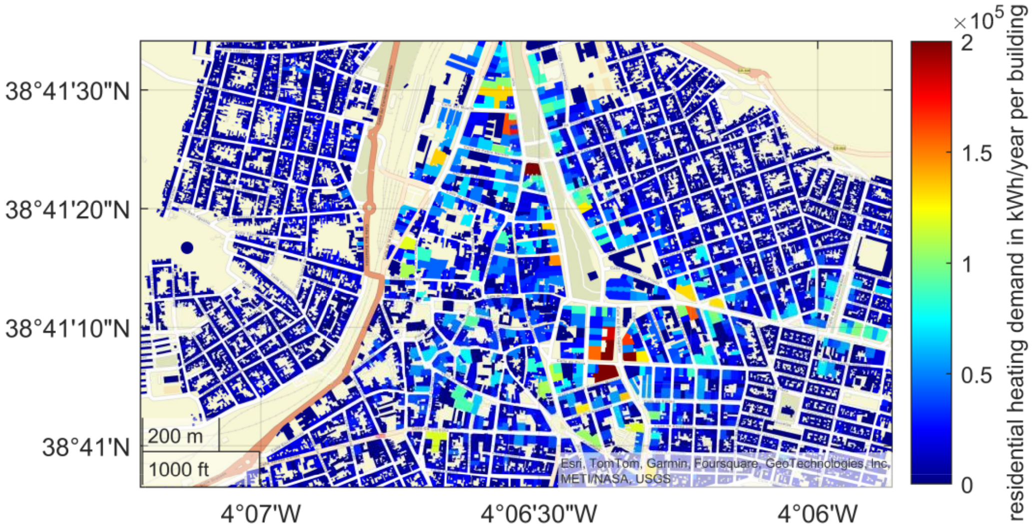

Figure 1: Yearly heating demand on a building level for the city of Puertollano/Spain.

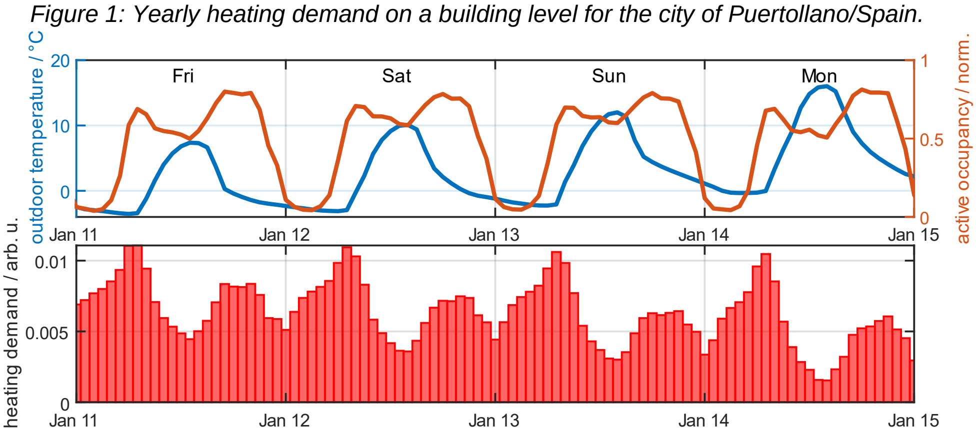

Figure 2: Simulated heating demand profile as a function of outdoor temperature and active occupancy.

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