

Generating energy carrier specific space heating and hot water load profiles at NUTS-3-level in Europe

Electricity, heat generation & storage

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Motivation and key issue

The electrification of heating applications represents one significant component in the decarbonisation of private households [1]. The spatial distribution of diverse energy carriers used for heating applications within a country (heating structure) is usually not homogeneous. Population density and climatic conditions are influencing factors determining the type of energy carrier and the used heating system in a region. The selective substitution of fossil driven heating systems by electrically driven ones induces therefore spatially varying changes in the electricity grid. Accordingly, the key motivation for this paper is to develop a methodology to generate spatially differentiated load profiles by using heating structures.

Methodological approach

A top-down approach is used to model space heating and hot water load profiles in the spatial resolution of NUTS-3-regions. National energy balances are modified to generate application balances in which the yearly final energy consumption is determined. The part of final energy needed for space heating and hot water split up into energy carriers is allocated to the NUTS-3-regions by using the distribution of heating systems. Variations in climatic conditions are taken into account by degree day numbers at NUTS-3-level.

The spatial distribution of heating systems by energy carriers is provided by the national offices for statistics. If the data quality is lower, regional final energy consumption by energy carrier is used. Thereby additional applications (lighting, cooking, ...) have to be subtracted from the data to derive the heating structure for space heating and hot water. However, these methods cannot be applied to all countries making individual ones necessary.

The annual final energy consumption for space heating and hot water of each NUTS-3-region is converted into daily data using the degree day numbers, whereby no seasonal effect is assumed for hot water consumption. Using temperature-dependent standard gas load profiles the daily quantities of space heating and hot water demand are transformed into hourly load profiles.

Results and conclusions

About 80 % of final energy in private households is resolved hourly for the NUTS-3-regions. Spatial characteristics concerning the use of energy carriers and the resulting loads, depending on the outdoor temperature can be derived from the model.

Figure 1 shows the distribution of electrical heating systems in France. There is a higher share of electrical heating systems in the south and south-west, declining by looking to the interior of the country.

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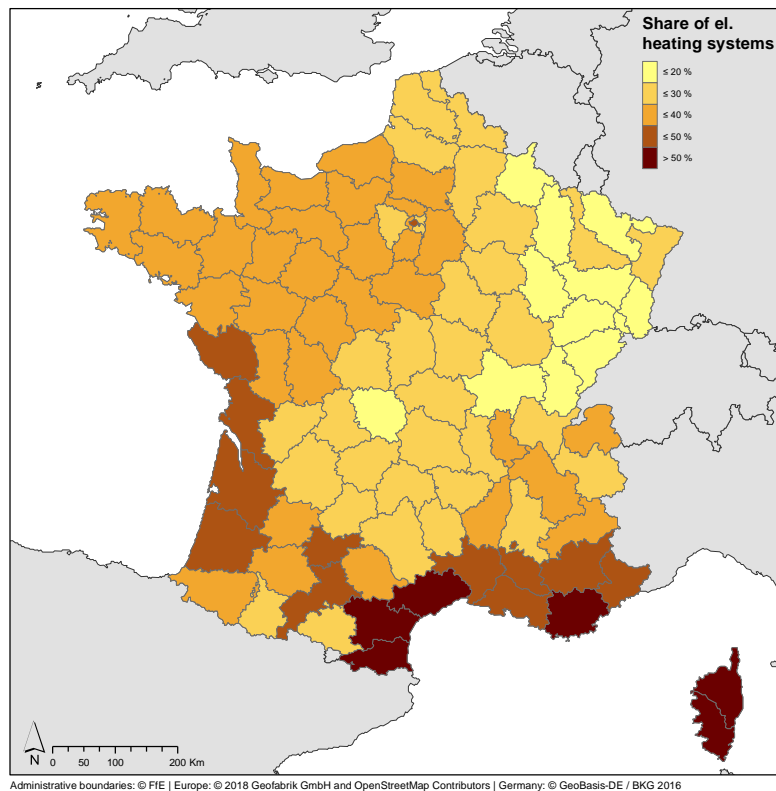


Figure 1: Share of electrical heating systems in each NUTS-3-region in France [2]

Considerable differences in the heating structure within a country are shown by the load profiles in figure 2 (exemplary shown for Switzerland). In Basel-Stadt district heating and gas are primarily used to provide heat. The share of electrical and oil-fired heating systems is lowest on state average, whereas in Ticino, their share is substantially higher. Base load corresponds to the provision of hot water while the volatile share of the annual load curve is attributable to the temperature-dependent space heating. The derived load curve, split into energy carriers, can be transformed into an electrical load (e.g. by using heat pumps as in [3]) to investigate effects of energy carrier specific policy measures. This data is valuable for spatially resolved energy system models.

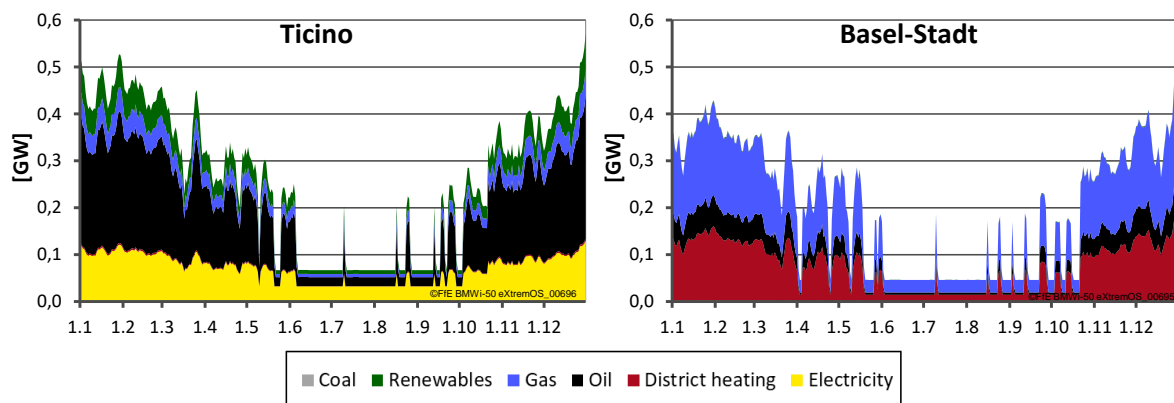


Figure 2: Space heating and hot water load curves of two Swiss NUTS-3-regions for 2014

Literatur

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