SCENARIOS FOR HEATING AND COOLING DEMAND IN THE EUROPEAN RESIDENTIAL SECTOR UNTIL 2030

Sebastian Forthuber, TU Wien/EEG, +4358801370360, forthuber@eeg.tuwien.ac.at
Michael Hartner, TU Wien/EEG, +4358801370379, hartner@eeg.tuwien.ac.at
Andreas Müller, TU Wien/EEG, +4358801370362, mueller@eeg.tuwien.ac.at
Lukas Kranzl, TU Wien/EEG, +4358801370351, kranzl@eeg.tuwien.ac.at

Overview

For various planning and policy issues the estimation of future development of heating and cooling demand is of great importance. In this paper we provide exemplary model results for the development of heating and cooling demand for 31 European countries which have been developed in the project *Mapping and analyses for the current and future (2020 - 2030) heating/cooling fuel development*. (See Fleiter, T.; Steinbach, J.; Ragwitz et.al.). Within this article we focus on the analysis of relevafornt indicators such as the development of total heat demand, specific heat demand per m^2, shares of the end use categories space heating, water heating and space cooling as well as renewable shares and CO_2 emissions. Additionally to the descriptive part of this study in which we want to provide a snapshot on heating and cooling demand in the European Heating and cooling demand we also discuss potentials for additional CO_2 reduction potentials of the residential building stock.

Methods

The scenario development for the residential sector is carried out by the Invert/EE-Lab model. It is a dynamic bottom-up simulation tool that evaluates the effects of different economic and regulatory conditions in scenarios up to 2020, 2030, 2050 (or beyond) based on the total energy demand, energy carrier mix, CO_2 reductions and costs for space heating, cooling, hot water preparation and lighting in buildings. More information is available on www.invert.at or, for example, in Kranzl et al. (2013).

The key idea of the model is to describe the building stock, heating, cooling and hot water systems at a highly disaggregated level, calculate related energy needs and delivered energy, determine reinvestment cycles and new investment in building components and technologies, and simulate the decisions of various agents (i.e. owner types) when an investment decision is required for a specific building segment. The core of the tool is a myopical, multinominal logit approach, which optimises the objectives of “agents” under imperfect information conditions and, by that, represents the decision maker concerning building related decisions.

Invert/EE-Lab covers residential and non-residential buildings. The residential building stock is distinguished according to different size of building (i.e. single family houses, apartment buildings etc.), construction period and state of thermal renovation. The levels of detail or the number of construction periods etc. depend on the data availability and structure of national statistics. Moreover, a set of about 30 heating and hot water technologies is considered in the description of the building stock, taking into account different energy carriers and technologies (e.g. local stoves or condensing boilers). In total, this leads to about 500-4500 reference building segments per country.

While numerous scenario runs have been performed this paper will focus on the developments within a current policy scenario and focuses on analysing the developments within this scenario rather than comparing scenarios or effects of implemented policies.

Results

Up to 2030 there is a decrease of 21% in the total final energy demand for the end-use sectors considered. Space heating remains the dominant end-use of the residential sector, although the proportion of space heating in total final energy demand slightly decreases. The share of space cooling increases from 0.63% to 1.15% and as such becomes a more relevant end-use category, especially for southern European countries. The relative growth of cooling far exceeds expected developments of energy demand in other sectors and end-uses. However, in the residential sector, space cooling in the aggregate of EU28 countries remains almost negligible compared to the overall energy demand, even though it might lead to considerable peak loads. The average share of hot water on total heating and cooling demand increasing slightly from 17% to 19%. Those estimations show that although space heating demand is expected to decline it will still be by far the most relevant end use category for total energy demand.

In terms of energy carriers we expect an increase of renewable energy carriers and decreasing use of fossil fuel. (see Figure 1) The rate of change however is moderate due to the relatively long life time of heating systems. The share of renewables changes in energy demand for heating and cooling according to the Eurostat definition increases from 21% in 2012 to 34% in 2030 due to an increase in market shares for heat pumps, biomass and solar thermal collectors. While it is expected that coal will almost disappear in the European residential sector and that the use of oil for heating will also strongly decrease, natural gas is expected still account for the largest share of heating and cooling supply in the residential sector. Note that natural gas still shows very high market shares in new heating system installations in many European countries at the moment as the gas infrastructure is continuously improved and gas is an economically attractive solution for many building owners.

The change in energy carriers together with reduced heat demand is expected to lead reductions of CO_2 emissions of more than -40% from the base year 2012 (541 Mio t_{CO2}) to the year 2030 (318 Mio t_{CO2}).

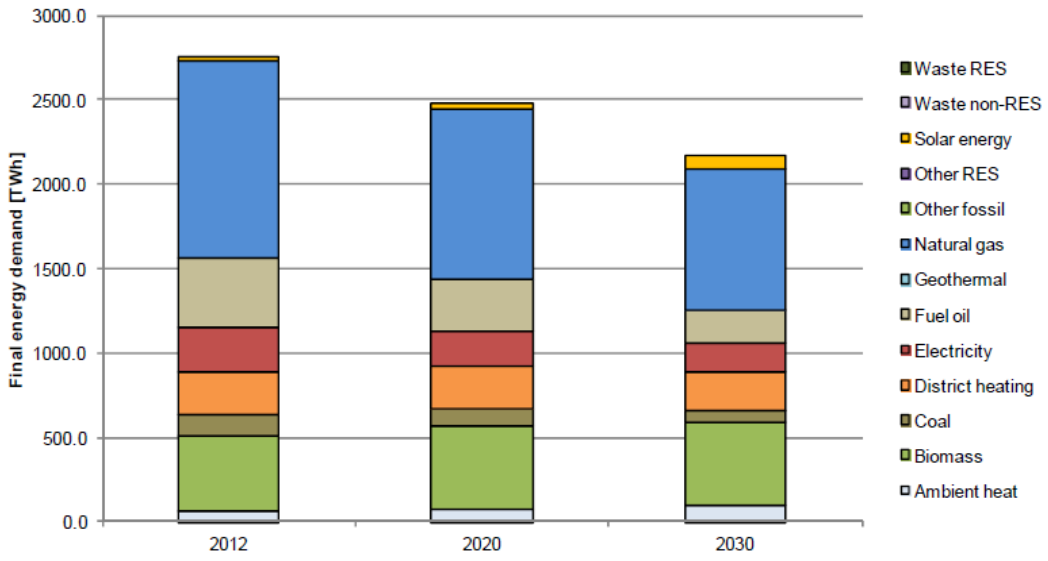

Figure 1: Final energy demand for space heating, cooling and hot water in residential buildings, EU28 in 2012, 2020 and 2030 by energy carrier, current policy scenario.

Conclusions

Similar to other studies we find that final energy demand for space heating in Europe will decrease significantly in the coming decades both due to climate change and improvements of building envelopes across Europe. Despite this decrease and increasing energy demand for cooling space heating will still be the most relevant end use category by 2030 and beyond. The share of renewables can be expected to increase significantly. However the speed of increase is limited by the relatively long lifetime of heating systems and high shares of natural gas, which is expected to be the most dominant source for heating across the EU by 2030. While the switch from coal and oil fired heating systems to efficient natural gas boiler (e.g. condensing boilers) lead to efficiency increases and CO_2 emission reductions, the current development might not be compatible with very ambitious climate mitigation targets where also a large share of gas boilers might have to be substituted by renewables. However the analysis also shows that renewables shares beyond 40% might be hard to achieve due to the already mentioned restrictions related to the long lifetime of heating systems in the residential building stock.

References

Fleiter, T., Steinbach, J., Ragwitz, M., Dengler, J., Köhler, B., Reitze, F., Tuille, F., Hartner, M., Kranzl, L., Forthuber, S., Reiter, U., 2016. Mapping and analyses of the current and future (2020 - 2030) heating/cooling fuel deployment (fossil/renewables). Project for the European Commission.

Müller, A., 2015. Energy Demand Assessment for Space Conditioning and Domestic Hot Water: A Case Study for the Austrian Building Stock (PhD-Thesis). Technische Universität Wien, Wien.

Kranzl, L., Müller, A., Toleikyte, A., Hummel, M., Forthuber, S., Steinbach, J., Kockat, J., 2014. Policy pathways for reducing the carbon emissions of the building stock until 2030. Report within the project ENTRANZE.

Invert/EE-Lab [Model website], URL http://invert.at/ (accessed 4.4.17).