KfW Research
Focus on Economics

››› The energy transition will not work without a heating transition

No. 129, 9 June 2016

Author: Anke Brüggemann, phone +49 69 7431-1736, research@kfw.de

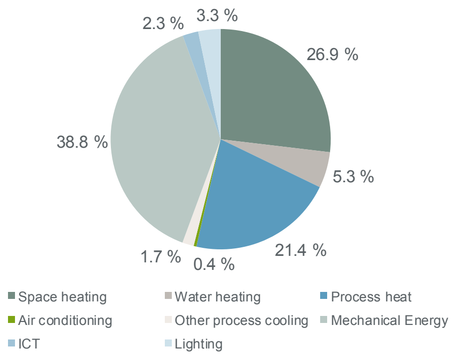
Heating accounts for more than half (54 %) of final energy consumption in Germany. The heating sector is responsible for around 26 % of Germany's total annual greenhouse gas emissions. Against this background, an energy transition cannot work without a heating transition. Energetic refurbishment and energy-efficient construction of new buildings as well as efficient process heat and waste heat use in trade and industry are key starting points for reducing heat consumption. It is also necessary to press ahead with the expansion of renewable energy use in the heating sector.

Importance of the heating sector for the energy transition

In order to make an effective contribution to the fight against global climate change, the German Federal Government has set itself far-reaching greenhouse gas reduction targets. GHG emissions in Germany are to be reduced by at least 40 % by the year 2020 and at least 80 to 95 % by the year 2050 against the reference year 1990 (situation in 2015: -27.2 %). The public debate over the energy transition in Germany primarily revolves around the conversion of power supply to renewable energy sources. However, a glance at the energy statistics shows that achieving the long-term climate protection goals will require not just an electricity transition but also a heating transition. Heating accounts for more than half (54 %) of final energy consumption in Germany (Figure 1). The heating sector is responsible for around 26 % of total annual greenhouse gas emissions.[1]

Figure 1: Final energy consumption by end-use in 2014

Total: 8,648 petajoules



Source: BMWi

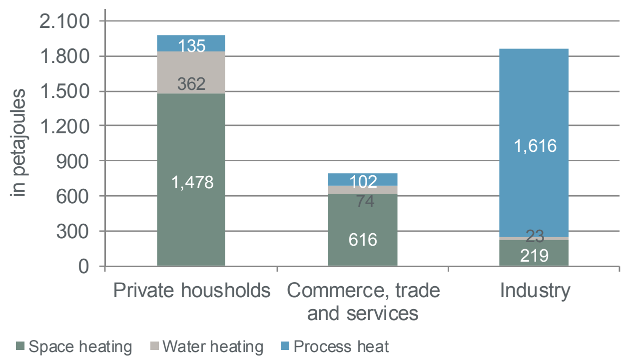
As part of the energy transition it is therefore indispensable to significantly reduce heating consumption as well and generate necessary heat efficiently and without harming the climate. That will not only benefit the climate but also help reduce Germany's dependence on fossil fuel imports such as oil and gas and lower energy costs.

Space heating in buildings accounts for the largest proportion of final energy consumption for heating in Germany, or 50 %. Process heat required for particular technical processes such as steam and hot water generation, drying, smelting, casting etc., occupies another large segment of the heating market, 40 %, while water heating only takes 10 %, a comparatively small share of Germany's total heat consumption.[2] A breakdown by sector shows that in private households and in commerce, trade and services the heating of buildings accounts for the bulk of heating requirements. In each of these sectors, approximately three fourths of the heating requirements are for space heating. In the industrial sector the dominant form of heat use is process heat, accounting for 87 % of industrial heat consumption (Figure 2).

Heating transition – only with energy-efficient buildings

The high proportion of space heating in total heat consumption illustrates that the heating transition must take place primarily in buildings. Various surveys estimating final energy saving potential in Germany have identified the building sector as offering the highest savings potential.[3] Figure 3 shows as an example the energy saving potentials computed by the Heidelberg Institute for Energy and Environmental Research (ifeu) and others in 2011 in the framework of the National Climate Initiative.[4]

Figure 2: Final energy consumption of sectors for heating purposes in 2014



Source: BMWi; excluding transport. Energy consumption of transport for space heating: 12.6 PJ.

Existing buildings offer great savings potential. Around half of all residential buildings in Germany – almost 9 million – are inadequately insulated, 90 % of which are old buildings erected before 1978. Energy savings can be achieved through the modernisation of the building envelope (insulation, windows) and technical refurbishment such as renewing and optimising heating and hot water systems. Hundreds of model refurbishments have demonstrated that the comprehensive modernisation of older buildings' energy systems can reduce their energy consumption by as much as 80 %.[5] High energy saving potential also exists in the approx. 2.7 million office and production buildings, commercial buildings, hotels and public buildings (schools, hospitals, theatres etc.) in Germany. Although they make up only 15 % of all existing buildings in Germany, these non-residential buildings are responsible for one third of building-related final energy consumption.[6] Buildings of this type consume comparatively high amounts of energy as they tend to be large. The range of non-residential buildings is very diverse, as are the users of these buildings and their demands. Accordingly, refurbishing their energy systems poses more complex challenges than for residential buildings.

Given their great energy savings potential, buildings constitute an important pillar of Germany's climate protection policy. With its energy strategy the Federal Government has formulated the explicit target of making the existing building stock almost climate-neutral by the year 2050. Specifically, by the year 2050 the primary energy requirement of the building sector is to be reduced by 80 % against the reference year 2008 (reduction in 2014: -14.8 %) and the refurbishment rate is to be doubled from currently 1 to 2 % per year. The remaining energy requirement is then to be met primarily by renewable energies.

With a view to the energy quality of the building stock in the target year 2050, buildings newly erected by that year must also meet high-efficiency criteria. Builders are still not making nearly enough use of voluntary energy-saving potential in this area. For example, the maximum annual primary energy requirement permitted by law can already be reduced by 60 % by erecting a residential building to the KfW Efficiency House 40 standard.

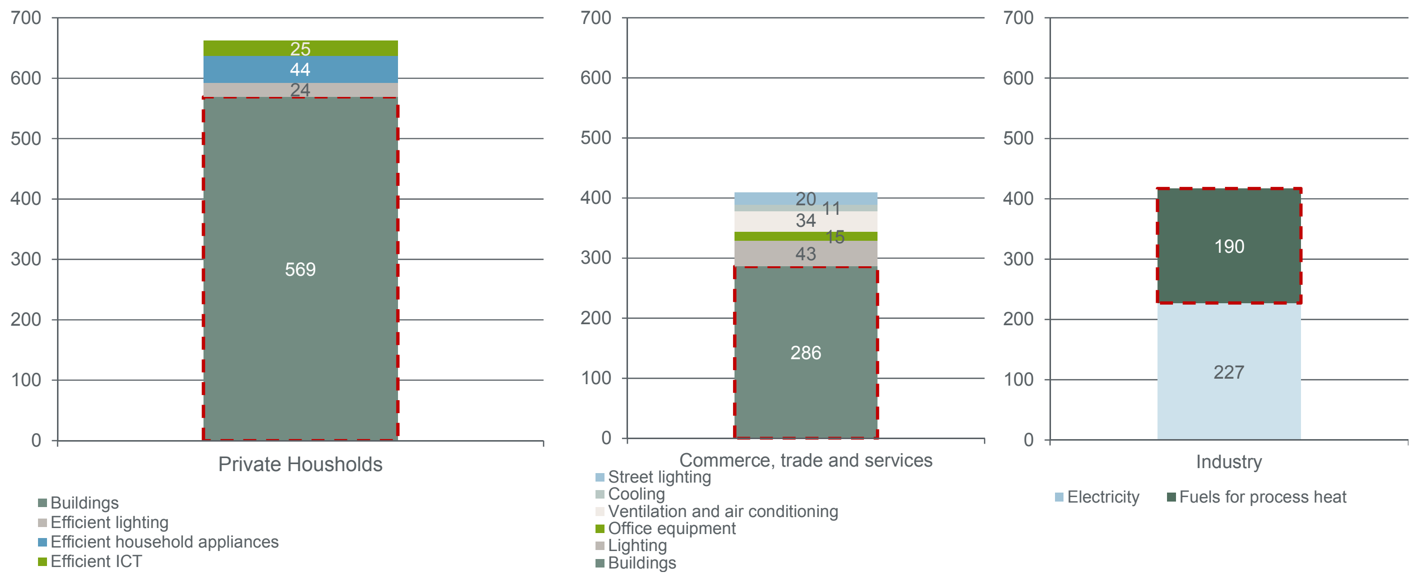
Using waste heat efficiently in trade and industry

A further important way of reducing heat consumption is through the efficient utilisation of process heat in industry (Figure 3). With a share of roughly two thirds of total industrial final energy consumption, process heat is by far the most energy-intensive field of use in the industrial sector.[7] Process heat is required in a great variety of production processes. They often generate waste heat that is released into the environment without being used. Typical waste heat sources in industry and trade are processing facilities (dryers, furnaces, boilers, etc.), but also wastewater from washing, dyeing and cooling processes as well as refrigeration plants, electric motor systems and room air conditioners.

Process heat requirements and resulting waste heat losses can be minimised by, among other things, process optimisation measures (use of energy-efficient technologies, optimisation of plant design and control, temperature reduction, etc.) and improved insulation of facilities and pipes. Unavoidable waste heat quantities can be transferred to new uses at the facility, for example by using them for space heating and hot water generation, or as part of the production process to pre-heat process water, combustion air and drying air. They can also be used outside the actual premises, e.g. by feeding heat into local and district heating networks, or by directly supplying a neighbouring facility. Excess waste heat can also be converted into other forms of useful energy such as electricity or cooling.[8] This, however, requires comparatively high waste heat temperatures in order to achieve acceptable conversion efficiency.[9]

Figure 3: Attractive end-use energy savings potential up to 2030 (compared with energy efficiency level of 2008)

In petajoules



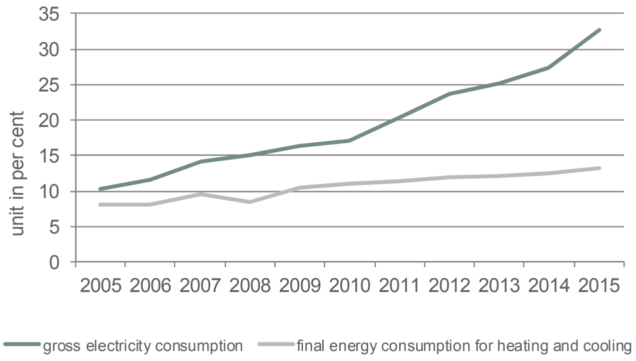
Source: Institute for Energy and Environmental Research Heidelberg et al. (ifeu) (2011), excluding transport (estimated savings potential in the transport sector by 2030: 590 PJ)

Increasing renewable energy use for heating

In the context of the heating transition it will also be necessary to generate the inevitable heating requirements more efficiently and in a more climate-friendly manner. One technical option is combined heat and power technology that generates electricity and heat at the same time. Highly efficient CHP facilities require significantly less fuel and, hence, emit much lower greenhouse gas levels than separate electricity and heat generation. What will also be necessary is to press ahead with the expansion of renewable energy use in the heating sector. Although the proportion of renewable energies in heating and cooling in Germany rose from 4.4 to 13.2 % between 2000 and 2015, their development momentum still remains substantially below the increased share in electricity generation (renewable energies accounted for 32.6 % of gross electricity consumption in 2015, see Figure 4).

By far the most important source of renewable heat is biomass, at 86 %. The lion's share is made up of wood fuels used in private households, industry and thermal power plants for heat regeneration. Geothermal energy and heat pumps contribute 7 % to renewable heat generation, followed by solar thermal energy at 5 %.[10] As biomass use competes for land with food production and nature conservation and because of the high importance of forests as carbon sinks, in the long term there will be limits to its use, so the use of solar thermal energy and geothermal energy / heat pumps will have to be promoted more strongly in the future. Looking further ahead, the closer interconnection of the heat and electricity system will gain importance through the use of electricity from wind power and photovoltaics for heating.

Figure 4: Shares of renewable energies in the years 2005 to 2015



Source: BMWi

The targets set for the building sector alone illustrate how big the challenge of expanding renewable energies in the heat sector is. By the year 2050 – 34 years from now – the aim is for the building stock to be almost carbon neutral. At present the share of renewable energies in final energy consumption for space heating and hot water is only 14 % in private households and 11 % in commerce, trade and services.[11] Most of the installed heating systems still run on gas and oil.[12]

Conclusion

The heat market is the most important final energy consumption sector in Germany. Consequently, the energy transition cannot succeed without a heating transition. The foregoing statements show that the heat sector holds great potential for reducing greenhouse gas emissions. However, this potential is not being sufficiently exploited by the relevant stakeholders because of numerous obstacles – including information deficits, financial restrictions or incomplete internalisation of the external environmental costs of fossil energy sources. Policymakers therefore need to stimulate the necessary investments by setting appropriate frameworks and creating targeted incentives. ■

[1] Cf. Graichen, P. (2016), presentation "Nach Paris und vor dem Klimaschutzplan 2050" (*After Paris and before the Climate Protection Plan 2050*) dated 5 April 2016, Agora Energiewende, Berlin (in German).

[2] Cf. BMWi, Energy data, as at 14 September 2015.

[3] Cf. i. a.: Institute for Energy and Environmental Research Heidelberg et al. (ifeu) (2011), Energieeffizienz: Potenziale, volkswirtschaftliche Effekte und innovative Handlungs- und Förderfelder für die Nationale Klimaschutzinitiative, Heidelberg / Karlsruhe / Berlin / Osnabrück / Freiburg; dena, Frontier Economics (2012), Steigerung der Energieeffizienz mit Hilfe von Energieeffizienz-Verpflichtungssystemen, Berlin / Köln; Fraunhofer Institut für System- und Innovationsforschung et al. (2014), Ausarbeitung von Instrumenten zur Realisierung von Endenergieeinsparungen in Deutschland auf Grundlage einer Kosten-/Nutzen-Analyse (all in German). Scientific support for the preparation of the National Action Plan on Energy Efficiency.

[4] Cf. Institute for Energy and Environmental Research Heidelberg et al. (ifeu) (2011), loc. cit.

[5] Cf. dena (2013), Auswertung von Verbrauchskennwerten energieeffizient sanierter Wohngebäude (*Evaluation of key consumption parameters of energetically refurbished residential buildings*), Berlin (in German).

[6] Cf. geea (2015), Positionspapier Energieeffizienz in Nichtwohngebäuden (*Position paper energy efficiency in non-residential buildings*, in German).

[7] Cf. BMWi, Energy data, as at 14 September 2015.

[8] Electricity generation: e.g. with the aid of ORC generators (ORC = Organic Rankine Cycle); generation of cooling, e.g. through an adsorption or absorption refrigerator.

[9] Cf. Energy Atlas Bavaria, www.energieatlas.bayern.de/thema_abwaerme/betriebsintern/nutzung.html, as at 12 May 2016.

[10] Cf. BMWi, Zeitreihen zur Entwicklung der erneuerbaren Energien in Deutschland (*Time series on the development of renewable energy sources in Germany*), as at February 2016 (in German).

[11] Cf. BMWi, Energy data, as at 14 September 2015.

[12] Cf. AG Energiebilanzen e.V. (2015), Energy consumption in Germany – data for the 1st to 4th quarter 2015 (in German).