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ENERGY RETROFITS IN MUNICIPALITIES

EXAMPLES FROM GERMANY

Heat accounts for the largest share of energy demand in Germany, and most energy is consumed in buildings. A heat transition in the building sector is therefore crucial, but the obstacles are often social, not technical. Municipalities are a good place to start because some of the social issues are easier to address there; communities are where people engage. In addition, municipal governments can serve as role models and also encourage the private sector through networking and special incentives.

MAIN TAKEAWAYS

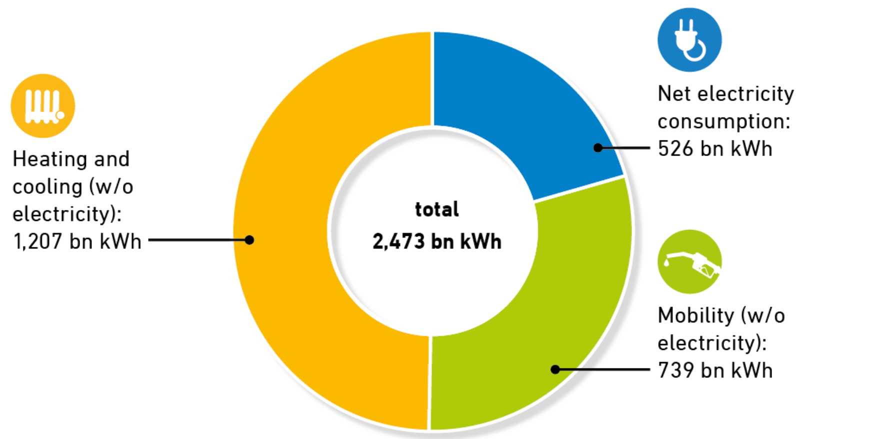
- Energy retrofits are progressing too slowly for mitigation, and the retrofits implemented are not ambitious enough.
- Municipalities are in a unique position to provide solutions for energy because they can overcome the obstacles preventing retrofits in the private sector.
- The projects below cover a wide range of activities that contribute to reduce the energy demand for heating and to shift to more sustainable sources of heat.

1 HEAT IS ALMOST HALF OF EUROPE'S ENERGY DEMAND

The energy transition has focused on electricity up to now, but a look at the composition of final energy consumption shows the importance of heat and mobility. Heat makes up 40 percent of total energy demand and accounts for around a third of carbon emissions in the EU – and that share is slightly higher in Germany (see chart below). When industry uses heat for manufacturing, one speaks of "process heat"; it makes up 40 percent of heat demand. Space heating in buildings makes up another 50 percent. A much smaller share, 10 percent, is for hot water. Space cooling (air-conditioning) is negligible in Germany at less than one percent of final energy consumption. In short, space heating alone is more than a quarter of German energy demand and hence bigger than the entire power sector (though the latter's emissions are greater because Germany burns so much coal in power plants).

Final energy consumption in Germany in 2018 by sector

in billion kilowatt-hours (terawatt-hours)



Source: own calculation based on AG Energiebilanzen, AGEE-Stat; 10/2019; some figures are preliminary

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Passive House architecture shows that, for space heating at least, extremely low energy consumption levels are attainable. This standard – or the similar EU standards for nearly zero-energy buildings – generally works on new builds, but most national requirements fall short of this standard. More importantly, almost all of our buildings are standing. Their lifespans range from decades to even centuries. The challenge is to renovate the building stock to be zero-carbon. The technologies are available; Passive House works in most retrofits. Social issues are the main obstacles – and municipalities play a crucial role in the solutions.

Germany currently has a "renovation rate" around one percent, meaning that fewer than one out of fifty buildings are retrofitted annually. At that pace, it would take a century to make the building stock zero carbon even if current renovations reached a zero-carbon level, which they rarely do. In other words, buildings renovated to a lower standard in 2019 can be expected to prevent us from reaching zero carbon by 2050. The math for what's needed is straightforward: we have (slightly less than) a third of a century left until 2050, so an annual renovation rate of three percent is needed – but only if all projects must strive for zero emissions. If they don't, the renovation rate needs to be even higher. The EU has tried to mandate this rate, such as in the 2010 Energy Performance of Buildings Directive, but only for buildings owned by central governments – and the target will be missed.

2 OBSTACLES TO ZERO-CARBON RENOVATIONS

Three main categories of obstacles inhibit better renovations (PDF in German). This situation is a bit unique in that Germany has the lowest level of home ownership in Europe, but the findings below apply generally.

1) **Different building types and owner structures** mean that policy proposals cannot be applied in blanket fashion without consideration of the specific obstacles.

   - In high rises and complexes with multiple owners, a single person can often veto any proposal. Zero-carbon renovations may seem like advanced efforts, and a consensus will generally focus on some compromise, especially if the payback is longer.
   - The tenant/landlord dilemma: "rent goes up but utility bills go down" is a hard sell. Tenants may perceive renovation as an excuse to raise the rent, particularly in Germany, which has relatively strict rent rules in an international comparison – and especially when the rent increase exceeds the savings form lower utility bills.
   - Homeowners tend to be older. Elderly couples may not be interested in a long payback period but instead prefer liquidity as they increasingly deal with unforeseen health issues.

- Young renters building up capital for a home still rent may not know how long they will be at a specific location. Their interest in paying higher rent to improve their current apartment may be lower than their wish to build up capital so they can move out sooner.

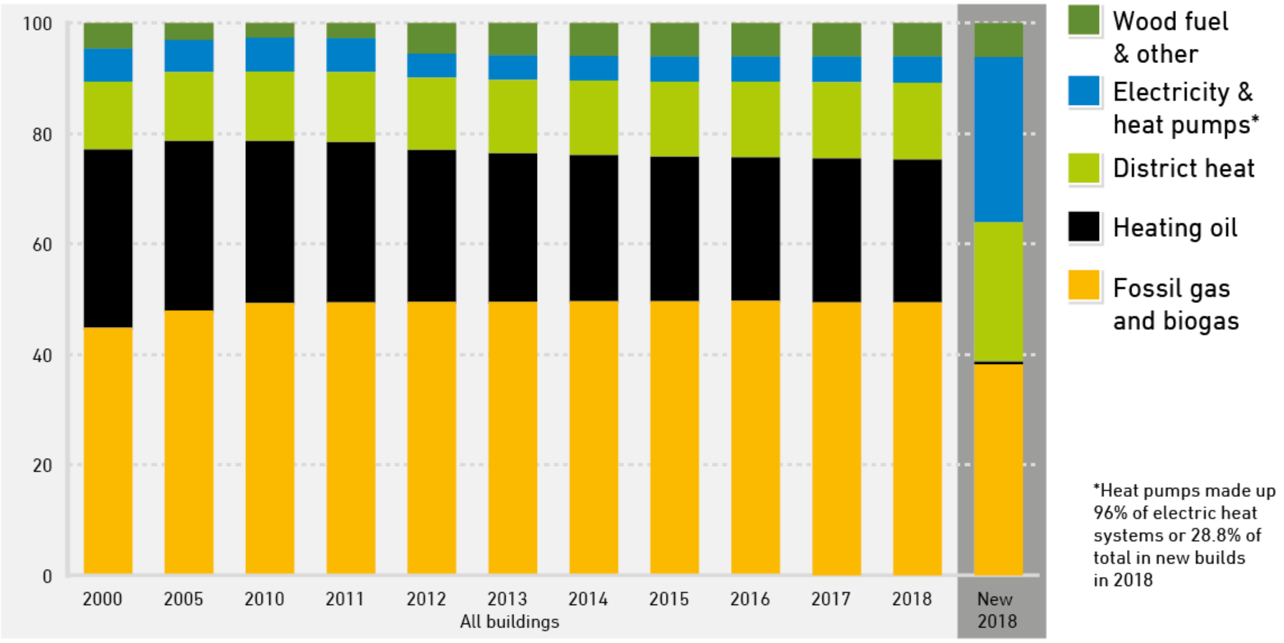
2) **Different building components have different service lives**, so upgrades are done bit by bit, not holistically. The result is suboptimal renovations. Windows, for instance are usually renewed every 20 years, while heating system can have service lives of up to 30 years – whereas roofs can hold up for 50 years depending on their composition. In practice, of course, heating systems are often only renewed when they break. Roof and wall insulation is often possible at any time but is quite an inconvenience for inhabitants. The result is that everything gets fixed when it breaks; there is then no holistic approach that could lead to optimal energy renovations.

3) Finally, there is a **lack of awareness**. Homeowners are rarely experts in renovations. They may contact tradespeople and planers to get information, but these experts may have learned their trade decades ago; a lot has happened since. As entrepreneurs, they might also prefer the quickest and easiest solutions for themselves or have promotion contracts with certain companies. Homeowners wishing to minimize their investments then speak with tradespeople peddling old technologies.

The good news is that most of these obstacles do not apply to municipal buildings. In terms of ownership, only the tenant/landlord dilemma is a potential factor. In Germany, municipal housing associations must manage their properties economically but do not need to generate profits. Therefore, they may stretch the pay-back time of the renovation cost over a longer period of time and need not raise rents as much as in privately owned housing.

New and old heating systems: change slow to come as old equipment continues to be used

Heating systems in German residential buildings by energy source



Source: BDEW, 2019

In Germany's first renovation of a high-rise in compliance with the Passive House standard, Freiburg's housing authority reduced demand for heating energy by 80 percent, resulting in savings of 51 cents a month per square meter. A 70 square meter apartment thus saves an estimated 428 euros annually on heating expenses. Rent nonetheless remained below the average for the city even as it slightly increased.

In the private sector, municipalities can promote regular further training of tradespeople by creating local networks and hosting events that bring together the interested public, craftspeople, and experts in the most modern options of building renovation. The website sanieren-profitieren.de (which translates as "retrofit-benefit") guides homeowners to an energy audit, which serves as the starting point for future work. It is hosted by German environmental foundation DBU in cooperation with trade organizations. The AEE has also helped develop (in German) an online cost calculator that building owners can use to get a rough estimate of their invest needs and the likely payback timeframe.

Finally, municipal buildings are generally large, and planning is usually more holistic. Municipalities can time renewal projects in order to tap synergies. Cities also usually have their own building experts contract tradespeople, so a focus on optimal energy renovations is written into the contracts. But the biggest benefits come when the approach covers many buildings at once.

The recommendations are often the same for municipal and privately owned buildings:

- If the building has an unheated attic, insulating the attic floor can be cheaper than insulating the roof with a similar effect, especially if the roof is pitched and takes up far more surface area.

- Hydronic balancing ensures that heating systems with long lines provide equal heat output to each radiator.
- Cavity wall insulation can be a highly affordable option in buildings constructed in this way.
- In any case, consult an energy auditor, who can tell you what measures make sense in what order. For instance, windows may need replacing first or in combination with insulation, etc.

3 DISTRICT PLANNING AND RENEWABLE HEAT

Since most buildings will not be zero-carbon anytime soon, it is important to make heat sources as low-carbon as possible. And what goes for groups of individual building components also goes for groups of buildings: thinking holistically pays off. Municipalities know where what is available and what is needed. A public indoor swimming pool may need more heat, and excess heat may be available from a nearby manufacturer. Furthermore, the district heat network may be running below capacity; connecting a new neighborhood might fill that gap. Or at least, city officials *could* have such information; data may need to be collected first so that actions can be coordinated.

Once the data are available, the next step is to draw up a neighborhood-wide plan of action. In German, two terms are commonly used for this approach: *integrierte Quartierskonzepte* (integrated neighborhood concepts) and *energetische Stadtsanierung* (urban energy retrofits). Germany's KfW Bank provides low-interest loans in its Energetische Stadtsanierungen program.

A certain amount of heat demand will remain because few buildings can be retrofitted to do without space heating entirely. Ensuring that the heat is as renewable as possible is therefore important. The first step is often a district heat (DH) network, without which different heat sources cannot connect. DH thus provides the same enabling function as the grid does for renewable electricity, particularly solar: whatever heat/power cannot be consumed immediately on-site can be shared with neighbors, thereby reducing the need for storage, which always comes at a cost. Municipal governments play a central role in launching and expanding DH.

DH often uses (waste) heat from fossil fuels today, but once a network is available, various sources of (renewable) heat can be connected:

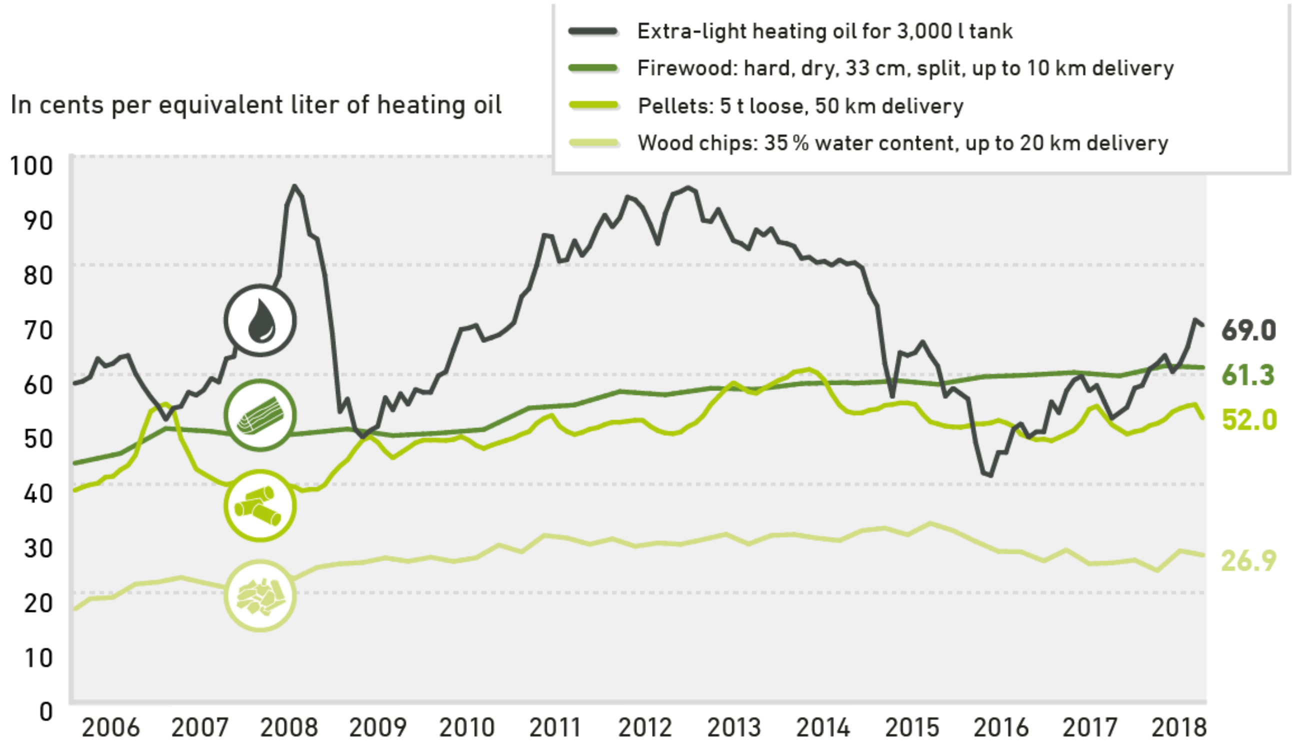
- waste heat (which would otherwise be wasted) from fossil fuels and industry processes,
- heat pumps, generally connected to shallow geothermal sources;
- locally sourced, sustainable biomass and waste;
- solar heat; and
- deep geothermal.

The Leibniz Institute for Applied Geophysics (LIAG) has calculated that deep geothermal could provide up to 100 TWh/a of carbon-neutral heat in district networks by 2050, thereby replacing roughly half of the heat currently provided by oil-fired systems for space heat.

Two examples of renewables in district heat are Waiblingen and Schafflund. Located just outside Stuttgart, the town of Waiblingen (population 56,000) adopted a target of a 50 percent reduction in carbon emissions by 2030 (relative to 2005). The share of renewable was to rise to 25 percent for heat and 40 percent for electricity.

To reach these goals, the city implemented a solar requirement in 2006: 50 percent of suitable roof area on new buildings must have solar. Builders are free to choose whether they install photovoltaics or solar

Price trends for wood products and heating oil in Germany



Source: Tecson, C.A.R.M.E.N., Technologie- und Förderzentrum, 6/2018

Even after the price of a barrel of oil fell by some 50 percent in late 2014, the price of locally sourced biomass remained competitive in Germany. What's more, prices remained relatively stable; future oil prices are highly speculative.

thermal. The city can only require solar on property it owns; it cannot mandate arrays on private buildings constructed on private land. So when the city makes land available to developers, it writes the solar requirement into those contracts.

As a result, more than 550 solar arrays were added between 2006-2018, and the amount of solar electricity generated rose from 430 MWh to 8,860 MWh during that timeframe. Solar was also installed on existing municipal buildings, with citizens helping to finance such projects. They include a solar thermal array with 700 square meters of surface area connected to the district heat network, which also gets heat from the water purification plant and a heat plant fired with woodchips.

In Schafflund (population: 2,700) less than 10 km from the Danish border, an energy plan was to be implemented – but it would not have worked without the active participation of lots of local citizens, given the high owner-residency rate. First, workshops were held where participants could discuss various renovation options to reduce demand along with a bigger heat network.

The original district heat network only served two municipal buildings with heat from a biogas unit but now increasingly covers residential buildings. A community coöperative was founded for the expansion, but a single developer made a bid the coöp couldn't refuse. Now, the focus is also shifting to energy retrofits. The campaign's website mitmachwärme.de ("participatory heat") lists 17 other projects in the region.

It's worth noting that heat from wood products have offered more stable, competitive prices than heating oil over the past decade in Germany.

4 NEIGHBORHOOD ENERGY PROJECTS[1]

According to the most recent review, the KfW's Energetische Sanierung program had provided some 56 million euros for the creation of 700 neighborhood concepts and nearly 200 implementations by the end of 2017. This funding generally covers up to 65 percent of investment costs up to a maximum of 150,000 euros per project for three years. The community has to cover at least 15 percent with its own funding, and state governments or other funders can step in to provide the other 20 percent. For instance, the state of Schleswig-Holstein covers the 20 percent gap for rural communities. Below are some examples of model projects (PDF in German).

Emmendingen: energy retrofits for homeowners

In the Bürkle-Bleiche district, a campaign was rolled out to raise awareness of retrofits among homeowners. A communications agency was hired, and an experienced local journalist wrote a weekly energy conservation column in the weekly paper. And wherever a project began, signs were posted and flags hung on the scaffolding to make it clear that the project was part of a bigger campaign.

As a result, from 2013 to 2015, 170 requests for energy audits were submitted, leading to 108 applications for funding – covering six percent of the district's building stock. Ten of these buildings were completely retrofitted; 34, partially. The approach is now used through the city in a campaign called Energiehaus Emmendingen.

Halle: new district heat in Luther neighborhood and future power-to-heat (P2H)

More than a kilometer of heat pipes were laid so that the Luther neighborhood in Halle could switch from an old gas boiler to a local gas-fired cogeneration unit. At peak times, the new network has access to the larger local heat network. As a result, some 900 households have seen their heat prices drop by 10-15 percent.

Now, the project is looking into adding power-to-heat (P2H). At times of low power prices, electricity would be used to generate heat, which is easier to store than electricity.

Prenzlau: mixed renewable heat in district network

Further to the north, the small town of Prenzlau combined geothermal energy and waste heat from biogas and a water purification plant. This heat is exported to a network, which was expanded in the project. More consumers continue to be added to it as well. The main ones are the local housing association, headquarters of a wind power company, an assisted-living facility with 46 units.

The next steps planned are, as in Halle, P2H combined with underground heat storage. Prenzlau is the seat of Uckermark County, which is famous for its large number of wind turbines. In 2009, the AEE crowned Prenzlau the Energy Community of the Month in August 2009, partly for its work with geothermal heat storage.

Crailsheim: industry waste heat for buildings

In Crailsheim, a southern German town, it was known that the industrial zone located close to a residential area had a lot of waste heat. Getting firms to share their data about the exact amount can be challenging, but the local businesses in Crailsheim cooperated. The challenge came on the demand end: only 116 households were connected to the old district heat network, and the amount of waste heat from industry far outstripped their heat consumption.

For the time being, a modern gas-fired cogeneration unit has replaced two old oil-fired boilers. The heat network is also currently being expanded in the hope that, in the foreseeable future, the demand it serves will eventually approximate the supply of waste heat currently thrown away. Then, the industrial zone can finally be connected.

Gelsenkirchen/Herten: coal region goes green

In 2018, Germany closed its last hard coal mines. Former mining regions are looking for ways to diversify their economies. In Gelsenkirchen, a new district is being built where the mine closed. Mine gas still escapes from the old facility, so it is to be collected and used to fire a cogeneration unit that heats the new residential area. P2H is also an option planned, and solar thermal is to be connected as well.

But this gas will not last forever. Once it runs out, heat from the mine will be used as a geothermal source. The district heat network has been upgraded to run at lower temperatures for this purpose, and 58 building owners have committed to connect to the system when it is finished.

[1] All of the examples in this section are taken from "Energetische Stadtsanierung in der Praxis III: Umsetzungserfolge und Herausforderungen für die Zukunft" (PDF in German).

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