DIW Weekly Report 35+36 2019

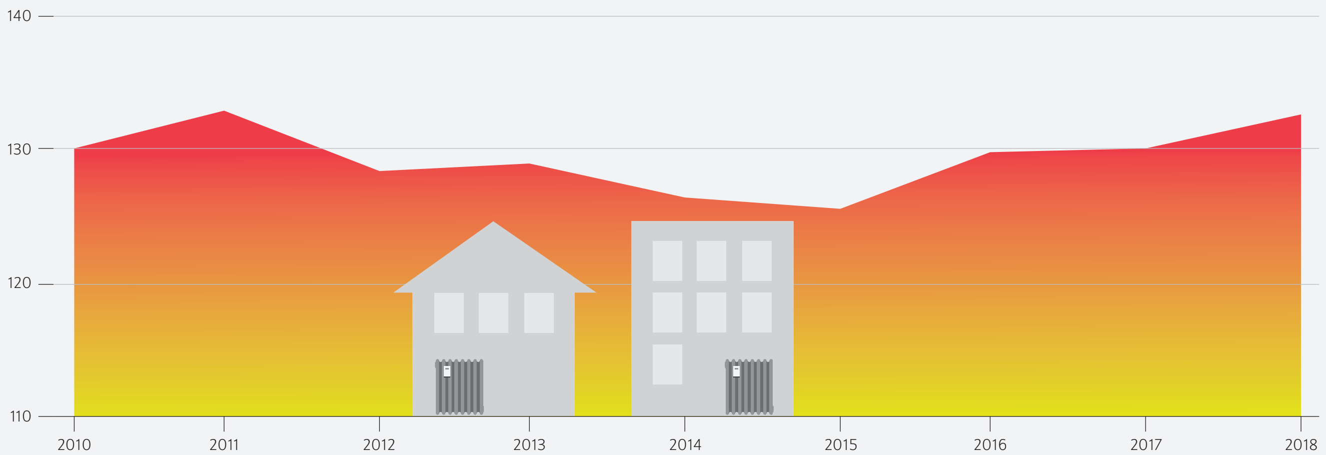
AT A GLANCE

Heat Monitor 2018: Rising heating energy demand, thermal retrofit rate must increase

By Puja Singhal and Jan Stede

- Heating energy demanded by residential buildings continues to increase
- Large increase in heating oil prices in 2018
- Differences in heating energy demand between East Germany and West Germany persist
- Higher rate of thermal retrofitting in the 1990s shows potential for more upgrades
- Policymakers should strengthen efforts to realize energy savings in the building sector

Lost decade in the building sector; heating energy demand in multi-family homes in 2018 surpasses 2010 demand
Kilowatt hours per square meter heated living space



Source: ista Deutschland GmbH, authors' own calculations.

FROM THE AUTHORS

"The low retrofit rate shows that we are far away from achieving the goal of significantly reducing energy consumption in the buildings sector. Existing policies do not have enough impact."

— Jan Stede —

MEDIA

Audio Interview with Jan Stede (in German)
www.diw.de/mediathek

Heat Monitor 2018: Rising heating energy demand, thermal retrofit rate must increase

By Puja Singhal and Jan Stede

ABSTRACT

Residential heating accounts for almost one-fifth of Germany's final energy consumption. This report evaluates an extensive database of heating bills for buildings with two or more apartments, representing more than two-thirds of the total housing stock in Germany. Despite commitments to pressing climate targets, the rate of thermal upgrades of the existing housing stock has remained low since the turn of the 21st century, while heating energy demanded per square meter by private households has been on an upward trend since 2015. This is an alarming development with respect to the 2050 climate goals for the buildings sector. An additional set of policies are therefore necessary to achieve the yet-unrealized reductions in energy consumption in the building sector. These include, for example, tax incentives for top-end retrofits that have been discussed for more than a decade and policies targeting household behavior such as providing consumers with more frequent and timely information.

Residential heating accounts for almost one-fifth of Germany's final energy consumption.[1] The German government plans to make the buildings sector "almost climate-neutral" by 2050.[2] More than 80 percent of the final energy use of private households comes from heating living space and water.[3] This makes policies addressing heating energy consumption central to achieving that target. The German Federal government's primary aim has been to improve the thermal performance of the existing housing stock. To achieve this goal, the leading policy instruments include: (1) mandatory thermal standards (*Energieeinsparverordnung* or EnEV) for retrofits since 2002, (2) providing financial incentives (loans or grants) to encourage energy-efficient renovations by homeowners via the German Development Bank (KfW), and (3) backing up these regulations by advocating that thermal upgrades achieving the mandatory standards pay back in the long run.[4] The investment level to modernize the housing stock, however, has remained extremely low. Even though the volume of refurbishments efforts has been steadily increasing, expenditures for energy efficiency renovations declined in 2018 (Figure 1).[5]

1 See Federal Ministry for Economic Affairs and Energy, "Zahlen und Fakten, Energiedaten," (Berlin: BMWi, 2019) (in German, available online; accessed on July 31, 2019; this applies to all other online sources in this report unless stated otherwise) and AG Energiebilanzen e.V., "Anwendungsbilanzen für die Endenergiesektoren in Deutschland in den Jahren 2013 bis 2017," (Berlin: AGEB, 2018) (in German, available online).

2 Federal Ministry for Economic Affairs and Energy, "Energy Efficiency Strategy for Buildings. Methods for achieving a virtually climate-neutral building stock" (Berlin: BMWi, 2015) (available online).

3 In 2017, heating space and heating water accounted for 68.8 and 15.3 respectively of the final energy demanded by households. By sector, households used about a quarter of the final energy consumed overall in Germany. See Federal Ministry for Economic Affairs and Energy, "Zahlen und Fakten, Energiedaten," 2019.

4 Starting with the EnEV 2002, there also exists a clause, according to which a homeowner, carrying out upgrades, has the possibility to apply for an exemption if the standards could be proven economically unviable. See Ray Galvin and Minna Sunikka-Blank, A Critical Appraisal of Germany's Thermal Retrofit Policy – Turning Down the Heat (London: Springer-Verlag, 2013).

5 Measures involving products such as insulation (roof, facade, etc.), replacing windows and outer doors, heating system renewal and solar thermal energy/photovoltaics are all considered energy efficiency upgrades. See Martin Gornig et al., "Strukturdaten zur Produktion und Beschäftigung im Baugewerbe – Berechnungen für das Jahr 2018." Gutachten im Auftrag des Bundesministeriums für Inneres, für Bau und Heimat (BMI) sowie des Bundesinstituts für Bau-, Stadt- und Raumforschung (BBSR). Endbericht. German Institute for Economic Research, Berlin, 2019 (in German; forthcoming).

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The 2018 *Heat Monitor* assesses the energy used for space heating by German residential buildings with two or more apartments – nearly 70 percent of the total housing stock[6] (Box 1). The main goal of this annual report is to describe trends in residential heating energy demand, and to evaluate heating costs paid by residential consumers with centralized natural gas or oil heating systems. Additionally, for the first time, the 2018 *Heat Monitor* also shows the long-term development of a thermal retrofit rate for the building sample served by *ista Deutschland*.[7] This rate indicates the area share of the building envelope of an average building that received an energetic modernization during any given year (Box 2).

Energy requirement increases yet again

Heating energy demand per square meter, adjusted for changes in climate and weather, increased by two percent in buildings with two or more apartments in 2018 relative to the previous year. This was the third consecutive increase in the energy demand (Figure 2). From the point of view of reducing energy required by the German building sector, the period since 2010 increasingly looks like a "lost decade" and the 20 percent heating energy reduction target is out of sight.[8]

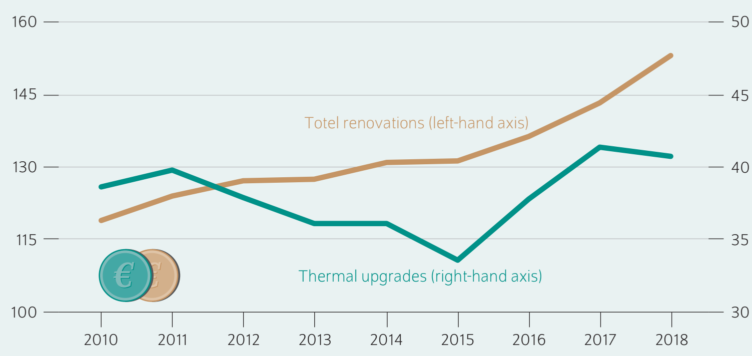
Strong regional differences in terms of heating energy demanded persist between East and West Germany as well as on the *Bundesland* level. In 2018, households in West Germany required seven percent more per square meter than households in East Germany (Figure 3). The East-West gap in energy demand continues to persist, but the gap has closed significantly since heating requirements fell at a faster rate in West Germany compared to East Germany in the early 2000s. One factor explaining the trends could be the differences in retrofit rates observed between the East and the West over time (discussed below):[9] Households in East Germany were gaining from a stronger wave of thermal renovations in the late 90s[10] while comparatively, West Germany has benefited more since the mid-2000s.

Heating energy demand in 2018 was highest in the Schleswig-Holstein Süd-West region and lowest in the Mecklenburg/Rostock region. However, there is no strict East-West divide; the West German region Allgäu and the city of Munich, for example, have the second-lowest and third-lowest per-square meter heating requirement of all German regions (Table).

Figure 1

Volume of renovations of existing residential buildings

Billion euros in current prices



Source: Construction volume calculation by DIW Berlin.

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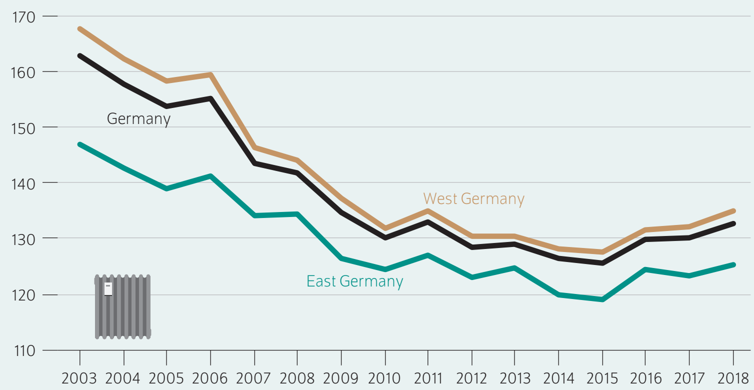
Expenditures on energy efficiency renovations declined in 2018 in contrast to the steadily increasing total refurbishment efforts.

Figure 2

Heating energy demand in two or more apartment buildings

Annual heating energy demand in kilowatt hour per square meter heated living space; adjusted for climate and weather



Source: ista Deutschland GmbH, authors' own calculations.

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Heating energy demanded per square meter by private households has been on an upward trend since 2015.

6 German Federal Statistical Office, "Bauen und Wohnen. Mikrozensus – Zusatzerhebung 2014." Fachserie 5 Heft 1, Statistisches Bundesamt, Wiesbaden, 2016 (in German; available online).

7 ista Deutschland GmbH is an energy metering service provider that also issues heating bills for a large share of German residential consumers.

8 Jan Stede, Claus Michelsen and Puja Singhal, "Wärmemonitor 2017: Heizenergieverbrauch stagniert, Klimaziel wird verfehlt," DIW Wochenbericht, no. 39 (2018): 833 (in German; available online).

9 However, thermal retrofits (or the energy efficiency of a building) are not the only reason why households adjust their energy demand. Other factors such as energy prices and household demographics (like income) also play an important role. See Ray Galvin and Minna Sunikka-Blank, Turning Down the Heat, 103–114.

10 See also Claus Michelsen and Nolan Ritter, "2016 Heat Monitor: 'Second Rent' Lower Despite Higher Heating Energy Consumption," DIW Weekly Report, no. 38 (2017): 378 (available online).

Box 1

Database und methodology used for Heat Monitor 2018

In partnership with *ista Deutschland GmbH*, one of the largest energy service providers in Germany, the DIW Berlin has developed the *Heat Monitor Germany*. The Monitor reports regional and national trends in heating energy consumption and heating costs for residential buildings annually. The calculations are based on (1) building-level heating bills from *ista Deutschland GmbH*, (2) climate adjustment factors from the German Weather Service (*Deutscher Wetterdienst*), and (3) census survey results from the German Federal Statistical Office. The heating bills contain information on energy consumption, billing periods, heating fuel type, energy costs, and building location and size.

The heating bills capture residential buildings with two or more apartments – i.e., the sample covers occupied buildings, owned or rented, with at least two households. We further limit the sample of buildings to those with heated living space of between 15 and 250 square meters per apartment. Note that we do not have a random sample from the population of residential buildings in Germany. In comparison with the 2014 microcensus supplementary survey,[1] buildings with three to six apartments and larger buildings (13 or more apartments) are overrepresented in the sample. We offset this by weighting average heating consumption according to the relative importance of each building size category in the statistical population. To accomplish this, we use results from the 2010 microcensus supplementary survey that indicate the shares of each building size category by planning region (ROR).

For each building, we calculate heating demand by adjusting total energy consumed for heating for local changes in the climate and weather. To ensure comparability across time and space, we use information from the German Weather Service. The available weighting factors normalizes heating consumption to climatic condition in Potsdam, the reference location.[2]

We calculate the annual quantity of heating energy demand in relation to the heated living space of a building. This is carried out in several steps: First, building-specific consumption values are limited to the amounts of energy used for heating space (excluding warm water). Second, the consumption value is multiplied by the heating value corresponding to the building's energy fuel type, giving us the absolute heating energy consumption in kilowatt-hours (kWh) for a building in a billing period. Third, the values are allocated to a specific heating year, since the closing date for measurement is not always December 31 of the relevant year. Fourth, we adjust the consumption values for the climatic conditions during the heating period in question and divide it by the amount of heating space in the building. The units are kilowatt-hours required per square meter of heated living space per year (kWh/sqm). We drop implausible values of heating energy demand – above 400 or below 30 kWh/sqm of heated living space – about four percent of the observations each billing year.

Lastly, average heating demand values at the planning region level are computed as the weighted arithmetic mean for the overall building stock of a planning region – for weights, we use the proportion of buildings in each housing size category (two, three to six, seven to 12, 13 to 20, and over 21 apartments) at the planning region level.

Heating bills are created with a time lag. The values of the 2018 heating period are calculated based on a smaller sample than the values for earlier years. Therefore updates would likely lead to corrections in the future.

We calculate heating costs using costs per kWh of heating energy consumed (excluding heating water). Only the amounts billed for natural gas and heating oil are included. District heating, electric heating systems, biomass, or other heating types are not considered. The average price per kWh for a planning region is calculated as a weighted average value, weighting by the share of buildings by heating type (natural gas or oil) in the statistical population as reported by the 2010 microcensus supplementary survey.

In previous *Heat Monitors*, the statistics were calculated using data on buildings with three or more apartments - i.e. only multi-family apartment buildings. The 2018 *Heat Monitor* reports results for a larger building stock and is thus not directly comparable to previous editions.

1 German Federal Statistical Office, „Bauen und Wohnen. Mikrozensus - Zusatzerhebung 2014." Fachserie 5 Heft 1, Statistisches Bundesamt, Wiesbaden, 2016 (in German; available online).

2 Our procedure follows an established method developed by the Association of German Engineers (*Verein Deutscher Ingenieure*, VDI): VDI Guideline 3807, "Characteristic consumption values for buildings").

Heating oil prices rise significantly

Overall median oil and gas prices that residential consumers paid per kWh for their heating bills remained flat in 2018 (Figure 4). However, there are regional differences. On the one hand, prices in Schleswig-Holstein Nord rose by more than seven percent compared to 2017. On the other hand, prices in Oldenburg decreased by more than seven percent. The price levels are also quite different. While in the Saar region consumers paid almost six cents per kilowatt-hour in 2018, it was only 4.5 cents in Prignitz-Oberhavel and Munich (Table).

The development of consumer prices for natural gas versus heating oil prices was very different in 2018. While prices for natural gas stagnated (-0.3 percent relative to the previous year), oil prices soared by more than 20 percent (Figure 5). However, changes in consumer prices for oil only translate into changes in heating costs with a time lag. Since heating oil is often "bunkered," there is a time lag between the rise of market prices and the actual heating costs paid by consumers[11]. Heating costs for multi-family homes using heating oil increased by only nine percent in 2018, while costs billed for gas heating decreased by around four percent.

Roughly, half of German homes are heated with natural gas while another quarter uses heating oil.[12] Expenditures for heating homes have increased by two percent in 2018 (Figure 6). This results due to the combination of stagnant energy prices and an increase in energy demanded per square meter. However, price increases were higher for households that use heating oil, since oil prices have soared.

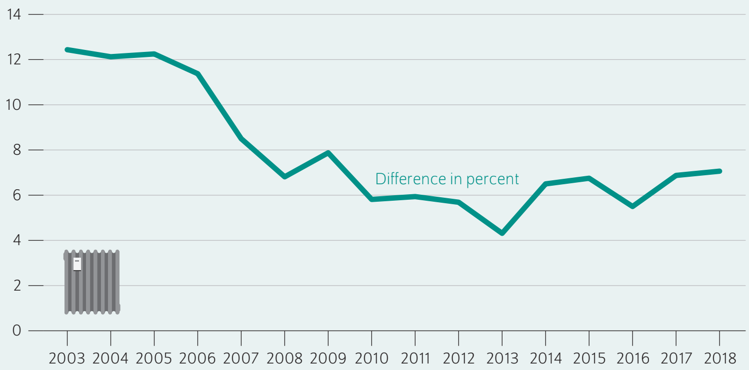
Retrofit rate in East Germany has dropped drastically since the 1990s

To achieve the climate targets in the building sector, the German federal government had planned to double the rate of thermal renovation from one to two percent. [13] However, there is surprisingly little consensus on how this thermal retrofit rate (also called "renovation rate") should be calculated methodologically, nor is there any long-term evidence on the development of the retrofit rate for Germany.[14]

Figure 3

Difference in heating energy requirements between East and West Germany in percent

Annual heating energy demand in kilowatt hour per square meter heated living space; adjusted for climate and weather



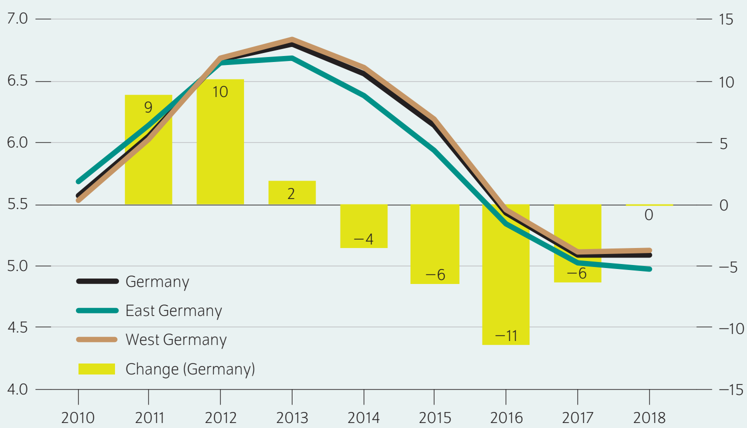
Source: ista Deutschland GmbH, authors' own calculations.

West Germany requires more heating energy than East Germany. In 2018, it required seven percent more.

Figure 4

Energy prices

Weighted median of natural gas and oil prices in euro cents per kilowatt hour (left axis), change in percent (right axis)



Source: ista Deutschland GmbH, authors' own calculations.

Energy prices faced by households were constant in 2018, in contrast to the continuous decline observed since 2014.

11 See Stede, Michelsen and Singhal, "Wärmemonitor 2017," 835: (in German; available online)

12 Stede, Michelsen and Singhal, "Wärmemonitor 2017," 835: (in German; available online)

13 Federal Ministry for Economic Affairs and Energy and Federal Ministry for the Environment, "Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung," (PDF, Federal Ministry for Economic Affairs and Energy, Berlin, 2010).

14 There are two studies calculating a retrofit rate for a representative sample of German residential buildings for the years 2005–2008 and 2010–2016, respectively. The average retrofit rate is based on the individual rates of the building components façade, roof/top floor ceiling, cellar, and windows. See Holger Cischinsky and Nikolaus Diefenbach, Datenerhebung Wohngebäudebestand 2016 (Darmstadt: IWU, 2018) (in German; available online) and Nikolaus Diefenbach et al., Datenbasis Gebäudebestand (Darmstadt: IWU/BEI, 2010) (in German; available online). Other authors have calculated a retrofit rate based on the labelling steps of energy performance certificates, see Filippidou et al., "Are we moving fast enough? The energy renovation rate of the Dutch non-profit housing using the national energy labelling database", Energy Policy 109 (2017): 488–498. On a European level, Article 5 of the EU Energy Efficiency Directive (Directive 2012/27/EU) obligates Member States to retrofit buildings representing three percent of the total floor area of all government buildings each year. After the renovations, buildings must meet the minimum energy performance requirements of the Energy Performance of Buildings Directive (Directive 2010/31/EU).

Box 2

Calculation of a thermal retrofit rate

The estimated annual retrofit rate indicates the share of all building surfaces that are retrofitted in a given year. It is a weighted average of energetic retrofit rates computed for each building component: façade, roof/top floor ceiling, cellar ceiling, and windows. The weights reflect the share of the total surface of a typical residential building attributed to each component.[1] Additionally, the rates for each of these components account for the share of the surface that is insulated on average, such as the fraction of windows that is replaced during a typical retrofit.[2]

We calculate the retrofit rate based on a subsample (henceforth EPC sample) of the full sample used for the *Heat Monitor*. The EPC sample covers more than 100,000 buildings for which *ista Deutschland GmbH* issued energy performance certificates (EPCs) according to the requirements of the *Energieeinsparverordnung*. Owners that sell or rent a building or flat in Germany have to provide such energy performance certificates to the potential buyer or tenant upon request for all buildings since January 2009.[3] EPCs include information on the year of the latest energetic retrofit of façade, roof, top floor ceiling, cellar, and windows, as well as the year of construction or modernization of the heating system. This information is provided by the building owners upon application for an energy performance certificate. Here, applicants are asked to state the last time a component of a building was thermally retrofitted, e.g. by insulating the façade (but excluding non-energetic refurbishments such as painting the façade).[4]

One caveat of the calculation is that for every EPC we only observe the most recent thermal upgrade for each building component. For many buildings in the EPC sample we only have information from one energy performance certificate on the retrofits in that building. Consequently, we may be underestimating the retrofit rate in the case that buildings have been retrofitted more than once. Our estimates should therefore be seen as a lower bound to the true retrofit rate, especially for the period of the 1990s. For some of the buildings, however, we have information from more than one EPC.[5] These buildings are included in the retrofit rate if they were already retrofitted in the past and some of their components are re-insulated.[6]

National trends of energy demanded per square meter for the EPC sample are almost identical to that of the full sample. Furthermore, the regional distribution (state-wise) of the buildings observed in the EPC sample is very close to the regional distribution of the actual German residential buildings in the microcensus supplementary survey.[7] However, the EPC subsample has a higher proportion of larger buildings (more than seven flats per building) than the full sample and is therefore not representative of the entire German residential building stock.

1 The weights used for the different components are 40 percent for the façade, 28 percent for the roof/top floor ceiling, 23 percent for the cellar and 9 percent for windows. Modernizations of the heating system are not included in the retrofit rate. For an overview of the methodology to calculate the weights, see Cischinsky and Diefenbach, Datenerhebung Wohngebäudebestand 2016 and Nikolaus Diefenbach and Tobias Loga, eds., "Application of Building Typologies for Modelling the Energy Balance of the Residential Building Stock". TABULA Thematic Report No. 2 (2012). Darmstadt (available online).

2 This share varies significantly by component. While it is high for façade, roof/top floor ceiling, and cellar (75 percent, 90.4 percent and 80.3 percent, respectively), only 54.6 percent of windows are replaced in a typical retrofit. See Cischinsky and Diefenbach, Datenerhebung Wohngebäudebestand 2016.

3 This legislation applies to both new buildings and the existing building stock. See Deutscher Bundesrat, "Verordnung über energiesparenden Wärmeschutz und energiesparende Anlagentechnik bei Gebäuden (Energieeinsparverordnung – EnEV)" (2007). Bundesrats-Drucksache 282/07 (27.04.07). The Energieeinsparverordnung 2014 (EnEV 2014) has introduced the additional requirement that key information from the energy performance certificate has to be included by default in advertisements for the sale or renting out of a building.

4 When information on the retrofit status of a component of any given building is missing, this building is not included in the calculation of the retrofit rate for that specific component (e.g., the rate for energetic modernisation of windows). When the year indicated as the retrofit year of any component equals the construction year of a building, we assume that no retrofit has taken place for that specific component. This might lead to an underestimation of the retrofit rate.

5 The energy performance certificates in our sample were issued mostly between 2008 and 2018. EPCs have to be renewed every ten years in order to comply with the Energieeinsparverordnung.

6 This applies to less than 100 of all buildings in our sample. For each component of these buildings, we assume that retrofits can only take place every five years.

7 See German Federal Statistical Office, "Mikrozensus – Zusatzerhebung 2014."

We calculate an annual retrofit rate based on the share of the building envelope of an average building that is covered by thermal retrofits of different building components, such as the façade, roof, or windows, for a subsample of more than 100,000 German buildings (Box 2). Although this subsample is not representative for the entire German building stock, the retrofit rate from our sample is similar to the rate calculated for a representative sample of German buildings using the same methodology.[15]

The annual retrofit rate has mostly remained below one percent in the last 15 years, although it has picked up since the early 2000s (Figure 7). Rates for West Germany have been higher than in East Germany since 2006. Compared to today's comparably low efforts, however, major renovations in Germany took place in the 1990s in East Germany. The average retrofit rate for the East German buildings in our sample rose to more than three percent after the reunification (between 1993 and 2000), peaking at values of close to four percent in 1995 and 1996.

Conclusion: Broader set of energy-saving policies necessary for the buildings sector

After a gradual decline until 2015, dropping by almost 23 percent relative to 2003 levels, heating energy demand in German residential buildings is on an upward trend. Temperature-adjusted heating energy demand has picked up and is now almost six percent above 2015 levels. This is an alarming development, which policymakers should take note.

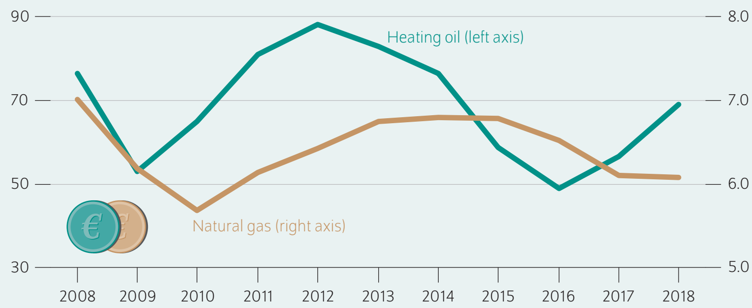
The 2018 *Heat Monitor* shows that the average rate of thermal retrofits was significantly higher in the 1990s for East Germany, while the average retrofit rate for West Germany did not exceed 0.5 percent. Nationally, the retrofit rate for the buildings was below one percent in the last 15 years. This means that on average less than one percent of the total building surface of buildings, served by *ista Deutschland*, received an energetic modernization. If trends are similar for Germany nationally, this will not suffice to tap the vast potential of energy efficiency programs in the buildings sector.

Additional sets of policies are necessary to achieve the yet-unrealized reductions in energy required by the building sector in Germany.[16] These include tax incentives for top-end retrofits that have been discussed for more than a decade and policies targeting household behavior such as providing

Figure 5

Development of consumer prices for heating oil and natural gas

Costs in cent per liter heating oil; cent per kilowatt hour natural gas



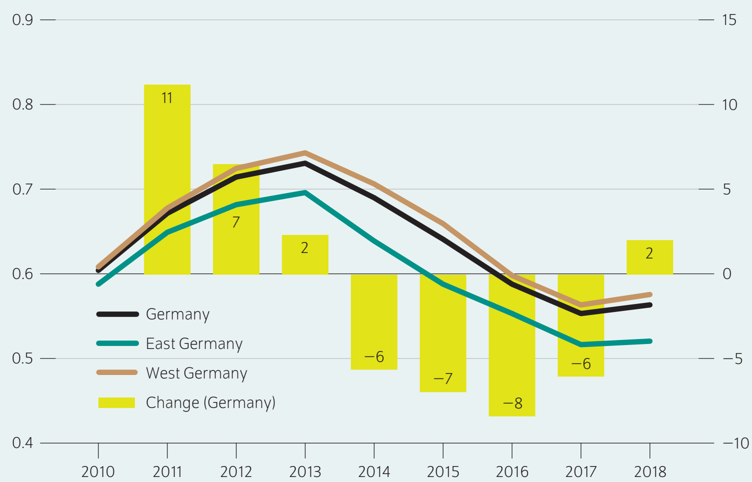
Source: Eurostat, Mineralölbundesverband.

After having fallen for years, consumer prices for heating oil have increased for the second year in a row.

Figure 6

Monthly heating expenditures

In euros per square meter heated living space (left axis), change in percent (right axis)



Source: ista Deutschland GmbH, authors' own calculations.

In the last year, expenditures on heating fuel rose for the first time since 2014.

15 For the years 2010–2016, Cischinsky and Diefenbach, Datenerhebung Wohngebäudebestand 2016 find an average retrofit rate of 0.99 percent for the entire residential building stock, and a rate of 1.43 percent for buildings built until 1978. Using the same same methodology as Cischinsky and Diefenbach, we obtain an overall yearly retrofit rate of 0.90 percent and a rate of 1.33 for old buildings in the same period. In their 2010 study, using a similar methodology, the authors calculate an annual retrofit rate of 0.8 percent for all buildings and 1.1 percent for old buildings for the years 2005 to 2008 (Nikolaus Diefenbach et al., Datenbasis Gebäudebestand, 12). For the same years, in our sample we compute rates of 0.64 percent and 1.02 percent, respectively. Consequently, the rates we calculate are about 10 percent lower.

16 For a critical and extended discussion of various measures that could contribute to climate goals in the housing sector, see Ray Galvin and Minna Sunikka-Blank, Turning Down the Heat, 103–114.

Table

Results of Heat Monitor 2018

Spatial planning region	Number of ROR (2009)	Annual heating energy demand (kilowatt hour per square meter heated living space), Average			Billed heating costs (euro cents per kilowatt hour), Median			Annual heating expenditure (euros per square meter), Average		
		2016	2017	2018[1]	2016	2017	2018[1]	2016	2017	2018[1]
Schleswig-Holstein Mitte	101	134.86	137.24	137.65	5.41	5.19	5.28	7.29	7.12	7.27
Schleswig-Holstein Nord	102	131.47	133.50	136.10	5.29	5.11	5.49	6.96	6.83	7.48
Schleswig-Holstein Ost	103	143.24	141.31	142.72	5.42	4.87	4.96	7.77	6.89	7.08
Schleswig-Holstein Süd	104	140.84	143.83	145.87	5.18	4.86	5.01	7.29	7.00	7.31
Schleswig-Holstein Süd-West	105	155.81	166.48	167.29	5.03	4.67	4.62	7.84	7.77	7.74
Hamburg	201	147.20	150.72	150.17	5.04	4.94	5.04	7.41	7.45	7.56
Braunschweig	301	126.69	128.26	127.30	5.50	5.24	5.20	6.97	6.72	6.62
Bremen-Umland	302	149.35	149.68	150.89	5.36	5.00	5.02	8.01	7.49	7.57
Bremerhaven	303	152.90	152.07	152.73	5.22	4.98	4.94	7.98	7.57	7.54
Emsland	304	148.38	149.18	158.79	5.24	4.86	4.81	7.77	7.24	7.64
Göttingen	305	125.12	127.29	132.78	5.44	5.09	5.03	6.80	6.48	6.68
Hamburg-Umland-Süd	306	142.88	143.55	140.70	4.97	4.64	4.75	7.11	6.65	6.68
Hannover	307	128.55	129.82	130.22	5.55	5.36	5.27	7.13	6.96	6.87
Hildesheim	308	133.76	134.33	131.52	5.47	5.16	5.15	7.31	6.93	6.77
Lüneburg	309	143.87	144.29	144.25	5.14	4.76	4.79	7.40	6.88	6.90
Oldenburg	310	150.97	153.16	153.64	5.36	4.98	4.61	8.09	7.62	7.08
Osnabrück	311	130.92	132.10	134.67	5.43	5.10	5.08	7.11	6.73	6.84
Ost-Friesland	312	158.62	159.52	161.09	5.52	5.09	4.81	8.75	8.12	7.74
Südheide	313	146.11	146.43	147.34	5.13	4.92	5.14	7.50	7.21	7.58
Bremen	401	143.67	147.51	143.50	5.52	5.20	5.05	7.93	7.67	7.25
Aachen	501	137.02	138.11	142.02	5.99	5.75	5.70	8.21	7.94	8.10
Arnsberg	502	129.45	130.61	135.73	5.52	5.13	5.17	7.15	6.70	7.02
Bielefeld	503	142.14	142.96	145.02	5.55	5.24	5.26	7.89	7.50	7.63
Bochum/Hagen	504	139.93	140.73	144.58	5.89	5.51	5.54	8.24	7.76	8.01
Bonn	505	144.29	145.04	149.45	5.86	5.49	5.47	8.45	7.97	8.18
Dortmund	506	139.28	140.45	141.27	5.74	5.37	5.28	7.99	7.54	7.45
Duisburg/Essen	507	141.00	141.38	142.74	5.99	5.73	5.67	8.45	8.10	8.09
Düsseldorf	508	145.00	145.94	147.52	5.63	5.37	5.35	8.16	7.83	7.89
Emscher-Lippe	509	132.99	134.09	133.30	6.24	5.85	5.67	8.30	7.84	7.56
Köln	510	140.48	140.66	143.93	5.52	5.19	5.18	7.75	7.30	7.46
Münster	511	132.13	132.40	134.67	5.16	4.76	4.74	6.81	6.30	6.39
Paderborn	512	126.96	131.25	134.89	5.90	5.49	5.49	7.50	7.21	7.41
Siegen	513	133.82	139.34	141.18	5.60	5.25	5.35	7.49	7.32	7.55
Mittelhessen	601	129.00	130.29	133.51	5.46	5.10	5.20	7.04	6.64	6.95
Nordhessen	602	127.20	128.65	129.96	5.42	5.14	5.31	6.90	6.61	6.89
Osthessen	603	114.43	116.43	121.24	5.31	4.88	5.03	6.08	5.68	6.10
Rhein-Main	604	134.41	133.05	135.86	5.30	4.87	4.81	7.13	6.47	6.54
Starkenburg	605	142.25	142.11	148.35	5.60	5.22	5.16	7.96	7.42	7.66
Mittelrhein-Westerwald	701	134.68	135.46	139.69	5.76	5.48	5.55	7.75	7.42	7.75
Rheinhessen-Nahe	702	140.02	141.63	143.86	5.63	5.32	5.21	7.88	7.54	7.49
Rheinpfalz	703	140.48	140.01	147.03	5.56	5.16	4.99	7.81	7.23	7.34
Trier	704	134.82	138.13	139.16	5.69	5.52	5.68	7.67	7.62	7.90
Westpfalz	705	141.22	139.53	148.81	5.73	5.46	5.40	8.10	7.61	8.04
Bodensee-Oberschwaben	801	114.60	113.82	119.71	5.42	4.91	4.93	6.21	5.59	5.90
Donau-Iller (BW)	802	115.88	117.61	121.66	5.54	5.07	5.08	6.41	5.97	6.18
Franken	803	123.62	120.98	123.53	5.49	4.96	5.00	6.79	6.00	6.17
Hochrhein-Bodensee	804	122.76	123.96	130.20	5.25	4.92	4.81	6.44	6.10	6.26
Mittlerer Oberrhein	805	128.86	127.29	133.48	5.40	5.03	5.06	6.96	6.40	6.75
Neckar-Alb	806	119.87	120.89	122.78	5.45	5.00	5.15	6.54	6.05	6.33
Nordschwarzwald	807	113.93	115.87	119.71	5.44	5.06	5.19	6.20	5.86	6.21
Ostwürttemberg	808	125.29	126.30	132.20	5.37	4.90	5.04	6.73	6.19	6.66
Schwarzwald-Baar-Heuberg	809	109.26	109.16	109.57	5.56	5.00	4.99	6.07	5.46	5.47
Stuttgart	810	125.89	125.90	129.28	5.35	4.89	4.92	6.73	6.15	6.36
Südlicher Oberrhein	811	114.61	114.10	120.15	5.33	4.89	4.85	6.11	5.58	5.83
Unterer Neckar	812	132.27	131.80	135.14	5.73	5.33	5.23	7.58	7.02	7.07
Allgäu	901	101.64	101.02	106.30	5.17	4.74	4.81	5.25	4.78	5.11
Augsburg	902	119.92	118.76	121.92	4.92	4.57	4.61	5.90	5.42	5.62
Bayerischer Untermain	903	135.82	138.36	131.13	5.19	4.77	4.77	7.04	6.60	6.25
Donau-Iller (BY)	904	117.39	117.80	124.12	5.25	4.85	4.80	6.16	5.71	5.96
Donau-Wald	905	113.64	116.93	119.96	5.25	4.94	5.10	5.96	5.78	6.12

Table (continued)

Results of Heat Monitor 2018

Spatial planning region	Number of ROR (2009)	Annual heating energy demand (kilowatt hour per square meter heated living space), Average			Billed heating costs (euro cents per kilowatt hour), Median			Annual heating expenditure (euros per square meter), Average		
		2016	2017	2018[1]	2016	2017	2018[1]	2016	2017	2018[1]
Industrieregion Mittelfranken	906	123.70	124.81	128.79	5.32	4.89	4.97	6.58	6.11	6.40
Ingolstadt	907	115.68	115.20	122.31	5.06	4.72	4.86	5.85	5.44	5.95
Landshut	908	110.84	113.17	116.94	5.13	4.82	4.92	5.69	5.45	5.75
Main-Rhön	909	122.45	124.30	127.01	5.47	4.99	5.03	6.70	6.21	6.39
München	910	105.98	105.45	109.65	4.87	4.41	4.54	5.16	4.65	4.97
Oberfranken-Ost	911	118.22	120.82	121.60	5.34	5.09	5.18	6.31	6.15	6.29
Oberfranken-West	912	118.97	121.88	129.02	5.36	5.00	5.15	6.38	6.09	6.65
Oberland	913	106.60	105.67	111.80	5.05	4.66	4.79	5.39	4.93	5.36
Oberpfalz-Nord	914	123.09	122.20	117.83	5.33	5.09	5.18	6.56	6.22	6.10
Regensburg	915	116.99	117.28	118.31	5.22	4.93	5.08	6.11	5.79	6.00
Südostoberbayern	916	111.04	114.50	116.64	5.14	4.82	4.92	5.71	5.51	5.74
Westmittelfranken	917	124.17	124.83	126.49	5.43	4.98	5.16	6.74	6.22	6.53
Würzburg	918	122.02	123.02	125.84	5.43	4.92	4.89	6.63	6.05	6.15
Saar	1001	147.15	146.76	155.51	5.99	5.77	5.90	8.82	8.47	9.18
Berlin	1101	136.23	135.64	135.26	5.13	4.90	4.95	6.99	6.65	6.69
Havelland-Fläming	1201	126.99	125.84	129.48	5.38	4.82	4.74	6.83	6.07	6.13
Lausitz-Spreewald	1202	126.97	122.89	130.76	5.44	5.17	4.91	6.91	6.35	6.43
Oderland-Spree	1203	130.20	127.42	131.06	5.40	5.08	5.05	7.03	6.47	6.61
Prignitz-Oberhavel	1204	136.07	134.89	143.59	5.28	4.67	4.50	7.18	6.30	6.46
Uckermark-Barnim	1205	125.28	126.42	132.81	5.42	5.20	4.99	6.79	6.57	6.63
Mecklenburgische Seenplatte	1301	118.58	123.80	123.90	5.82	5.63	5.69	6.90	6.97	7.05
Mittleres Mecklenburg/Rostock	1302	101.52	97.61	97.68	5.03	4.80	4.79	5.10	4.68	4.68
Vorpommern	1303	111.24	110.73	112.70	5.39	5.14	5.09	5.99	5.69	5.74
Westmecklenburg	1304	114.96	118.27	114.04	5.70	5.31	5.14	6.55	6.28	5.86
Oberes Elbtal/Osterzgebirge	1401	113.57	112.86	116.58	5.16	4.72	4.63	5.86	5.33	5.40
Oberlausitz-Niederschlesien	1402	124.13	122.73	129.09	5.47	5.01	4.94	6.79	6.14	6.38
Südsachsen	1403	117.79	117.11	118.79	5.35	5.08	4.95	6.30	5.95	5.88
Westsachsen	1404	115.98	112.19	117.94	5.54	5.05	5.04	6.43	5.66	5.94
Altmark	1501	137.47	128.50	127.83	5.79	5.52	5.54	7.96	7.09	7.09
Anhalt-Bitterfeld-Wittenberg	1502	129.55	128.83	127.85	5.43	5.20	5.26	7.04	6.70	6.72
Halle/S.	1503	123.75	124.38	131.51	5.55	5.24	5.27	6.86	6.52	6.93
Magdeburg	1504	127.00	126.02	128.44	5.89	5.49	5.38	7.48	6.91	6.91
Mittelthüringen	1601	112.87	113.96	115.30	5.24	4.81	4.68	5.92	5.48	5.39
Nordthüringen	1602	119.83	116.36	117.20	5.39	5.22	5.08	6.46	6.07	5.95
Ostthüringen	1603	119.32	111.68	117.29	5.39	5.10	5.03	6.43	5.69	5.90
Südthüringen	1604	119.07	121.39	120.80	5.38	5.09	5.02	6.41	6.18	6.06
Federal State										
Schleswig-Holstein	1	139.2	141.4	142.9	5.30	4.98	5.13	7.37	7.05	7.33
Hamburg	2	147.2	150.7	150.2	5.04	4.94	5.04	7.41	7.45	7.56
Lower Saxony	3	136.0	137.1	138.0	5.41	5.12	5.06	7.36	7.02	6.98
Bremen	4	143.7	147.5	143.5	5.52	5.20	5.05	7.93	7.67	7.25
Northrhein-Westfalia	5	139.6	140.5	142.8	5.73	5.41	5.38	8.00	7.60	7.68
Hesse	6	133.0	132.8	136.1	5.39	4.99	5.00	7.17	6.63	6.81
Rheinland-Palatinate	7	138.2	138.8	143.6	5.67	5.37	5.34	7.84	7.46	7.66
Baden-Wuerttemberg	8	122.9	122.7	126.9	5.43	4.99	5.00	6.67	6.12	6.34
Bavaria	9	114.8	115.5	118.7	5.14	4.74	4.84	5.90	5.48	5.74
Saarland	10	147.1	146.8	155.5	5.99	5.77	5.90	8.82	8.47	9.18
Berlin	11	136.2	135.6	135.3	5.13	4.90	4.95	6.99	6.65	6.69
Brandenburg	12	128.6	126.6	132.4	5.39	4.98	4.83	6.93	6.31	6.40
Mecklenburg-Western-Pomerania	13	110.8	111.4	110.9	5.45	5.18	5.13	6.04	5.77	5.69
Saxony	14	117.0	115.5	119.2	5.36	4.97	4.89	6.27	5.74	5.83
Saxony-Anhalt	15	127.1	126.1	129.4	5.68	5.35	5.33	7.22	6.75	6.90
Thuringia	16	117.3	115.0	117.3	5.34	5.02	4.92	6.26	5.78	5.77
Germany		**129.83**	**130.13**	**132.75**	**5.43**	**5.09**	**5.09**	**7.05**	**6.63**	**6.76**
East Germany		**124.32**	**123.16**	**125.42**	**5.35**	**5.03**	**4.98**	**6.65**	**6.19**	**6.24**
West Germany		**131.51**	**132.24**	**134.97**	**5.46**	**5.11**	**5.12**	**7.18**	**6.76**	**6.92**

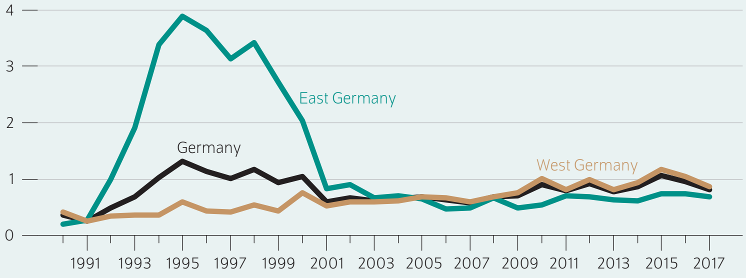
1 Preliminary. Notes: Heating energy use is adjusted for changes in the climate and weather to give heating demand; billed heating costs are a weighted average of natural gas and oil prices; for some regions, values have been substantially revised compared to the publication from last year.

Source: ista Deutschland GmbH, authors' own calculations.

Figure 7

Thermal retrofit rate

Area share of the total building envelope of an average building that receives an energetic modernisation, in percent



Source: ista Deutschland GmbH, authors' own calculations.

After major retrofits in East Germany in the 1990s, the retrofit rate has remained below one percent in the last 15 years.

consumers with more frequent and timely information[17]. As of today, Germany is not on a pathway towards reaching its 2050 climate goals for the buildings sector.

17 See Rupert Pritzl, "Warum die steuerliche Förderung der energetischen Gebäudesanierung in Deutschland nicht kommt – eine institutionenökonomische Betrachtung," Zeitschrift für Energiewirtschaft, vol. 43, no. 1 (2018): 39–49 (in German).

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