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263 Report by Sophie M. Behr, Till Köveker, and Merve Kücük

Heat Monitor 2023: Despite continued price increases, lower decline in households' heating energy consumption

- Heating energy consumption in German building sector decreases by four percent in 2023
- Heating energy prices increase by another third compared to 2022
- Larger variations in prices are observed for district heating compared to gas and oil

LEGAL AND EDITORIAL DETAILS

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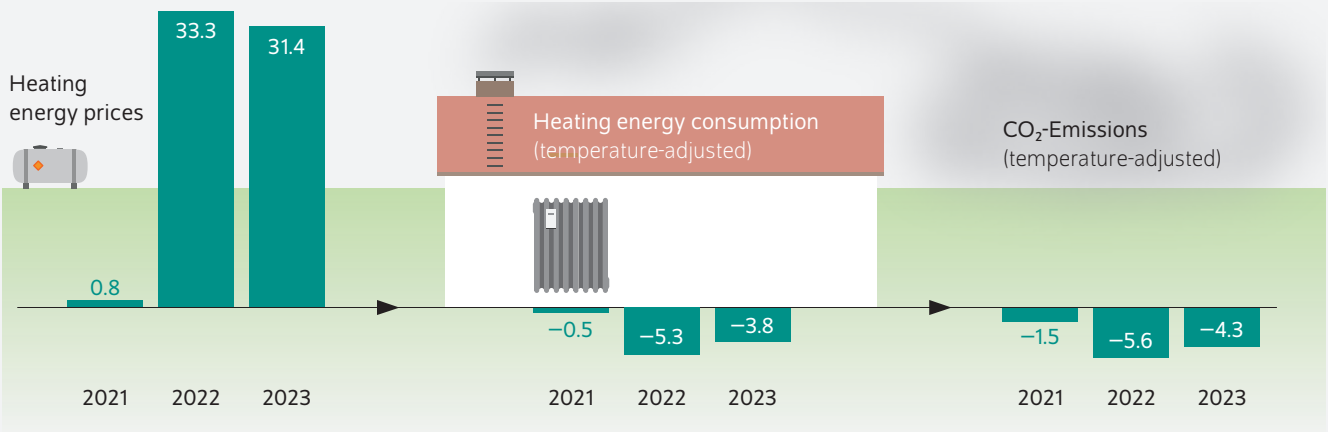
AT A GLANCE

Heat Monitor 2023: Despite continued price increases, lower decline in households' heating energy consumption

By Sophie M. Behr, Till Köveker, and Merve Kücük

- Temperature-adjusted heating energy consumption and CO_2 emissions in Germany's building sector went down by four percent in 2023 – a smaller reduction than in 2022
- Data from the energy service provider ista shows that the lowest heating energy consumption was in Mecklenburg-Western Pomerania, while the highest demand was in Saarland
- Heating energy prices continued to rise in 2023 – taking them up by yet another third compared to the previous year
- Variation in prices is higher for district heating than for gas and oil
- As a continued increase in residential energy savings is unlikely, meeting climate targets will require pushing of energy-efficient building retrofits

Despite further increases in heating energy prices, households reduced their energy consumption less than in the previous year
Change from previous year in percent



Source: ista SE, authors' own calculations.

Note: The values for 2023 are preliminary. Billed heating energy prices as a weighted average of natural gas, heating oil and district heating prices.

FROM THE AUTHORS

*"The high heating costs have heavily burdened many households, despite the gas price cap introduced in 2023. Households' capacity to achieve further energy savings is limited. Tenant households, in particular, have little influence over energy-efficient retrofits or heating systems in their rented residential spaces." — **Merve Kucuk** —*

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Audio Interview with Sophie M. Behr (in German)
www.diw.de/mediathek

Heat Monitor 2023: Despite continued price increases, lower decline in households' heating energy consumption

By Sophie M. Behr, Till Köveker, and Merve Kücük

ABSTRACT

In 2023, heating energy prices increased by substantial 31 percent compared to the previous year, following a 33 percent increase already seen in 2022. Calculations based on data from the energy service provider *ista* show average price increases were the highest in the German state of Rhineland-Palatinate, and the lowest in Hamburg. Owing to these price hikes and ongoing energy-saving efforts, the temperature-adjusted heating energy consumption of two- and multi-apartment buildings in Germany covered in this study fell by an average of four percent compared to the previous year, which was slightly less than the decline observed in 2022. The biggest energy savings were seen in households in Saxony. At the same time, temperature-adjusted CO_2 emissions per square meter also fell, although to a slightly lesser extent than in 2022. With heating energy prices stabilizing, the momentum in emissions reductions is expected to slow down. If Germany is to meet its climate targets, further efforts are needed, particularly in improving energy efficiency in the building sector and in switching to renewable heating systems.

The impact of the gas price crisis continued to be felt strongly in 2023. Since Gazprom began restricting gas supply in the second half of 2021, and all the more so after Russia launched its attack on Ukraine in February 2022, gas and other heating fuels have become significantly more expensive in Germany. After dramatic price hikes in the first year of the war, prices continued their steep upward trend over the course of 2023.

In both 2022 and 2023, as a response to a looming gas shortage and the ever-increasing burden on private households, the German government took various measures in an attempt to reduce energy consumption while simultaneously alleviating the burden on private households. In December 2022, for instance, households' monthly heating bill for gas and district heating was paid by the government.[1] In January 2023, a gas and heating price cap was introduced to be applicable for private households and small and medium-sized enterprises. For natural gas consumers, the cap was set at 12 cents per kilowatt-hour (kWh). This price was applied to 80 percent of the projected annual heating energy consumption in September 2022.[2] Any consumption beyond that had to be paid at the regular market price. Similarly, for households using district heating, heating costs were capped at 9.5 cents per kWh. The relief granted by the state had to be clearly indicated on the heating bill. The aim of this instrument was to maintain the incentive to reduce heating energy consumption through higher energy prices while simultaneously protecting consumers from overly high prices.[3] This measure came into force on March 1, 2023 (and also retroactively included January and February) and expired on December 31, 2023.

1 Bundesregierung, "Energie-Rabatt für Haushalte und Unternehmen," 2023 (in German; available online, accessed October 14, 2024; this applies to all other online sources in this report unless stated otherwise).

2 If a household reduces its heating energy consumption by more than 20 percent in comparison to the previous year, the annual statement will show these entire savings reimbursed at the new, higher energy price, meaning that the greater incentives created by the new higher prices apply to the entirety of saving.

3 The gas and heating price cap applied to private households, small and medium-sized enterprises with a gas consumption of less than 1.5 million kilowatt-hours per year, as well as clubs and associations. Cf. Bundesregierung, "Fragen und Antworten zu den Energiepreisbremsen," 2024 (in German; available online).

DOI: https://doi.org/10.18723/diw_dwr:2024-45-1

Box 1

Database und methodology used for Heat Monitor 2023

In partnership with *ista SE (former ista Deutsschland GmbH)*, one of the largest energy service providers in Germany, the DIW Berlin has developed the *Heat Monitor Germany in 2014*. The Monitor reports regional and national trends in heating energy consumption, energy prices and heating expenditures for residential buildings on an annual basis. The calculations are based on (1) building-level heating bills from *ista SE* for about 300000 residential buildings with two or more apartments (more than two million apartments), (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 multi apartments – i.e., the sample covers 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, 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 spatial planning region (ROR).

For each building, we calculate the temperature-adjusted heating energy consumption 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.[1]

We calculate the annual quantity of heating energy consumption 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).

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

Heating bills are created with a time lag. The values of the 2021 heating period are calculated based on a smaller sample than the values for earlier years. For 2023, around 50 percent of the homes are available, compared to 2022. The results for 2023 should therefore be regarded as preliminary. For heating consumption, a correction was made by calculating a hypothetical value for 2023 energy consumption and by correcting the energy consumption for 2022 with the national trend. It is possible, however, that an update may nevertheless result in retroactive corrections.

To calculate the price and consumption changes in the different regions, the prices for one kilowatt hour of heating energy and the temperature-adjusted heating energy requirements per square meter in 2023 are compared with those from 2022. As the contracts of households do not reflect the wholesale price, but usually a price fixed for one or two years is paid, the energy prices in 2023 differed greatly depending on when the new contract was concluded and what the energy cost level was at the time. Energy prices also differ significantly from region to region. For these reasons, only the energy prices and requirements of buildings for which data is available in both 2022 and 2023 are compared. Buildings that appear in the data set for 2022 but for which no data is currently available for 2023 are not included in this analysis. Therefore, the changes in prices and requirements per federal state or region shown in Figures 3 and 4 and in the text cannot be directly compared with the figures in the table, which are based on all buildings available for the respective year.

1 The effect of different temperature correction methods was determined in a study from 2022. The study shows that the results of the temperature-corrected values do not differ greatly. See Peter Mellwig et al., "Klimaschutz im Gebäudebereich: Erklärungen für stagnierende CO_2-Emissionen trotz erfolgreicher Sanierungsmaßnahmen," Short study commissioned by Agora Energiewende 2022 (in German; available online).

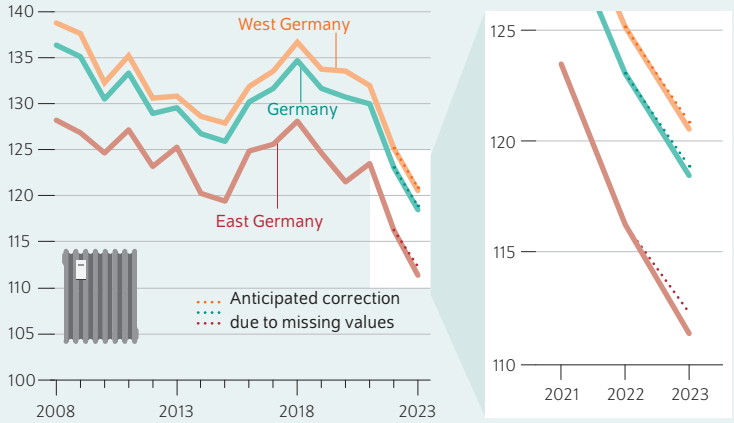
In response to the energy price crisis, Germany has stepped up its efforts to lessen its dependence on fossil fuels in the building sector. The goal was to further reduce Europe's dependence on (Russian) gas imports, on the one hand, and meet the climate targets outlined in the Paris Agreement, on the other. In 2022 and 2023, emissions from the German building sector totaled 108 and 102 million tonnes of CO_2 equivalent, respectively,[4] which is considerably higher

4 To be able to compare the impact of different climate-active gases, they are converted into CO_2 equivalents. This involves converting emissions of greenhouse gases other than CO_2 into CO_2 equivalents based on their global warming potential.

Figure 1

Heating energy consumption in two- or multi-apartment buildings

Annual heating energy consumption in kilowatt-hours per square meter of heated living space; temperature-adjusted



Note: 2023 values are preliminary. The corrections shown on the graph are estimates of the correct figure for the complete dataset.

Source: ista SE; authors' own calculations.

East German households consume less heating energy than their West German counterparts, with an increasing gap between the two during the energy price crisis.

than the 67 million tonnes of CO_2 equivalent specified in Germany's climate action targets for 2030.[5]

DIW Berlin's Heat Monitor Germany analyzes heating energy consumption, energy prices, and heating expenditures as well as the resulting CO_2 emissions for residential buildings on an annual basis. The calculations are based on heating energy bills for two- and multi-apartment buildings. The comprehensive dataset, which comprises around 300,000 buildings and was provided by energy service provider *ista SE* (formerly *ista Deutschland GmbH*)[6], is weighted on the basis of the German microcensus, and therefore paints a representative picture for the whole of Germany. Our analysis for 2023 is based on energy bill data already available for over 170,000 buildings (Box 1).

This year's analysis focuses on the continued savings in heating energy consumption as well as the development of heating costs and prices in the first year after the beginning of the energy price crisis. The analysis of heating energy prices and consumption, which previously included gas and oil heating only, was extended this year to include district heating. The increasing share of district heating, which currently accounts for around 15 percent of homes in Germany, is thus taken into account as a potentially sustainable heat source in the heat supply.[7] Consequently, the average prices for 2023 and the historical comparison years listed in this report now also include district heating.

Heating energy consumption remains higher in the west than in the east and south of Germany

Heating energy consumption[8] in two- and multi-apartment buildings continued to fall in 2023 (Figure 1). In fact, the average temperature-adjusted heating consumption of 118 kWh per square meter of heated living space was 3.8 percent lower than in the previous year (123 kWh) and nine percent lower than in 2021 (130 kWh). The combination of higher heating energy prices, alongside appeals to save energy during the 2022/2023 heating period, and targeted measures to reduce heating energy consumption (such as hydraulic balancing, additional energy efficiency measures, heating curve adjustments) had a noticeable impact on the heating energy consumption in 2023. However, the increase in prices could not be offset by the savings in demand, resulting in higher expenditures for households.

We observe significant regional differences in heating energy consumption, specifically between the west and northwest of Germany, on the one hand, and the east and south, on the other. Once again, Mecklenburg-Western Pomerania consumed the least heating energy at 99 kWh per square meter. As in the previous year, Saarland was at the other end of the scale with the highest consumption of 137 kWh per square meter (Table and Figure 2). Taken together, the western German states consumed 121 kWh per square meter, exceeding the heating energy consumption of their eastern German counterparts, which required an average of 111 kWh (Figure 1). A possible explanation for this could be the higher retrofit rates for residential buildings in the eastern German states.[9]

At the regional level, the differences between the highest and lowest level of consumption are even more pronounced. Central Mecklenburg/Rostock had the lowest average heating energy consumption in Germany at 87 kWh per square meter, followed by Western Pomerania at 98 kWh. East Fresia, in contrast, consumed far more heating energy with 140 kWh per square meter. The Saar region was in second place with 137 kWh.

5 Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz, "Das neue Klimaschutzgesetz – Jahresemissionsmengen nach Bereichen bis 2030," 2024 (in German; available online)

6 Alongside its competitor Techem, ista is one of the two largest billing companies for heating and hot water in Germany. In 2017, the two companies combined held a market share of around 50 percent.

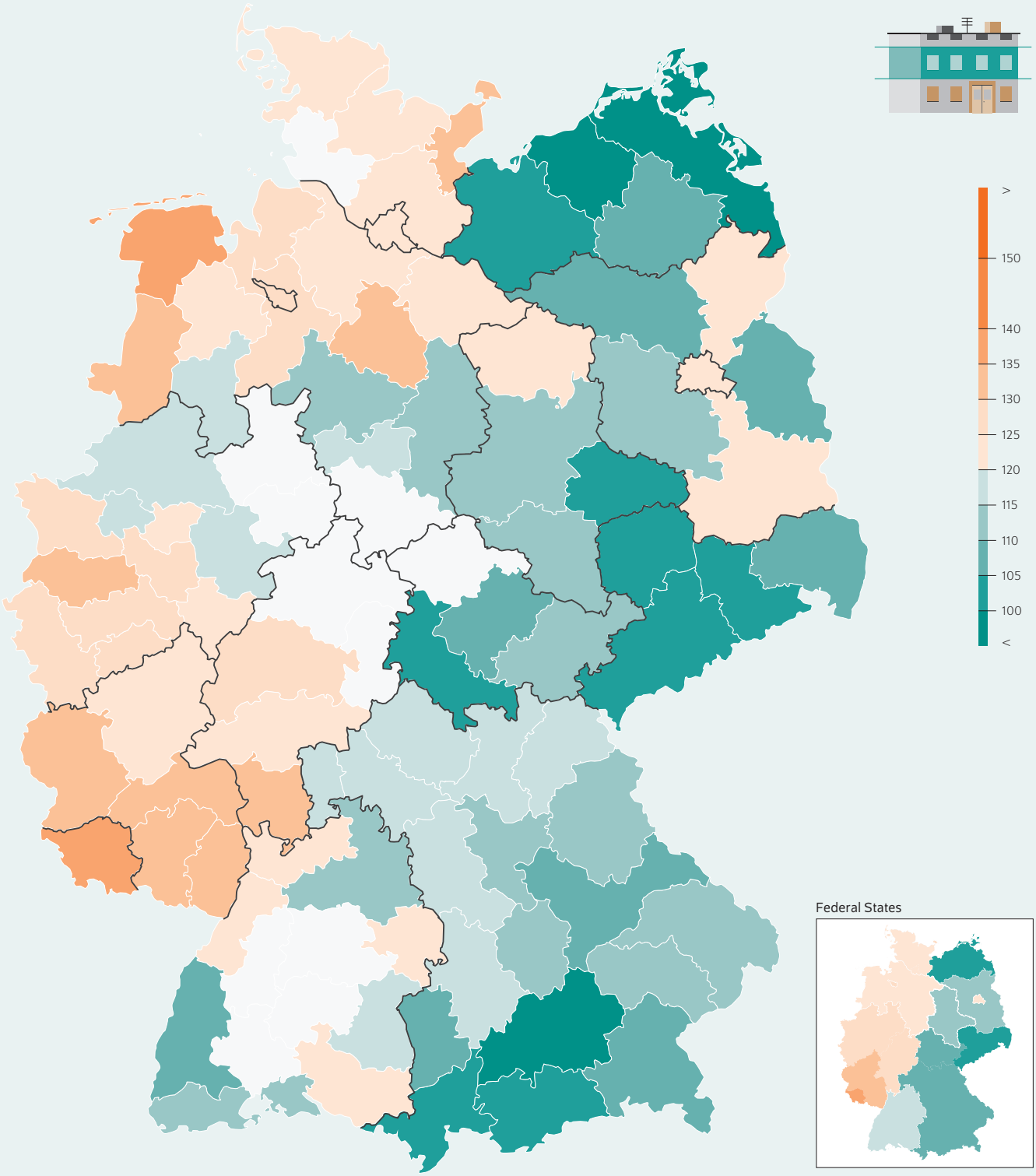
7 This corresponds to around six percent of residential buildings in Germany, cf. BDEW (2024): Wie heizt Deutschland 2023? BDEW-Studie zum Heizungsmarkt (in German; available online, accessed on November 1, 2024).

8 Heating energy consumption is adjusted for local changes in the climate and weather (Box 1).

9 Cf. Sophie Behr, Merve Kücük, and Karsten Neuhoff, "Energetische Modernisierung von Gebäuden sollte durch Mindeststandards und verbindliche Sanierungsziele beschleunigt werden," DIW aktuell 87 (2023) (in German; available online).

Figure 2

Heating energy consumption in two- or multi-apartment buildings by region (ROR)
Annual heating energy consumption in kilowatt-hours per square meter of heated living space; temperature-adjusted



Note: Also available online as an interactive graphic on heating energy prices, demand and expenditure at https://www.diw.de/waermemonitor_2021-2023.

Source: ista SE; authors' own calculations.

Less heating is used from the Baltic Sea to Allgäu than in the west and northwest of Germany.

Table

Results of Heat Monitor 2023

Spatial planning region (ROR)	Number of ROR	Annual heating energy use (kilowatt-hour per square meter heated living space) Average			Billed heating prices (euro cents per kilowatt-hour) Median			Annual heating expenditure (euros per square meter) Average		
		2021	2022	2023[1]	2021	2022	2023[1]	2021	2022	2023[1]
Schleswig-Holstein Mitte	101	136.27	124.14	124.48	8.09	10.73	13.93	10.63	12.40	16.27
Schleswig-Holstein Nord	102	136.66	129.45	122.07	7.55	9.72	11.63	10.29	12.16	13.87
Schleswig-Holstein Ost	103	147.36	132.75	130.25	6.32	8.64	11.19	9.04	11.48	13.58
Schleswig-Holstein Süd	104	138.03	127.53	122.16	6.67	9.45	12.47	8.73	11.36	13.97
Schleswig-Holstein Süd-West	105	162.58	153.21	N/A	5.24	7.60	11.75	9.03	12.62	15.09
Hamburg	201	137.30	126.85	120.61	7.41	10.65	11.56	9.60	12.20	12.92
Braunschweig	301	123.97	116.12	113.40	6.81	9.56	12.03	8.17	10.35	12.85
Bremen-Umland	302	144.80	135.64	126.34	5.70	7.46	11.46	8.12	9.93	13.41
Bremerhaven	303	143.45	130.58	126.30	5.80	8.09	11.50	8.13	10.47	13.58
Emsland	304	146.86	139.12	130.58	5.81	7.91	11.57	8.10	9.84	13.84
Göttingen	305	131.75	119.26	N/A	5.87	7.29	N/A	7.77	8.63	N/A
Hamburg-Umland-Süd	306	140.74	130.91	123.94	5.56	7.87	10.49	8.07	10.63	13.08
Hannover	307	125.96	117.83	113.08	6.61	9.02	11.68	8.50	10.67	13.09
Hildesheim	308	132.94	125.48	117.68	6.06	8.58	11.67	8.03	10.34	13.09
Lüneburg	309	137.34	130.58	123.13	5.63	7.48	12.07	7.77	9.97	14.38
Oldenburg	310	142.97	129.45	123.45	5.84	8.87	10.85	8.30	10.41	12.08
Osnabrück	311	129.73	118.38	119.23	5.99	8.24	11.74	7.84	9.82	12.82
Ost-Friesland	312	157.03	144.46	139.77	6.17	7.58	11.43	9.27	10.32	14.08
Südheide	313	146.87	134.56	132.80	5.84	7.92	11.66	8.58	10.92	14.51
Bremen	401	140.37	132.12	125.84	6.77	8.64	11.08	8.69	10.31	12.80
Aachen	501	139.95	131.76	126.71	6.50	9.00	11.79	9.21	11.41	13.96
Arnsberg	502	129.12	121.16	117.50	5.89	8.56	11.80	7.64	9.73	13.03
Bielefeld	503	142.05	132.13	N/A	6.14	7.77	N/A	8.50	9.93	N/A
Bochum/Hagen	504	142.75	131.64	127.02	6.75	8.85	11.91	9.48	11.08	13.76
Bonn	505	145.22	134.14	128.38	6.48	9.34	11.53	9.36	11.79	14.22
Dortmund	506	139.75	129.20	123.59	6.52	8.88	11.66	9.29	11.63	13.49
Duisburg/Essen	507	142.95	132.98	126.94	7.20	9.40	12.28	10.23	11.80	14.32
Düsseldorf	508	148.10	136.58	130.18	6.23	8.39	11.75	9.36	11.41	14.35
Emscher-Lippe	509	136.64	127.42	119.25	7.47	10.11	12.06	10.05	12.31	13.48
Köln	510	140.87	133.04	125.64	6.24	8.87	11.79	8.77	11.39	13.94
Münster	511	130.94	120.82	115.82	5.84	7.75	11.36	7.67	9.08	12.12
Paderborn	512	131.58	120.38	N/A	6.11	7.59	N/A	8.18	9.58	N/A
Siegen	513	137.89	126.03	121.74	5.84	8.26	11.70	7.98	10.16	13.12
Mittelhessen	601	129.85	124.58	129.90	6.27	7.95	11.81	7.94	9.90	14.84
Nordhessen	602	128.92	122.20	N/A	6.38	8.50	N/A	8.09	10.26	N/A
Osthessen	603	121.06	113.31	N/A	5.71	7.55	N/A	6.87	8.46	N/A
Rhein-Main	604	134.23	127.49	121.39	6.30	8.22	11.55	8.42	10.14	13.27
Starkenburg	605	142.70	137.05	133.18	6.17	8.38	11.65	8.80	11.25	14.57
Mittelrhein-Westerwald	701	135.88	128.83	124.24	6.25	8.07	11.73	8.33	10.24	13.70
Rheinhessen-Nahe	702	140.63	135.38	133.81	6.30	8.21	11.74	8.94	11.31	14.57
Rheinpfalz	703	140.98	136.62	133.61	6.36	8.36	11.49	8.95	10.92	14.33
Trier	704	138.64	139.52	130.48	6.11	8.07	11.57	8.56	11.62	14.47
Westpfalz	705	143.98	142.16	133.27	6.02	7.46	11.42	8.61	10.46	15.15
Bodensee-Oberschwaben	801	116.71	114.49	120.92	5.71	6.87	9.03	6.84	8.59	11.80
Donau-Iller (BW)	802	120.99	117.40	115.04	6.11	8.07	11.57	7.67	9.77	13.17
Franken	803	124.32	119.99	111.71	5.98	7.90	12.03	7.78	10.09	13.77
Hochrhein-Bodensee	804	123.21	121.24	113.62	5.86	7.56	10.68	7.32	9.38	11.86
Mittlerer Oberrhein	805	129.00	124.06	121.38	6.43	8.11	11.34	8.21	10.31	13.38
Neckar-Alb	806	120.27	122.12	N/A	6.63	8.40	N/A	7.33	9.42	N/A
Nordschwarzwald	807	116.10	116.16	N/A	6.07	8.00	N/A	7.25	9.80	N/A
Ostwürttemberg	808	127.10	126.36	122.05	5.99	7.69	9.50	7.76	9.99	12.83
Schwarzwald-Baar-Heuberg	809	112.37	112.48	N/A	5.91	7.50	N/A	6.87	9.11	N/A
Stuttgart	810	126.35	121.76	N/A	6.64	8.30	N/A	8.24	10.22	N/A
Südlicher Oberrhein	811	114.87	114.29	109.88	5.90	7.42	11.11	7.06	9.36	12.11
Unterer Neckar	812	131.65	125.54	123.77	7.57	9.37	12.06	9.88	11.54	14.53
Allgäu	901	105.77	101.13	102.38	6.09	7.46	10.93	6.12	8.30	10.32
Augsburg	902	122.20	117.38	115.06	5.79	8.57	11.30	7.22	10.02	11.98
Bayerischer Untermain	903	129.98	131.68	119.30	5.77	7.84	11.93	7.63	10.30	13.96

Spatial planning region (ROR)	Number of ROR	Annual heating energy use (kilowatt-hour per square meter heated living space) Average			Billed heating prices (euro cents per kilowatt-hour) Median			Annual heating expenditure (euros per square meter) Average		
		2021	2022	2023[1]	2021	2022	2023[1]	2021	2022	2023[1]
Donau-Iller (BY)	904	120.42	121.00	109.71	5.98	7.93	11.72	7.40	10.01	12.64
Donau-Wald	905	119.10	114.58	113.26	5.88	7.52	11.57	6.95	9.28	12.64
Industrieregion Mittelfranken	906	122.56	119.74	113.42	6.69	8.31	11.86	7.94	9.60	12.45
Ingolstadt	907	115.30	115.34	110.52	6.09	7.94	11.38	7.07	9.31	11.72
Landshut	908	114.70	112.85	110.20	5.86	7.59	11.61	6.73	8.90	12.08
Main-Rhön	909	122.57	118.63	116.06	6.22	7.37	11.46	7.45	9.01	12.36
München	910	106.40	103.50	98.50	6.65	9.86	11.82	7.11	9.98	11.36
Oberfranken-Ost	911	121.00	119.51	115.22	5.90	7.60	11.77	7.15	9.23	12.66
Oberfranken-West	912	124.71	123.05	116.85	6.05	7.35	11.34	7.50	9.73	12.44
Oberland	913	109.18	108.15	103.34	6.03	7.83	11.06	6.58	9.12	11.35
Oberpfalz-Nord	914	129.87	119.46	111.30	6.10	8.32	11.37	7.58	10.48	12.26
Regensburg	915	116.66	116.26	109.14	5.92	7.67	11.49	6.93	9.46	11.68
Südostoberbayern	916	111.62	110.32	108.15	6.00	7.85	11.45	6.75	9.06	12.01
Westmittelfranken	917	124.42	122.10	116.63	6.04	8.00	11.87	7.49	10.17	13.37
Würzburg	918	125.69	121.28	117.55	6.14	7.33	11.17	7.67	9.49	12.11
Saar	1001	147.98	140.68	136.54	6.83	9.72	12.32	9.68	12.95	15.58
Berlin	1101	136.85	127.67	123.56	7.28	10.47	12.87	9.51	12.32	13.97
Havelland-Fläming	1201	124.36	114.56	110.64	7.94	10.13	12.80	8.83	10.08	12.51
Lausitz-Spreewald	1202	128.93	122.07	124.02	8.11	10.17	12.61	8.67	10.00	12.30
Oderland-Spree	1203	127.00	118.23	107.02	8.78	10.13	12.39	9.12	10.16	12.23
Prignitz-Oberhavel	1204	132.19	119.74	109.17	8.48	12.24	14.60	9.07	11.55	13.05
Uckermark-Barnim	1205	124.90	118.33	120.12	7.65	11.16	11.67	7.46	9.38	10.13
Mecklenburgische Seenplatte	1301	112.50	110.53	109.67	8.67	10.85	12.70	7.93	8.89	11.04
Mittleres Mecklenburg/Rostock	1302	98.25	90.68	87.33	8.96	10.22	13.16	7.87	7.87	10.04
Vorpommern	1303	110.99	107.42	98.21	9.12	12.47	12.99	8.38	10.52	11.23
Westmecklenburg	1304	116.88	109.13	103.96	8.24	9.80	11.95	8.10	9.24	10.44
Oberes Elbtal/Osterzgebirge	1401	116.92	110.11	101.96	8.25	13.36	13.44	8.10	10.52	11.15
Oberlausitz-Niederschlesien	1402	121.32	115.11	109.97	7.24	8.97	11.84	7.55	8.80	10.82
Südsachsen	1403	118.10	112.15	103.56	7.34	8.42	10.55	7.62	8.71	9.96
Westsachsen	1404	113.53	107.32	100.37	8.15	9.49	12.74	8.06	8.42	10.53
Altmark	1501	134.69	121.67	121.11	7.61	9.05	8.84	9.33	11.88	10.22
Anhalt-Bitterfeld-Wittenberg	1502	121.31	127.16	102.83	8.20	10.09	13.36	8.81	10.57	12.97
Halle/S.	1503	123.51	117.10	111.64	7.94	9.38	11.92	8.52	9.82	11.80
Magdeburg	1504	122.57	118.41	114.34	8.03	10.65	12.43	8.49	10.92	11.89
Mittelthüringen	1601	113.44	103.85	105.99	7.63	14.71	11.77	7.37	10.45	10.07
Nordthüringen	1602	120.00	111.84	N/A	7.55	9.50	12.82	8.58	9.28	13.78
Ostthüringen	1603	111.70	104.85	112.77	7.86	8.63	12.09	7.72	8.06	11.07
Südthüringen	1604	119.49	115.31	104.41	7.13	8.24	11.33	7.45	8.28	10.37
Schleswig-Holstein	1	140.70	129.56	124.45	7.05	9.58	12.47	9.58	11.89	14.61
Hamburg	2	137.30	126.85	120.61	7.41	10.65	11.56	9.60	12.20	12.92
Lower Saxony	3	133.86	124.29	120.03	6.21	8.47	11.61	8.24	10.22	13.20
Bremen	4	140.37	132.12	125.84	6.77	8.64	11.08	8.69	10.31	12.80
Northrhein-Westfalia	5	141.36	131.30	125.46	6.49	8.75	11.83	9.17	11.14	13.83
Hesse	6	133.67	127.27	125.25	6.25	8.21	11.62	8.29	10.22	13.81
Rheinland-Palatinate	7	139.62	135.24	130.56	6.24	8.07	11.61	8.67	10.82	14.34
Baden-Wuerttemberg	8	123.69	120.53	117.44	6.41	8.10	11.15	7.96	10.02	13.09
Bavaria	9	116.23	113.43	108.58	6.24	8.40	11.59	7.21	9.63	11.97
Saarland	10	147.98	140.68	136.54	6.83	9.72	12.32	9.68	12.95	15.58
Berlin	11	136.85	127.67	123.56	7.28	10.47	12.87	9.51	12.32	13.97
Brandenburg	12	127.19	118.35	114.52	8.17	10.55	12.80	8.71	10.20	12.21
Mecklenburg-Western-Pomerania	13	109.31	103.83	98.76	8.77	10.87	12.71	8.08	9.17	10.66
Saxony	14	117.08	110.81	103.15	7.76	10.04	11.99	7.84	9.12	10.51
Saxony-Anhalt	15	123.61	119.68	111.95	8.00	9.98	12.13	8.62	10.55	11.92
Thuringia	16	114.96	107.58	108.32	7.60	10.62	11.94	7.68	9.04	11.00
Germany	17	130.01	123.10	118.44	6.74	8.99	11.81	8.44	10.49	12.99
East Germany	18	123.47	116.33	111.36	7.78	10.36	12.40	8.50	10.29	11.90
West Germany	19	131.99	125.15	120.58	6.43	8.57	11.63	8.43	10.55	13.33

1 Preliminary data.

Notes: Heating energy use is adjusted for changes in temperature; billed heating costs are a weighted average of natural gas and oil prices.

Source: ista SE; authors' own calculations.

Box 2

Calculation of CO_2 emissions

To calculate a building's CO_2 emissions, the heating energy consumption per square meter is multiplied by the emission factors of each energy carrier (Table). To allow for a comparison with emissions in the building sector for the whole of Germany, only direct CO_2 emissions are calculated. Upstream emissions resulting from energy extraction, transport, and transformation (for example when generating electricity and district heating) are not taken into account.

To calculate representative average annual CO_2 emissions per square meter, the annual CO_2 emissions per square meter are weighted for each property according to the share of the building category in the statistical population. The weighting is similar to the calculation for temperature-adjusted heating energy consumption (Box 1). In other words, the different building size categories are weighted according to their share in the microcensus.

Table

CO_2 emission factors depending on energy carrier

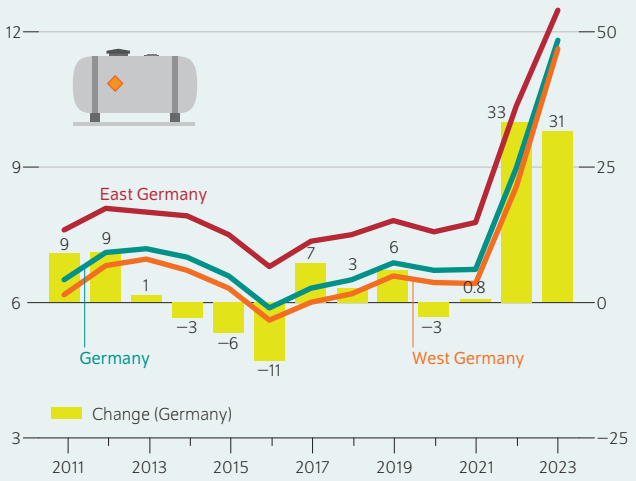
Energy carrier	CO_2 emission factor
Natural gas (H)	0.201
Natural gas (L)	0.201
Oil	0.266
Heavy oil	0.293
Lignite	0.359
Coke	0.389
Hard coal	0.345
Liquified gas	0.236
District heating	0
Electricity	0
Pellets	0
Wood	0
Wood chips	0

Source: Umweltbundesamt 2014

Figure 3

Energy prices

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



Source: ista SE; authors' own calculations.

In the two years 2022 and 2023, the increase in energy prices adds up to 75 percent.

Strong regional differences in price changes and consumption per square meter

The median heating energy price for 2023, accounting for rebates granted under the energy price cap, was 11.81 cents per kWh. In 2023, Germany saw a 31.4 percent increase over the previous year, which was almost as high as the increase in the first year after the start of the war on Ukraine, when energy prices rose by 33.3 percent (Figure 3). This corresponds to a 75-percent increase in average prices compared to 2021.

There are several reasons for this sharp increase in energy prices despite the price cap. First, the cap applied to gas and district heating only;[10] second; the average prices for 2022 were far lower than the price cap; and third, the price cap applied only to 80 percent of past consumption. If a household was only able to reduce its consumption by less than 20 percent compared to 2022 and the new contractual price would have been higher than the level of the price cap, the resulting average price for this household would exceed the price cap.

Arguably the main reason why heating energy prices continued to increase in 2023, as compared to 2022, was that

Another area where we observe stark differences between German states is in the billed heating prices (Table). Median heating prices were the lowest in Bremen with 11.08 cents per kWh, followed by Baden-Württemberg with 11.15 cents. In contrast, Berlin and Brandenburg had the highest heating prices with median prices of 12.87 and 12.80 cents per kWh, respectively. Regional differences at the more granular level were even more pronounced. Households in Prignitz-Oberhavel and Central Schleswig-Holstein paid 14.60 and 13.93 cents per kWh, making their median prices the highest. Median heating prices in Altmark, Saxony-Anhalt, were lowest at just 8.84 cents per kWh, followed by Bodensee-Oberschwaben at 9.03 cents.

10 In 2023, there was also an electricity price cap. However, this only impacted heating energy prices for a very small number of households, as only a very small proportion of buildings in Germany have electric heating. Since the present analysis is limited to the three dominant heating energy sources—gas, oil, and district heating—the electricity price cap has no effect for the sample considered.

some households did not have to pay the higher energy prices until 2023. Thanks to the one to two-year energy price plans signed up for in advance, they were not subject to price increases in 2022. The different contract structures therefore resulted in a significant increase in price variation. Accordingly, there are households that came through the crisis almost unscathed, while others ended up paying very high prices. At the federal state level, Rhineland-Palatinate saw the biggest price increase with 45.2 percent, while the state of Hamburg recorded the smallest increase with just 8.8 percent in comparison to the previous year.

The biggest energy savings in 2023 were recorded in Saxony, which reduced their heating energy consumption by 5.8 percent. Saarland and Brandenburg, in contrast, saw the smallest reductions in consumption (2.6 and 2.8 percent, respectively). One of the reasons households did not save more, despite the steep price increases, was likely the energy efficiency of the buildings, something over which particularly tenant households generally have no influence. Hence, the relation between price increases and reduced heating energy consumption is not clear (Figure 4). The fact that reduced consumption cannot fully offset these sharp price increases is also reflected in the steep rise in overall heating expenditures, with 2023 seeing an increase in heating energy expenditure of around 24 percent over the previous year (compared to 2021, the last year before the energy crisis, the increase was as high as 54 percent).

Price and demand structure for district heating differs noticeably from gas and oil

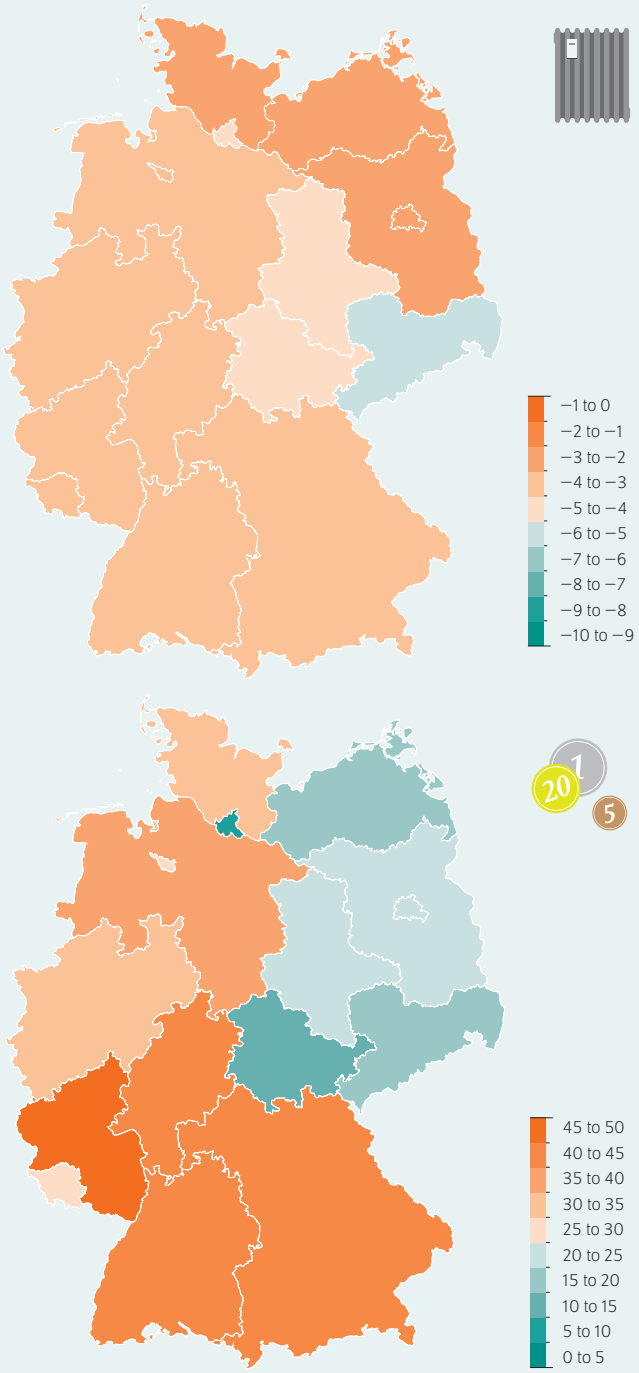
District heating and heat networks have the potential to make a significant contribution to the decarbonization of heat supply: They can be operated with sustainable energy sources and are more efficient than building-internal gas and oil-based heating systems. In order to map the potential switch to sustainable sources in heat generation, this year for the first time the Heat Monitor's analysis of heating energy prices covers not just oil and gas but also district heating. The analysis clearly shows that the price range for district heating is considerably wider than for gas and oil (Figure 5). Similarly, the median price of district heating per kilowatt-hour is, on average, substantially higher than those for gas and oil.

That said, at 97 kWh per square meter, heating consumption for district heating is 24 percent lower than for oil (127 kWh) and 19 percent lower than for gas (120 kWh) (Figure 6). Differences in price and demand for district heating arise, among other reasons, from the fact that heat is supplied directly with district heating, whereas with gas and heating oil, there are conversion losses due to heat generation in the house. Another reason for the lower average heating energy consumption for district heating is that buildings supplied with district heating have, on average, more residential units than buildings, which are heated with gas or oil. These larger buildings have less outer walls per square meter of living space, resulting in lower heating energy requirements.

Figure 4

Change in (temperature-adjusted) heating energy consumption and heating energy prices in two and multi-apartment buildings (2022–2023)

In percent



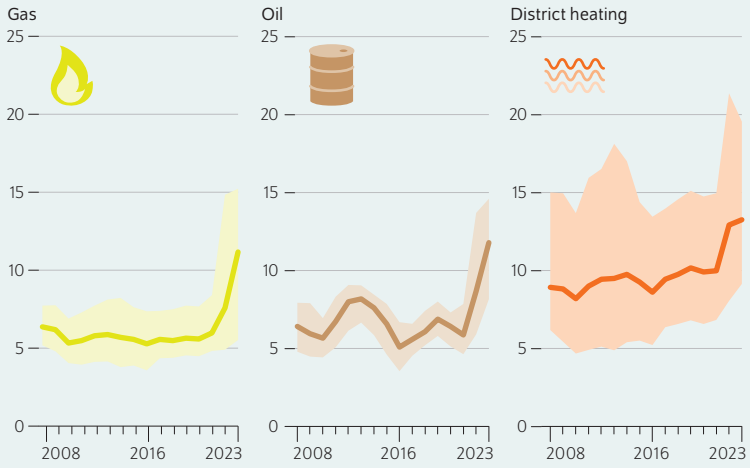
Note: Billed heating costs are a weighted average of natural gas, oil, and district heating prices. To calculate the changes, only buildings that could be observed in both 2022 and 2023 are taken into account and weighted using the microcensus. For this reason, this figure is not comparable with the table.

Source: ista SE; authors' own calculations.

Savings in consumption were not necessarily related to price increases: Households in Saxony saved the most on heating energy, even though prices did not rise that much there in 2023.

Figure 5

Heating energy prices in two- and multi-apartment buildings by energy source
Euro cents per kilowatt-hour



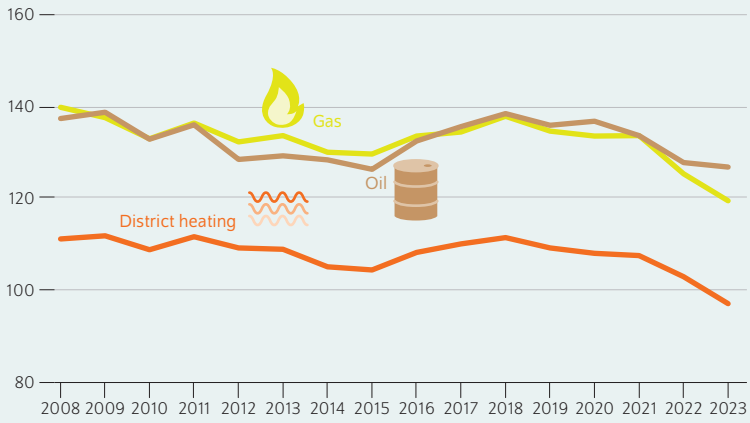
Note: The shaded areas show the price variance.

Source: ista SE; authors' own calculations.

Average prices for district heating are higher than for gas and oil and also show a stronger variation.

Figure 6

Heating energy consumption in two- and multi-apartment buildings by energy source
Annual heating energy consumption in kilowatt-hours per square meter of heating living space; temperature-adjusted



Source: ista SE; authors' own calculations.

Heating energy consumption per square meter is significantly lower for district heating than for oil and gas.

Emissions reductions losing momentum

Last year, building sector emissions in Germany amounted to 102 million tonnes of CO_2 equivalent.[11] This is 51 percent less than in 1990. Nevertheless, for Germany to meet its 2030 climate targets, the building sector has to reduce its emissions by 69 percent compared to 1990 levels.

A building's CO_2 emissions depend on multiple factors (Box 2), in particular its energy efficiency and the heating system used. The emissions per square meter for the two- and multi-apartment buildings examined here continue to be on a downward trend (Figure 7). With 19.1 kilos per square meter of heated living space, the CO_2 emissions attributed to heating were eight percent lower in 2023 than in the previous year. Temperature-adjusted, however, this corresponds to a 4.3 percent reduction only, as 2023 was a relatively mild year. Thus, although the downward trend has continued, the reduction in emissions was lower in 2023 than the 5.6 percent observed in the previous year (16 percent without temperature adjustment). Given the smaller decrease in heating energy consumption, it is not surprising that emissions levels are no longer falling as dramatically, but the momentum in the building sector is still not enough to meet Germany's climate targets.

Conclusion: Greater investment in building energy efficiency needed

In 2023, once again, households faced strong increases in heating costs compared to the previous year—amounting to 31 percent, on average. That being said, there were strong regional variations. These resulted, on the one hand, from the different types of fuel used, as well as from the different types of contracts used by electricity and gas suppliers. Other important factors might be the different points in time at which contracts were concluded or oil tanks filled.

The analysis shows that, in 2023, the (now expired) energy price cap to protect households from potentially extreme heating cost hikes was indeed effective. For the majority of households, the unit prices billed were not substantially higher than the price cap of 12 cents. When it came to district heating, on the other hand, the average price of heating energy was 13 cents per kWh—well above the price cap of 9.5 cents per kWh. With the price cap only applying to 80 percent of forecasted consumption and anything above this being charged at given market energy prices, 2023 saw a very high average price for district heating in many places.

Despite similar price increases as in 2022, heating energy savings in 2023 were lower than in the previous year. Temperature-adjusted, private households consumed 3.8 percent less heating energy than in 2022. In the previous year, the saving was 5.3 percent. One reason for this might be that

11 Umweltbundesamt, "Treibhausgasminderungsziele Deutschlands," 2024 (in German; available online).

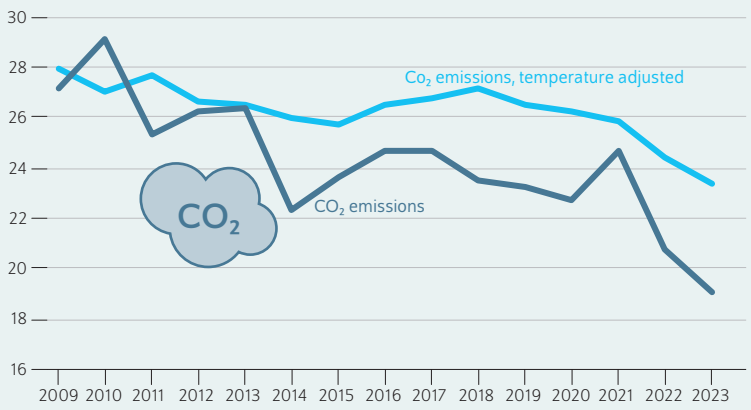
in 2023, much less attention was devoted to saving heating energy than in 2022. Another reason might be that the potential to save energy through changes in consumer behavior had already been exhausted in some households. In some regions, however, savings were more than twice as high as the national average. This indicates that savings in heating energy and therefore also emissions are still possible in the short term – whether through behavioral adjustments or energy-efficient renovations.

The months following the energy price crisis of 2022/2023 saw the price pressure on the supply side decrease as wholesale energy prices dropped and started to stabilize. In the years ahead, however, the cost of CO_2 emissions from fossil fuels is likely to increase heating costs for private households. That said, the energy price crisis has demonstrated that higher heating costs have a limited impact on people's heating behavior and therefore also CO_2 emissions.

When it comes to reducing emissions, the momentum is thus unlikely to continue unless it is supported by other means. Yet, emissions have to be reduced for the climate targets in the building sector to be met. The Expert Commission on Gas and Heat has proposed a number of specific measures to achieve these reductions. The advice and in-kind contributions intended to help households reduce their heating energy and electricity consumption should therefore be strengthened. Even more importantly, however, the energy-efficient retrofits of inefficient buildings as well as the switch to sustainable heating systems such as heat pumps must be accelerated. If this is not vigorously pursued, we can expect that heating energy consumption and thus also emissions in the building sector will rise again in the coming years.

Figure 7

Development of CO_2 emissions in the residential building sector
In kilograms of CO_2 per square meter of heated living space



Source: ista SE; authors' own calculations.

CO_2 emissions from residential buildings fall steadily, albeit at a very slow pace.

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