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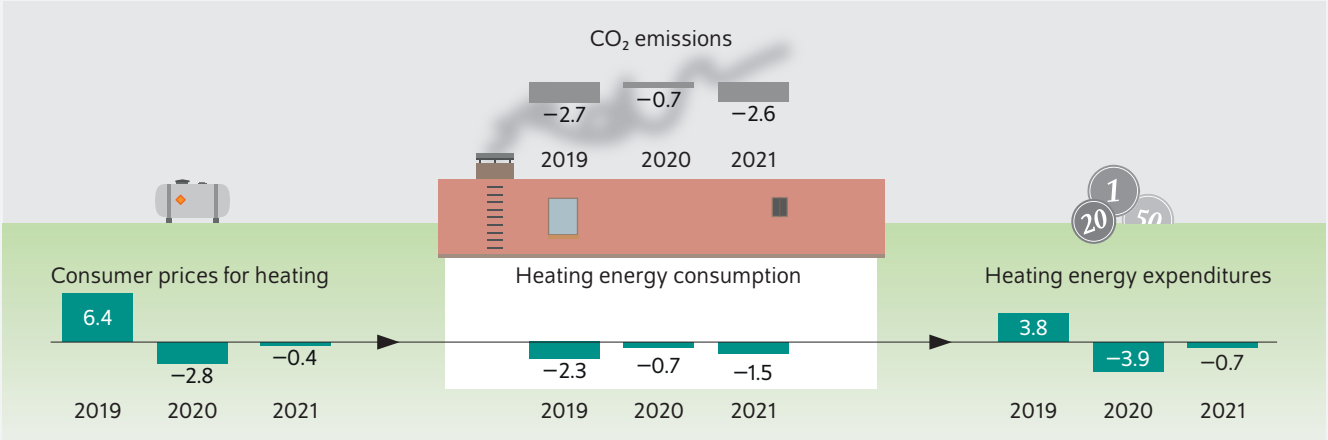
AT A GLANCE

Heat Monitor 2020 and 2021: Heating energy consumption down slightly but climate targets still not met

By Till Köveker, Mats Kröger, Franziska Schütze

- Temperature-adjusted heating energy consumption in German residential buildings slightly down in 2020 and 2021 despite lockdowns and increase in homeworking due to the pandemic
- Climate targets not being reached despite decrease in temperature-adjusted CO_2 emissions
- Heating energy prices and expenditure down slightly in the past two years
- Rising energy prices in 2022 will drastically increase expenditures
- Short-term support measures must go hand in hand with long-term improvements in energy efficiency and a switch to renewable heating systems in the building sector

Heat consumption and expenditures decreased in the years of the pandemic
Change from previous year in percent (heating energy consumption and CO_2 emissions temperature-adjusted)



Source: ista SE, authors' own calculations. Note: 2021 data is preliminary.

FROM THE AUTHORS

„High heating costs will become a heavy burden on many private households. In addition to short-term relief, more long-term investments are now needed, such as energy-efficient building renovations and a change in heating systems, especially to renewable energies. This is in the interests of both private households and climate protection".
— Franziska Schütze —

MEDIA

Audio Interview with Franziska Schütze (in German)
www.diw.de/mediathek

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ABSTRACT

The building sector plays a major role when it comes to meeting climate targets. An analysis by DIW Berlin based on data from energy provider ista SE shows that in the past two years both the temperature-adjusted heat consumption in German multi-apartment buildings and the temperature-adjusted CO_2 emissions have dropped slightly. As positive as this decrease is—despite the increase in homeworking due to the coronavirus pandemic—it is nowhere near enough to meet the climate targets. For this to happen, it would be necessary to achieve annual CO_2 emission reductions in the order of magnitude of around four percent of emissions in 2020. The soaring heat energy prices resulting from the war in Ukraine may cause a noticeable decrease in energy consumption and CO_2 emissions because households will heat less for financial reasons. The government will need to go beyond delivering short-term relief packages and use the momentum for long term measures, making buildings more energy efficient. For energy saving and climate protection reasons, the government needs to accelerate investment in energy-efficient building renovations and in the use of renewable energies in the heating sector.

In the wake of the war in Ukraine and the resulting energy crisis, heating is on top of the agenda this winter, with both industry and households in Germany and across the rest of Europe having to make substantial savings on heating and hot water consumption in the face of looming gas shortages. In recent years, government climate policy has already pushed for heating consumption reductions and greater energy efficiency in buildings as a means of lowering CO_2 emissions. Following an increase in the period 2015 to 2018, temperature-adjusted heating energy consumption decreased again since 2019, resulting in a reduction in temperature-adjusted greenhouse gas emissions in German residential buildings since that year.[1]

The building sector, whose direct emissions make up roughly 16 percent of total CO_2 emissions in Germany, is essential to meeting climate targets.[2] For this sector to make a difference, however, far greater savings are needed than what we have seen to date. In light of this, in June 2021, the German government amended the Climate Change Act, tightening its climate targets. The amendment raised the emissions reduction target for 2030 (to a total of 65 percent over 1990, with as much as 68 percent in the building sector) and moved the carbon neutrality target forward by five years (to 2045 rather than 2050). Under the German Fuel Emissions Trading Act (BEHG), a CO_2 price was introduced for the building sector—set at 25 euros per tonne of CO_2 when launched in 2021, increasing to 55 euros per tonne of CO_2 by 2025. From 2026, the national CO_2 price will move into a price corridor of 55 to 65 euros.

The annual maximum permissible emissions levels in the building sector were 118 and 113 million tonnes of CO_2 equivalent for the years 2020 and 2021, respectively.[3] These targets

1 Cf. Jan Stede, Franziska Schütze, and Johanna Wietschel, "Wärmemonitor 2019: Klimaziele bei Wohngebäuden trotz sinkender CO_2-Emissionen derzeit außer Reichweite," *DIW Wochenbericht*, no. 40 (2020): 769–779 (in German; available online, accessed October 7, 2022; this applies to all other online sources in this report unless stated otherwise).

2 Cf. table of the Umweltbundesamt: „Emissionsentwicklung und Sektorziele für 2020 und 2030 des Klimaschutzgesetzes" (online verfügbar).

3 Cf. Website of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. For better comparability, emissions of greenhouse gases other than CO_2 are converted into CO_2 equivalents according to their global warming potential.

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were not met in either of these years, however. According to the German Environment Agency, direct emissions for both years were well above the target. [4] For 2022, a limit of 108 million tonnes was set; by 2030 this will drop to 67 million.

Under the Climate Change Act, if these targets are not met, an immediate action program is required, which was then presented in July 2022 and subsequently scrutinized by the Council of Experts on Climate Change (Expertenrat für Klimafragen).[5] In their assessment, the council concluded that the immediate action program can indeed make a "substantial contribution to the reduction of greenhouse gas emissions" in the building sector.[6] The Council however criticized that the measures outlined in the plan, were only in part likely to lead to the necessary reductions in CO_2 emissions and that the target path for the building sector defined in the Climate Action Act could not be ensured by the program.

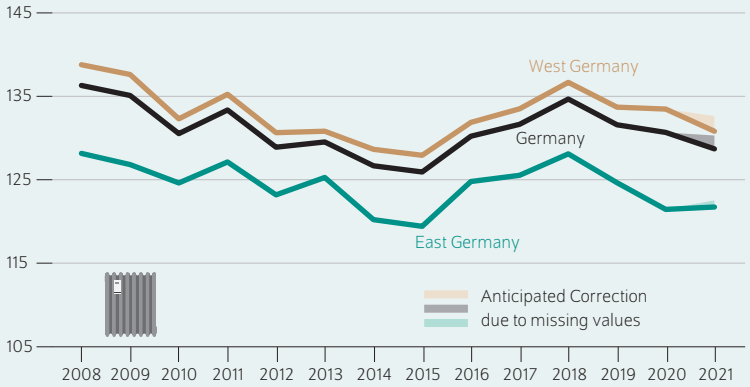
To monitor the progress in the building sector, the DIW Heat Monitor regularly examines the development of heating consumption and CO_2 emissions, as well as the heating energy prices and expenditure of 250,000 two- and multi-apartment buildings in Germany whose heating energy bills are provided by ista SE.[7] This year's report covers the period 2010 to 2021, focusing in particular on the years 2020 and 2021, influenced by the covid-19 pandemic (see Box 1).[8] The report also provides an outlook for the years ahead, since the the war in Ukraine and the resulting energy crisis also pose unforeseen challenges for the heating sector.

Temperature-adjusted heat consumption down slightly in 2020 and 2021

Between 2015 and 2018, the average heat consumption (temperature-adjusted) per square meter of heated living space rose significantly in Germany and did not start to fall again until 2019.[9] In 2020, heating energy consumption

Figure 1

Heating energy consumption in two or multi-apartment buildings
Annual heating energy consumption in kilowatt hour per square meter heated living space; adjusted for temperature



Source: ista SE, authors' own calculations.

Heating energy consumption in Germany has been falling again since 2019. In East Germany, it is currently stagnating.

(temperature-adjusted) continued to decrease—by around 0.7 percent—to 130.7 kilowatt hours per square meter of heated living space, with a further 1.5 percent decrease observed in 2021 down to 128.7 kilowatt hours (see Figure 1). Following an adjustment of the data for the year 2021 to take into account the buildings that were missing in the 2021 data (see Box 1), however, a slight decrease of just 0.3 percent to about 130 kilowatt hours per square meter of heated space can be expected, as the consumption for the missing buildings tends to be above average. Without temperature adjustment heat energy consumption in 2021 increased by nine percent, a fact that can be mainly attributed to the colder winter. In 2020, unadjusted heat energy consumption fell by around two percent.

The fact that temperature-adjusted consumption of heating in private dwellings decreased at all over the past two years is somewhat surprising against the background of the coronavirus pandemic. In fact, the pandemic forced many people to shift their offices from the workplace to their private homes, especially during the winter months, when more people were working from home and/or working reduced hours. The long-term trend in Germany shows that, due to Covid-19, the number of people working from home almost doubled in 2020 to just under 21 percent, reaching almost 25 percent the following year.[10] During the lockdowns these figures were even higher.[11] It would certainly not have been

4 Cf. greenhouse gas emissions data of the Umweltbundesamt (available online). According to the Federal Environment Agency, natural gas consumption increased in 2021 due to weather conditions. Heating oil purchases in 2021, however, were lower due to storage effects from the year 2019/2020.

5 The immediate action program for the buildings sector (Sofortprogramm gemäß § 8 Abs. 1 KSG für den Sektor Gebäude) comprises a total of 15 individual measures. Among other things, new heating systems are now to be operated with 65 percent renewable energies from 2024, i.e., one year earlier than envisaged in the coalition agreement. In addition, the government subsidy for energy-efficient buildings (BEG) is to be further developed and focus more strongly on existing building stock with low energy efficiency. To achieve this, the introduction of an additional funding bonus for "worst performing buildings" with the worst energy efficiency classes is planned, for example.

6 Council of Experts on Climate Change, Verification Report on the Immediate Action Programmes 2022 for the Building and Transport Sectors. Examination of the assumptions underlying the immediate action programmes for the building and transport sectors pursuant to § 12 of the Federal Climate Change Act (KSG)Berlin (2022): (in German; available online).

7 The dataset contains approximately 1.8 million dwellings, which accounts for about four percent of the approximately 43 million dwellings in Germany, or about seven percent of approximately 25 million dwellings in apartment buildings (Destatis 2021 and 2018). Alongside its competitor Techem, ista Deutschland is one of the two largest billing companies for heating and hot water in Germany. In 2017, together they held a market share of around 50 percent.

8 The Heat Monitor was not published in 2021 because data were not available in time due to a system change. As a result, the data basis for a 2020 Heat Monitor was insufficient, which is why the two pandemic years have been analyzed together.

9 Stede, Schütze, and Wietschel (2020), "Wärmemonitor 2019."

10 These figures are based on our own calculations which draw on data from Eurostat (available online, accessed on 30 June 2022). "Working from home" also includes respondents who stated that they "sometimes" or "usually" work from home.

11 According to the first SOEP-CoV survey carried out during the first Covid-19 wave in spring 2020, 35 percent of the those in employment were working from home at that time and 17 percent were working reduced hours. Cf. Carsten Schröder et al., "Erwerbstätige sind vor dem Covid-19-Virus nicht alle gleich," *DIW aktuell*, no. 41 (2020) (in German; available online).

Box 1

Database und methodology used for Heat Monitor 2020/2021

In partnership with *ista SE*, 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, 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*, (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 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).

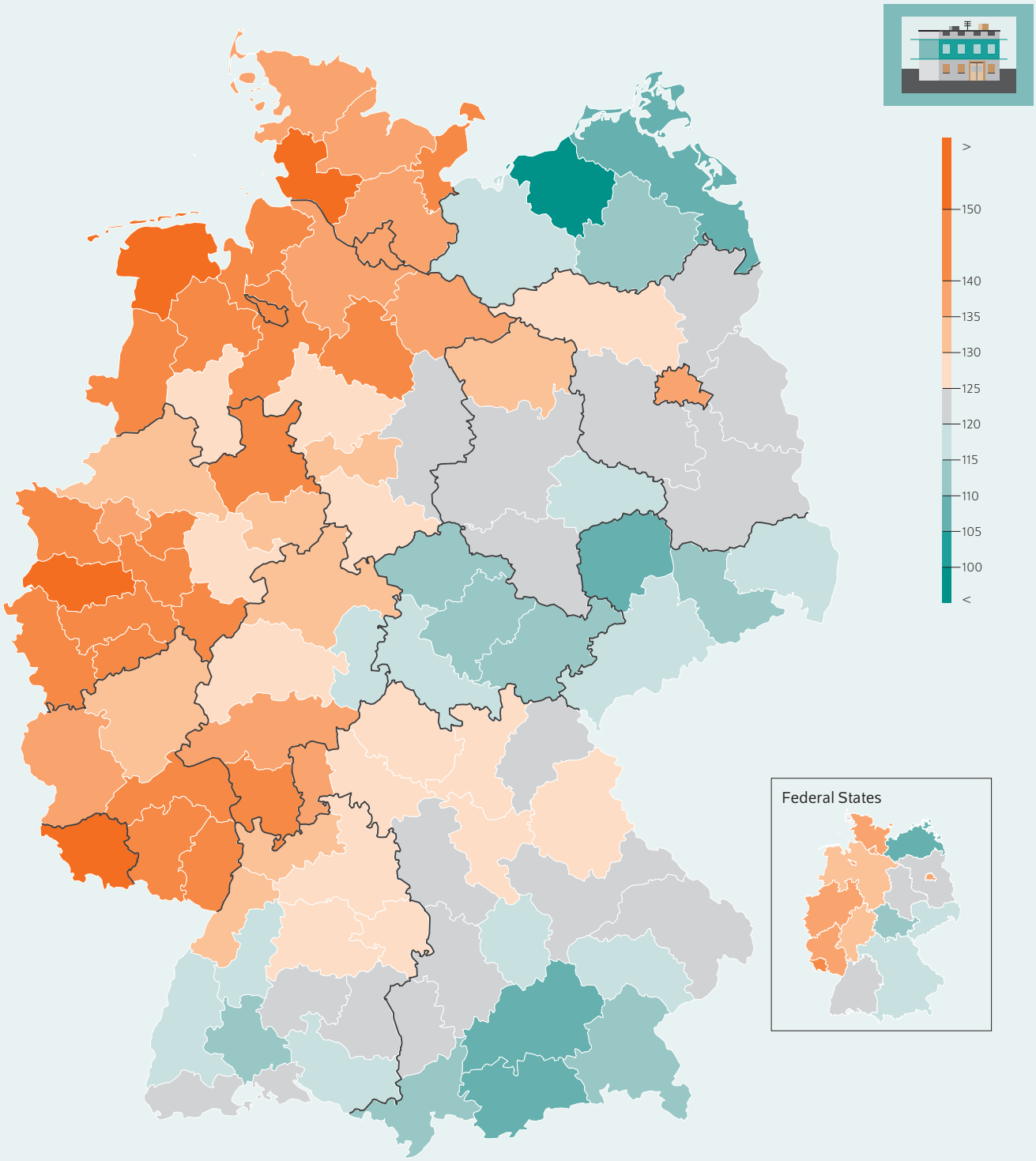
Lastly, average heating demand values at the regional level are computed as the weighted arithmetic mean for the overall building stock of a region – for weights, we use the proportion of buildings in each housing size category (two, three to six, seven to twelve, 13 to 20, and over 21 apartments) at 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 2021, around 70 percent of the homes are available, compared to 2020. The results for 2021 should therefore be regarded as preliminary. For heating consumption, a correction was made by calculating a hypothetical value for 2021 energy consumption for the missing houses and by correcting the energy consumption with the national trend. It was found that the missing houses have a higher heating energy consumption on average. The correction therefore takes this effect into account. It is possible, however, that an update may nevertheless result in retroactive corrections.

1 The effect of different temperature-adjustment methods was examined in a recent study. The study shows that the temperature-adjusted values do not deviate substantially depending on the method used. Vgl. Peter Mellwig et al (2022), "Klimaschutz im Gebäudebereich: Erklärungen für stagnierende CO_2-Emissionen trotz erfolgreicher Sanierungsmaßnahmen." Kurzstudie im Auftrag von Agora Energiewende (available online).

Figure 2

Heating energy consumption in two or multi-apartment buildings 2020 by region (ROR)
Annual heating energy consumption in kilowatt hour per square meter heated living space, adjusted for temperature



Note: Available online as an interactive graphic for the years 2019 to 2021.

Source: ista SE, authors' own calculations.

In the northwest of Germany, the temperature-adjusted heating energy consumption is much higher than in the northeast.

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 (see 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 (see Box 1). In other words, the different building size categories are calculated into the average based on their specific weighting or 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

much of a surprise for temperature-adjusted heating energy consumption in residential buildings to increase in the years 2020 and 2021. Either way, the building sector is still not even close to achieving the consumption cuts needed to meet climate targets.

More heating consumption in the western Germany

Regional differences can also be seen in heating consumption. In 2020 and 2021, the average temperature-adjusted consumption of heat energy per square meter of heated living space in western German states was almost nine percent higher than that in eastern German states. The regions of Southwest Schleswig-Holstein and East Friesland displayed the highest average consumption of heating (temperature-adjusted) in 2020 and 2021, while the region of Middle Mecklenburg/Rostock had the lowest average heat energy consumption for the same years. This was also the only region in Germany where heating consumption was below 100 kilowatt hours per square meter. One possible reason for this could be the major renovations carried out after the German reunification on many of the buildings metered by ista in eastern German states in particular.[12] In 2021, the difference between the regions with the highest and lowest average heat energy consumption (temperature-adjusted) was around 59 kilowatt hours per square meter, i.e., the figure remained unchanged over the previous years (see Figure 2 and Table).

CO_2 emissions reductions not sufficient

Germany's climate goals for 2030 include a 68 percent reduction in direct CO_2 emissions over the 1990 level.[13] And while carbon emissions have already fallen by around 43 percent since 1990, the projected trend still falls well short of the targets for the building sector. For the 2030 targets for the buildings sector to be met, annual emissions reductions of approximately four percent of the 2020 level (or five million tonnes of CO_2 emissions) would be needed.

If we look at the total unadjusted CO_2 emissions in two- and multi-apartment buildings, however, we can see that the figures in fact went up last year—as did heating energy consumption. Early 2021 was unusually cold, a fact that is reflected in the average climate factor[14] for 2021, which, at 1.00, was far lower than in previous years (2019 climate factor: 1.10; 2020 climate factor: 1.13).[15] This is in all likelihood one of the reasons why people were heating more in 2021. For the year 2021, therefore, a far stronger increase in unadjusted CO_2 emissions was seen at eight percent (Figure 3).

In 2020, the temperature-adjusted CO_2 emissions (see Box 2) resulting from heating demand in two- and multi-apartment buildings in Germany went down, on average, by as little as around one percent, however (see Figure 3). The provisional figures for 2021 show a decrease of about three percent. With households with higher consumption missing from the data for 2021, however, we can assume that the actual reduction in CO_2 emissions in 2021 is lower, as is the case with heating energy consumption.

12 Cf. Stede, Schütze, and Wietschel (2020), "Wärmemonitor 2019", and Puja Singhal and Jan Stede, "Heat Monitor 2018: Rising Heating Energy Demand, Thermal Retrofit Rate Must Increase," *DIW Weekly Report*, no. 36 (2019): 620-629 (available online).

13 For absolute reduction targets, see Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (2021): Draft of a First Act Amending the Federal Climate Change Act (available online) and see calculations by the Federal Environment Agency for percentage reductions compared to 1990 (available online).

14 Climate factors record the effect of weather and climate on energy consumption and allow the influence of annual climate and weather conditions to be calculated and energy consumption to be compared. Put simply, the lower the climate factor, the colder the average year (further explanations from the German Weather Service can be found here).

15 Deutscher Wetterdienst (German Weather Service) (2022); Climate factors (KF) for energy consumption certificates (available online).

Too little progress in energy efficiency

Multiple factors impact CO_2 emissions in buildings. First, energy upgrades in residential buildings can help improve energy efficiency and reduce heating energy consumption. Second, a change in the fuel used to generate heat can lower heating requirements and heating-related CO_2 emissions significantly. Besides energy efficiency measures, a change in heating system can also help meet climate targets in the heating sector. To achieve climate neutrality, however, the increased use of wind and solar power, key renewable sources of energy, is an absolute must.[16]

In the area of building renovations, DIW Berlin's construction volume calculation shows that expenditure on modernization measures on existing residential buildings increased slightly in 2020 and 2021—from around 174 to around 190 billion euros (compared to 166 billion euros in 2019). The share of energy-efficiency refurbishment measures was also up, increasing from around 47 to 52 billion (compared to 43 billion in 2019).[17]

At the same time, the switch from gas and oil heating to district heating, electricity (heat pump systems), and other energy sources is not progressing as quickly as it should. In the last two years, as little as one percent of the houses metered by ista switched over to a different heating source.[18]

Energy prices drop marginally in 2020 and 2021

The average energy bill prices paid by private households for natural gas and heating oil fell by just under three percent in 2020 compared to the previous year. Between 2020 and 2021, energy bill prices barely changed, with average heating energy prices at 5.89 cents per kilowatt hour in 2020 and 5.86 cents per kilowatt hour in the following year (see Figure 4).

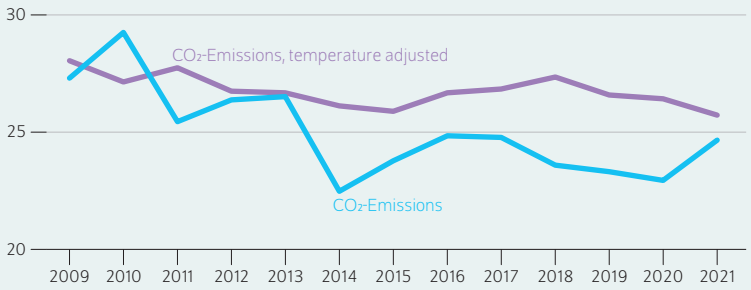
There were, however, significant regional price differences. In both 2020 and 2021, the federal state of Saarland was found to have the highest average heating energy prices (6.4 cents per kilowatt hour in 2020 and 6.3 cents in 2021), while the lowest average heating energy prices were paid in Hamburg, where the price was 5.4 cents in both 2020 and 2021 (see Table).

Consumer prices for heating oil and natural gas rose moderately from 2010 to 2021. A closer look at the last two years, however, shows a sharp drop in the price for heating oil in 2020, which plummeted by 26 percent (See Figure 5). One of the reasons for this is the dramatic decline in crude oil prices following the outbreak of the coronavirus pandemic.[19] Consumer prices for natural gas, on the other hand, remained relatively constant until 2020.

The introduction of the national CO_2-price in Germany and the recovery of global crude oil prices caused consumer prices for heating oil to rise by 42 percent in 2021, almost

Figure 3

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

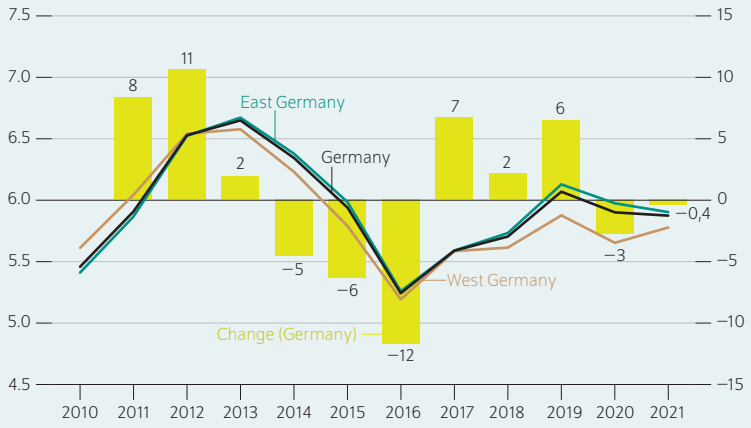


Source: ista SE, authors' own calculations.

The cold winter at the beginning of 2021 caused unadjusted CO_2 emissions to rise.

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 SE, authors' own calculations.

In 2020 and 2021, heating energy prices fell slightly. The current increase in the wholesale price of gas will cause prices for households to rise sharply in 2022.

16 Cf. Alexander Roth et al., "Expanding Solar Power Capacity to Power the Transition to Heat," *DIW Weekly Report*, no. 22 (2022) (available online).

17 DIW construction volume calculations (DIW Bauvolumenrechnung) at current prices. Internal updated calculation based on the DIW Bauvolumenrechnung vgl. Martin Gornig, Claus Michelsen und Laura Pagenhardt (2022): Bauwirtschaft: Hohe Preisdynamik setzt sich fort – Geschäfte laufen trotz Corona-Krise gut. DIW Wochenbericht Nr. 1/2, 3–13 (in German; available online).

18 According to the Ampel-Monitor Energiewende, the target for heat pumps is five million units by 2030 (and around 15 million units by 2045). With an existing stock of around 1.4 million heat pumps in 2021, this would correspond to an increase of around 400,000 heat pumps per year. With approximately 19.4 million residential buildings in Germany, about two percent of the heating systems would have to be replaced each year (in German; available online).

19 Cf. Dawud Ansari and Hella Engerer, "Coronavirus Pandemic and Low Oil Prices Putting Pressure of the Gulf Countries," *DIW Weekly Report*, no. 48 (2030): 881-888 (available online).

Table

Results of Heat Monitor 2020/2021

Spatial planning region (ROR)	Number of ROR	Annual heating energy consumption (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		
		2019	2020	2021[1]	2019	2020	2021[1]	2019	2020	2021[1]
Schleswig-Holstein Mitte	0101	136.94	136.96	138.99	6.13	5.90	5.76	8.98	8.68	8.81
Schleswig-Holstein Nord	0102	141.86	136.52	132.51	6.38	6.02	5.90	9.48	8.81	8.21
Schleswig-Holstein Ost	0103	147.21	146.84	142.80	5.59	5.32	5.52	8.42	8.16	8.34
Schleswig-Holstein Süd	0104	140.52	139.26	136.11	5.94	5.67	5.61	8.78	8.23	8.11
Schleswig-Holstein Süd-West	0105	164.46	158.32	153.82	5.55	5.26	5.28	9.42	8.79	9.02
Hamburg	0201	139.54	138.26	138.07	5.54	5.40	5.43	8.57	8.25	8.23
Braunschweig	0301	127.94	124.49	122.69	6.16	5.93	5.96	7.98	7.40	7.56
Bremen-Umland	0302	145.94	145.45	141.40	5.91	5.73	5.67	8.30	8.10	7.85
Bremerhaven	0303	150.00	146.64	142.10	5.95	5.79	5.73	8.63	8.16	7.96
Emsland	0304	150.61	148.41	147.08	5.65	5.44	5.73	8.24	7.85	8.06
Göttingen	0305	129.97	129.64	130.88	5.91	5.73	5.66	7.84	7.52	7.55
Hamburg-Umland-Süd	0306	141.60	139.49	141.17	5.88	5.70	5.50	8.41	7.95	7.86
Hannover	0307	127.31	125.87	126.28	6.19	5.99	6.11	8.10	7.72	7.95
Hildesheim	0308	134.51	131.39	132.27	6.11	5.95	6.01	8.11	7.58	7.81
Lüneburg	0309	144.61	139.13	139.17	5.68	5.49	5.42	8.36	7.71	8.74
Oldenburg	0310	144.40	146.00	141.99	5.51	5.44	5.71	7.77	7.82	7.98
Osnabrück	0311	130.71	129.02	131.48	5.95	5.84	5.92	7.70	7.37	7.82
Ost-Friesland	0312	157.19	158.02	154.66	5.73	5.72	5.90	8.69	8.81	8.77
Südheide	0313	143.84	143.78	146.27	6.13	5.71	5.76	8.80	8.16	8.38
Bremen	0401	143.70	143.71	139.89	6.11	5.96	5.70	8.88	8.64	8.06
Aachen	0501	141.15	143.36	137.91	6.32	6.26	6.16	9.04	9.11	8.87
Arnsberg	0502	132.50	125.36	129.64	5.98	6.16	5.74	7.89	7.51	7.49
Bielefeld	0503	142.94	143.29	140.89	6.16	5.93	5.96	8.68	8.34	8.29
Bochum/Hagen	0504	143.13	142.36	142.07	6.26	6.04	6.20	9.10	8.92	8.99
Bonn	0505	147.07	146.61	144.90	6.27	6.20	6.05	9.30	9.11	8.92
Dortmund	0506	142.41	145.82	137.59	6.01	5.87	6.08	8.77	8.72	8.68
Duisburg/Essen	0507	143.47	144.11	140.45	6.22	6.10	6.22	9.35	9.20	9.18
Düsseldorf	0508	149.14	150.77	145.97	6.01	5.87	5.93	9.16	9.00	8.96
Emscher-Lippe	0509	136.22	137.19	134.02	6.31	6.14	6.28	8.97	8.92	8.93
Köln	0510	143.85	145.58	139.65	5.90	5.79	5.74	8.75	8.50	8.29
Münster	0511	132.41	134.11	130.10	5.83	5.65	5.65	7.74	7.55	7.42
Paderborn	0512	133.08	130.82	130.40	6.24	6.06	6.08	8.31	7.94	8.05
Siegen	0513	138.27	145.55	136.22	6.32	5.87	5.76	8.51	8.59	7.77
Mittelhessen	0601	130.54	128.27	129.84	6.29	6.14	6.00	8.06	7.72	7.74
Nordhessen	0602	130.13	130.54	127.64	6.39	6.17	5.98	8.23	7.87	7.66
Osthessen	0603	118.50	119.41	122.21	6.24	5.99	5.68	7.30	6.95	6.89
Rhein-Main	0604	136.43	135.74	132.48	5.93	5.76	5.75	8.51	8.21	8.10
Starkenburg	0605	146.37	146.08	140.16	6.14	6.03	5.84	9.05	8.76	8.43
Mittelrhein-Westerwald	0701	137.38	134.83	137.11	6.25	6.24	6.15	8.50	8.24	8.34
Rheinhessen-Nahe	0702	143.85	144.38	139.67	6.21	6.02	5.99	9.11	8.81	8.47
Rheinpfalz	0703	142.88	143.23	140.30	5.97	5.90	6.03	8.76	8.59	8.60
Trier	0704	137.24	138.81	135.74	6.51	6.19	6.02	8.88	8.39	8.19
Westpfalz	0705	145.80	145.11	145.81	6.13	5.90	5.83	8.89	8.57	8.45
Bodensee-Oberschwaben	0801	121.32	115.61	115.34	5.88	5.82	5.65	7.03	6.76	6.65
Donau-Iller (BW)	0802	121.68	120.72	120.47	6.15	6.08	6.05	7.60	7.37	7.46
Franken	0803	124.99	125.11	121.82	6.31	6.15	5.90	8.08	7.84	7.47
Hochrhein-Bodensee	0804	124.94	124.20	121.87	6.05	5.86	5.79	7.54	7.27	7.08
Mittlerer Oberrhein	0805	131.61	131.23	126.47	6.27	6.14	5.95	8.51	8.21	7.85
Neckar-Alb	0806	122.10	122.74	119.09	6.36	6.19	5.86	7.73	7.45	6.89
Nordschwarzwald	0807	116.75	118.93	115.61	6.53	6.36	6.03	7.81	7.57	7.13
Ostwürttemberg	0808	130.47	127.73	127.26	6.20	6.06	5.93	7.99	7.63	7.61
Schwarzwald-Baar-Heuberg	0809	114.83	113.57	112.10	6.16	5.96	5.84	7.17	6.75	6.74
Stuttgart	0810	128.58	126.52	124.28	6.25	6.20	6.10	8.18	7.90	7.72
Südlicher Oberrhein	0811	115.89	115.46	113.02	6.18	6.00	5.82	7.36	7.09	6.79
Unterer Neckar	0812	133.57	132.27	131.27	6.54	6.43	6.17	9.28	8.92	8.55
Allgäu	0901	106.23	112.46	105.80	6.26	6.34	5.88	6.47	7.46	5.96
Augsburg	0902	120.94	122.16	121.75	5.74	5.50	5.42	7.27	6.99	6.92
Bayerischer Untermain	0903	135.39	136.57	127.01	6.02	5.93	5.70	7.90	7.91	7.30
Donau-Iller (BY)	0904	124.39	121.32	118.07	6.13	6.00	5.71	7.81	7.56	7.07

Spatial planning region (ROR)	Number of ROR	Annual heating energy consumption (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		
		2019	2020	2021[1]	2019	2020	2021[1]	2019	2020	2021[1]
Donau-Wald	0905	122.39	120.40	117.89	6.50	6.32	5.82	7.81	7.31	6.69
Industrieregion Mittelfranken	0906	125.50	125.84	120.95	6.07	5.96	5.90	7.89	7.70	7.45
Ingolstadt	0907	119.29	117.84	114.96	6.11	5.96	5.75	7.43	7.10	6.67
Landshut	0908	112.59	115.37	113.62	6.32	6.17	5.83	7.17	7.01	6.48
Main-Rhön	0909	123.89	125.88	122.73	6.29	6.20	6.00	7.53	7.47	7.14
München	0910	108.15	107.06	104.87	5.99	5.82	5.66	7.08	6.75	6.55
Oberfranken-Ost	0911	123.38	123.17	122.13	6.33	6.09	5.84	7.65	7.28	7.02
Oberfranken-West	0912	124.13	125.65	123.95	6.41	6.22	5.97	7.82	7.53	7.03
Oberland	0913	111.44	108.93	106.74	6.41	6.22	5.70	7.06	6.62	6.27
Oberpfalz-Nord	0914	126.19	127.31	127.65	6.43	6.22	6.07	8.13	7.62	7.23
Regensburg	0915	122.45	122.85	116.86	6.40	6.32	5.81	7.58	7.40	6.67
Südostoberbayern	0916	116.11	114.28	110.58	6.53	6.33	5.72	7.72	7.23	6.41
Westmittelfranken	0917	126.26	124.28	123.99	6.46	6.31	6.03	8.11	7.64	7.36
Würzburg	0918	126.15	127.79	125.20	6.10	6.03	5.95	7.69	7.66	7.43
Saar	1001	148.55	152.11	146.43	6.70	6.42	6.30	9.79	9.38	9.11
Berlin	1101	138.77	136.01	135.24	5.78	5.46	5.63	8.76	8.14	8.46
Havelland-Fläming	1201	127.69	121.64	124.69	5.72	5.57	5.82	7.94	7.50	7.95
Lausitz-Spreewald	1202	124.18	123.53	124.75	5.96	5.73	5.80	7.81	7.48	7.73
Oderland-Spree	1203	127.33	120.50	118.57	5.58	5.30	6.09	7.81	7.46	8.53
Prignitz-Oberhavel	1204	133.78	128.36	126.91	5.60	5.35	5.44	8.45	7.76	7.78
Uckermark-Barnim	1205	127.29	124.50	131.01	5.95	5.75	5.86	7.81	7.19	7.88
Mecklenburgische Seenplatte	1301	116.45	114.47	114.58	6.61	6.25	6.27	7.98	7.33	7.26
Mittleres Mecklenburg/Rostock	1302	101.52	97.12	95.77	5.78	5.54	5.79	6.78	6.24	6.38
Vorpommern	1303	113.05	107.33	106.04	6.02	5.72	5.75	7.42	6.77	6.90
Westmecklenburg	1304	121.18	118.00	114.56	6.09	5.85	5.79	7.84	7.26	7.31
Oberes Elbtal/Osterzgebirge	1401	115.90	114.37	114.94	5.57	5.55	5.59	7.11	6.88	7.17
Oberlausitz-Niederschlesien	1402	122.79	119.43	120.36	5.87	5.55	5.51	7.33	6.81	6.97
Südsachsen	1403	117.92	115.28	117.91	5.79	5.66	5.69	7.02	6.71	6.93
Westsachsen	1404	113.40	109.92	110.45	5.92	5.63	5.77	7.20	6.74	6.84
Altmark	1501	132.99	133.13	130.56	6.08	5.59	5.99	8.05	7.61	7.93
Anhalt-Bitterfeld-Wittenberg	1502	121.89	117.02	120.91	5.96	5.83	5.97	8.20	7.66	8.36
Halle/S.	1503	124.10	120.18	121.47	6.24	5.97	6.16	8.14	7.56	7.79
Magdeburg	1504	125.83	122.72	121.33	6.16	5.99	6.20	8.00	7.56	7.49
Mittelthüringen	1601	114.50	112.42	111.21	5.57	5.45	5.57	6.70	6.31	6.67
Nordthüringen	1602	116.60	112.64	117.29	5.98	5.75	6.17	7.70	6.99	7.47
Ostthüringen	1603	116.47	112.14	112.30	6.13	6.03	5.88	7.31	6.89	7.33
Südthüringen	1604	119.42	115.97	115.53	6.05	5.90	5.84	7.10	6.74	6.67
Federal State										
Schleswig-Holstein		142.56	140.87	138.80	5.97	5.70	5.66	8.92	8.47	8.42
Hamburg		139.54	138.26	138.07	5.54	5.40	5.43	8.57	8.25	8.23
Lower Saxony		135.61	133.90	133.39	5.99	5.81	5.87	8.13	7.74	7.92
Bremen		143.70	143.71	139.89	6.11	5.96	5.70	8.88	8.64	8.06
Northrhein-Westfalia		142.66	143.66	139.75	6.11	5.96	6.00	8.89	8.72	8.64
Hesse		135.54	134.92	132.24	6.09	5.92	5.83	8.44	8.13	7.99
Rheinland-Palatinate		141.33	140.86	139.56	6.19	6.05	6.02	8.80	8.51	8.43
Baden-Wuerttemberg		125.67	124.49	122.19	6.26	6.14	5.97	8.04	7.75	7.50
Bavaria		118.09	118.08	115.13	6.17	6.02	5.78	7.47	7.23	6.82
Saarland		148.55	152.11	146.43	6.70	6.42	6.30	9.79	9.38	9.11
Berlin		138.77	136.01	135.24	5.78	5.46	5.63	8.76	8.14	8.46
Brandenburg		127.49	123.23	124.72	5.77	5.56	5.81	7.94	7.49	7.96
Mecklenburg-Western-Pomerania		112.62	108.59	106.97	6.08	5.80	5.86	7.45	6.85	6.93
Saxony		116.89	114.26	115.64	5.77	5.61	5.66	7.12	6.77	6.98
Saxony-Anhalt		125.10	121.65	122.01	6.15	5.93	6.13	8.09	7.58	7.78
Thuringia		116.44	113.06	113.29	5.91	5.78	5.82	7.13	6.69	7.01
Germany		131.60	130.67	128.69	6.06	5.89	5.86	8.23	7.91	7.86
East Germany		124.65	121.46	121.73	5.87	5.64	5.77	7.82	7.33	7.60
West Germany		133.70	133.47	130.81	6.12	5.97	5.89	8.36	8.09	7.94

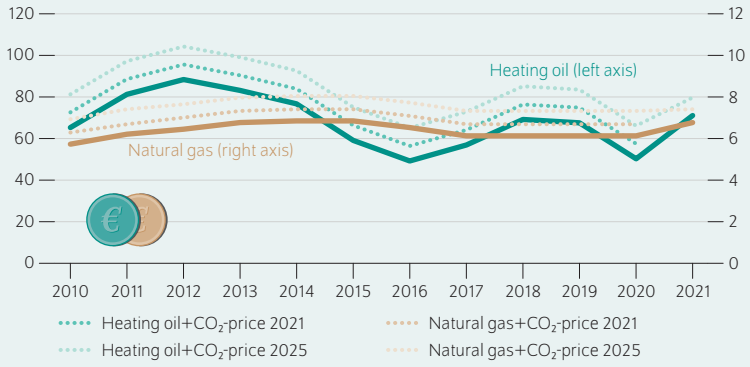
1 Preliminary data.

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.

Figure 5

Consumer prices for heating oil and natural gas
Costs in cent per liter heating oil (left axis); cent per kilowatt hour natural gas (right axis), including taxes and levies



Source: Eurostat, Mineralölbundesverband.

Consumer prices for natural gas remained stable until 2020 and rose in 2021. For heating oil, it fell sharply in 2020 but rose again significantly in 2021.

15 percentage points of which are attributable to the introduction of the CO_2-price (with a price of 25 euros per tonne of CO_2). Consumer prices for natural gas rose by about ten percent in 2021, which is largely attributable to the introduction of the national CO_2 price.

As to the average annual heating expenditure (in euros per square meter of heated living space), following a steady increase between 2016 and 2019, the past two years have again seen a decline. Average annual heating expenditure in 2020 decreasing by 3.9 percent to 7.91 euros per square meter of heated living space. In 2021, there was a further reduction of 0.7 percent to 7.86 euros.

Outlook: Energy price crisis poses new challenges for the heating sector

The war in Ukraine and the subsequent sharp reduction in gas supplies from Russia have caused a steep rise in gas prices. This increase as well as the burden on private households underline the need to do more to promote energy saving and improve energy efficiency.

Wholesale gas prices already rose sharply in the fourth quarter of 2021, increasing once again with the start of the Russian war of aggression (from about 15 euros per megawatt hour in December 2020 to more than 100 euros in December 2021 up to about 200 euros per megawatt hour in September 2022). These wholesale price increases also caused consumer prices to rise sharply over the course of 2022. Accordingly, new customer tariffs have risen from an average of around five cents per kilowatt hour over the last decade (see Figure 5) to 15.4 cents per kilowatt hour in January 2022, reaching as much as 21.75 cents per kilowatt hour in September 2022 outside the basic supply ("*Grundversorgung*").[20]

The results of the Heat Monitor show just how much heating energy consumption as well as billed heating costs vary from region to region. This would suggest that increases in the cost of heating energy can also have very different regional effects. For a gas price increase of 15 cents per kilowatt hour, a difference of 59 kilowatt hours per square meter, as seen between the region with the highest and lowest heating energy consumption (temperature-adjusted) in 2021, would result in a difference in spending of around 8.85 euros per year and square meter of living space.

Measured against income, the price increases hit low-income households particularly hard.[21] In 2020, low-income households spent a significantly higher proportion of their disposable income on heating costs (on average around 6.2 percent) than high-income households (1.5 percent). In buildings with bad heat insulation this share would even be higher. Poor households are thus more strongly affected by the current gas price hikes. Even with a gas price increase to 12.5 cents per kilowatt hour, which is just above the currently suggested level of the gas price cap ("Gaspreisbremse"), the share of heating costs in the income of low-income households would increase from 6.2 percent to 11.7 percent.[22]

With the relief packages and the measures currently in place (one-off payments and gas price caps), the German government is attempting to ease the burden on private households in the current crisis. But support measures do not solve the root cause of the problem: To avoid gas shortages, consumption will have to be reduced significantly in private households that heat with gas. And even if heating energy consumption were to go down this winter, a development that would also have a positive impact on emissions levels from the building sector, these short-term savings will not be enough to meet climate targets in the long term.

Alongside short-term relief, long-term measures are crucial for two reasons, i.e., to meet climate targets and to protect households from the social hardship caused by increasing energy prices. After all, for the foreseeable future, energy prices are likely to remain at a much higher level than in recent years. Important long-term adjustments would include making buildings more energy efficient through building renovations and switching to a heat supply from renewable energies.[23]

20 Cf. Verivox consumer price index gas, average gas price for annual consumption of 20,000 kilowatt hours for German households (in German; available online).

21 Cf. Karsten Neuhoff et al. "Hohe Gaspreisanstiege: Entlastungen notwendig," *DIW Wochenbericht*, no. 36 (2022): 455–463 (in German; available online).

22 Cf. Karsten Neuhoff et al., "Gaspreisschock macht kurzfristige Unterstützung und langfristige Effizienzverbesserung erforderlich," *DIW aktuell*, no. 78 (February 3, 2022) (in German; available online); Mats Kröger et al., "The Costs of Natural Gas Dependency: Price Shocks, Inequality, and Public Policy," *DIW Discussion Paper*, no. 2010 (2022) (available online).

23 At EU level, plans are in place to introduce Minimum Energy Performance Standards (MEPS) within the framework of the EPBD (Energy Performance of Buildings Directive).

Conclusion: Energy prices and climate targets require long-term measures

As in the previous year, the temperature-adjusted heating energy consumption and CO_2 emissions of apartment buildings in Germany only fell slightly in 2020 and 2021. While this is surprising given the increased number of people working at home during the coronavirus pandemic, it still means that Germany is failing to meet its climate targets in the building sector as set out in the German Climate Change Act. For the 2030 targets for the buildings sector to be met, annual emissions reductions of approximately four percent of the 2020 level would be needed.

The ongoing energy crisis shows just how dependent the heating supply in Germany is on natural gas, demonstrating how important it is to transition to renewable energies. The sharp rise in energy prices is currently driving the heating costs of private households to dizzying heights and calls for short-term support, especially for low-income households. The dependence on natural gas is thus costing the state dearly.

The current gas shortage requires savings in heating energy consumption and short-term economic policy measures. The current measures, however, will neither suffice to adequately relieve the burden on private households, nor to meet the climate targets. This calls for long-term measures such as increased investment in and promotion of energy-efficient refurbishment, particularly for those buildings with the lowest energy efficiency.

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LEGAL AND EDITORIAL DETAILS

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