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Decline in nominal construction volume expected for the first time since the financial crisis; residential construction situation worsening

- Nominal construction volume expected to decline by 3.5 percent due to falling construction prices
- Marked decline in residential construction activity; civil engineering cushions the downturn
- Goal of constructing 400,000 residences per year becoming more out of reach

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DIW Weekly Report 1+2 2024

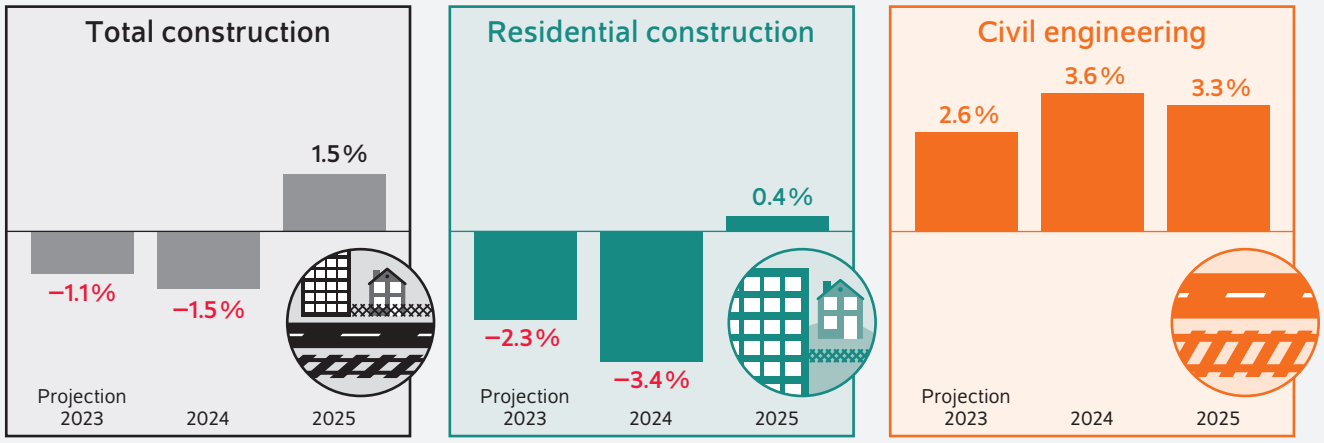
AT A GLANCE

Decline in nominal construction volume expected for the first time since the financial crisis; residential construction situation worsening

By Martin Gornig and Laura Pagenhardt

- Falling construction prices will cause construction volume to decline by 3.5 percent in nominal terms and by 1.5 percent in real terms in 2024
- Residential construction is declining markedly, more so in new construction than in renovation
- Goal of constructing 400,000 residences per year becoming more out of reach
- Only civil engineering is cushioning the downturn and will increase again in 2025
- The situation is expected to stabilize in 2025

2024 even weaker than 2023: Worsening crisis in residential construction, while civil engineering cushions the downturn
Real change in construction volume in percent compared to previous year



Source: DIW Berlin Construction Volume.

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FROM THE AUTHORS

"To provide the construction industry with some momentum again, it is very important for policy makers to deal with the uncertainty regarding subsidy programs as soon as possible. This includes the subsidy program for energy-efficient building renovation, but also new residential construction."
— Laura Pagenhardt —

MEDIA

Audio Interview with Laura Pagenhardt (in German)
www.diw.de/mediathek

Decline in nominal construction volume expected for the first time since the financial crisis; residential construction situation worsening

By Martin Gornig and Laura Pagenhardt

ABSTRACT

High construction prices and worsened financing conditions are weighing on the construction industry, especially building construction. Despite a nominal increase of six percent in construction expenses in 2023, it decreased by just over one percent in inflation-adjusted terms. In 2024, the nominal construction volume is likely to contract by around 3.5 percent, declining for the first time since the financial crisis due to falling construction prices. Residential construction in particular experienced a sharp decline in 2023 and will continue on this downward trend more strongly in 2024. Renovation and modernization activity is less affected than new construction. The situation will stabilize by 2025. The prospect of constructing 400,000 new residences annually is thus becoming increasingly out of reach. Only civil engineering is stabilizing the construction industry overall; it is likely to expand in both 2024 and 2025. The different growth prospects of the sectors require restructuring in the construction industry. In particular, capacities freed up in new residential construction should be utilized in the energy-efficient renovation of private and public buildings. Policy makers should actively support this restructuring. In addition, they should provide clarity about the subsidy programs for energy-efficient building renovation and residential unit construction. At the same time, it is important to maintain focus on the new housing construction target.

The construction industry in Germany continues to struggle. The crisis began in 2021 with material and supply bottlenecks and continued in 2022 and 2023 with the energy crisis and loss of household purchasing power due to consumer price inflation. This was compounded by rapidly rising interest rates, which made it considerably more difficult to finance construction projects, particularly for private households, but also for companies. In particular, incoming orders and building permits for new residential construction plummeted last year. Due to the very dynamic development of construction prices, the construction volume in nominal terms increased over the years, but price-adjusted declines have already been recorded in almost all construction sectors since 2021.

Nominal construction volume is expected to contract in 2024. Due to declining capacity utilization and falling material prices, prices are likely to fall as well and a turnaround in interest rates is expected in summer 2024. However, as prices and interest rates are likely to remain high overall and many subsidy programs are in limbo, the building construction volume in particular is likely to suffer and in some cases decline considerably. Development is likely to improve in 2025, but strong growth is not expected.

These are the results of DIW Berlin's calculations of the construction volume,[1] which includes construction investments as well as repairs that do not increase value. Furthermore, in addition to construction in the narrower sense, the calculations encompass related sectors, such as steel and light metal construction, the manufacture of prefabricated buildings, building fittings, planning, and other services. As a supplement to the investment calculation of the Statistical Offices, DIW Berlin's annual construction volume differentiates

1 The construction volume calculation is financed with funds from the *Zukunft Bau* research initiative of the Federal Ministry for Housing, Urban Development and Building (*Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen*, BMWSB). Cf. the most recent construction volume calculation: Martin Gornig and Laura Pagenhardt, "Construction Boom Coming to an End; Change in Policy Strategy Needed," *DIW Weekly Report*, no. 1+2 (2023) (available online; accessed on December 18, 2023. This applies to all other online sources in this report unless stated otherwise).

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

Box

Method for forecasting construction volume

Indicator-based statistical models are used to forecast the construction volume. The forecasting variable, for example residential construction volume, is regressed on an autoregressive term and on concurrent as well as lagged values of the respective indicator, for example new orders. The construction volumes of new and existing buildings are estimated separately.

The forecast equation is as follows:

$$y_t = \alpha + \sum_{i=1}^{n} \beta_i y_{t-i} + \sum_{j=1}^{m} \gamma_j x_{t-j} + \varepsilon_t$$

y_t stands for the value to be forecast, x_t for the indicator, and ε_t for the statistical error term. α, β_i, and γ_j are the estimated parameters. The numbers of lags n and m (years) are determined based on the autocorrelation or cross-correlation function. The approach of estimating a large number of individual models and using average values for the forecast has proved effective. For an individual series, up to 1,500 single models are estimated. Construction permits, new orders and the order backlog, production, interest, loan volumes, employment and income trends, and surveys of construction companies and freelance architects have proven to be suitable indicators.[1]

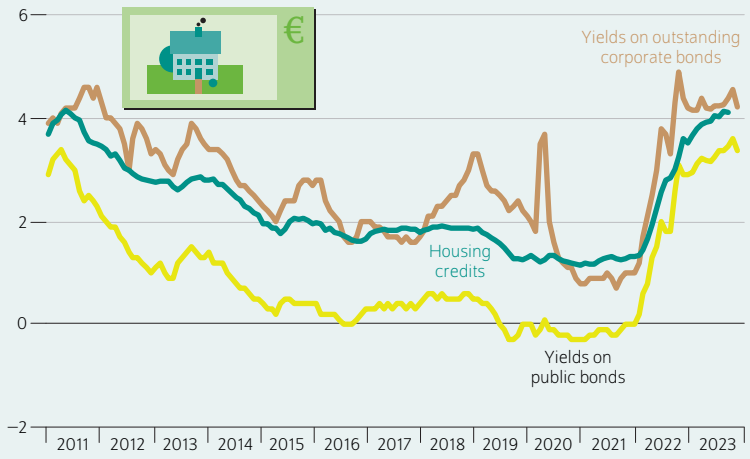
Using this approach, a forecast with a prediction capability of up to two years can be made for all aggregates. It should be noted, however, that the number of point estimates used for averaging decreases significantly as the forecast range increases due to the different prediction capabilities of the individual indicators. To provide the forecast with additional stability, expectations for employment and GDP for 2023 to 2025 are therefore also included in the models as concurrent indicators. Expected civil engineering volume is equal to the difference between total volume and construction volume.

The construction volume forecast for the previous year (2023) is also calculated using this method (nowcast). The indicators are updated using statistical methods to obtain values for 2023. All model results are rationalized using the construction investment forecast. Assumptions about the development of construction prices are based on the DIW Berlin economic forecast for winter 2023 and the authors' calculations. Price forecasts are adjusted for each sectors.

1 Michelsen and Gornig, "Prognose der Bestandsmaßnahmen und Neubauleistungen im Wohnungsbau und im Nichtwohnungsbau."

Figure 1

Interest rates and yields
In percent, monthly average



Source: Deutsche Bundesbank.

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Interest rates and yields have returned to the 2011 level.

between new housing construction activity and housing stock modernization.[2]

DIW Berlin not only calculates and documents the construction volume of past years; it also forecasts corresponding values for the current (2024) and upcoming years (2025). This forecast (Box) is integrated into DIW Berlin's Economic Outlook, particularly with regard to investment activity. In addition to the present estimates regarding the development of construction investment, the construction volume calculation includes forecasts on the growth of new and existing housing volumes in the building construction, residential, and non-residential sectors.[3] Moreover, these figures are used to derive the development trends of the core construction industry and the renovation sector.

Residential construction situation worsening

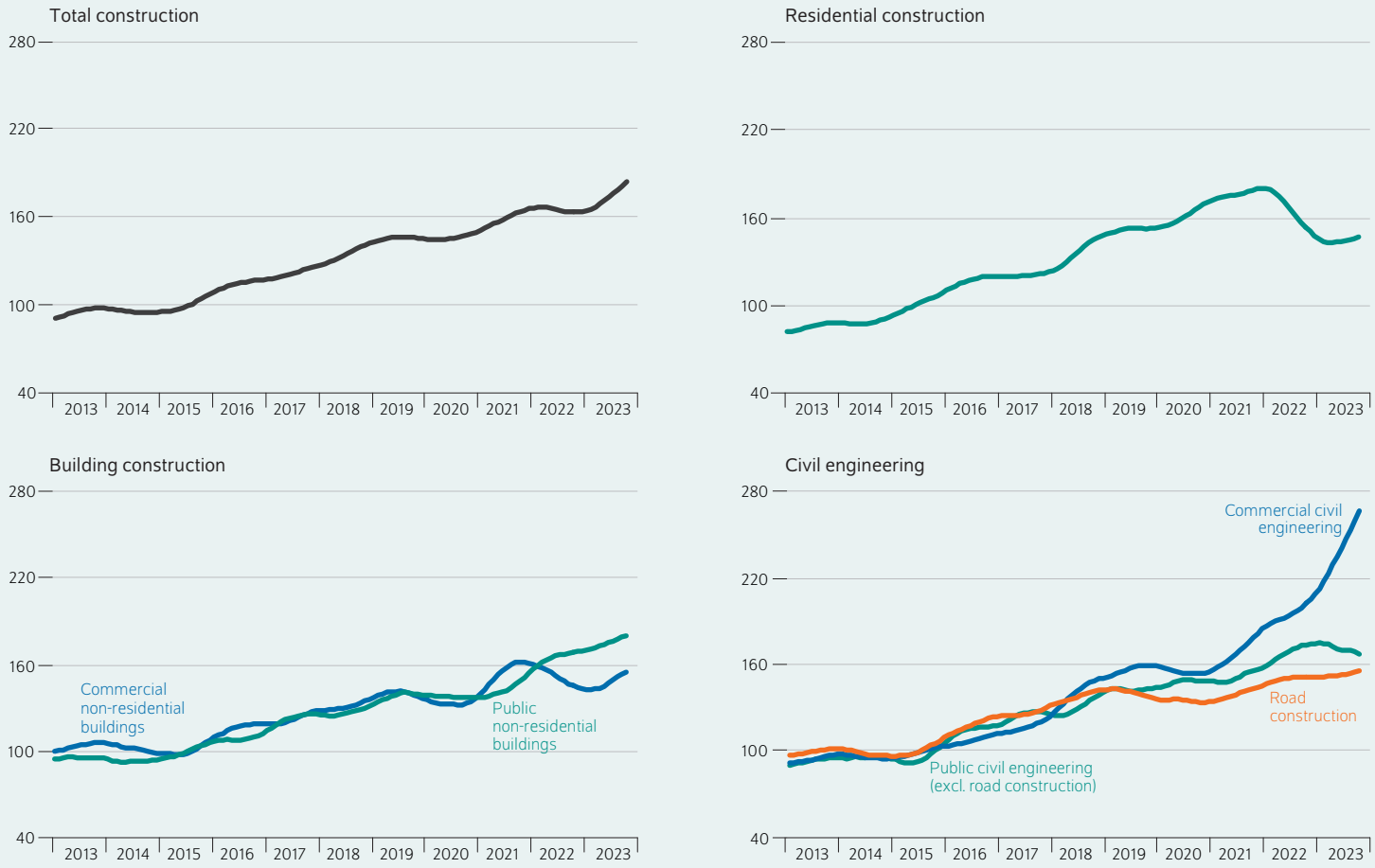
The past three years have been difficult for the residential construction sector. The enormous price increases—which began in 2021 due to supply bottlenecks and material shortages before then being exacerbated by the energy crisis in 2022—were compounded by the ECB's key interest rate hikes, which had an impact on mortgage rates within a very short period of time: Between the end of 2021 and autumn 2023, interest rates rose from 1.3 to over four percent. In 2024, they are now as high as they were last in 2011 (Figure 1). Financing conditions are currently almost impossible to meet, especially for private households, resulting in projects being reduced, canceled, or not initiated at all. This is also reflected in new orders, which have been trending downward since early 2022 and have only recently stabilized (Figure 2).

2 Martin Gornig and Hanna Révész, "Strukturdaten zur Produktion und Beschäftigung im Baugewerbe – Berechnungen für das Jahr 2022," *BBSR Online Publikation*, no. 53 (2023) (in German; available online).

3 Cf. Claus Michelsen and Martin Gornig, "Prognose der Bestandsmaßnahmen und Neubauleistungen im Wohnungsbau und im Nichtwohnungsbau," *BBSR-Online-Publikation*, no. 7 (2016) (in German; available online).

Figure 2

New orders in the main construction industry
Index 2015 = 100, current prices, trend component



Source: Federal Statistical Office.

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Extensive new orders were recorded recently, especially in civil engineering.

According to the ifo Institute, nearly half of residential construction companies have complained about a lack of orders, while a fifth of them are dealing with order cancelations.[4] For example, the number of existing orders have shrunk considerably since the peak in spring 2022 (Figure 3). According to an autumn 2023 survey conducted by the *Zentralverband des Deutschen Baugewerbes* (ZDB), 70 percent of construction companies expect the business situation to worsen.[5]

The outlook for 2024 is not much better. Although the price momentum significantly slowed down over 2023, it remains high. In addition to this, there is the general loss of household purchasing power due to the sharp rise in consumer prices, which wage development has so far been unable to compensate for. The uncertainty about the future development of income and the overall economic output is likely to further dampen housing investments. The continuing high demand for (affordable) living space, especially in urban centers, does little to change this. For example, according to studies from the Hans Böckler Foundation and its Macroeconomic Policy Institute (IMK), potentially millions of additional units of social housing are still needed in large German cities.[6]

Following three years of enormous increases, construction prices are expected to decline in 2024: Due to dwindling demand, capacity utilization in building construction has markedly declined to below the 70 percent threshold at the end of 2023 (Figure 4). Together with falling material prices, this reduces price pressures. The price expectations of the

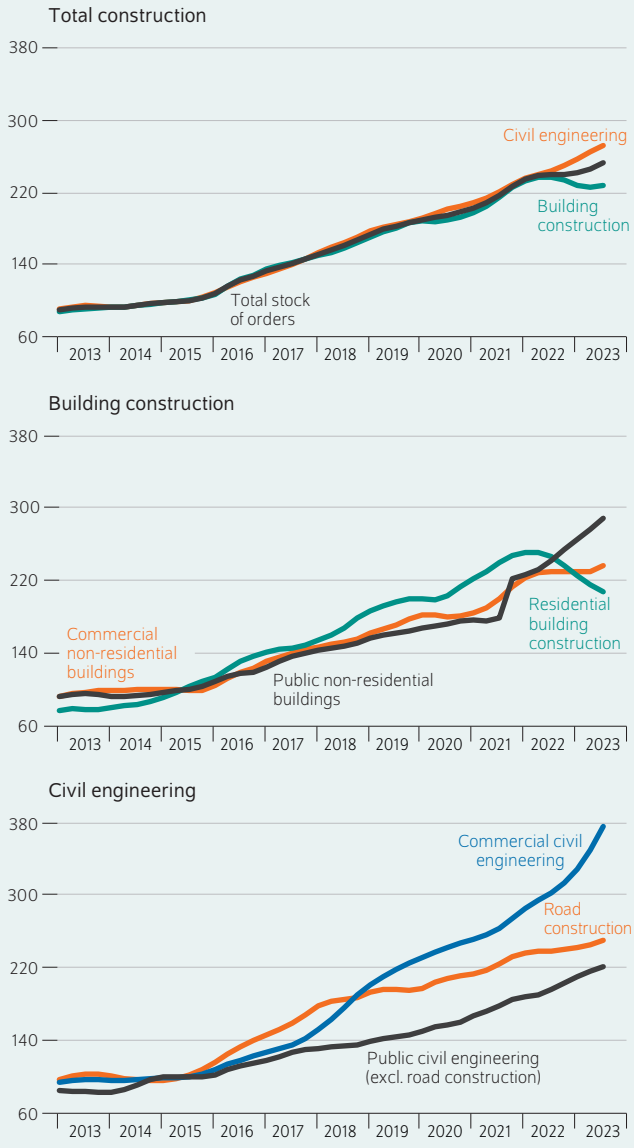
4 ifo Institute, "Düstere Perspektiven für den Wohnungsbau," press release from December 11, 2023 (in German; available online).

5 Zentralverband des Deutschen Baugewerbes, "Baukonjunktur 2023/2024: Zwischen Fachkräftemangel und Kurzarbeit," press release from December 6, 2023 (in German; available online).

6 Lukas Jonas, Carolin Martin, and Thomas Theobald, "Mehr öffentlicher Wohnungsbau zum Erhalt der Kapazitäten?" *IMK Policy Brief*, no. 155 (2023) (in German; available online).

Figure 3

Stock of orders in the main construction industry
Index 2015 = 100, current prices, trend component



Source: Deutsche Bundesbank.

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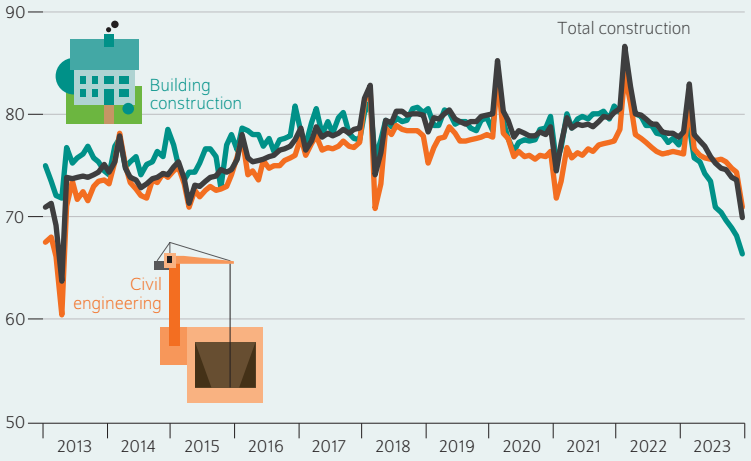
The stock of orders in residential construction is trending upward.

Figure 4

Capacity utilization in the construction sector
As a percentage of normal seasonal machine utilization



Source: ifo Institute.

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In 2023, a lot of capacity in building construction remained unused.

construction companies also indicate falling construction prices. Accordingly, the noticeable wage increases that are expected following the collective wage negotiations are likely to come at the expense of corporate profits.

Meanwhile, a turnaround in interest rates is expected in early summer 2024, when market participants foresee the first ECB interest rate cuts.[7] Financing conditions are therefore likely to ease somewhat this year. The declines in prices, however, will likely be unable to completely compensate for the continued high interest rate.

Overall, the nominal residential construction volume in 2023 likely increased by 5.5 percent (Table 1). Construction price inflation is likely to have completely swallowed up this increase, resulting in a real decline of 2.3 percent. In 2024, the residential construction volume is expected to significantly decrease despite falling prices in both nominal (minus 5.4 percent) and real (minus 3.4 percent) terms. A further nominal decline of 0.4 percent is expected for 2025 (Figure 5). As prices are expected to sink further, there is real growth of 0.4 percent.

Residential unit construction sector in a slump

The problems in residential construction are particularly affecting new construction. There, difficult financing conditions are likely playing the decisive role, making it impossible for a large share of households to start new construction plans. Building permits have plummeted since the beginning of 2022: In autumn 2023, they were almost 40 percent below the peak values in 2021 and 2022 (Figure 6). In addition, a large number of approved projects have not started because financing is no longer viable in many places. This is likely to have a significant impact in new construction activity in the coming years if existing orders are increasingly processed and fewer and fewer new projects are initiated. For example, the *Verband der Wohnungswirtschaft Deutschland* (GdW) is already reporting that many housing companies

7 Timm Bönke et al., "DIW Berlin Economic Forecast: Forecast ranges from cloudy to bright," *DIW Weekly Report*, no. 50+51+52 (2023): 305–313 (available online).

Table 1

Residential construction volume in Germany

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2017	2018	2019	2020	2021	2022	2023	2024	2025
	In billion euros at the respective year's prices										Change from the previous year in percent								
New construction volume[1]	62.8	67.2	71.7	75.4	79.2	85.6	93.4	95.2	87.2	86.7	7.1	6.6	5.1	5.0	8.1	9.2	1.9	−8.4	−0.6
Construction on existing buildings[2]	136.3	143.2	153.1	165.5	173.5	189.1	213.7	228.6	219.2	218.6	5.0	6.9	8.1	4.8	9.0	13.0	7.0	−4.1	−0.3
Total residential construction volume	199.1	210.4	224.8	240.9	252.7	274.7	307.1	323.8	306.4	305.3	5.7	6.8	7.2	4.9	8.7	11.8	5.5	−5.4	−0.4
	Shares in percent																		
New construction volume[1]	31.5	32.0	31.9	31.3	31.3	31.1	30.4	29.4	28.5	28.4									
Construction on existing buildings[2]	68.5	68.0	68.1	68.7	68.7	68.9	69.6	70.6	71.5	71.6									
Total residential construction volume	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0									
	Index 2015 = 100																		
Price development	102.1	105.4	110.3	115.2	117.3	127.3	145.7	156.9	153.9	152.7	3.3	4.6	4.5	1.8	8.5	14.4	7.7	−2.0	−0.8
	Real, chain index 2015 = 100																		
New construction volume[1]	109.2	113.3	115.6	116.4	120.1	119.5	113.3	106.7	99.9	100.1	3.8	2.0	0.7	3.2	−0.5	−5.2	−5.8	−6.5	0.2
Construction on existing buildings[2]	101.7	103.5	105.9	109.8	113.1	113.6	112.0	111.2	108.8	109.3	1.7	2.4	3.6	3.0	0.5	−1.4	−0.7	−2.2	0.5
Total residential construction volume	104.0	106.5	108.9	111.8	115.2	115.4	112.4	109.8	106.1	106.5	2.4	2.3	2.7	3.1	0.2	−2.6	−2.3	−3.4	0.4

1 Estimated using the estimated construction costs (construction activity statistics), plus surcharges for architects' services and fees, exterior facilities, and internal activities of investors.
2 Buildings and housing modernization (incl. conversion and extension measures) as well as repair services in the construction industry.

Sources: Federal Statistical Office; DIW Construction Volume calculations.

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Table 2

Non-residential construction volume in Germany

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2017	2018	2019	2020	2021	2022	2023	2024	2025
	In billion euros at the respective year's prices										Change from the previous year in percent								
New construction volume[1]	35.3	38.1	41.7	45.0	46.8	50.2	57.3	59.5	57.0	57.8	8.0	9.3	8.0	4.0	7.2	14.1	3.8	−4.2	1.4
Construction on existing buildings[2]	56.5	57.8	59.7	60.8	61.4	65.3	72.7	77.1	75.6	76.4	2.4	3.3	1.9	0.9	6.4	11.3	6.1	−2.0	1.1
Total non-residential construction volume[3]	91.8	95.9	101.4	105.8	108.2	115.5	130.0	136.6	132.6	134.2	4.5	5.7	4.4	2.2	6.8	12.5	5.1	−3.0	1.2
	Shares in percent																		
New construction volume[1]	38.5	39.7	41.1	42.5	43.3	43.4	44.1	43.5	43.0	43.1									
Construction on existing buildings[2]	61.5	60.3	58.9	57.5	56.7	56.6	55.9	56.5	57.0	56.9									
Total non-residential construction volume[3]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0									
	Index 2015 = 100																		
Price development	101.9	105.6	110.5	114.6	116.9	126.6	145.7	154.5	151.3	149.4	3.7	4.6	3.7	2.0	8.4	15.1	6.0	−2.1	−1.3
	Real, chain index 2015 = 100																		
New construction volume[1]	108.8	113.5	118.9	124.0	126.5	124.6	123.4	120.7	118.2	121.3	4.4	4.7	4.3	2.0	−1.5	−1.0	−2.2	−2.1	2.7
Construction on existing buildings[2]	95.5	94.3	93.0	91.3	90.4	88.3	84.9	85.0	85.0	87.1	−1.3	−1.3	−1.9	−1.0	−2.3	−3.8	0.1	0.1	2.4
Total non-residential construction volume[3]	100.2	101.1	102.1	102.8	103.0	101.1	98.5	97.6	96.7	99.1	0.9	1.0	0.6	0.2	−1.9	−2.6	−0.9	−0.9	2.5

1 Including agricultural buildings.
2 Including other non-agricultural buildings.
3 Construction volume in commercial and public building construction.

Sources: Federal Statistical Office; DIW Construction Volume calculations.

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are having to cancel some of their projects or are currently unable to build any housing at all.[8]

In a surprising move, the *Kreditanstalt für Wiederaufbau* (KfW) stopped applications for its *Klimafreundlicher Neubau* (climate-friendly new builds) subsidy program in December 2023, as the program's funds had been exhausted. Although applications that had already been approved have been secured and applications should be possible again at the beginning of 2024, this is likely to discourage private households from investing in new construction and further reduce new construction activity.

The more difficult financing conditions have so far hardly been offset by the special tax deduction for the construction of new rental units, which was reactivated in January 2023.

8 Wohnungswirtschaft Deutschland (GdW), "Wohnungsbau im freien Fall – Regierung muss jetzt Schluss machen mit 'aber' und 'wird schon'," press release from November 29, 2023 (in German; available online).

Figure 5

New and existing building construction in Germany
In billion euros in current prices (left axis), change from previous year in percent (right axis)

Source: DIW Berlin Construction Volume Calculation.

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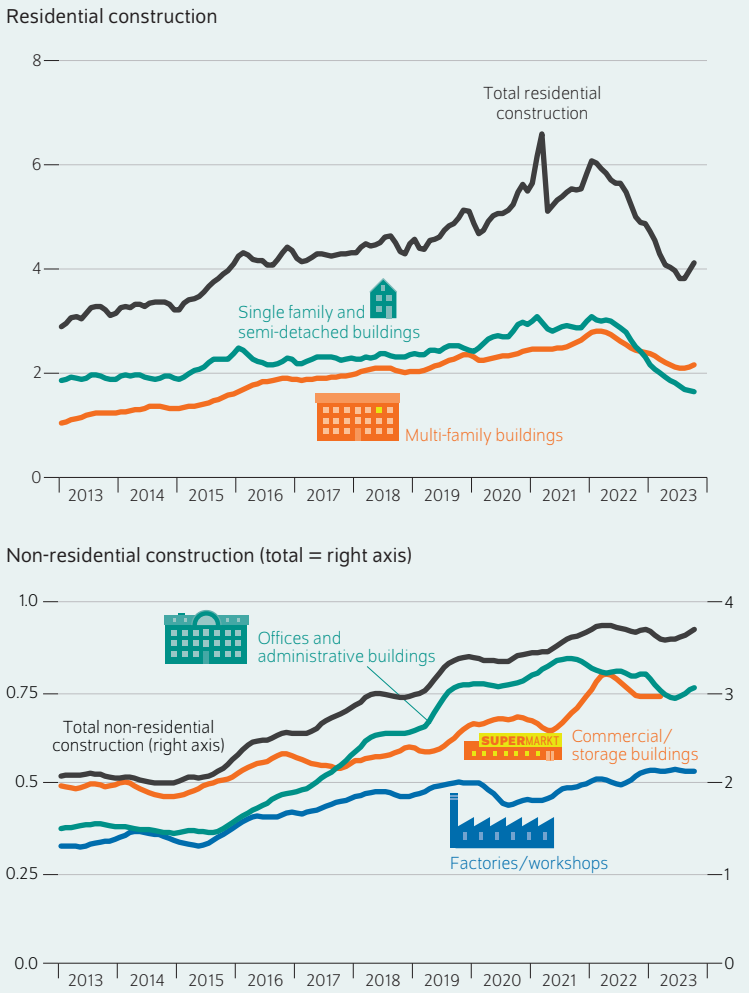
Nominal residential construction will decline in 2024, especially new construction.

Figure 6

Building permits in building construction in Germany
Current prices in billion euros, trend component



Source: Federal Statistical Office.

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The total number of approved construction projects markedly declined in 2023, but is recovering in the public and commercial sectors.

This regulation allows up to five percent of acquisition and production costs to be written off per year over four years if the approved building meets certain sustainability criteria (efficiency house 40, EH40). Furthermore, at the same time, the linear depreciation rate was increased from two to three percent. Since October 2023, these conditions have been supplemented by the additional possibility of degressive depreciation of six percent, which is also permittable for buildings of the lower efficiency class EH55.[9] With falling interest rates and prices, these measures are likely to have more of an effect from the second half of 2024 and will stimulate new construction activity.

Nevertheless, nominal residential construction is expected to decline by 8.4 percent in 2024 and to not recover in 2025 (minus 0.6 percent). In price-adjusted terms, there is a decline of 6.5 percent in 2024 as well as slight growth of 0.2 percent in 2025.

Work on existing buildings continues to have a stabilizing effect

The robust development in renovation measures is likely to have supported housing construction activity in 2023. While some expansion and renovation projects have likely been cut back or even canceled completely due to higher costs—such projects can be adjusted more quickly and easily than new construction projects—at the same time the decline in new construction is likely to make more builders available for renovation and modernization projects, which in turn will make these projects more feasible.

At the same time, renovation and modernization is likely to be significantly less affected by rising financing costs: Compared to new residential construction, modernization and maintenance measures are much smaller in scale, meaning that households often have sufficient capital to finance the costs.[10] Only the higher incentive for households to save capital must be considered here. However, saving is only worthwhile to a limited extent: The credit interest rates for longer-term investments are currently only half as high as the mortgage rate for ten-year loans.

The fact that households are increasingly switching to renovation and modernization measures is also reflected in the costs for approved construction projects: At the start of 2022, the costs for new construction and for work on existing buildings were still at similar levels. While permit figures and new construction costs have almost halved, the figures for renovation have remained at near constant levels (Figure 7).

Measures to increase energy efficiency are likely to continue to play a central role: Energy prices, despite the declines in recent years, remain high and are expected to rise again somewhat as a result of the Federal Government initiating an additional increase in the carbon price in the *Nachtragshaushaltsgesetz* 2021 in reaction to the recent Federal Constitutional Court ruling.[11] This increases the incentives to invest in energy-related renovations.

9 Cf. the measures of the Federal Government for additional investments in the construction of affordable and climate-friendly residences and for economic stabilization of the construction and real estate industries on the website of the Federal Ministry for Housing, Urban Development and Building (Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen, BMWSB) (in German; available online).

10 Christian Blanke and Katrin Klarhöfer, "Bestandsinvestitionen 2020: Struktur der Investitionstätigkeit in den Wohnungs- und Nichtwohnungsbeständen," *BBSR Online Publikation*, no. 39 (2022) (in German; available online).

11 In November 2023, the Federal Constitutional Court ruled against the German government, prohibiting the reallocation of 60 billion euros borrowed under emergency legislation during the COVID-19 pandemic towards the Climate and Transformation Fund. In order to mitigate the effects of the ruling, amongst other measures, the government decided to increase the price of carbon dioxide further than had been initially planned: Instead of the planned 40 euros per ton, CO_2 costs 45 euros per ton in, 2024. In 2023, CO_2 cost 30 euros per ton.

However, public funding for energy-efficient refurbishment measures is still unclear. For example, around 19 billion euros were planned for funding energy-efficient renovations in the building sector in the *Klima- und Transformationsfonds* (Climate and Transformation Fund, KTF) in 2024. While the Federal Government promised this funding immediately after the Federal Constitutional Court's ruling, the application process at KfW is still on hold. Thus, the development of renovation work may also be slowed down or at least delayed.

Overall, renovation works are expected to decline by 4.1 percent this year, considerably less than new construction work. For 2025, a further slight decline of 0.3 percent is expected. Price-adjusted, this results in minus 2.2 percent in 2024 and in 0.5 percent in 2025.

More robust development in non-residential construction than in residential construction

Non-residential construction was more stable than residential construction in 2023. The worsened financing conditions are likely to have affected companies less than households. While new orders for both public and commercial building construction declined somewhat in 2023, they are currently increasing again due to multiple major projects (Figure 2). Thus, existing orders remain at a record level (Figure 3).

Nevertheless, weak overall economic development and high interest rates are dampening the outlook for commercial construction. The global economy has developed less dynamically recently; in 2023, German exports declined noticeably. The development of the German economy over the course of the year remains uncertain, partly due to the Federal Constitutional Court ruling and despite the planned mitigating measures, dampening both exports and investments in 2024.[12] This is likely to keep companies from investing in capacity expansion, for example by constructing new workshops or warehouses.

In 2023, nominal non-residential construction increased by 5.1 percent. In price-adjusted terms, however, it declined by 0.9 percent. This development is expected to reverse in 2024: A nominal minus three percent is expected, which, due to falling prices, ends up as a real minus of nearly one percent. In 2025, non-residential construction volume is expected to expand by 1.2 percent nominally and by 2.5 percent in price-adjusted terms (Table 2).

Public construction projects supporting new construction of non-residential buildings

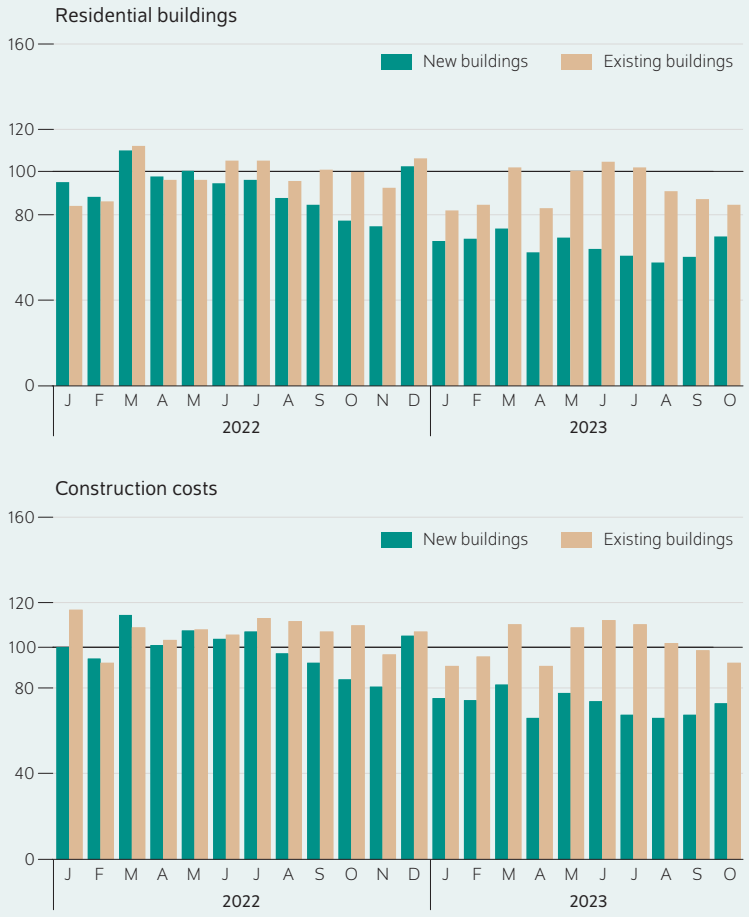
The demand for new commercial buildings has slowed due to weak economic development, which makes investments in new corporate buildings seem imprudent. Moreover, the possibility to work from home, which has become more prevalent since the coronavirus pandemic, is dampening the need for office buildings. In 2022 (the most recent available statistics), nearly a quarter of all employees partially worked at home. This share is likely to not have declined significantly in 2023. Thus, the number of building permits for office and administrative buildings has also continually declined since 2020 (Figure 6). No stimuli are expected here.

Large projects are now stabilizing the order situation in the public construction sector; existing orders have increased considerably (Figure 3). Funds that have been created in recent years should now gradually be converted into project budgets. Falling construction prices facilitate this development. Thus, positive stimuli from public construction are expected in both 2024 and 2025.

Overall, new construction activity in non-residential buildings is likely to decrease by 4.2 percent nominally in 2024 before expanding by 1.4 percent in 2025. Price-adjusted,

Figure 7

Number of permits granted for new construction projects
Index, Monthly average in 2021 = 100



Source: Federal Statistical Office.

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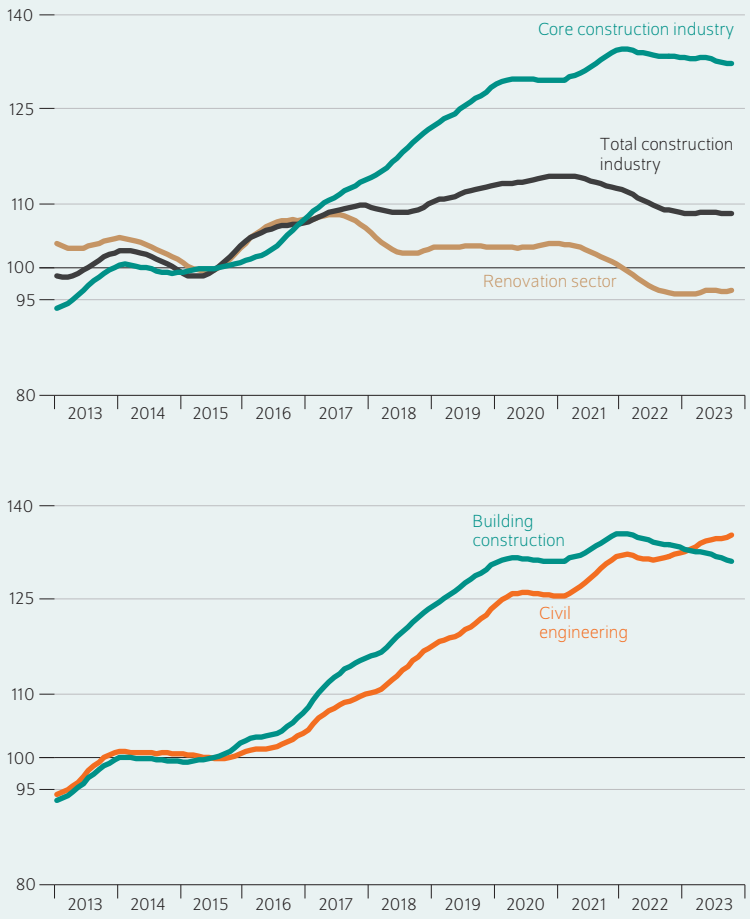
The number of construction permits for existing buildings is markedly higher than the figure for new buildings.

12 Bönke et al., "DIW Berlin Economic Forecast."

Figure 8

Production in the construction industry
Index 2015 = 100, constant prices, trend component



Source: Federal Statistical Office.

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Civil engineering production continued to trend upward in 2023 in contrast with building construction.

this results in a 2.1-percent decline in 2024 and 2.7 percent growth in 2025.

Energy-related renovation increases construction on existing buildings

Construction on existing non-residential buildings has become less important over recent years: Between 2016 and 2022, its share of total construction volume declined continually (Table 2), primarily because the new construction volume increased substantially. In 2023, this development is likely to have reversed: Higher energy prices increase the incentive to perform energy-related renovations. This is likely to have played a decisive role in the strong increase in renovation and modernization.

The incentives will remain in 2024 and are likely to continue to support renovation and modernization. There is also still a large investment gap, particularly in the public sector: Planned and realized investments have gradually increased in nominal terms in recent years, with an emphasis on investments in school buildings and other childcare facilities. Overall, however, the projects realized remained well below the planned budget.[13] Here, there is still much potential to expand construction work.

Work on existing non-residential buildings is likely to decline by two percent nominally in 2024 before increasing by a good one percent in 2025. Due to the falling prices, the price-adjusted growth is 0.1 percent for 2024 and 2.4 percent for 2025.

Only civil engineering to increase in 2024

The activity in the civil engineering sector stabilized the construction volume in 2023. While construction output in building construction was on the decline, it continued on an upward trend in civil engineering (Figure 8). Capacity utilization in civil engineering also declined less significantly than in building construction (Figure 4).

Because of the considerable need for infrastructure expansion, civil engineering is likely to expand further in 2024 and 2025. Strong stimuli are expected, primarily from the commercial investor side. New orders are already indicating significant growth (Figure 2): In commercial civil engineering, new orders were nearly 30 percent higher in nominal terms in autumn 2023 compared to 2022. Large orders from the Deutsche Bahn are likely to be the decisive factor here, with massive investments being made in the rail network. These investments will likely continue in 2024 and 2025, partly because the KTF funds earmarked for railway infrastructure appear to be secured. In addition, there are investments in the mobility and energy transitions. New orders in road construction, which is part of the public sector, are also trending upward, although with less momentum. A similar picture emerges for the existing orders (Figure 3).

Following nominal growth of 9.5 percent in 2023 (real: 2.6 percent) in civil engineering, it is expected to increase by only 1.8 (real: 3.6) percent this year and to expand again by 2.3 percent (real: 3.3 percent) in 2025 (Table 3).

Civil engineering cannot compensate decline in building construction

Real construction volume is expected to decline for the third year in a row in 2024. Following declines of 2.2 percent in 2022 and of a little over one percent in 2023, construction volume is likely to decline by 1.5 percent in price adjusted terms in 2024. Real growth in the total construction volume is not expected until 2025 (Table 4).

However, the construction industry is divided. The sometimes drastic declines in new residential construction are

13 Christian Raffer and Henrik Scheller, *KfW – Kommunalpanel 2023* (2023) (in German; available online).

Table 3

Civil engineering in Germany

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2017	2018	2019	2020	2021	2022	2023	2024	2025
	In billion euros at the respective year's prices										Change from the previous year in percent								
Commercial civil engineering	30.3	32.9	35.0	37.2	39.2	43.2	50.7	56.2	58.0	59.6	8.6	6.4	6.1	5.6	10.1	17.4	10.9	3.1	2.8
Public civil engineering	28.5	30.9	34.4	36.5	37.7	38.7	45.1	48.7	48.8	49.6	8.4	11.5	6.0	3.2	2.9	16.5	7.9	0.2	1.7
Total civil engineering	58.8	63.8	69.5	73.7	76.9	81.9	95.8	104.9	106.8	109.2	8.5	8.9	6.1	4.4	6.6	16.9	9.5	1.8	2.3
	Shares in percent																		
Commercial civil engineering	51.5	51.6	50.4	50.5	51.0	52.7	52.9	53.6	54.3	54.6									
Public civil engineering	48.5	48.4	49.6	49.5	49.0	47.3	47.1	46.4	45.7	45.4									
Total civil engineering	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0									
	Index 2015 = 100																		
Price development[1]	101.6	106.3	113.0	118.2	119.9	127.6	149.1	159.3	156.4	154.8	4.6	6.4	4.6	1.5	6.4	16.8	6.9	−1.8	−1.0
	Real, chain index 2015 = 100																		
Commercial civil engineering	101.1	105.2	105.7	108.1	112.0	115.2	115.2	121.6	128.3	133.8	4.0	0.4	2.3	3.6	2.9	−0.1	5.6	5.5	4.3
Public civil engineering	102.4	106.3	111.3	112.0	114.5	111.2	111.6	110.6	112.1	114.5	3.8	4.8	0.6	2.3	−2.9	0.3	−0.9	1.4	2.1
Total civil engineering	101.8	105.7	108.4	110.0	113.2	113.4	113.5	116.5	120.6	124.6	3.9	2.5	1.4	2.9	0.2	0.1	2.6	3.6	3.3

1 As no detailed information on price developments in civil engineering is available, the same price changes are assumed for civil engineering and non-residential building construction.

Sources: Federal Statistical Office; DIW Construction Volume calculations.

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Table 4

Key figures for the development of construction volume in Germany

	2018	2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025
	In billion euros at the respective year's prices								Change from the previous year in percent						
Total construction volume	395.7	420.4	437.8	472.2	532.9	565.3	545.8	548.7	6.3	4.1	7.8	12.9	6.1	−3.5	0.5
Residential construction	224.8	240.9	252.7	274.7	307.1	323.8	306.4	305.3	7.2	4.9	8.7	11.8	5.5	−5.4	−0.4
Commercial construction	116.3	122.0	124.8	135.1	154.4	162.5	159.2	161.6	4.9	2.3	8.2	14.3	5.2	−2.0	1.5
Public construction	54.6	57.5	60.3	62.4	71.5	79.0	80.1	81.8	5.4	4.9	3.5	14.5	10.6	1.4	2.1
	Index 2015= 100														
Price development	110.8	115.6	117.7	127.3	146.5	156.9	153.9	152.4	4.3	1.8	8.2	15.1	7.1	−2.0	−0.9
	Real, chain index 2015 = 100														
Total construction volume	107.0	109.1	111.6	111.2	108.8	107.6	106.0	107.6	2.0	2.3	−0.3	−2.2	−1.1	−1.5	1.5
By construction sector															
Residential construction	108.9	111.8	115.2	115.4	112.4	109.8	106.1	106.5	2.7	3.1	0.2	−2.6	−2.3	−3.4	0.4
Commercial construction	103.3	104.6	104.9	104.8	102.7	102.7	103.1	106.2	1.2	0.3	−0.1	−2.0	0.0	0.3	3.0
Public construction	107.5	108.0	112.0	108.3	107.3	109.3	112.1	114.9	0.5	3.7	−3.2	−1.0	1.9	2.5	2.5
By producer group															
Core construction industry	111.0	114.0	117.9	116.1	115.2	114.7	114.2	116.4	2.7	3.4	−1.5	−0.8	−0.4	−0.5	1.9
Renovation sector	104.1	104.9	107.2	106.3	103.5	101.7	99.2	100.1	0.7	2.2	−0.9	−2.7	−1.7	−2.5	0.9
Other producers	110.2	112.6	114.2	114.8	112.7	111.5	109.8	111.6	2.2	1.4	0.6	−1.8	−1.1	−1.5	1.6

Sources: Federal Statistical Office; DIW Construction Volume calculations.

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partly counterbalanced by quite substantial increases in civil engineering. Even some structural engineering sectors, such as roofing and insulation, have a positive outlook for 2024 as a result of increased energy-related renovation.

Overall, real construction volume in the main construction industry is likely to decline only slightly in 2023 and 2024. A significant increase of nearly two percent is expected for 2025. The renovation sector will continue to be heavily impacted by the declines in residential construction. In 2024, the real construction volume in construction installation and other expansion work will likely be 2.5 percent below the 2023 level again. Weak residential unit construction in particular is having a negative impact on other construction-related services such as architecture firms. Real construction volume in the renovation sector will probably contract for the fourth year in a row in 2024. As in the other sectors of the industry, however, the economic outlook should brighten in 2025.

Conclusion: Necessary shifts in capacity require binding political guidelines

Construction services will decline again in 2024. Noticeable real growth in construction volume is not expected until

2025. Nevertheless, many construction companies are facing major challenges. The differing outlooks for various sectors in the industry require major restructuring in its capacity profile. In particular, it will be important to utilize the freed-up capacities in the energy-related renovation of private and public buildings. In some cases, growth opportunities in civil engineering can only be realized by using corresponding capacities from building construction.

Policy makers should actively support restructuring in the construction industry. For example, inter-company training and retraining capacities could be expanded and funded. In many cases, it will be crucial for the success of internal restructuring for workers to receive wage replacement benefits from the short-time work allowance during this phase.

The continuing decline in new residential construction continues to trigger major political pressure for action. The number of completed residential units will not increase in light of shrinking investments in new construction over the next years. The target of 400,000 new dwellings per year is thus becoming less and less likely to be achieved. In reaction to the low completion figures, among other things, the Federal Government passed a package of measures that should incentivize the construction of affordable and climate-friendly dwellings and stabilize the construction and real estate industries.[14]

However, initial assessments, particularly of tax incentives from degressive depreciation, indicate that a considerable increase in the number of newly built residences is unlikely in the short to medium term.[15] The focus, however, should be less on the total number of newly constructed buildings. Instead, as the greatest imbalance between high housing demand and low housing supply exists in metropolitan areas, creating housing in the lower price segment should be prioritized. Densification, which has been discussed for years, can relieve the shortage in metropolitan areas specifically. In terms of cost, densification is more cost effective than creating residences on newly developed and expensive land. Furthermore, there are now cost-effective methods of adding stories to existing buildings.

There is currently a great deal of uncertainty about how the Federal Constitutional Court ruling will affect funding of construction activity and the longer-term funding of the transition to climate neutrality. While clear agreements with federal companies are emerging in civil engineering, there is particular uncertainty as to how energy-efficient building refurbishment and new residential construction will be funded. Policy makers must quickly implement binding regulations here, especially with regard to the KfW, so that its funding can continue.

14 Cf. the BMWSB website.

15 Claus Michelsen, Simon Junker, and Ferdinand Fichtner, "Simulation des Wachstumschancengesetzes: Richtung stimmt, Effekte zu gering," *Economic Policy Brief*, no. 9 (Verband Forschender Arzneimittelhersteller e. V. Berlin: 2023) (in German; available online).

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139 Report by Sophie M. Behr, Merve Kücük, Maximilian Longmuir, and Karsten Neuhoff

Thermal retrofitting of worst performing buildings mitigates risk of high heating costs

- Study investigates impact of prioritizing thermal retrofitting of very inefficient buildings
- Low-income households in particular would be protected from high heating costs
- Tenancy law combined with public support should ensure that thermal retrofits do not increase the sum of rent and heating costs

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DIW Weekly Report 19 2024

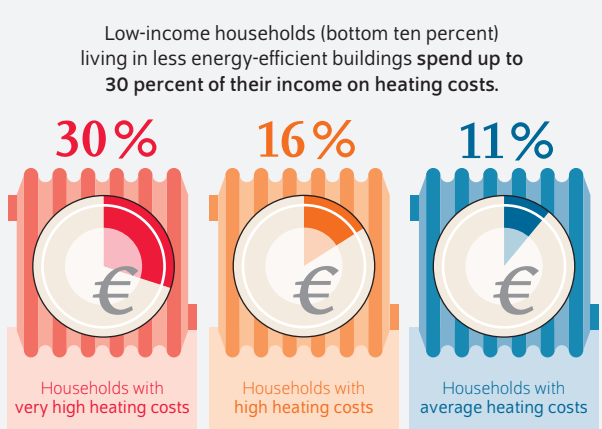
AT A GLANCE

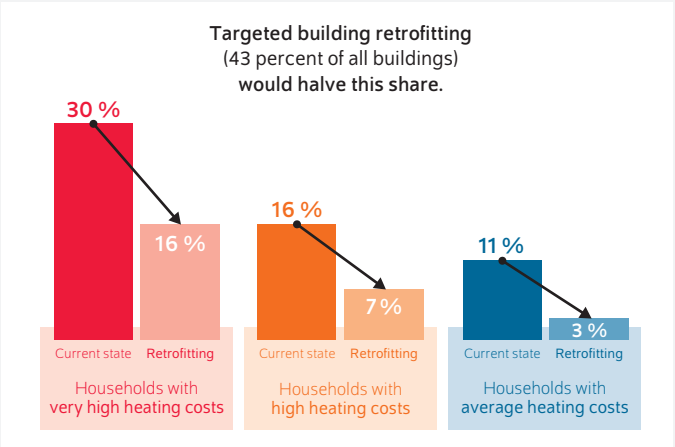
Thermal retrofitting of worst performing buildings mitigates risk of high heating costs

By Sophie M. Behr, Merve Kücük, Maximilian Longmuir, and Karsten Neuhoff

- Retrofitting of very inefficient buildings mitigates social hardship and has economic as well as energy policy advantages
- Thirteen percent of owners have assets and income below the Wohngeld-Plus threshold and live in very inefficient buildings
- Twenty-eight percent of tenants are below the Wohngeld-Plus threshold and live in very inefficient buildings
- Tenancy law combined with public support should ensure that thermal retrofits do not increase the sum of rent and heating costs
- Minimum energy standards are also necessary in the longer run

Targeted thermal retrofitting of inefficient buildings also has distribution advantages





Sources: Authors' depiction and calculations.

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FROM THE AUTHORS

"The most inefficient buildings should undergo thermal retrofitting first. In addition to the economic advantages, this also has positive effects on distribution policy."

— Karsten Neuhoff —

MEDIA

Audio Interview with Karsten Neuhoff (in German)
www.diw.de/mediathek

Thermal retrofitting of worst performing buildings mitigates risk of high heating costs

By Sophie M. Behr, Merve Kücük, Maximilian Longmuir, and Karsten Neuhoff

ABSTRACT

The pace of thermal retrofit of buildings in Germany remains slow. A Worst-First approach, prioritizing the retrofit of inefficient buildings, would address energy- and social policy objectives and deliver economic and climate benefits. Data from the German Socio-Economic Panel (SOEP) show how such an approach would protect especially low-income households often living in very inefficient buildings from heating costs risks. This group comprises 28 percent of all tenants and 13 percent of all homeowners. Yet, uncertainty about the cost-benefit of retrofitting and other priorities of homeowners mean that not enough buildings are retrofitted. As a result, the saving potentials, especially from very inefficient buildings, are not being realized. This would, however, be necessary to reduce heating cost risks and energy import dependency, and to meet climate targets. Better alignment of financing and subsidy instruments with the ownership structure, the further development of building standards to include minimum energy performance standards, and reform of tenancy law could improve the situation.

Thermal retrofitting can effectively reduce high energy costs and cost risks due to energy price shocks.[1] Low-income households that currently live in very inefficient buildings[2] and spend up to 30 percent of their income on heating costs would particularly benefit from such retrofits (Figure 1). The Worst-First approach, in which funding programs, building standards, and other measures are designed to ensure that very inefficient buildings are retrofitted first, would help these households specifically. Energy cost subsidies such as *Wohngeld-Plus*, which was expanded during the gas price crisis, or the climate dividend (*Klimageld*) discussed in relation to carbon prices, only partially address cost increases in very inefficient buildings, as the flat-rate payments do not cover the higher cost burdens of inefficient homes.

Although energy cost subsidies directly linked to heating or carbon costs can mitigate the burden, they lead to high fiscal costs as they reduce the incentives for investments in higher energy efficiency. This dilemma can be addressed by accelerating the retrofitting of very inefficient buildings, ideally before another energy price crisis occurs, and as a response to the climate crisis and the high level of dependency on energy imports.

Worst-First approach as a social program

We use the German Socio-Economic Panel (SOEP) data to estimatete the heating cost distribution within income deciles for the year 2024 and to compare it with two scenarios featuring accelerated retrofitting of very inefficient buildings (Figure 1). The 2024 Energy Performance of Buildings Directive requires prioritizing thermal retrofitting of the 43 percent worst-performing residential buildings.[3] Scenario 1 assumes that 70 percent of these buildings are retrofitted, which corresponds to 30 percent of all buildings. In

1 Karsten Neuhoff, Maximilian Longmuir, Mats Kröger, and Franziska Schütze, "Hohe Gaspreissanstiege: Entlastungen notwendig," *DIW Wochenbericht* no. 36 (2022) (in German; available online). Accessed on April 15, 2024. This applies to all other online sources in this report.

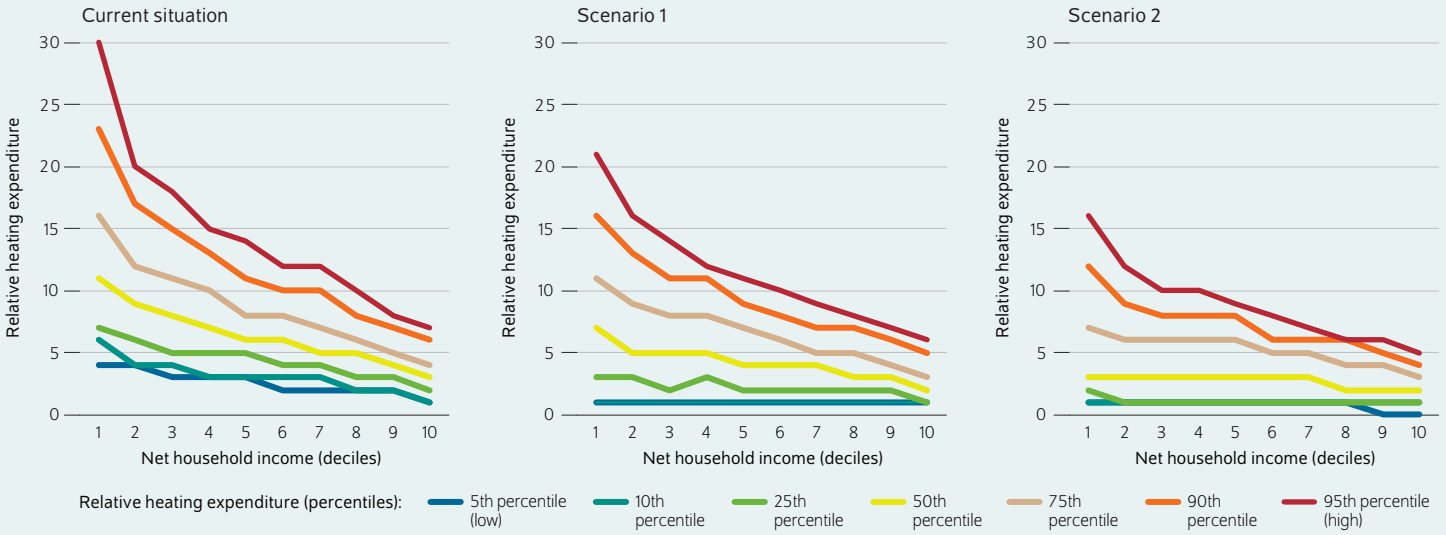
2 In a European Parliament draft, 43 percent of buildings with the highest heating energy consumption are considered inefficient. European Parliament, *Energy performance of buildings (recast)* (2024) (available online). This Weekly Report refers to the buildings as "very inefficient."

3 European Parliament, *Energy performance of buildings (recast)* (2024) (available online).

DOI: https://doi.org/10.18723/diw_dwr:2024-19-1

Figure 1

Heating expenditure relative to income by income decile
In percent



Legend: In Scenario 1, the relative heating expenditure falls to about 20 percent for the houses with the lowest income (first decile) and the highest shares of heating costs (95th percentile).

Note: Households are grouped according to their equivalent net household income in deciles and according to the amount of their relative heating expenditure in percentiles.

Sources: Authors' calculations based on SOEP v.37, Federal Statistical office.

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Thermal retrofits reduce energy costs expenditures and risks particularly for lower income households.

Scenario 2, all 43 percent of very inefficient buildings are retrofitted (Box).

The scenario comparison shows that the energy cost burden relative to the income of households in all income brackets is starkly reduced when retrofitting of very inefficient buildings is prioritized.

Households with very high shares of energy costs will benefit from this in particular. In Scenario 1, the heating cost expenditure relative to the income falls from 19.8 percent to 15.5 percent for households with a particularly high cost burden in the second-lowest income decile (95th percentile). When all very inefficient buildings are retrofitted as in Scenario 2, the heat energy cost share drops to 11.6 percent.

Our analysis shows that tenants are considerably more affected by poorly insulated buildings than homeowners. Tenants, on average, pay higher heating costs per square meter than homeowners in all income brackets (Figure 2). On average, the energy condition of rental housing is worse than owner-occupied housing, an intensively discussed topic in the literature known as the tenant-landlord dilemma that is attributed to a number of factors.[4] For example, unlike

4 Jacob Ahlrich and Sebastian Rockstuhl, "Estimating fair rent increases after building retrofits: A max-min fairness approach," *Energy Policy* 164 (2022): 112923; Martin Görnig and Katrin Klarhöfer, "Investments in Energy-Efficient Building Renovation Are on a Downward Slide," *DIW Weekly Report* no. 32/33 (2023): 225–232 (available online).

Box

Calculating the scenarios

It is assumed that two thirds of the retrofitted buildings undergo comprehensive retrofitting, analogous to the assumptions in the long-term scenarios of the Federal Ministry for Economic Affairs and Climate Action (*Bundesministerium für Wirtschaft und Klimaschutz*, BMWK).[1] The heating energy consumption of a single-family home is thus 55 kilowatt hours per square meter (kWh/sqm) and 40 kWh/sqm for a multi-family home. In the case of partial retrofitting, we assume that the energy consumption is reduced to 100 kWh/sqm for all buildings. A random selection is used to decide which 70 percent of the very inefficient buildings are retrofitted in Scenario 1 is depicted via random selection. In the reference year 2017, the average heating prices were 0.06 euros/kWh;[2] since then, prices have risen by 40 percent.[3] During the same period, however, incomes only rose by 17 percent.[4]

1 Bundesministeriums für Wirtschaft und Klimaschutz, *Hintergrundpapier zur Gebäudestrategie Klimaneutralität 2045* (2022) (in German; available online).

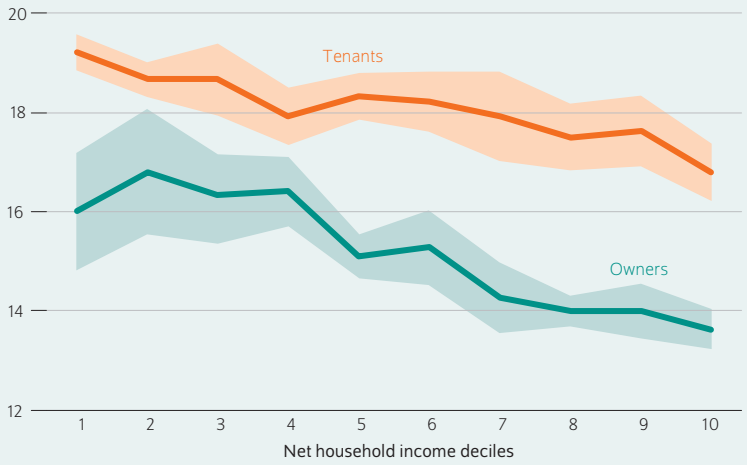
2 Puja Singhal and Jan Stede, "Wärmemonitor 2018: Steigender Heizenergiebedarf, Sanierungsrate sollte höher sein," *DIW Wochenbericht* no. 36 (2019) (in German; available online).

3 Statistisches Bundesamt, *Statistischer Bericht – Daten zur Energiepreisentwicklung – Januar 2024* (2024) (in German; available online).

4 Statistisches Bundesamt, *Reallohnindex* (2024) (in German; available online).

Figure 2

Heating expenditure by income deciles of tenants and owners
In euros per square meter



Note: Prices and wages for 2024 are extrapolated (Box). The shaded areas indicate the 95 percent confidence interval, meaning there is a 95 percent likelihood that the value is within this area.

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In every income decile, tenants spend more on heating per square meter than owners.

owner-occupiers, landlords only benefit indirectly from heating cost savings through the modernization levy.

However, the Worst-First approach offers more benefits beyond the social components. For example, less gas would need to be imported. If the current retrofitting rate of nearly one percent was gradually increased to four percent over the next three years and the retrofitting of very inefficient buildings was prioritized, around 14.4 percent of the German gas demand in the building sector could be saved in this period.[5]

The Worst-First approach can also result in major heating cost savings. If the energy efficiency of 30 percent (or 43 percent in the second scenario) of buildings is improved, 34 (or 56) percent of heating costs could be saved.[6] In general, buildings with the worst energy efficiency offer the greatest economic opportunities for retrofitting at both an individual and the societal level. It is important to prioritize these buildings due to the limited capacity for construction and building retrofitting and to achieve the targeted increase in the annual retrofitting rate.

Ultimately, the heat supply must also become climate neutral to achieve climate neutrality in Germany by 2045. This requires an extensive switch to heat pumps in buildings and for district heating. Adequate energy efficiency of buildings also increases the efficiency of heat pumps and leads to energy savings that go beyond insulation. Reducing the maximum heat requirement reduces the investment costs for heat pumps and the electricity system costs to cover peak electricity demand during periods of cold weather.

Uncertain profitability of thermal retrofitting is a challenge

Thermal retrofitting is often viewed as an investment risk. High-income households or households with real estate funds with a larger investment portfolio can, in principle, make profitable, albeit risky, investments more easily. For other households, the risks may be too great and result in investments not being made.[7]

When a building undergoes general modernization, the costs of an additional thermal insulation compound system for walls or more energy-efficient windows account for around one third of the total retrofitting cost. Per square meter of living space, additional investments in thermal modernization amount to 180 to 360 euros per square meter.[8] On their own, the energy costs saved cannot justify the total investment costs of 600 to 700 euros per square meter.[9] If retrofitting or modernization measures are not necessary, a targeted partial retrofitting is more cost effective. Insulation of the top floor and cellar ceilings is often an option and in many buildings insulation material can be blown into the gap between the wall and the façade. Overall, this results in total costs of around 120 euros per square meter in single-family homes.[10]

The costs mentioned provide information about the profitability of retrofitting as well as their amortization periods, but both can vary significantly. Furthermore, lower energy prices or higher interest charges can prolong the amortization period, which increases thermal retrofitting risks (Figure 3).

Increase subsidies for low-income homeowners

Currently, a combination of standards, incentives, and subsidies provide financial support for the thermal retrofitting of buildings (Figure 4). The Federal Funding for Efficient Buildings (*Bundesförderung für effiziente Gebäude*, BEG) funds both comprehensive retrofitting measures for residential buildings (BEG WG) as well as individual measures (BEG

5 Sophie M. Behr, Merve Kücük, and Karsten Neuhoff, "Energetische Modernisierung von Gebäuden sollte durch Mindeststandards und verbindliche Sanierungsziele beschleunigt werden," *DIW akutell* no. 87 (2023) (in German; available online).

6 Calculated with the reduction in the median cost per square meter: Scenario 1 (11.04–16.8)/16.8*100 = −34.285714, Scenario 2: (7.41-16.8)/16.8*100 = −55.892857.

7 The effects of technical risks accumulate during implementation, as do energy price, real estate market, and financing risks. Claus Michelsen, Karsten Neuhoff, and Anne Schopp, "Beteiligungskapital als Option für mehr Investitionen in die Gebäudeenergieeffizienz?" *DIW Wochenbericht* no. 19 (2015) (in German; available online).

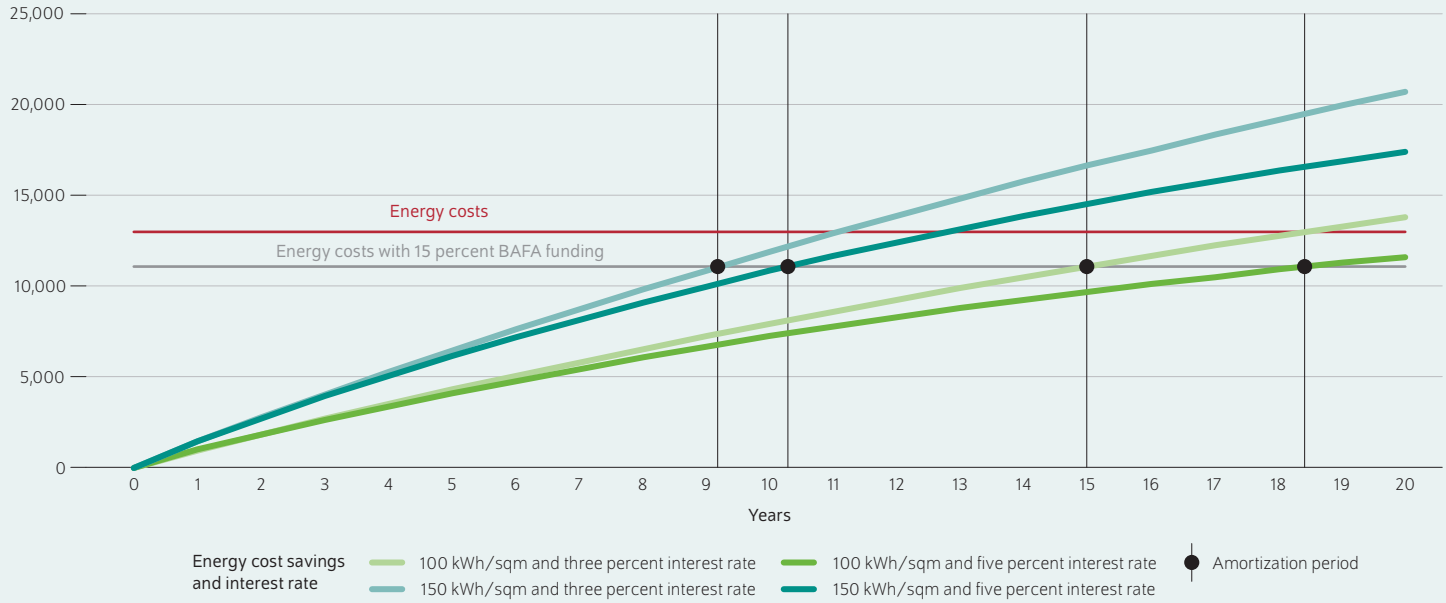
8 Katja Schumacher, Christian Nissen, and Sibylle Braungardt, *Energetische Sanierung schützt Verbraucher*innen vor hohen Energiepreisen – Vorschläge für eine soziale Ausrichtung der Förderung* (2022) (in German; available online). Savings calculated assuming energy consumption of between 200 and 250 kWh/m² pre-retrofitting and of 50–100 kWh/m after retrofitting.

9 Schumacher, Nissen, and Braungardt, *Energetische Sanierung schützt Verbraucher*innen vor hohen Energiepreisen.*

10 Guidehouse, *Ausblick auf potenziell die MEPS erfüllende Maßnahmen für Einfamilienhäuser in Deutschland* (2023) (in German; available online).

Figure 3

Example calculation for investment costs and amortization period for subsidized retrofitting
Costs and savings in euros



Note: Assuming a living space of 110 square meters, heating costs of 0.084 euros per square meter, BAFA funding of 15 percent, and a planned investment volume of 13,000 euros.

It is assumed that the living space is 110 square meters, heating costs are 0.084 euros per square meter, there is BAFA funding of 15 percent, and a planned investment volume of 13,000 euros. Energy cost savings are discounted.

Source: Authors' calculations.

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The amortization period varies starkly depending on the interest rate and savings.

EM). Alternatively, individuals who pay income tax can write off 20 percent of the costs of measures and 50 percent of the costs of specialist planning and construction monitoring.

Both subsidy programs maintain the relatively large incentive to retrofit very inefficient buildings because in these buildings more energy costs can be saved with comparable investment costs; subsidizing a portion of the investment costs with low-interest loans or subsidies does not affect this. However, SOEP data show that the share of owner-occupiers with assets and income below the *Wohngeld-Plus* threshold who are living in very inefficient buildings is 40 percent higher than for other homeowners.[11] This indicates major challenges in implementing retrofitting in this income bracket and is consistent with the relatively higher investment and financing risks for these households. Accordingly, a higher subsidy rate[12] or supplementary financing instruments (for example subordinated loans) are necessary for the affected households, thirteen percent of all owner-occupied or six percent of all households (Figure 5).[13] Since January 1, 2023, an additional ten percent repayment bonus has been available through KfW loans for comprehensive retrofitting of inefficient buildings.

Homeowners may face challenges in financing thermal retrofitting due to limited equity capital and the resulting limited access to additional debt capital. To ensure that thermal investment measures can nevertheless be implemented profitably in the longer term, granting subordinated and low-interest loans from KfW should be considered, or, for example, providing residential building cooperatives with state-backed equity capital for such investments.[14]

Carbon cost distribution strengthens incentives to retrofit

Landlords' incentives to thermally retrofit buildings are limited, as tenants, not owners, usually carry the energy and carbon costs and thus the related risks. Inefficient buildings do

11 The share of homeowners below the *Wohngeld-Plus* threshold living in very inefficient buildings is 42 percent, around 40 percent higher compared to homeowners above the threshold, where the share is around 30 percent. Tax incentives are not attractive for homeowners with lower incomes who pay income taxes. However, they can take advantage of alternative subsidy programs and KfW loans.

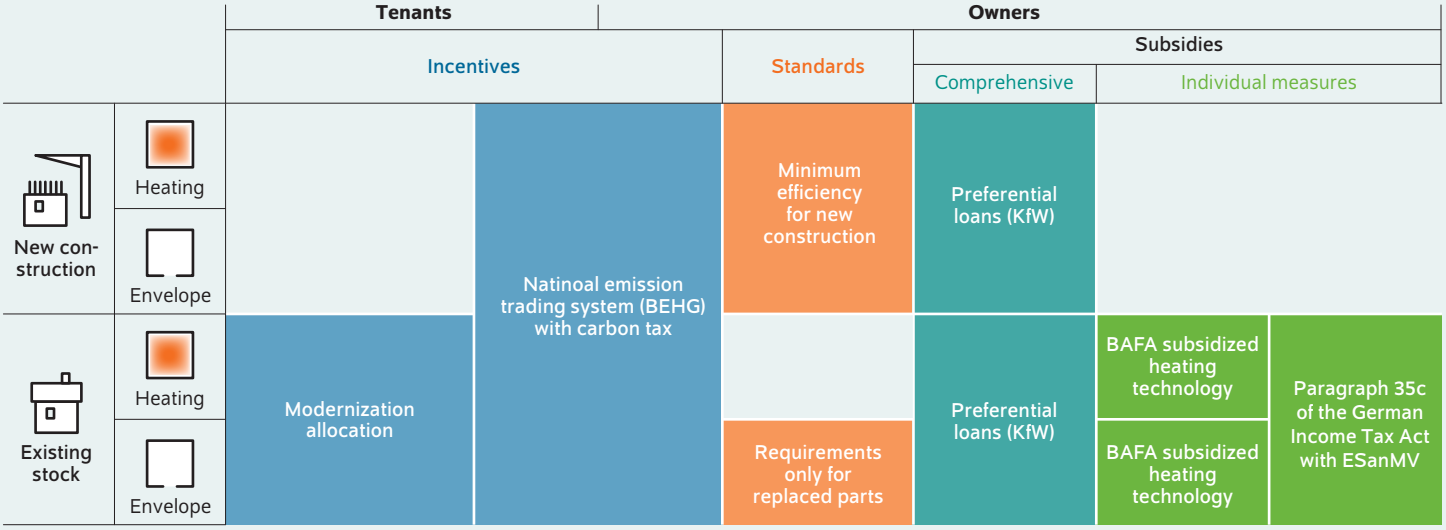
12 For example, MaPrimeRenovation, the French subsidy program for thermal building retrofitting offers higher subsidy rates for low-income households (in French; available online).

13 In the event of insolvency or liquidation, subordinated loans are only serviced after the claims of prioritized creditors have been met in full. This contributes to reducing risks and lowering financing costs for additional loans. Claus Michelsen, Karsten Neuhoff, and Anne Schopp, "Beteiligungskapital als Option für mehr Investitionen in die Gebäudeenergieeffizienz?" *DIW Wochenbericht* no. 19 (2015) (in German; available online).

14 Klaus Mindrup, *Roundtable Wärmewende* (2024) (in German; available online).

Figure 4

Incentives, standards, and subsidy instruments for thermal retrofitting



Source: Federal Office for Economic Affairs and Export Control, (Bundesamt für Bundesamtes für Wirtschaft und Ausfuhrkontrolle, BAFA); Fuel Emissions Trading Act (Brennstoffemissionshandelsgesetz, BEHG); Credit Institute for Reconstruction (Kreditanstalt für Wiederaufbau, KfW); (Energetische Sanierungsmaßnahmen-Verordnung, ESanMV); authors' depiction.

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Currently, there are no comprehensive minimum energy standards for existing buildings in Germany.

not result in rent reductions for owners, especially in regions with housing shortages and rent control. To create retrofitting incentives, the carbon costs from the German National Emissions Trading System have been split between tenants and landlords since 2023. The higher the carbon emissions per square meter, the greater the share of carbon costs carried by the landlords. In buildings with carbon emissions of more than 52 kg of CO_2 per square meter per year, the share is 95 percent.[15] However, there is a concern that the costs will be passed on to tenants living in buildings not subject to rent control in the medium term.[16]

Ensuring implementation with building standards

In 1977, the first thermal insulation requirements for newly constructed buildings were defined in the Thermal Insulation Regulation (*Wärmeschutzverordnung*).[17] The Buildings Energy Act (*Gebäudeenergiegesetz*, GEG) now also stipulates thermal insulation requirements for existing buildings, for example if more than ten percent of an exterior wall is modernized.[18] In addition, certain boilers must be replaced and the top floor ceiling to unheated attics must be insulated when ownership changes.[19]

Minimum energy performance standards should be adopted to unlock the savings potential of existing inefficient buildings. Such standards will apply to non-residential buildings across the EU from 2032.[20] Some countries, such as England and Wales, already have minimum standards for residential buildings.[21] Minimum energy performance standards have the advantage that, as assumed in Scenario 2, all very inefficient buildings are retrofitted and no households remain exposed to energy cost risks (Scenario 1).

Modernization levy should be designed to be rent neutral

Since 2001, the modernization levy has allowed landlords to pass on the costs of modernizing buildings to tenants. While this has improved the quality of rental housing in many places, the rent increases have far surpassed the energy savings.[22] Since 2019, eight percent (instead of 11 percent) of the thermal modernization investments and up to a maximum

15 *Kohlendioxidkostenaufteilungsgesetz* (BGBl. I S. 2154) (2022) (in German; available online).

16 To limit the burden on households due to the carbon price, a price limit of 45 euros per ton of CO_2 was agreed upon in the second European Emissions Trading System (ETS II) (preamble), but only implemented to a limited extent. This limits incentives.

17 Bundesgesetzblatt, *Verordnung über einen energiesparenden Wärmeschutz bei Gebäuden (Wärmeschutzverordnung – WärmeschutzV)* (1977) (in German; available online).

18 GEG § 48.

19 GEG § 47, GEG § 72.

20 European Parliament, "Energy efficiency of buildings: MEPs adopt plans to decarboise the sector", press release from March 12, 2024 (available online).

21 Steven Nadel and Adam Hinge, *Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals* (Washington, DC: American Council for an Energy-Efficient Economy, 2023) (available online); Öko-Institut e.V. (in German; available online).

22 Institut für Energie- und Umweltforschung Heidelberg, *Klimaschutz in Mietwohnungen: Modernisierungskosten fair verteilen. Kurzstudie zur Weiterentwicklung und Aktualisierung der „Drittelmodells"* (Berlin: 2024)(in German; available online).

of three euros per square meter per year can be passed on to tenants within six years.[23]

Twenty-eight percent of all tenant households live in very inefficient buildings and have income and assets below the *Wohngeld-Plus* threshold (Figure 5).[24] For this reason, the German Expert Commission on Gas and Heat appointed by the Federal Government recommended in 2022 that "state support should be designed in such a way that landlords can implement an almost rent-neutral retrofitting" and that the modernization levy should be adjusted accordingly.[25]

There are three advantages to reforming the modernization levy with the goal of rent increases not surpassing the heating cost savings following thermal modernization measures. First, the incentives for a Worst-First approach would increase because it is more profitable to retrofit rented buildings with higher potential energy savings. Second, landlords' motivation to use existing subsidy programs would increase, as they would not be able to increase the rent by the non-subsidized share of the investment costs, as is currently the case. Third, financial support could be linked to proof of quality so that a certain energy level is actually achieved following retrofitting.

Conclusion: Worst-First is a promising policy approach

The Worst-First approach is a promising policy strategy. It is a social policy as it can protect highly burdened low-income households and tenants from high heating costs especially from energy price increases and has climate and energy policy benefits. Limiting the modernization levy to the heating costs saved does not only increase the acceptance among tenants, but also supports the prioritization of retrofitting the least efficient buildings.

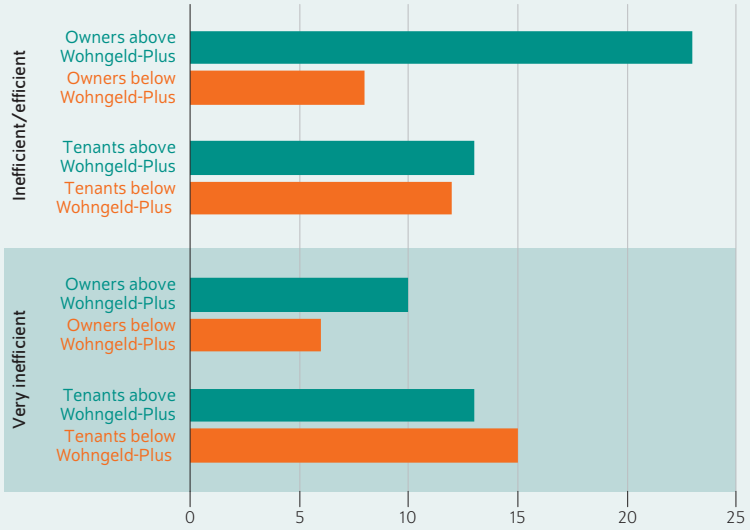
Although retrofitting entails certain risks for homeowners, it often pays off and could be further advanced by increased building standards and targeted support for low-income homeowners. Minimum energy performance standards could ensure all very inefficient buildings are retrofitted and tenants are protected from heating cost risks. The expectation that Germany might also introduce standards creates incentives for owners to already take corresponding efficiency requirements into account now in modernization measures. Minimum energy performance requirements could also be added as requirement to existing support programs, for example for heat pumps.

The persistent lack of predictability is a challenge for policymakers, homeowners, and industry, which is why the scale of retrofitting declined even during the energy crisis.[26] As the Worst-First approach has both social policy and economic policy advantages, it could help build societal and political support for building retrofit policies.

Figure 5

Tenants and owner-occupiers by residence efficiency and income

In percent of all households



Note: Residential buildings with the 43 percent highest heating costs per square meter are defined as very inefficient. The entitlement to a housing benefit (Wohngeld) is calculated according to rent band 4 for 2024 and estimated using SOEP data.

Source: Authors' calculations based on SOEP v.36.

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Proportionally, more tenants live in very inefficient buildings than owner-occupiers.

23 BGB § 559.

24 The 28 percent figure results from the fact that 15 percent of households live in inefficient rental housing and are below the *WohnGeld-Plus* threshold (Figure 5). Tenants make up 54 percent of households.

25 Expert*innen-Kommission Gas und Wärme, *Sicher durch den Winter. Abschlussbericht 2022* (in German; available online).

26 Martin Gornig und Katrin Klarhöfer, "Investments in energy-efficient building renovation are on a downward slide," *DIW Weekly Report* no. 32/33 (available online).

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JEL: D12 , D31, L90, Q41

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DIW BERLIN

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

DIW BERLIN

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DIW Weekly Report 45 2024

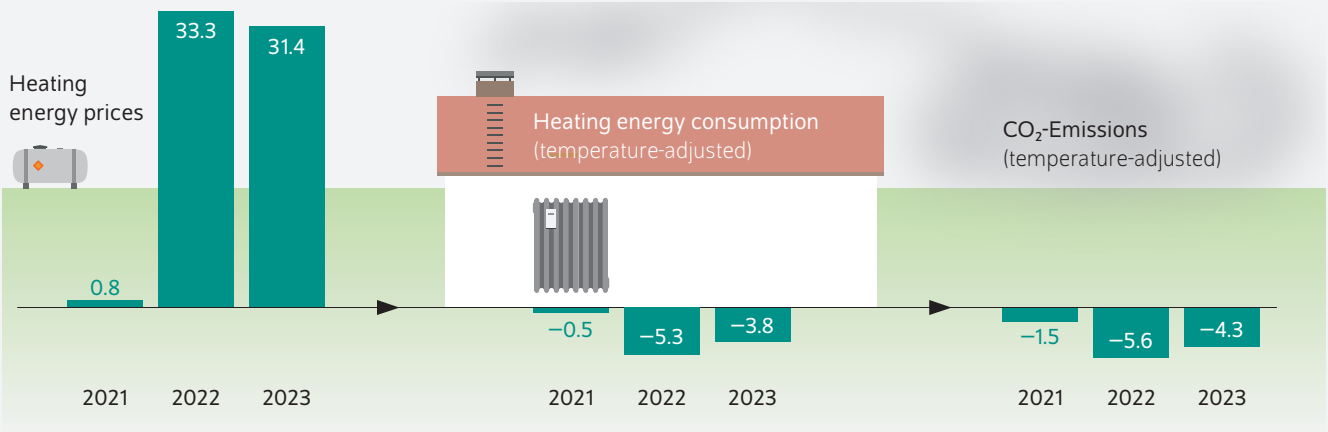
AT A GLANCE

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.

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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** —*

MEDIA

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).

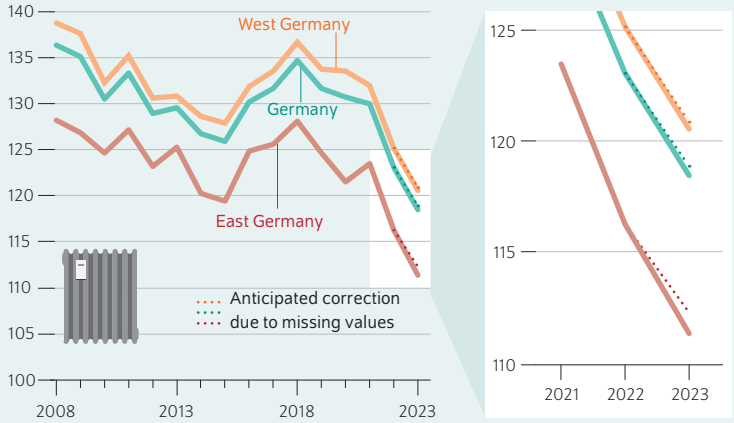
In response to the energy price crisis, Germany has stepped up its efforts to lessen its dependence on fossil fuels in the building sector. The goal was to further reduce Europe's dependence on (Russian) gas imports, on the one hand, and meet the climate targets outlined in the Paris Agreement, on the 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.

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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.

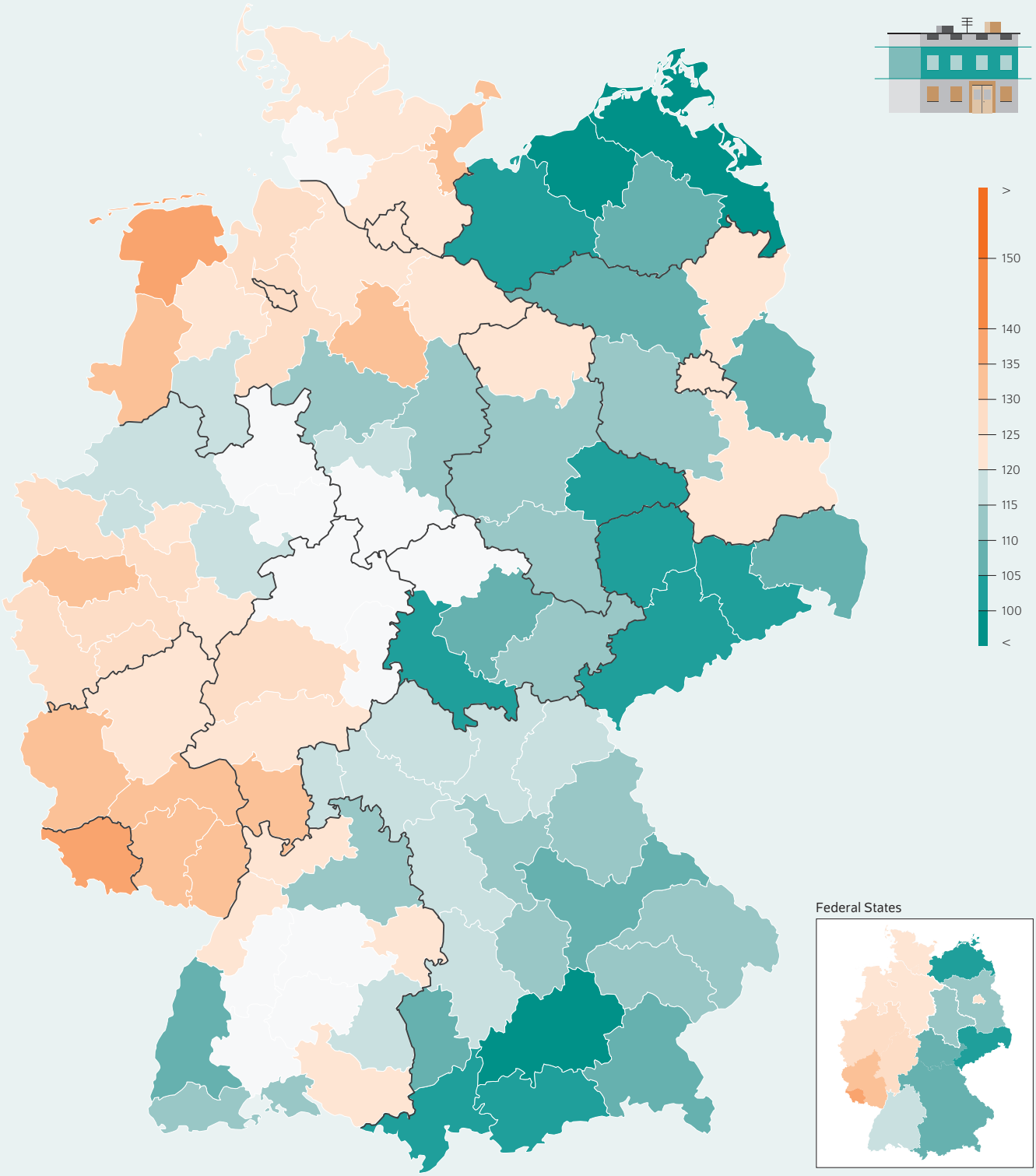
7 This corresponds to around six percent of residential buildings in Germany, cf. BDEW (2024): Wie heizt Deutschland 2023? BDEW-Studie zum Heizungsmarkt (in German; available online, accessed on November 1, 2024).

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.

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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.

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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

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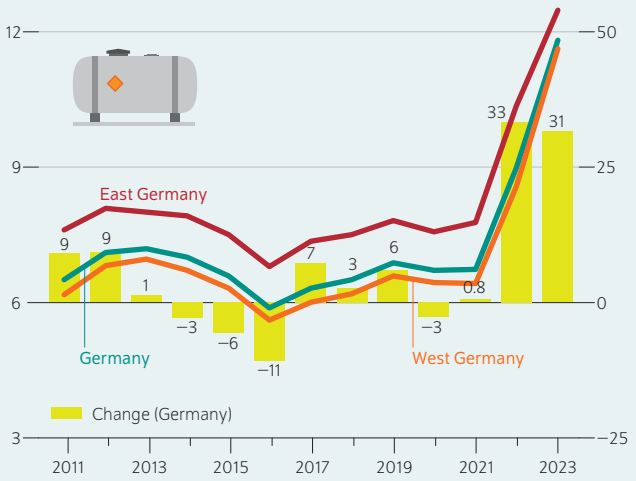
Figure 3

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.

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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

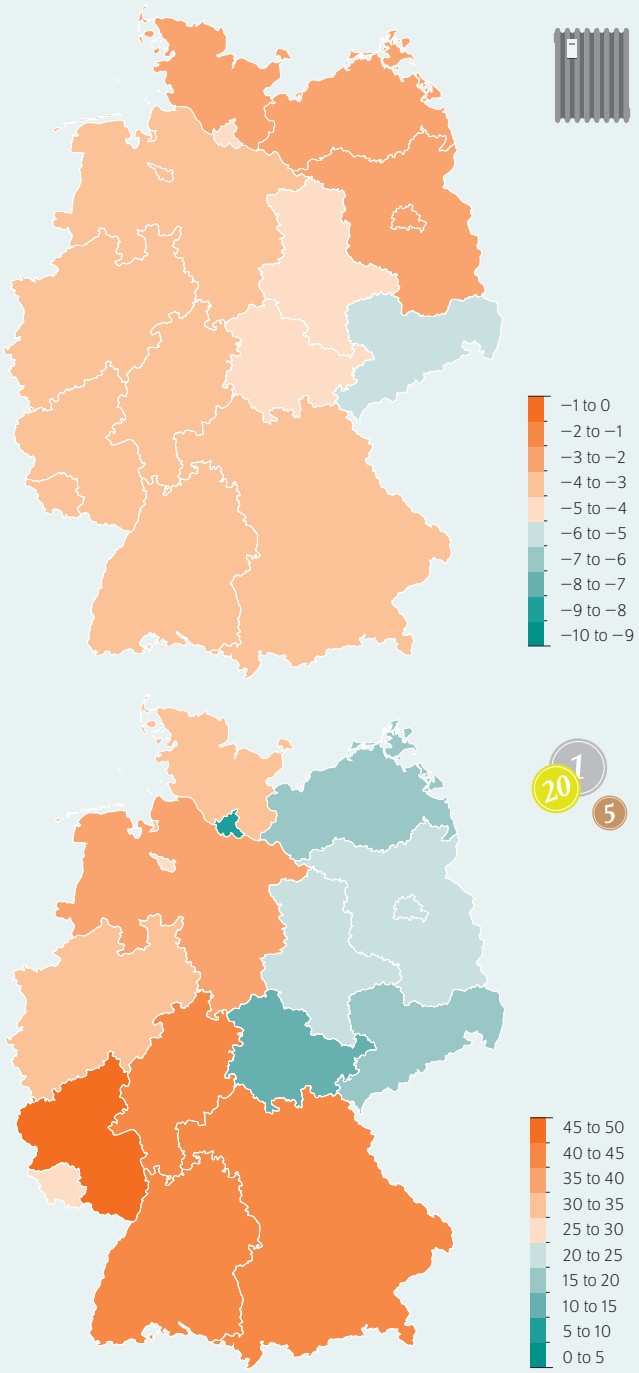
District heating and heat networks have the potential to make a significant contribution to the decarbonization of heat supply: They can be operated with sustainable energy sources and are more efficient than building-internal gas and oil-based heating systems. In order to map the potential switch to 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.

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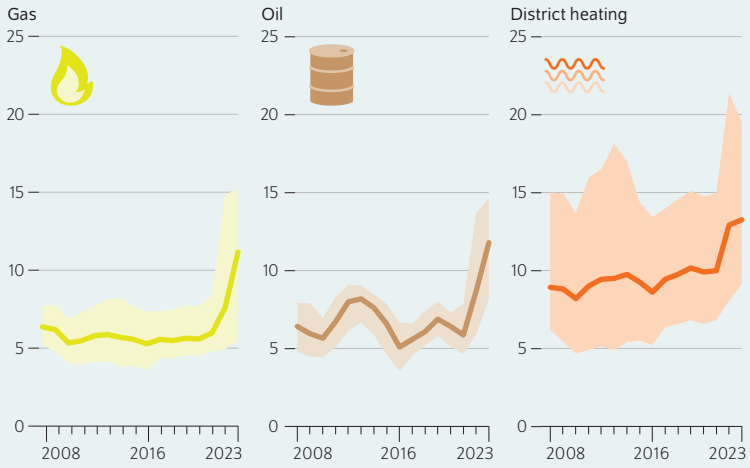
Savings in consumption were not necessarily related to price increases: Households in Saxony saved the most on heating energy, even though prices did not rise that much there in 2023.

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.

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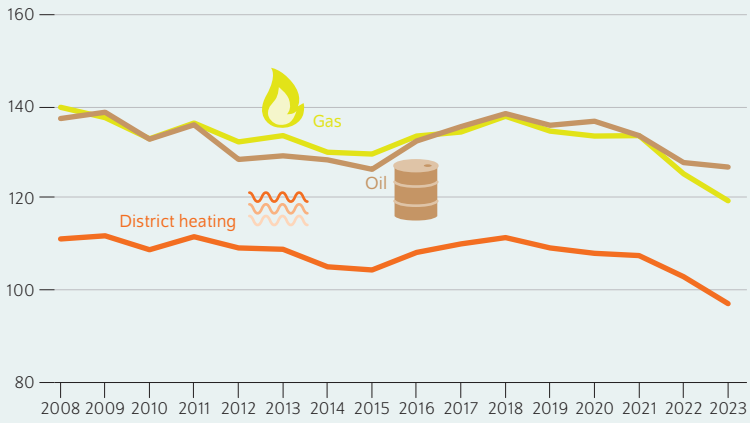
Average prices for district heating are higher than for gas and oil and also show a stronger variation.

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.

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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).

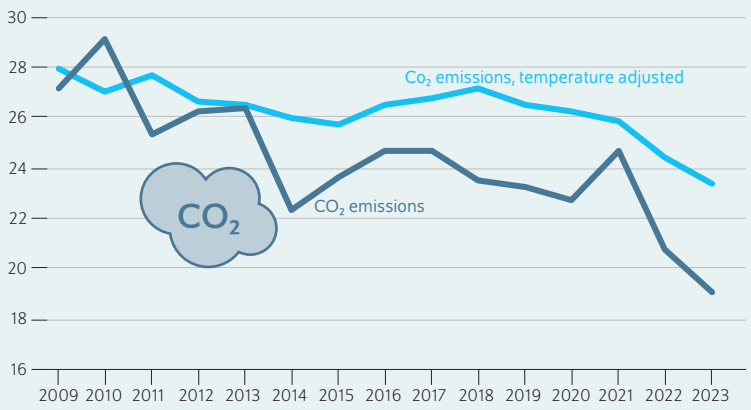
in 2023, much less attention was devoted to saving heating energy than in 2022. Another reason might be that the potential to save energy through changes in consumer behavior had already been exhausted in some households. In some regions, however, savings were more than twice as high as the national 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.

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

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JEL: R31, Q21, Q40

Keywords: Heating demand, heating costs, building energy efficiency, residential buildings, gas prices

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277 **Report** by Martin Gornig and Katrin Klarhöfer

Energy-efficient building renovation: Price-adjusted investments declining; trend reversal needed to reach climate targets

- Energy-efficient building renovation investments have increased in nominal terms but declined in price-adjusted terms since 2013
- Not enough energy-efficient building renovation has occurred to achieve climate targets in building sector
- German Federal Government must provide more funding to reverse the trend

LEGAL AND EDITORIAL DETAILS

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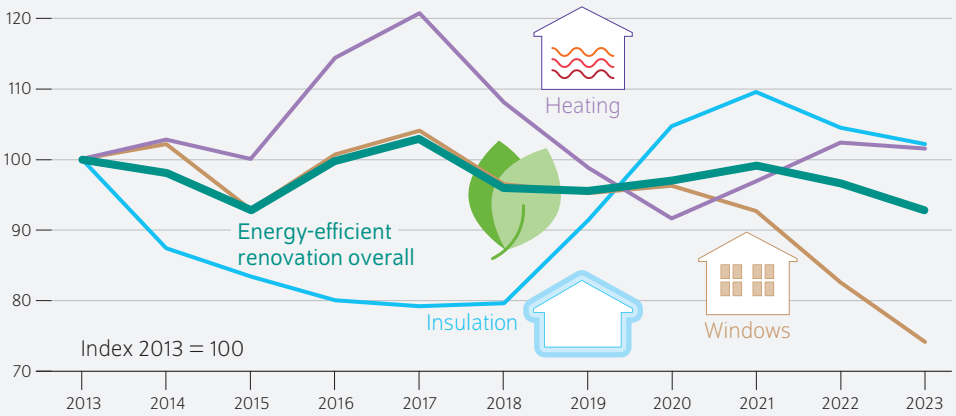
AT A GLANCE

Energy-efficient building renovation: Price-adjusted investments declining; trend reversal needed to reach climate targets

By Martin Gornig and Katrin Klarhöfer

- Investments in energy-efficient building renovation in Germany increased by 12 billion euros to 72 billion euros between 2021 and 2023, in part due to rising energy prices
- However, investments fell by over six percent in price-adjusted terms because due to the simultaneous increase in construction prices
- To achieve climate targets, considerably more real investments in insulation, new windows, heating, and other measures are needed
- Also needed are corresponding framework conditions as well as investment aid in Germany and across Europe
- German Federal Government increased funding for 2024 to 16.7 billion euros, but more is needed to reverse the trend in energy-efficient renovation

Excluding price increases, property owners have been investing less in energy-efficient renovation in 2024 compared to 2014



7%

less was invested in energy-efficient renovation measures in real terms in 2023 compared to 2013

Sources: DIW Berlin Construction Volume; Heinze GmbH Modernization Volume; authors' calculations.

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FROM THE AUTHORS

"Most energy-efficient renovation is performed on residential buildings. However, commercial and public buildings also hold an enormous amount of potential. Sometimes these buildings are so poorly insulated that larger investments could possibility reduce heating emissions in this area faster."

— Martin Gornig —

MEDIA

Audio Interview with Martin Gornig (in German)
www.diw.de/mediathek

Energy-efficient building renovation: Price-adjusted investments declining; trend reversal needed to reach climate targets

By Martin Gornig and Katrin Klarhöfer

ABSTRACT

In light of rising oil and gas prices, investments in energy-efficient building renovation in Germany have risen recently in nominal terms. In 2023, around 72 billion euros were spent on the energy-efficient renovation of residential, public, and commercial buildings, about 12 billion more than in 2021. Nevertheless, investments declined by over six percent in price-adjusted terms, as construction prices rose sharply during this time as well. To reach climate targets, however, significantly more real investments in energy-efficient building renovation are needed, as are framework conditions in Germany and Europe. Investment aid for energy-efficient renovation measures also plays an important role. The German Federal Government increased funding for these measures for 2024 to 16.7 billion euros. However, policymakers will need to provide even more funding in the future due to rising financing and construction costs if they actually want to increase the rate of energy-efficient building renovation.

In its most recent report, the Council of Experts on Climate Change warned that much more progress needs to happen in the building sector than has occurred to date to reach the greenhouse gas reduction targets in Germany.[1] Reducing heating energy consumption in the building stock is one way to significantly reduce greenhouse gas emissions. For over a decade, there have been calls to improve the energy condition of the building stock by increasing building envelope insulation (walls, windows, roof) and installing more efficient heating systems.[2]

Energy-efficient renovation is difficult to measure, but there are suitable indicators

It is difficult to evaluate the extent to which energy-efficient renovation measures have actually improved the energy condition of the building stock over the past years. Detailed studies on this topic are extremely complex and only available for specific years.[3] Studies based on smaller samples can only determine rough trends in the development of energy-efficient building renovation over a few years. Moreover, they are limited to the existing residential building stock. According to the available data, the annual energy-efficient renovation rate, which is the share of a building's surface area that has undergone energy-efficient renovation in a certain year, has hardly changed since 2000 and is estimated to be less than one percent for 2017.[4]

An alternative approach for measuring energy-efficient renovation is based on the amount of money invested in this type of renovation instead of focusing on physical indicators.

1 Expert Council on Climate Change, *Review of Projection Data: Compliance with climate target for 2021 to 2030 not confirmed. Special Report in accordance with Section 12 (4) KSG* (2024).

2 Jürgen Blazejczak, Dietmar Edler, and Wolf-Peter Schill, "Steigerung der Energieeffizienz: ein Muss für die Energiewende, ein Wachstumsimpuls für die Wirtschaft," *DIW Wochenbericht* no. 4 (2014): 47-60 (in German; available online). Accessed on November 4, 2024. This applies to all other online sources in this report unless stated otherwise).

3 Holger Cischinsky and Nikolaus Diefenbach, *Datenerhebung Wohngebäudebestand 2016. Forschungsbericht* (Darmstadt: Institut Wohnen und Umwelt, 2018) (in German); Michael Hörner, Markus Rodenfels, and Holger Cischinsky, *Der Bestand der Nichtwohngebäude in Deutschland ist vermessen. Projektinformationen* (Darmstadt: Institut Wohnen und Umwelt, 2021) (in German).

4 Puja Singhal and Jan Stede, "Wärmemonitor 2018: Steigender Heizenergiebedarf, Sanierungsrate sollte höher sein," *DIW Wochenbericht* no. 36, 519–628 (in German; available online).

DOI: https://doi.org/10.18723/diw_dwr:2024-46-1

Box

Determining investments in energy-efficient building renovation

Investments in energy-efficient building renovation are estimated by combining aggregate statistical official evaluations from the DIW Construction Volume that have been broken down with extrapolated survey results from the construction service provider Heinze GmbH's Modernization Volume (Figure). The DIW Construction Volume contains the total of all services that are involved in the construction or maintenance of buildings and structures. In this respect, the Construction Volume goes beyond the construction investment figures of the Federal Statistical Office because their figures do not take into account consumable construction services, which are primarily repairs that do not increase in value (i.e., maintenance services provided by the main construction and finishing trades). Unlike in the official statistics, the DIW Construction Volume differentiates between construction services on the existing building stock and on new buildings.

Existing measures, or rather the volume of existing construction measures, are estimated from a macro perspective by looking at the differences between total construction output according to construction statistics and new construction output derived from construction activity statistics.[1] This has the advantage of allowing consistent comparisons over time. However, the model calculations using the difference approach lack structural information.

To identify such structural information, the results from the model calculations based on official statistics are considered. These are then compared with extrapolations of modernization volumes based on surveys. The extrapolation results are based on special analyses on the years 2014, 2018, 2020, and 2022 by Heinze GmbH.[2]

In Heinze GmbH's studies, the modernization volume is calculated by linking secondary statistical market data with survey results from target groups relevant to the modernization market. The main source of housing market data is a survey of representatively selected tenant and owner households. In addition, commercial housing developers are surveyed. The results for non-residential construction are based on evaluations of questionnaires on modernization measures run by architects. In addition, surveys of tradespeople are used. Using these sources, the existing measures can be differentiated by sector. Insulation measures (roofs, facades, etc.); replacement of windows and exterior doors; and the renewal of heating, air conditioning, and ventilation systems are considered components of energy-efficient renovation.

Structural information on the importance of the above sectors from a micro approach is consistently integrated into DIW construction volume calculation. A prerequisite for this is that the results of the two methods correspond with each other. This applies to the quantitative total result as well as the specific definition of construction services. Thus, investment construction services are the focus of the Heinze GmbH survey results. Due to its connection to the architect survey, this applies to non-residential construction especially. In the case of residential construction, on the other hand, work performed by the occupant, including neighborhood assistance and undeclared work, is not valued, unlike in the Construction Volume.

The structural information gleaned from the Heinze GmbH surveys is therefore not directly related to the Construction Volume as a whole, but only to the investment part. A model calculation to separate construction services into investment and non-investment measures is required to integrate the values from the structural information from Heinze. For this purpose, DIW Berlin specifically evaluated the structural information on repair measures from the Heinze surveys and made corresponding extrapolations for the average maintenance measures. The measures were differentiated over time by linking them to the development of gross fixed assets in structural engineering, for which DIW Berlin developed special model calculations.[3]

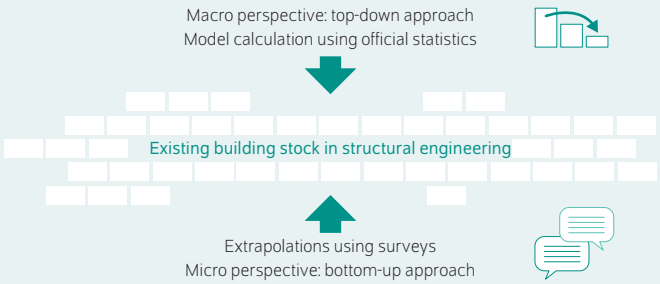
1 Martin Gornig, Claus Michelsen, and Hannah Révész, "Strukturdaten zur Produktion und Beschäftigung im Baugewerbe. Berechnungen für das Jahr 2020," *BBSER-Online-Publikation* 32 (2021) (in German; available online).

2 Katrin Klarhöfer, Christopher Kramp, and Christian Tiller, "Bestandsinvestitionen 2022. Struktur der Investitionstätigkeit in den Wohnungs- und Nichtwohnungsbeständen," *BBSR-Online-Publikation* 80 (2024) (in German; available online).

3 Susanne Hotze et al., "Struktur der Bestandsinvestitionen 2014. Investitionstätigkeit in den Wohnungs- und Nichtwohnungsbeständen," *BBSR-Online-Publikationen* no. 03 (2016) (in German; available online).

Figure

Analytical approach for determining investments in the building stock



Source: Authors' depiction.

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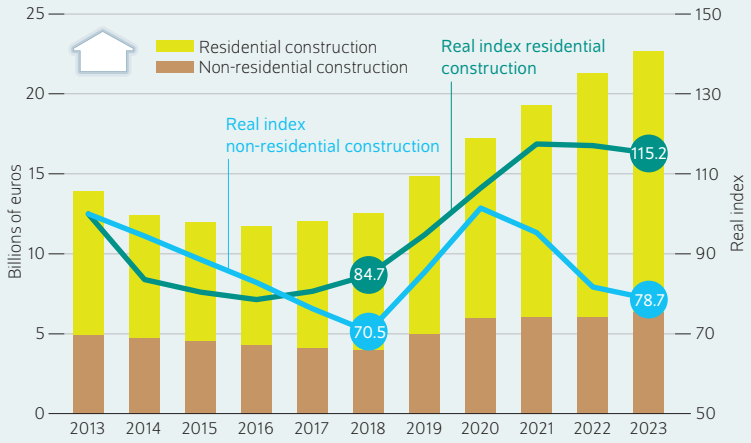
The extent of construction measures on the building stock is narrowed down by statistical model calculations and survey-based extrapolations.

How much has been spent on energy-efficient renovation can be estimated by observing construction activity. However, it is not possible to determine the specific additional amount spent on improving energy efficiency that results, for example, from installing a triple-glazed window compared to a double-glazed one. Nevertheless, it is possible to determine

Figure 1

Investments in roof, basement, and exterior door insulation
In billions of euros at current prices, as an index of price-adjusted values, 2013 = 100



Sources: DIW Berlin Construction Volume; Heinze GmbH Modernization Volume; authors' calculations.

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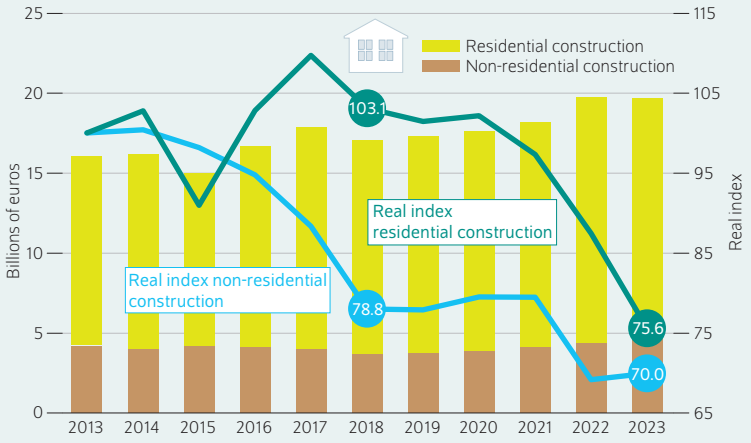
Investments in the insulation of residential buildings have not increased in real terms since 2021.

Figure 2

Investments in the replacement of windows and exterior doors
In billions of euros at current prices, as an index of price-adjusted values, 2013 = 100



Sources: DIW Berlin Construction Volume; Heinze GmbH Modernization Volume; authors' calculations.

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When accounting for the enormous price increases of recent years, investments in windows and doors have declined considerably.

the total cost of window installation, including preparatory and finishing work. These gross costs are much higher than the additional spending specifically related to energy-efficient renovation. Previous studies on residential construction suggest that the investment costs are twice as high as the specific additional spending.[5]

The total amount invested in energy-efficient building renovation is estimated by breaking down aggregate statistical official evaluations that are a part of the DIW Construction Volume and by extrapolating survey results from the Modernization Volume of the construction service provider Heinze GmbH (Box). The Federal Institute for Research on Building, Urban Affairs and Spatial Development (*Bundesinstitut für Bau-, Stadt- und Raumforschung*, BBSR[6]) and the Federal Environment Agency (*Umweltbundesamt*, UBA[7]) regularly publish these results, which are based on the DIW Construction Volume and the Heinze Modernization Volume, on the investment volume in the energy-efficient renovation of residential and non-residential buildings.

Furthermore, this Weekly Report presents a differentiated evaluation of three energy-efficient renovation sectors: roof/wall insulation, window/door replacements, and heating/air conditioning system renewal.[8] In addition, the real development of investments in energy-efficient renovation are presented here to account for the strong price increases of recent years. A mix of price indicators are used to measure deflation, as the official price statistics do not directly reflect the individual energy-efficient renovation sectors. Roof/wall insulation, windows/doors, and heating/air conditioning are thus assigned to price indices for suitable product areas and economic classes.

Roof/wall insulation stagnating following growth

A significant share of expenditure on energy-efficient renovation is spent on improving the insulation of the building envelope. At current prices, over 16 billion euros were invested in insulating roofs, basement ceilings, and facades of residential buildings in 2023. Once again, roughly six billion euros were spent on insulating commercial and public non-residential buildings (Figure 1).

The nominal amount invested in insulation, especially of residential buildings, increased significantly over the past years. For example, the amount invested in the insulation of residential facades and roofs in 2023 was nearly twice as high as in 2018. However, when considering the enormous price increases since 2021, the real value of investments in the insulation of residential buildings did not increase in 2022 or 2023.

5 Institut der deutschen Wirtschaft, *Energetische Modernisierung des Gebäudebestandes: Herausforderungen für private Eigentümer. Untersuchung im Auftrag von Haus & Grund Deutschland* (2012) (in German); Prognos, *Ermittlung der Wachstumswirkungen der KfW-Programme zum Energieeffizienten Bauen und Sanieren. Untersuchung im Auftrag der KfW-Bankengruppe, Berlin* (2013) (in German).

6 Including photovoltaics: Martin Gornig, Claus Michelsen, and Hannah Révész, *Strukturdaten zur Produktion und Beschäftigung im Baugewerbe. Berechnungen für das Jahr 2020* (Bundesinstitut für Bau-, Stadt- und Raumforschung: 2024) (in German; available online).

7 Without photovoltaics: Jürgen Blazejczak et al., "Ökonomische Indikatoren von Maßnahmen zur Steigerung der Energieeffizienz – Materialien Berichtsjahr 2019," *Umwelt, Innovation, Beschäftigung* no. 3 (2020) (in German).

8 The 2023 values are based on preliminary calculations.

The insulation of non-residential buildings developed considerably less dynamically. Spending on building insulation in the commercial and public sectors rose again from 2019. However, only in 2020 were the nominal increases sufficient enough to reach the real investment level of 2013. Investments in the insulation of non-residential buildings, in contrast, were only around 80 percent of the initial level in 2024.

Window and exterior door replacements trending downward

The amount spent on window and exterior door replacements in residential buildings has barely changed over many years (Figure 2). For example, around 13.5 billion euros were spent on window and exterior door replacements from 2017 to 2020. Only recently has spending increased noticeably. However, the nominal increases were considerably lower than the high price increases due to the extremely high costs of glass production. Accordingly, real investments in window/exterior door replacements in the past three years have declined sharply: In 2023, the real investment level was nearly 25 percent lower than it was in 2013.

In price-adjusted terms, investments in the replacement of windows and exterior doors of commercial and public non-residential buildings declined even more markedly during the observation period. In 2023, real investments were 30 percent lower than in 2013. In nominal terms, about five billion euros have been spent on window and exterior door replacements by commercial and public building owners in 2024.

Renewed growth in heating system renewal since 2020

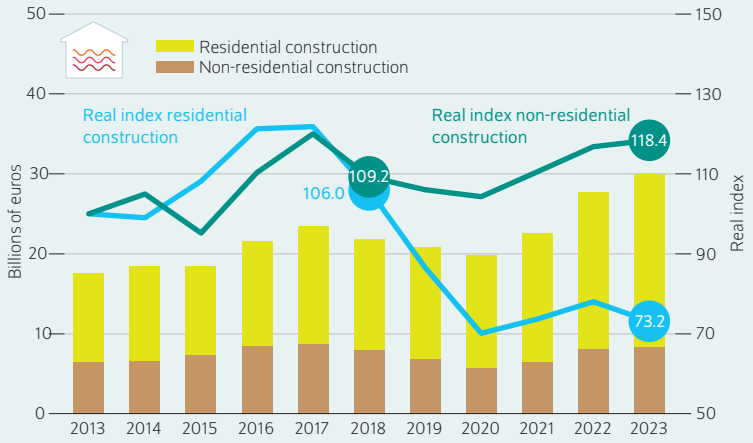
Compared to energy-efficient retrofitting of building envelopes via insulation or the replacement of windows and exterior doors, spending on heating system renewal has experienced stronger growth (Figure 3). Spending on heating system renewal in the residential housing stock has nearly doubled in nominal terms over the last 10 years. Although heating construction prices rose even more sharply than prices for energy-saving measures on the building envelope, the increases in spending were enough to maintain a high level of real investments in the renewal of heating systems in residential buildings. It is assumed that households are also investing in new gas heating systems before they become subject to strict regulations. However, investments narrowly missed reaching the peak value of real investments from 2017 in 2023.

Investments in heating and air conditioning (AC) technology for non-residential buildings have been on an upward trend for many years. From 2011 to 2017, spending on heating and AC technology increased from roughly six to nearly nine billion euros. Moreover, because the increase in spending outpaced price increases in this sector, real investments rose as well. Compared to 2017, however, commercial and public building owners' spending has declined considerably. As heating and AC technology prices experienced a strong increase at the same time, real investments declined by nearly 30 percent compared to 2013.

Figure 3

Investments in the renewal of heating and air conditioning systems

In billions of euros at current prices, as an index of price-adjusted values, 2013 = 100



Sources: DIW Berlin Construction Volume; Heinze GmbH Modernization Volume; authors' calculations.

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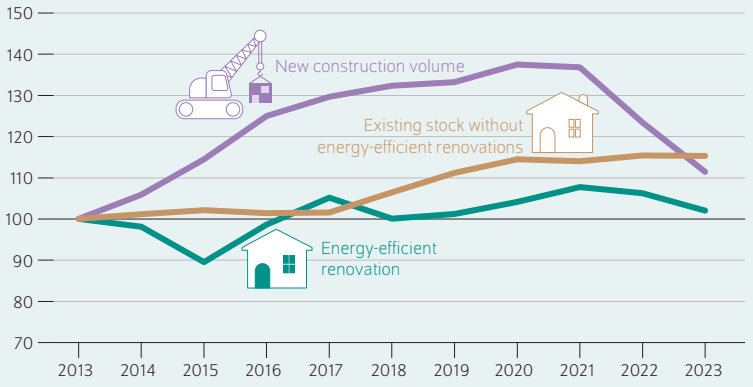
The development of real investments in heating and air conditioning systems differs greatly between residential and non-residential buildings.

Figure 4

Development of real investments in energy-efficient renovation of residential buildings, in existing building stock, and newly constructed buildings

Index 2013 = 100



Sources: DIW Berlin Construction Volume; Heinze GmbH Modernization Volume; authors' calculations.

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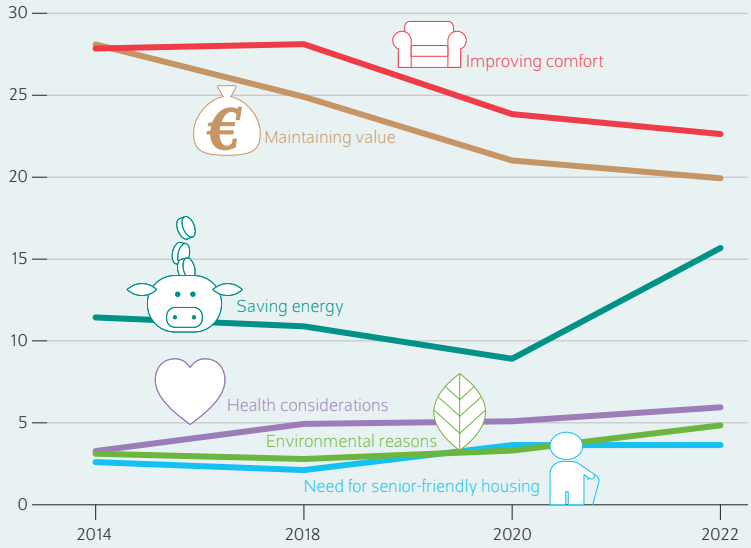
Overall, real investments in the energy-efficient renovation of residential buildings were marginally higher in 2024 compared to 2014.

Figure 5

Reasons for modernizing residential buildings
Shares in percent



Note: This information was provided by property owners who live in their own property as well as owners who rent out their property.

Sources: Heinze GmbH; authors' calculations.

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While saving energy is still not the most important reason for modernizing, it has increased in significance recently.

Energy-efficient renovation of residential buildings losing momentum overall

Overall, a bleak picture emerges when looking at investments in the energy-efficient renovation of residential buildings: Over the past 10 years, annual spending on this type of renovation increased by more than 65 percent to nearly 53 billion euros. However, when considering price increases, real investments in 2023 were barely higher than in 2013 (Figure 4). The first low point of real investments in energy-efficient renovation of residential buildings was in 2015 and was followed by a significant recovery in real investment activity. It had reached its previous peak value in 2021, when the annual total investment amount was about eight percent greater than the base year value. However, the considerable price increases in 2022 and 2023 almost canceled out the real growth in investments entirely.

Investments in the energy-efficient renovation of buildings thus developed markedly worse than in other areas of residential construction. Construction of new housing in particular experienced strong growth until 2020. Despite the current weak phase, investments in new construction were around 11 percent higher in price-adjusted terms in 2023 than in 2013. Other measures on existing buildings, such as the modernization of sanitary facilities or general maintenance, also resulted in real growth over the entire period. In price-adjusted terms, such spending was 15 percent higher in 2023 than in 2013.

There are diverse reasons for this investment restraint.[9] For many years, comparatively low oil and gas prices, which reduced pressure to undertake energy-efficient renovation, were a significant factor. Due to the climb in energy prices since 2021, saving energy has increased in importance as a reason for modernizing owner-occupied or rented residential buildings (Figure 5).[10] While only nine percent of investors cited energy savings as a reason for modernizing buildings in 2020, the figure had risen to 16 percent in 2022.

The parallel sharp rise in financing costs and construction prices is likely why the change in reasons for modernizing has not been reflected in a real increase in investments in energy-efficient renovation of residential buildings. In addition, the survey on modernization reasons shows that even in 2022, increasing comfort and maintaining value were still seen as more important investment reasons, with response rates of 23 percent and 20 percent, respectively.

Energy-related renovation in commercial and public structural engineering continuing its downward slide

Combining the results for investments in the individual sectors of energy-efficient public and commercial building renovation results in a concerning picture. In 2023, nearly 20 billion euros were spent on the energy-efficient renovation of non-residential buildings, around 25 percent more than in 2013. However, as prices for construction work rose by over 50 percent during the same period, one quarter less is being invested in the energy-efficient renovation of public and commercial buildings in real terms compared to 10 years ago (Figure 6).

Investment activity in energy-efficient renovation developed markedly worse than in other sectors of public and commercial structural engineering. In particular, the construction of new buildings increased considerably. In 2023, investments in new construction were about 25 percent higher than in 2013 in price-adjusted terms despite the current weak phase. Measures other than energy-efficiency measures on existing buildings also suffered real losses. In price-adjusted terms, spending was 17 percent lower in 2023 compared to 2013. The decline was thus noticeably lower than in energy-efficient renovation.

For many years, public and commercial investors were hesitant to renovate buildings to improve energy efficiency, likely due to comparatively low oil and gas prices. In addition, the structural change in the non-residential housing stock is occurring more strongly in new construction than in residential construction. Currently, it should also be noted that public authorities in particular are tied to nominal investment

9 Martin Gornig und Katrin Klarhöfer, "Investments in energy-efficient building renovation are on a downward slide," *DIW Weekly Report* no. 32/33 (2023): 225-232 (available online).

10 Katrin Klarhöfer, Christopher Kramp, and Christian Tiller, "Bestandsinvestitionen 2022. Struktur der Investitionstätigkeit in den Wohnungs- und Nichtwohnungsbeständen," *BBSR-Online- Publikation* no. 80 (2024) (in Germna; available online).

budgets and have only been able to partially adjust their budget estimates to the sharp rise in construction prices.

Conclusion: Trend reversal in energy-efficient building renovation urgently needed

There is no doubt that the energy efficiency of the building stock needs urgent improvement. In light of the weak real investment activity in recent years, energy-efficient renovation of the existing building stock must be quadrupled. Binding minimum standards and renovation targets must be set to reverse the trend in renovation activities.[11] The long-term expected development of energy prices is a decisive factor for the willingness to invest in energy-efficient renovation. Political decisions on carbon pricing play a key role here irrespective of fluctuating raw materials prices. A reliably foreseeable path of further energy cost increases is essential for creating investment incentives to reach the climate targets.

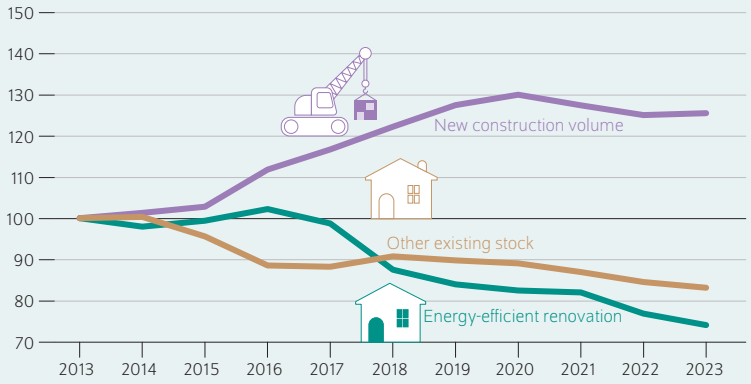
Furthermore, there must be appropriate funding conditions to achieve a noticeable increase in investments in the energy-efficient renovation of existing buildings. At the end of 2023, the German Federal Government reorganized the funding measures in the building sector as part of the Climate Action Program. The Federal Funding for Efficient Buildings program is the main approach to energy-efficient improvements in the building stock.[12] Since the beginning of 2024, the *Kreditanstalt für Wiederaufbau* and the Federal Office of Economics and Export Control (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*) have made newly structured funding programs available for the energy-efficient renovation of residential and non-residential buildings.

The new focus of the funding programs has been accompanied by a sharp increase in funding for energy-efficient renovation. Funds in the amount of 16.7 billion euros for 2024 have been earmarked in the *Klima- und Transformationsfonds* for Federal Funding of Efficient Buildings.[13] This represents an increase of almost 50 percent compared to the funding for 2023.[14] Compared to the long-term average, the subsidies are even over three times as high.[15] However, the higher funding will likely not be enough to provide the strong impetus needed for renovation activities. The increase in nominal funding is offset by higher construction and financing costs in particular. Interest charges are likely to be almost three times higher compared to the end of the 2010s, even after the European Central Bank's further interest rate cuts. Construction costs have risen by an average of more than 40 percent in the same period. If policymakers really want to provide a strong impetus for energy-efficient renovation activities in existing residential buildings, they must be prepared to invest significantly higher amounts of funding in the coming years.

When designing the subsidy programs, care should be taken to ensure that the approved measures can be implemented in a flexible manner. Although the decline in new residential construction has significantly reduced construction capacity utilization,[16] there are still partial bottlenecks in individual trade services.

Figure 6

Development of real investments in energy-efficient renovation of non-residential buildings, in existing building stock, and newly constructed buildings
Index 2013 = 100



Sources: DIW Berlin Construction Volume; Heinze GmbH Modernization Volume; authors' calculations.

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Real investments in non-residential construction are characterized by lots of new construction and little energy-efficiency renovation.

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12 Deutscher Bundestag, "Klimaschutzprogramm 2023 der Bundesregierung," Drucksache 20/8150 (2023) (in German; available online).

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