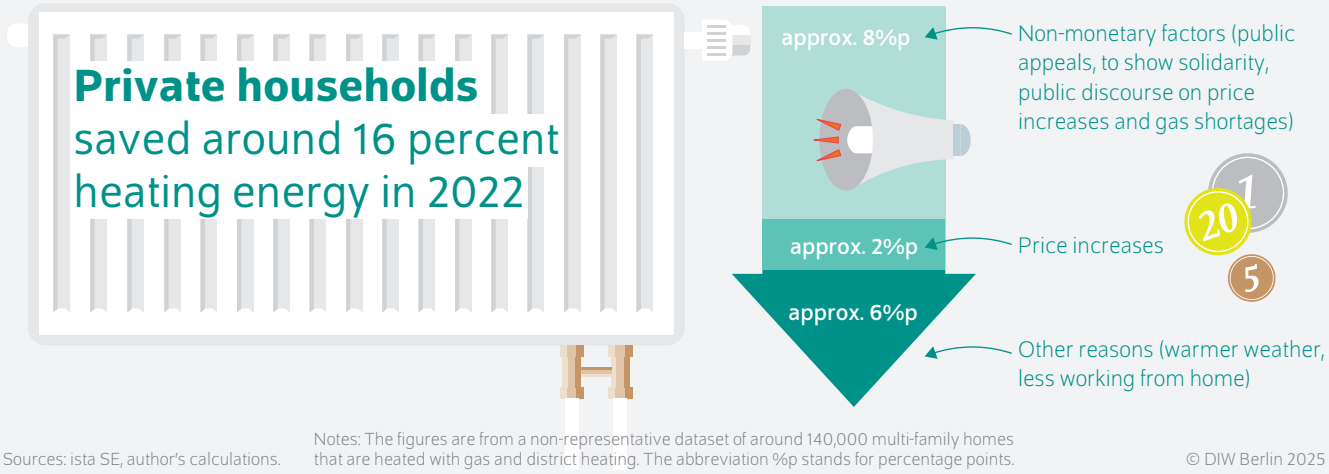
AT A GLANCE

Non-monetary factors were an important driver of residential energy savings during the energy crisis

By Sophie M. Behr and Till Köveker

- This Weekly Report investigates the extent to which price increases or non-monetary factors contributed to savings in heating energy during the 2022 energy crisis
- Non-monetary factors such as public appeals had around four times as much influence on the heating behavior of households in the short term as price increases
- Households exposed to higher price increases saved more in absolute terms, but short-term price elasticity remains consistently low regardless of how much a price was increased
- Households in buildings with district heating had higher price-driven savings and a higher short-term price elasticity than households in buildings with gas heating
- Influence of non-monetary factors should be used more in future crises

Non-monetary factors influence heating energy consumption much more than price increases do in the short term



Sources: ista SE, author's calculations.

Notes: The figures are from a non-representative dataset of around 140,000 multi-family homes that are heated with gas and district heating. The abbreviation %p stands for percentage points.

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FROM THE AUTHORS

"As non-monetary factors, such as saving energy for political and/or solidarity reasons, have a stronger short-term effect on savings than price increases, public appeals or information campaigns should be used more in future crises."

— Till Köveker —

MEDIA

Audio Interview with Till Köveker (in German)
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ABSTRACT

The Russian invasion of Ukraine in 2022 triggered an energy crisis in Germany, with consumer energy prices skyrocketing over the course of the year. Due to concerns about gas shortages, various programs aimed at reducing consumption were set up and the German Federal Government and numerous organizations appealed to consumers to save as much energy as possible. This Weekly Report investigates how much of the energy savings of private households (16 percent in total) was due to higher prices and how much was due to non-monetary factors, such as government appeals, public campaigns, or a fear of price increases. The results of an analysis of a comprehensive dataset on the prices and consumption of heating energy in multi-family buildings in Germany show that only about two percentage points of savings were due to higher prices. Therefore, non-monetary factors had a nearly four times greater effect on heating energy consumption at over eight percentage points, at least in the short term. The rest of the savings is due to factors such as weather. To tackle future energy crises in the short term, policymakers should utilize non-price interventions to complement the limited effect of heating energy price increases on savings.

The Russian attack on Ukraine in February 2022 plunged Europe into an energy crisis and stoked fears of a supply shortage in the winter of 2022/23. Before the war, Europe purchased most of its gas from Russia.[1] In the 2010s, more than 40 percent of Germany's natural gas came from Russia.[2] In the months leading up to the war, Gazprom began reducing natural gas deliveries to Germany and further reduced them after the war began, with deliveries dropping to zero in September 2022.[3]

As a result of Russian gas deliveries coming to a halt, the wholesale price for gas shot up from 20 euros per megawatt hour (MWh) in the middle of 2021 to over 100 euros for many months in 2022; in August, the price even reached more than 300 euros per MWh at times.[4] The prices that households pay are not directly linked to the wholesale price, but if an energy contract ended during the crisis or an energy supplier filed for insolvency, the households or renters affected had to conclude new contracts at higher prices. Moreover, prices in existing contracts were raised in some cases, if, for example, an energy supplier's procurement costs increased. This increase was not limited to gas; prices for other heating sources such as district heating and heating oil rose as well. The households analyzed in this Weekly Report paid an average of 42 percent higher heating energy prices in 2022 (Figure 1).

There were also intense public discussions about the possibility of gas shortages during the winter of 2022/23. As private households would be given priority in such an event, industrial production facilities would have been forced to shut down—with potentially damaging economic consequences. To prevent this, the European Union (EU) announced a

1 Cf. Franziska Holz et al., "Europa kann die Abhängigkeit von Russlands Gaslieferungen durch Diversifikation und Energiesparen senken," *DIW aktuell* no. 81 (2022) (in German; available online. Accessed on April 11, 2025. This applies to all other online sources in this report unless stated otherwise).

2 Alexander Roth and Felix Schmidt, "Not only a mild winter: German consumers change their behavior to save natural gas," *Joule* 7, no. 6 (2023): 1081–1086 (available online).

3 Bundesnetzagentur, "Bundesnetzagentur veröffentlicht Zahlen zur Gasversorgung 2022," press release from January 6, 2023 (in German; available online).

4 Cf. data on the website of the Federal Network Agency (in German; available online).

DOI: https://doi.org/10.18723/diw_dwr:2025-20-1

savings target of 15 percent.[5] The EU plan also envisaged encouraging private households, industry, and commerce alike to reduce gas consumption.[6]

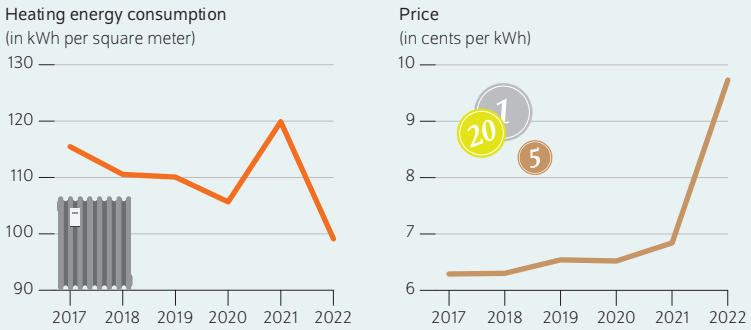
In June 2022, the Federal Ministry for Economic Affairs and Climate Action (*Bundesministerium für Wirtschaft und Klimaschutz*, BMWK) began a campaign together with many other organizations, calling for consumers to save energy and giving energy-saving tips.[7] In addition, other regulatory measures for saving energy in residential and commercial buildings, such as lowering the minimum and maximum temperatures and requiring the optimization of heating systems, were issued.[8] Although the energy crisis had been triggered by a gas shortage, the campaign focused on saving energy in general and reducing consumption of all energy sources due to high energy prices.

Policymakers were faced with a dilemma: On the one hand, they had to provide financial relief to private households due to the high price increases, but on the other, financial relief would reduce the pressure to save energy. The German Federal Government attempted to solve this dilemma with the energy price brake that was passed in December 2022 and came into effect in March 2023: The price brake applied to only 80 percent of predicted consumption and thus maintained incentives for saving energy.[9] In the end, Germany achieved the EU savings target, reducing its natural gas consumption by a total of 15.7 percent compared to the previous year.[10]

In retrospect, the question arises as to what share of the savings was due to higher prices and what share was due to non-monetary factors such as government appeals, public campaigns, and fears of a price increase.[11] To answer this question, we performed a causal analysis of annual heating bills from over 100,000 multi-family homes in Germany. This data was provided to DIW Berlin by the real estate service provider ista (Box 1).[12] The sample includes buildings that use district heating or gas between the period of 2017 to 2022.[13] These buildings saved around 16 percent in heating energy in 2022 compared to 2021.

Figure 1

Development of heating energy consumption and prices
In kilowatt hours per square meter and in cents per kilowatt hour



Note: Dataset from ista including buildings heated with gas or district heating. Heating energy consumption is not adjusted for temperature.

Sources: ista SE; authors' calculations.

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While heating energy prices experienced a sharp increase in 2022, heating energy consumption declined considerably.

Non-monetary savings considerably larger than price-driven savings

The large majority of the buildings observed (96.3 percent) were exposed to a price increase during the 2022 energy crisis. A small share of the buildings (3.7 percent) was not affected by these price increases because their supplier did not raise the prices of existing contracts in 2022. By comparing both groups, it is possible to determine the causal effect of the increase in energy prices on energy savings and to differentiate from the effect of other non-monetary factors.

To analyze how demand reacted to price changes and to calculate how much energy was saved for price reasons, a difference-in-differences strategy was used in combination with propensity score matching (Box 1). Furthermore, numerous other factors were considered, most importantly among them climate factors to control for the influence of temperature.

The results show that the group of buildings exposed to a price increase (price shock group) saved a statistically significant average of around two percentage points more heating energy than the control group not exposed to a price increase (Figure 2). This results in average price-driven savings of around two percent. Compared to average total savings of around 16 percent, only a relatively low share of the observed savings was actually due to higher prices. Thus,

5 Council of the European Union, "Council adopts regulation on reducing gas demand by 15 % this winter," press release from August 5, 2022 (available online).

6 European Commission, *Questions and Answers on the EU "Save Gas for a Safe Winter" Plan* (available online).

7 Federal Ministry for Economic Affairs and Climate Action, "Breites Bündnis ruft zum Energiesparen auf," press release from June 10, 2022 (in German; available online).

8 Cf. Verordnung zur Sicherung der Energieversorgung über kurzfristig wirksame Maßnahmen (*Kurzfristenergieversorgungssicherungsmaßnahmenverordnung*, EnSikuMaV) (in German; available online).

9 Bundesregierung, *Fragen und Antworten zu den Energiepreisbremsen* (2024) (in German; available online).

10 Cf. information on the *AG Energiebilanzen* website (in German; available online).

11 More details on the econometric analysis can be found in Sophie M. Behr, Till Köveker, and Merve Kücük, "Understanding Energy Savings in a Crisis: The Role of Prices and Non-monetary Factors," *DIW Discussion Paper* no. 2112 (2025) (available online).

12 For a more detailed description of the ista data, cf. Sophie M. Behr, Till Köveker, and Merve Kücük, "Wärmemonitor 2023: Trotz weiter gestiegener Preise sparen private Haushalte weniger Heizenergie," *DIW Wochenbericht* no. 45 (2021): 691–701 (in German; available online).

13 This analysis only includes gas and district heating. The data does not provide enough information to determine which households received the December relief for other heating sources, such as heating oil. Therefore, the heating energy prices that were actually paid in 2022 could not be determined accurately.

Box 1

Data and methodology

The analysis uses data provided by the real estate service provider ista SE. This data includes the annual building-specific heating bills of German multi-family buildings from 2017 to 2022. The heating bills contain information on energy and hot water consumption and billing periods, heating energy supply, energy costs, and the location and size of the buildings. The rounded heating energy prices are fuel costs only and do not include additional heating costs such as maintenance costs or costs for collecting consumption data. The one-off relief payment in December 2022 was included in calculating the final prices paid. Buildings that had lower energy prices in 2022 and buildings that underwent renovation or changed energy carriers during the observation period are not considered in the analysis. More than 140,000 buildings are contained in the dataset.

Regional climate factors from the German Weather Service are used to control for weather influences. The data on regional rates of working from home was provided by infas360 and is normalized by national working from home trends using data from Destatis.

Difference-in-differences approach with propensity score matching

The difference-in-differences approach is a statistical method to determining the causal effect of a treatment on a dependent variable. Two groups are created: A price shock group, which was exposed to the treatment of a price increase for heating energy during the crisis, and a control group that was not exposed to this treatment. To estimate the causal effect, the difference between the independent variable (in this case, heating energy consumption) before and after the treatment is first calculated for both groups. Subsequently, the difference of the price shock group is compared to the difference of the control group. The difference between these two differences is the causal effect. The analysis moreover controls for the influence of other factors such as weather, working from home rates, building condition, and calendar year.

The difference-in-differences approach is combined with propensity score matching to increase the comparability of the groups. First, an individual propensity that the building was exposed to a price increase during the energy crisis is estimated for each building based on multiple control variables (such as building size, energy consumption, and energy prices before the crisis). Then each building that was exposed to a price increase in 2022 is matched with a building from the control group that was not exposed to a price increase with a similar propensity score. Matching buildings that have a similar propensity of having been exposed to a price increase during the crisis ensures that the two buildings have as similar characteristics as possible. The difference-in-differences method is then conducted using this matched dataset.[1]

Predicting counterfactual energy consumption and estimating non-monetary savings

To calculate the non-monetary savings, counterfactual energy consumption in 2022 was estimated for buildings that were not exposed to a price increased during the energy crisis.[2] To do so, a lasso model (least absolute shrinkage and selection operator[3]) is trained on the data from the pre-crisis years to predict energy consumption using the building's energy consumption from the previous year as well as different variables that lead to short-term changes in consumption (such as weather and working from home rates). Price effects are excluded, as the prediction of counterfactual consumption is only done for the buildings with constant energy prices during the crisis. Effects from energy-related retrofits were also excluded by removing buildings from the dataset that underwent retrofits. For this group, the difference between the counterfactual and actual observed energy consumption is the estimate of the non-monetary savings.

1 Cf. Sophie M. Behr, Till Köveker, and Merve Kücük, "Understanding Energy Savings in a Crisis: The Role of Prices and Non-monetary Factors," *DIW Discussion Paper* no. 2112 (2025) (available online).

2 Cf. Behr, Köveker, and Kücük, "Understanding Energy Savings in a Crisis."

3 Robert Tibshirani, "Regression shrinkage and selection via the lasso," *Journal of the Royal Statistical Society Series B: Statistical Methodology* 58, no. 1 (1996): 267–288 (available online).

the majority of savings was a result of non-monetary factors such as public appeals, energy saving programs, or fears of higher prices. Moreover, non-crisis-related factors played a role, such as lower rates of employees working from home and the comparatively warm weather in 2022.

To calculate how much energy was saved due to non-monetary factors, a second method, a lasso model, first estimates the counterfactual energy consumption that would have occurred if the energy crisis had not happened (Box 1). Next, the difference between this counterfactual consumption and the actual consumption is calculated for the group that was not exposed to a price shock. This makes it possible to estimate the non-monetary savings. At around 8.5 percent, the non-monetary savings are around four times as high as the price-driven savings on average.

Short-run price elasticity of energy demand is relatively low

Using the estimated price-driven savings, we can determine the price elasticity of heating energy demand (Box 2). The price elasticity indicates how strongly demand responds to price changes. To calculate the price elasticity, the average

Box 2

Price elasticity of demand

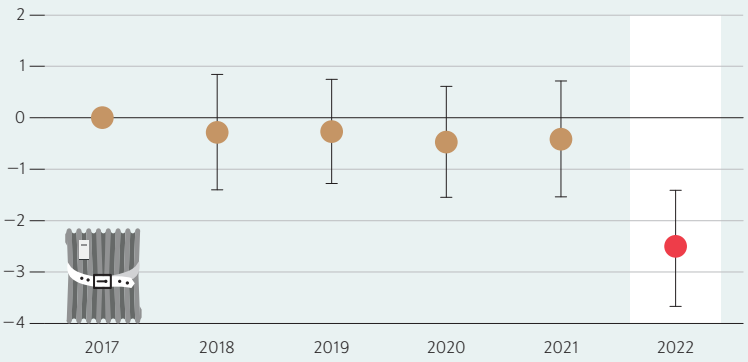
The price elasticity of demand is a measure for the responsiveness of the demand for a good to changes in its price. The price elasticity indicates by what percent demand changes when the price increases by one percent. As demand for a good usually declines when the price of that good rises, the price elasticity is negative in most cases. A price elasticity of −1 means that a one-percent increase in price leads to a one-percent decline in demand. A price elasticity between 0 and −1 means that a price increase of one percent leads to a lower percentage decrease in demand. A price elasticity that is smaller than −1 means that a price increase of one percent leads to a larger percentage decrease in demand. To determine the price elasticity of demand during the energy crisis, the midpoint formula of the arc price elasticity is used, i.e., the relative price change is calculated by dividing the price change between 2021 and 2022 by the average price for 2021 and 2022. The relative change in energy demand is calculated analogously.[1]

1 For a more detailed description of how price elasticity is calculated, cf. Behr, Köveker, and Kücük, "Understanding Energy Savings in a Crisis."

Figure 2

Development of heating energy consumption in buildings exposed to a price increase during the energy crisis compared to buildings not exposed to a price increase

Year-on-year price-induced change in energy consumption in percent in buildings exposed to a price increase[1]



1 The savings estimates are based on logarithmic energy consumption so that the results can be read approximately as percentages. The base year is 2017.

Notes: The vertical lines indicate the 95-percent confidence interval.

Sources: ista SE; authors' calculations.

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In 2022, over two percentage points more heating energy was saved in buildings exposed to a price increase than in buildings not exposed to a price increase.

price-driven savings (in percent) were divided by the average price increase (in percent) for the price shock group. The price-driven savings in percent are calculated as described above using the difference-in-differences approach. As households in buildings with constant prices during the energy crisis were exposed to the same non-monetary influences as households with a price shock, we can be sure that the estimated price elasticity is not distorted by savings due to non-monetary factors.

During the energy crisis, the short-term price elasticity of heating energy demand was –0.07.[14] This means that when the price increases by one percent, heating energy consumption declines by only 0.07 percent.[15] Considering the sharp decline in total heating energy consumption, the price elasticity seems to be low. This can be explained by the fact that private households saved energy during the crisis primarily because of warmer weather and non-monetary factors such as public appeals or the general discussion about high energy prices. The rather muted response to the price increases could also be due to the fact that Germany has high information frictions in the residential energy market: Many households only receive information about their consumption once a year when they receive their annual heating bill.[16]

For existing contracts, consumers must be informed in writing about price changes, but despite this, many households are not aware of the exact price they are paying for heating energy.[17] Moreover, the low price elasticity may also be due to the fact that some households had already exhausted their maximum savings potential before the energy crisis began. During the crisis, they could then only adjust their heating energy consumption to a limited extent.

Previous studies on the price elasticity of energy and gas demand during the 2022 energy crisis in Germany that do not account for these non-monetary factors in the statistical analysis result in price elasticities that are much higher.[18] In contrast, studies that include the non-monetary factors find price elasticities of a similar magnitude as the one estimated in this study.[19]

The major differences in the estimated price elasticities of energy demand between the studies makes it clear how important it is to consider non-monetary factors when

14 In this analysis, "short term" refers to a period of up to one year.

15 If the price is doubled (100 percent increase), demand decreases by seven percent.

16 The information requirements were expanded in 2022, but only applied to remotely readable devices.

17 Cf. Markus Dertwinkel-Kalt et al., "Household reduction of gas consumption in the energy crisis is not explained by individual economic incentives," *Proceedings of the National Academy of Sciences* 121, no. 48 (2024): e2411740121. (available online).

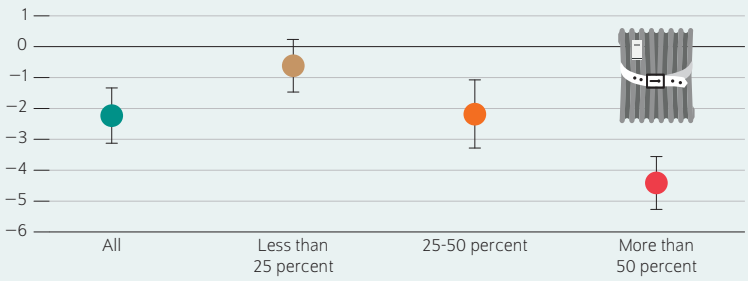
18 One study, for example, calculated a price elasticity for gas demand of at least 0.16 for small consumers (households and small businesses), cf. Oliver Ruhnau et al., "Natural gas savings in Germany during the 2022 energy crisis," *Nature Energy* 8, no. 6 (2023): 621–628 (available online).

19 Cf. David Jamissen et al., "The price elasticity of natural gas demand of small consumers in Germany during the energy crisis 2022," *Energy Efficiency* 17, no. 8 (2024): 98 (available online); cf. Dertwinkel-Kalt et al., "Household reduction of gas consumption in the energy crisis."

Figure 3

Price-driven savings in heating energy demand across different magnitudes of price increases in 2022

Year-on-year price-induced change in energy consumption in percent in buildings exposed to a price increase[1]



1 The savings estimates are based on logarithmic energy consumption so that the results can be read approximately as percentages.

Notes: The vertical lines indicate the 95-percent confidence interval.

Sources: ista SE; authors' calculations.

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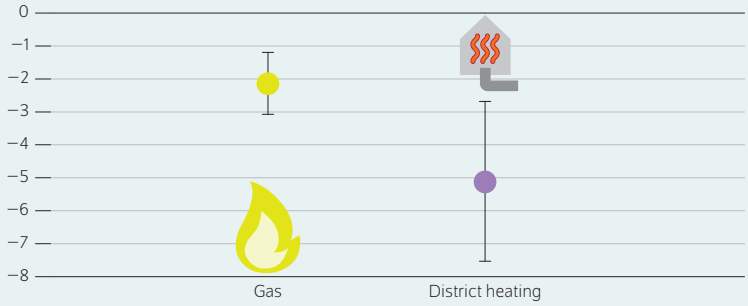
Households with higher price increases in 2022 saved more heating energy on average.

Figure 4

Price-adjusted heating energy savings by energy source in 2022

Year-on-year price-induced change in energy consumption in percent in buildings exposed to a price increase[1]



1 The savings estimates are based on logarithmic energy consumption so that the results can be read approximately as percentages. Notes: The vertical lines indicate the 95-percent confidence interval.

Sources: ista SE; authors' calculations.

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Significantly more heating energy was saved in buildings heated with district heating than in buildings heated with gas.

estimating energy price elasticities during crises. Moreover, it underscores the importance of non-monetary factors in achieving short-run energy savings. Non-monetary factors such as saving energy for political and/or solidarity reasons apparently had a more pronounced effect on short-run heating energy savings than the price hikes. Therefore, in future energy crises, appeals to save or information campaigns could be used even more strongly to achieve short-run reductions in energy consumption.

Savings increase with higher price increases

The price increases for heating energy during the energy crisis were many times greater than the usual price fluctuations of previous years. To understand how the amount of the price increase and the heating energy source influenced households' price-driven savings, the buildings in the dataset were divided into groups according to the magnitude of their price increase. Notably, we could only measure statistically significant short-term energy savings for households with relatively high price increases of more than 25 percent. There was no statistically significant effect for the group with low price increases of less than 25 percent (Figure 3). In the group with price increases between 25 and 50 percent, households saved around 2.2 percent due to the increase. The group with the largest price increases of more than 50 percent had the highest price-driven savings at 4.4 percent. Thus, the higher the price increase, the greater the savings. At –0.07, the price elasticity of heating energy demand is the same at for all three groups (even though it is not statistically significantly different from zero for the group with low price increases).

As expected, the results show that private households in Germany saved more when facing higher price increases. However, price-driven savings only made up a small share of the total savings. A significant effect on consumption is only noticeable for households that experienced a price increase of more than 25 percent. This could be due to a number of reasons, for example that some landlords did not adjust tenants' monthly advance payment if the price increase was minor. In this case, tenants would only have found out about these smaller price increases towards or after the end of 2022 in the mandatory information letters or their annual heating bill.

Price elasticity of district heating higher than price elasticity of gas

There are considerable differences in the price-driven savings when comparing gas and district heating (Figure 4) and in the price elasticity of the heating energy demand. Heating energy prices for gas and district heating increased similarly in the multi-family buildings observed, by 43 percent and by 40 percent respectively, in 2022. However, at an average of around two percent, price-driven savings in gas-heated buildings were considerably lower than in buildings that use district heating, where around five percent was saved due to price increases. Accordingly, there is also a difference in price elasticity: For district heating, it is –0.17, markedly higher than for gas at –0.06.

The higher price elasticity of district heating could be due to the fact, among other reasons, that there is usually only one local district heating provider. Thus, households with district heating are all exposed to the same price increase,

which can lead to better dissemination of information about price increases.

Conclusion: Non-monetary instruments need to be used to achieve energy savings

Energy prices skyrocketed following the Russian invasion of Ukraine in February 2022, resulting in an energy crisis. This Weekly Report analyzes to what extent the price increases and other non-monetary factors, such as government appeals and public campaigns, resulted in energy savings. Overall, the buildings analyzed saved 16 percent more heating energy in 2022 compared to 2021. Only a good two percentage points of this increase, however, were due to price increases.

The low average price elasticity of –0.07 shows that households do not respond much to price changes in the short run, even during the high price increases in 2022.[20] This could be for two reasons: For one, many households are not informed about their heating consumption and costs often enough. Therefore, information deficits should be reduced to ensure a better spread of information and make current prices and consumption clearer to private households. The amendment to the Heating Costs Ordinance (*Heizkostenabrechnungsverordnung*), which stipulates monthly consumption information from January 1, 2022, insofar as is technically possible, is a welcome step in this direction. Two, it could be that many households had already exhausted their savings potential before the crisis began.[21] Low-income households and tenants in particular are disproportionately affected by high heating energy costs.[22] At the same time, they have less leeway to react to price increases by refurbishing or renovating their homes, for example. Therefore, policymakers should consider providing relief to vulnerable households by implementing energy price caps or providing financial aid during future crises. These instruments can and should be designed to maintain saving incentives from energy prices (as it was done for the December emergency aid and the heat price brake in Germany).

Non-monetary factors were much more decisive for energy savings in 2022 than price increases: At 8.5 percentage points, the share of non-monetary factors was more than four times as high as the price-driven savings at only two percentage points. The rest of the savings are due to factors unrelated to the crisis, such as weather or higher rates of working from home. The current data cannot reveal in detail which non-monetary factors motivated private households to save. However, it is likely that government appeals to save energy to avert a gas shortage, political motivation due to the Russian invasion of Ukraine, and the general discussion about high energy prices all played a role. As non-monetary factors have proven to be effective in achieving short-term savings, non-monetary instruments such as public appeals and saving tips should be used again alongside monetary energy-saving incentives and targeted financial support in future energy crises.

20 In the long term, the price elasticity can be higher because energy-related renovations or a heating system exchange can be performed in this period.

21 Cf. Behr, Köveker, and Kücük, "Understanding Energy Savings in a Crisis," and cf. Lassi Ahlvik et al., "Household-Level Responses to the European Energy Crisis," *CEPR Discussion Paper* No. 19972 (2025) (available online).

22 Cf. Sophie Behr et al., "Thermal retrofitting of worst performing buildings mitigates risk of high heating costs," *DIW Weekly Report* no. 19/20 (2024): 139-145 (available online).

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