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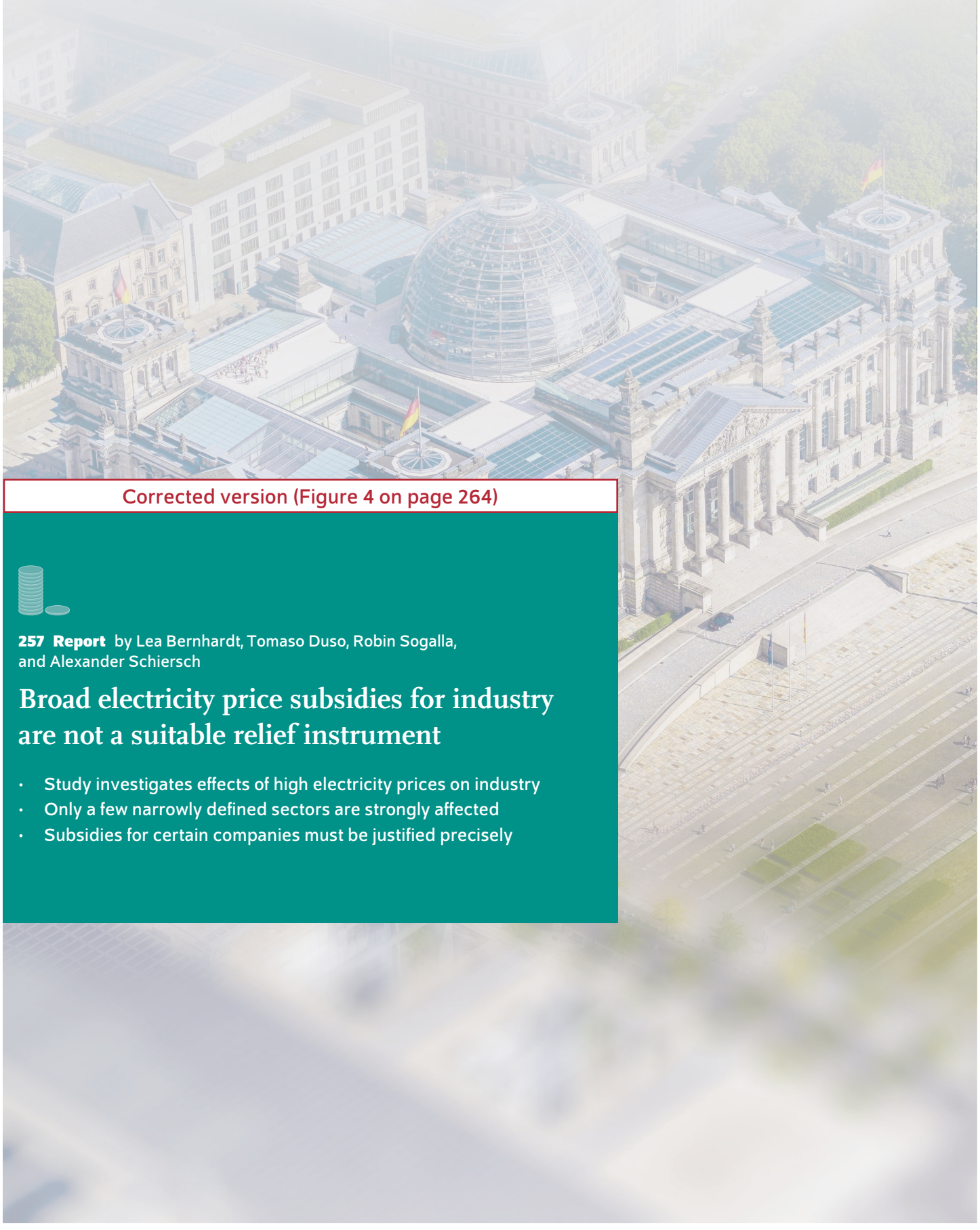

Corrected version (Figure 4 on page 264)

257 Report by Lea Bernhardt, Tomaso Duso, Robin Sogalla, and Alexander Schiersch

Broad electricity price subsidies for industry are not a suitable relief instrument

- Study investigates effects of high electricity prices on industry
- Only a few narrowly defined sectors are strongly affected
- Subsidies for certain companies must be justified precisely

LEGAL AND EDITORIAL DETAILS

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DIW Weekly Report 38+39 2023

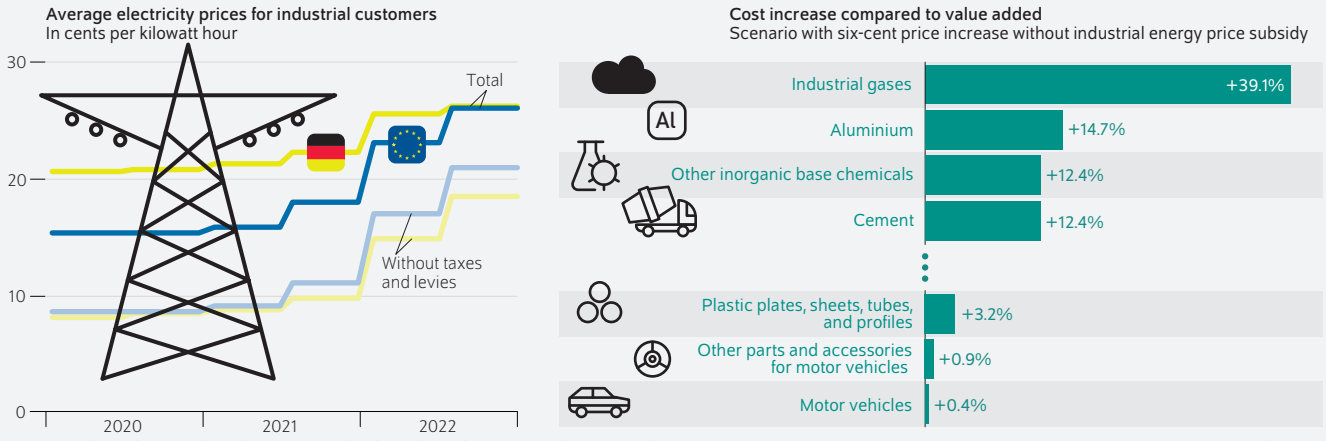
AT A GLANCE

Broad electricity price subsidies for industry are not a suitable relief instrument

By Lea Bernhardt, Tomaso Duso, Robin Sogalla, and Alexander Schiersch

- Electricity prices in Germany have risen significantly; for many firms, prices are at the European average but higher than in the USA
- Effects of increases in narrowly defined sectors would be severely affected; limited effect for large majority of companies
- Only a few companies in select sectors would be much more affected than the large majority of companies
- Electricity price subsidy of six ct per kWh could somewhat mitigate cost increases, but not eliminate them completely; temporary nature of the price subsidy is questionable for these industries
- Policymakers must give more precise reasons if they want to provide targeted relief to companies for strategic reasons

Industrial electricity prices in Germany have risen sharply, but remain around the European average; further price increases affect sectors to varying degrees



Source: Authors' depiction based on Eurostat data for industrial consumers (nrg_pc_205).

FROM THE AUTHORS

"Only a few subsectors and firms would be strongly affected by the electricity price increases. Whether and to what extent these subsectors should be subsidized requires a data-driven consideration of their strategic importance."

— Lea Bernhardt —

MEDIA

Audio Interview with Lea Bernhardt (in German)
www.diw.de/mediathek

Broad electricity price subsidies for industry are not a suitable relief instrument

By Lea Bernhardt, Tomaso Duso, Robin Sogalla, and Alexander Schiersch

ABSTRACT

The sharp rise in electricity prices has led to a discussion on possible subsidies for companies in the form of an industrial power tariff. The subsidies should help companies remain internationally competitive and prevent them from relocating overseas. Although German electricity prices for (industrial) firms are around the European average due to many tax exemptions, they are significantly higher compared to other non-European countries. Simulations using price increases of different magnitudes show that only a small share of companies would face major price increases compared to their value added. Moreover, there is considerable heterogeneity between the sectors. For example, the industrial gases or aluminum production sectors would be much more affected than other sectors. Thus, a large-scale industrial electricity price subsidy does not seem to be very effective. Selective relief for certain sectors may be problematic under competition law and may need to be granted well beyond the temporary nature of the subsidy.

Considering the persistently high energy prices in Germany, relief possibilities for especially energy-intensive companies are under discussion. Following a decade of relative stability, electricity prices have been rising over the past few years, both in Germany and in other EU countries.

Since the beginning of 2022 and the Russian invasion of Ukraine, the average electricity prices in Germany for industrial customers have peaked at over 25 cents per kilowatt hour (kWh) (Figure 1). The wholesale electricity price was 5.4 cents on average in 2018 and it reached a peak value of 46.5 cents per kWh in 2022. Since the beginning of 2023, wholesale electricity prices have sunk to around ten cents per kWh. The development on the futures market also shows that market expectations are for a price level of between eight and 15 cents per kWh.

Over the last years, industrial electricity prices have been above the European average. However, the effective prices for many (industrial) companies in Germany were below the European average due to numerous tax exemptions.[1] In addition to electricity tax relief through exemptions for certain transport companies or the tax rebate for electricity-intensive companies (*Spitzenausgleich*), there were far-reaching reductions in the surcharges for renewable energy sources until the end of 2022.[2] At the beginning of 2023, the *Energiefinanzierungsgesetz* (EnFG) came into effect, which replaced the *Besondere Ausgleichsregelung* (BeSAr) in the *Erneuerbare-Energien-Gesetz* (EEG).[3]

Nevertheless, several voices in the economic policy debate strongly advocate a state-subsidized industrial electricity power tariff to ensure the competitiveness and existence of

1 Cf. study including DIW Berlin authors: Paolo Bussirossi et al., *Energy and Environmental Guidelines (EEAG) Revision Support Study. Final Report* (2021) (available online; accessed on August 25, 2023. This applies to all other online sources in this report unless stated otherwise).

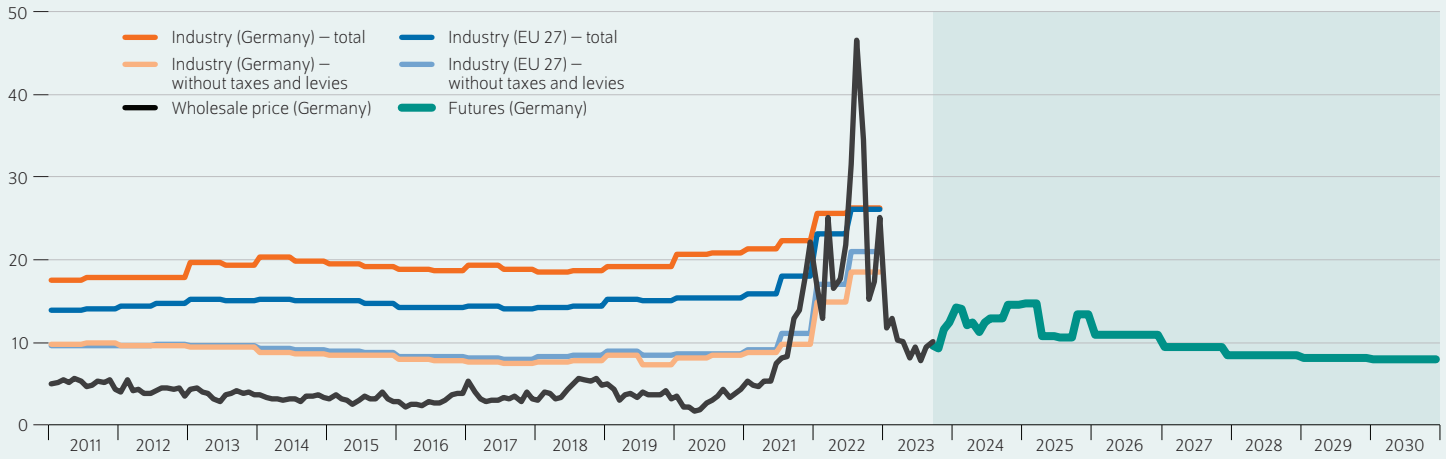
2 This subsidy is considered state aid and was approved as such by the EU Commission. The two central criteria for an exception from the EEG and KWK surcharges are energy intensity and trade intensity (see Bussirossi et al., *Energy and Environmental Guidelines*).

3 According to the BeSAr, companies with high electricity costs from internationally competitive sectors pay a reduced EEG surcharge. §§ 28 ff *Energiefinanzierungsgesetz* (2022) (in German); BGBl. I pgs. 1237, 1272 (2023) (in German); BGBl. I no. 202 (2023) (in German).

DOI: https://doi.org/10.18723/diw_dwr:2023-38-1

Figure 1

Average electricity prices for industrial customers, wholesale prices, and futures
In cent per kilowatt hour



Notes: The figure shows various electricity prices that are available at different time intervals. The electricity price for industrial customers shows the average electricity price for all consumer classes up to 150 gigawatt hours per six months. As the electricity prices per consumer class vary considerably, the average masks any potential heterogeneity. The wholesale prices show the volume-weighted average of the one day ahead prices at the monthly level. The futures show the Phelix DE Base Futures from September 4, 2023. These data are shown at the monthly level until June 2024 and at a quarterly or annual level thereafter.

Source: Authors' depiction based on Eurostat data for industrial consumers (nrg_pc_205), wholesale prices from Energy Charts, and futures from energate-messenger.at (in German; available online; downloaded on September 5, 2023).

In 2022, electricity prices in Germany and the entire European Union rose sharply.

vulnerable companies.[4] Without such relief for energy-intensive companies, according to the argument, there would be the risk they will relocate abroad, which could in turn lead to a loss in value added and jobs in Germany.[5] Yet these fears are not new: In 2014, the Federal Ministry for Economic Affairs warned of the threat of deindustrialization,[6] comparing German electricity prices with the markedly lower prices in the USA.[7] This concern is being raised again now more forcefully with the implementation of the US Inflation Reduction Act, which could lure energy-intensive manufacturing away from Germany.[8]

Thus, at the beginning of May 2023, the Federal Ministry for Economic Affairs and Climate Action (*Bundesministerium für Wirtschaft und Klimaschutz*, BMWK) presented a concept for implementing subsidized electricity prices for German industrial firms (Box 1).[9] This is meant to relieve particularly energy-intensive companies that are competing internationally.

The aim of this study is to contribute to the debate by providing new data-based evidence on the impact of higher electricity prices on the value added of German industrial firms.

Simulations on rising electricity costs show major differences between sectors

Although the economic policy discussion on the effects of a subsidized electricity price for industrial costumers is lively, it has relatively thin empirical support. Specifically, statistics are used at a highly aggregated industry level that neglect the considerable heterogeneity of firms even within the same sectors. However, empirical studies show that moderate changes in the electricity price do not have a negative effect on the competitiveness of the average company, but there are major differences between and within individual sectors.[10]

This study's empirical analyses use firm-level data from official statistics, the *AFiD-Panel Industrieunternehmen*, and the *AFiD-Modul Energieverwendung*. Using this data, the study simulates the costs that electricity-intensive industrial firms

4 Bundesverband der Deutschen Industrie e.V., *Wettbewerbsfähigkeit der Industrie in der Transformation sichern* (2023) (in German; available online).

5 Verband der Chemischen Industrie e.V., *Ja zum Industriestrompreis!* (2023) (in German).

6 Cf. information on the website of the Federal Ministry for Economic Affairs and Climate Action from March 24, 2014 (in German).

7 Currently, electricity prices in the USA are around 8 cents per kWh, cf. data from the website of the US Energy Information Administration.

8 Jens Südekum, "Was für den Industriestrompreis spricht," *Wirtschaftsdienst* 103, no. 8 (2023): 506–507 (in German).

9 Bundesministerium für Wirtschaft und Klimaschutz, *Wettbewerbsfähige Strompreise für die energieintensiven Unternehmen in Deutschland und Europa sicherstellen* (2023) (in German; available online).

10 Andreas Gerster and Stefan Lamp, "Energy Tax Exemptions and Industrial Production," *SSRN Working Paper* (2022) (available online); Katharine von Graveneitz and Elisa Rottner, "Do Manufacturing Plants Respond to Exogenous Changes in Electricity Prices? Evidence From Administrative Micro-Data," *ZEW Discussion Paper* no. 22-038 (2022); Kathrine von Graevenitz, Elisa Rottner, and Andreas Gerster, "Brückenstrompreis: Fehler aus der Vergangenheit fortführen?" *ZEW Policy Brief* (2023) (in German; available online).

Box 1

BMWK proposal

According to the BMWK, electricity prices could be reduced to six cents per kilowatt hour for 80 percent of consumption until the end of 2030 at the latest. This so-called bridge electricity price should be practically implemented by the reimbursement of the difference between the price on the electricity exchange and the electricity price cap of six cents. Moreover, a reference consumption determined via electricity consumption benchmarks, and not the actual consumption, is used. In the analysis, it is assumed that these benchmarks are based on historical electricity consumption, like it was done for the electricity and gas price brakes. The sum of the state's transfer payments to companies depends neither on the effective price paid nor on the actual consumption, so that an incentive to use as little electricity as possible remains.

To limit the circle of recipients, the BMWK wants to adhere to the *Besondere Ausgleichsregelung* (BesAR) from the EnFG. Accordingly, companies that operate in a specific subsector would be eligible to apply.[1] The potential group of recipients thus contains firms from over 100 branches, although only firms with electricity consumption over one gigawatt hour per year receive the relief.[2] In 2022, a total of 1,990 companies were relieved.[3]

One condition being discussed for this relief is an obligation on the part of companies to be climate-neutral by 2045 and to provide a location guarantee. The expenditure is to be financed from resources of the Economic Stabilization Fund in the amount of 25 to 30 billion euros. Subsidies are expected to amount to around 4.8 billion euros per year.[4]

1 See § 31 EnFG.

2 See lists 1 and 2 of the annex to § 31 EnFG.

3 Bundesamt für Wirtschaft und Ausfuhrkontrolle, *Hintergrundinformationen zur Besonderen Ausgleichsregelung. Antragsverfahren 2021 für Begrenzung der EEG-Umlage 2022* (2022) (in German; available online).

4 Wissenschaftlicher Beirat beim Bundesministerium der Finanzen, *Ein Industriestromtarif für Deutschland? Stellungnahme* (2023) (in German; available online).

in Germany would have to pay if electricity prices were significantly above the actual level in 2018 (Box 2).[11]

Different scenarios are simulated to show the effects of both a moderate and an extreme price increase. Scenarios I and II simulate the wholesale electricity price increases by six cents per kWh compared to 2018 (Table 1). As the average wholesale price in 2018 was 5.4 cents per kWh, the corresponding wholesale price in Scenarios I and II is 11.4 cents per kWh, which is slightly above the current wholesale price as well as the average expected future prices (Figure 1).

11 The base year is 2018, as this is the most recent year with AFiD data available.

Table

Scenario overview

Electricity price increase/ subsidy	No subsidy	Electricity price subsidy of 6 cents
6 cents per kilowatt hour	Scenario I	Scenario II
18 cents per kilowatt hour	Scenario III	Scenario II

Note: The Scenarios simulate a cost increase of six or 18 cents per kilowatt hour compared to 2018 with and without state subsidies.

Source: Authors' depiction.

Scenarios III and IV simulate an increase of 18 cents per kWh, reflecting the electricity price increase in 2022 to an average wholesale electricity price of 23 cents per kWh. As current wholesale electricity prices are significantly lower and the futures for 2024 indicate lower prices, this price increase is a rather unlikely extreme scenario.[12]

The wholesale electricity price increases are combined with assumptions about whether they will be passed on to downstream customers fully (Scenarios I and III) or offset by the industrial power tariff proposed by the BMWK (Scenarios II and IV). In this case, the companies would receive a payment in the amount of the difference between the respective wholesale electricity price and six cents multiplied by 80 percent of the company's historical electricity consumption (Box 1).

For further calculations, it is assumed that the companies recipient of the subsidy pass on 70 percent of the price increase to their customers without reducing their sales volume or changing their efficiency (Box 2).[13]

Results show a relatively small average cost increase, but also major differences between sectors

Taking a relatively highly aggregated view of different sectors (two-digit hierarchical level), the average cost increases vary widely, but even in the extreme scenario they are just over ten percent of their value added in only two sectors (Figure 2).[14]

Overall, the strongest effects are on paper and paperboard production as well as metal production and processing. With a cost increase of six cents per kWh without a subsidy and

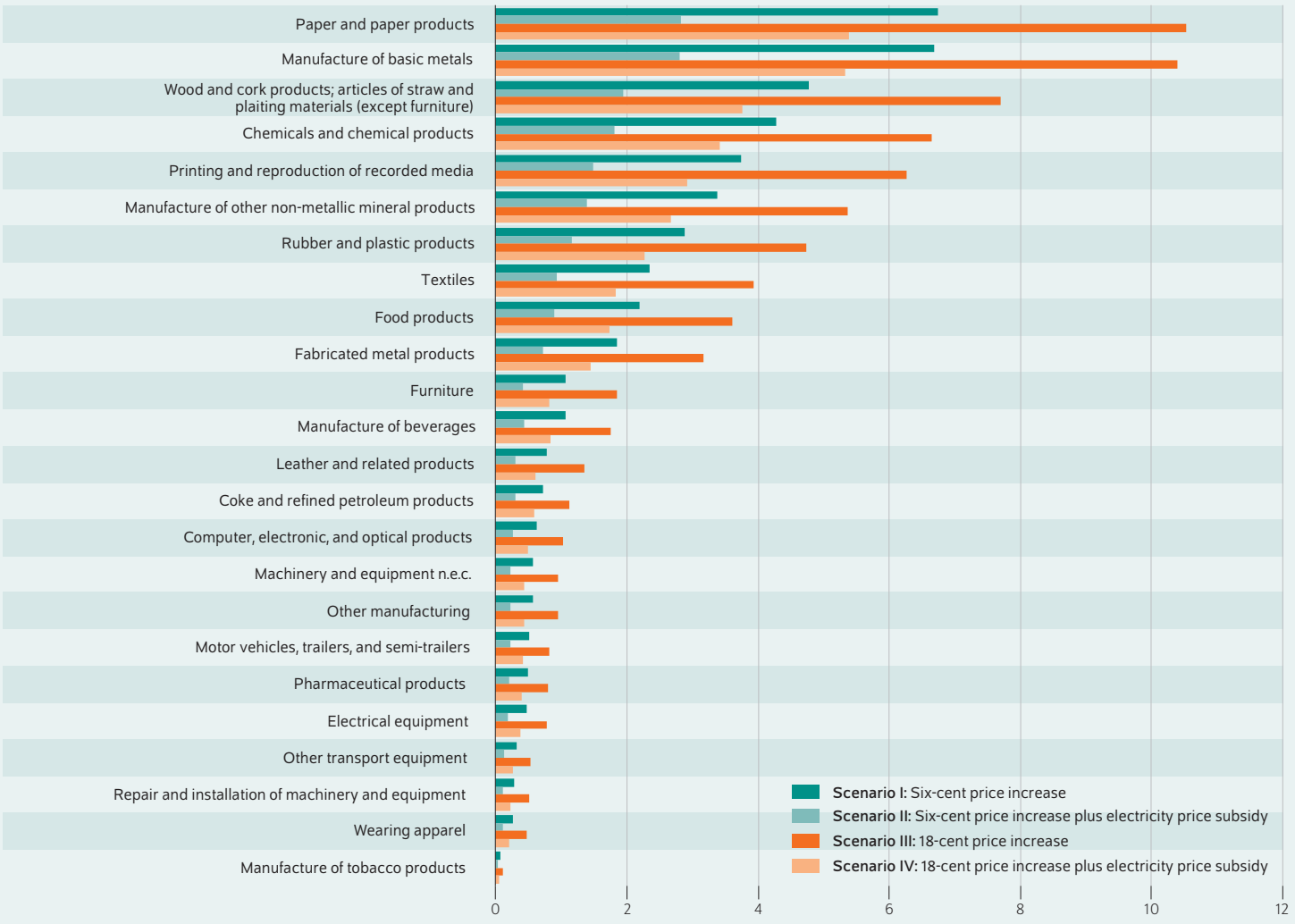
12 According to SMARD (electricity market data for Germany), the average wholesale electricity price was 9.2 cents per MWh in the second quarter of 2023 and 12 cents in the first quarter: SMARD, *Der Strommarkt im 1. Quartal: Großhandelsstrompreis gesunken* (2023) (in German; available online) and SMARD, *Der Strommarkt im 2. Quartal: Hohe PV-Einspeisung* (2023) (in German; available online).

13 A recent study from the USA estimates the cost pass-through rate of energy price increases to be around 70 percent; see Sharat Ganapati, Joseph S. Shapiro, and Reed Walker, "Energy Cost Pass-Through in US Manufacturing: Estimates and Implications for Carbon Taxes," *American Economic Journal: Applied Economics* (2020) (available online).

14 According to the classification by the Federal Statistical Office, economic sectors are divided into statistical units. For example, two-digit economic divisions have a more aggregated breakdown than four-digit economic sectors. Cf. Information on the website of the Federal Statistical Office. In the following sections, the terms "sector" and "subsector" are used as synonyms for economic divisions (two-digit) and economic classes (four-digit).

Figure 2

Cost increase compared to value added per sector with and without subsidies
In percent



Note: Average cost increase weighted by value added compared to the value added of individual companies at the two-digit hierarchical level.

Source: Depiction of authors' simulations using microdata from official statistics.

Cost increases vary depending on the sector. The sectors most affected are the paper, metal, and wood sectors.

passing on 70 percent to the customer, the value added of these sectors declines by nearly seven percent. The production of wood products and the chemical industry are affected the second most, with cost increases between four and five percent. For all other sectors, there are cost increases below four percent compared to value added. Even in the simulation of an extreme price increase of 18 cents per kWh, most sectors face lower cost increases of 0.1 percent to just under eight percent.

With a subsidized power tariff for industrial customers (Scenario II and IV), the cost increases are smaller, as expected. For example, the costs in the metal and paper industries would increase by less than three percent of value added if there was an electricity price increase of six cents per kWh. The industrial power tariff would roughly halve the cost increases for the most affected sectors.

Considerable heterogeneity also within the sectors using the most electricity

A more detailed analysis (four-digit economic sectors of the Federal Statistical Office) shows that there is considerable heterogeneity within the electricity-intensive sectors.[15]

15 Other potentially majorly affected subsectors are manufacture of pulp (17.11) and of paper and paperboard (17.12) as well as the manufacture of coke oven productions (19.10) and of refined petroleum products (19.20). However, the results cannot be shown due to data protection restrictions.

Box 2

Calculating the simulations

The empirical analyses are based on administrative firm level data. The data used here include the *AFiD-Panel Industrieunternehmen* as well as the *AFiD-Modul Energieverwendung*. Both data sources include all companies in Germany in manufacturing (section C) with 20 or more employees. The *AFiD-Panel Industrieunernehmen* includes the value added at the firm level as well as data on the cost structure of a representative sample, which makes it possible to calculate value added. The *AFiD-Modul Energieverwendung* provides information about electricity consumption. The base year for all calculations is 2018, as this is the most current year with data available.

The cost increase in the individual scenarios is calculated as follows: First, the price increase for company *i* with the exchange electricity price scenario *b* is calculated:

$$P^{new}_{i,b} = P^{Industrie}_{i,2018} + \Delta \mathrm{P}^{\mathrm{börse}}_{\mathrm{b}}$$

with $P^{Industrie}_{i,2018}$ as the electricity price that company *i* paid in 2018. As no company-specific electricity price is observed, the electricity price for the respective consumer group from Eurostat is used. $\Delta \mathrm{P}^{\mathrm{börse}}_{\mathrm{b}}$ is the increase in the exchange electricity price in each scenario, six or 18 cents per kWh, respectively.

The subsidy arising from the industrial power tariff is calculated as follows:

$$Sub_{i,b} = (P^{börse}_{2018} + \Delta \mathrm{P}^{\mathrm{börse}}_{\mathrm{b}} - 6ct) \times 0.8 \times verbrauch_{i,2018}$$

In the simulation the subsidy is calculated using a firm's historical consumption and not benchmarks for the most electricity-efficient companies.[1] For the exchange electricity price in 2018, $P^{börse}_{2018}$, the average price of 5.4 cents per kWh is used. This results in the following cost increase for company *i* after the subsidy is considered via the industrial power tariff,

$$CI_{i,b,p} = (P^{new}_{i,b} - P^{Industrie}_{i,2018}) \times verbrauch_{i,2018} - Sub_{i,b}$$

Finally, the new value added is calculated under the assumption that companies can pass on 70 percent of the cost increase and thus bear only 30 percent of the cost increase. This results in the new value added:

$$WS^{new}_{i,b,p,c} = (1 + 70\% \times \frac{CI_{i,b,p}}{P^{Industrie}_{i,2018} \times verbrauch_{i,2018}}) \times WS_{i,2018}$$

The value added is defined as sales minus all advance services.

In the absence of detailed data and estimates, the calculation abstracts from some aspects. First, it does not take into account that companies could partially substitute their electricity use with other inputs as a result of higher electricity prices. As the calculations exclude this, the cost increase is potentially overestimated. Second, the price increases for downstream electricity-intensive products are not considered. Through this value chain effect, the costs for downstream sectors increase more than in the scenarios calculated here.

1 The BMWK cites the use of electricity consumption benchmarks in the proposal. However, it is unclear whether this refers to historical consumption or benchmarks related to the most efficient companies.

While the cost increases for the chemical sector are the fourth largest, (Figure 2), the industrial gas production subsector shows the greatest cost increase by far with a share of nearly 40 percent of value added in Scenario I (Figure 3).[16] With an electricity price subsidy, the increase would fall to nearly 17 percent. Overall, the subsidized prices could curb the cost increases for the very electricity-intensive subsectors, but it could not completely relieve the companies.

Other subsectors in the chemical industry show significantly lower cost increases. In Scenario I, the cost increase is 12 percent of value added for inorganic chemical production and six percent for fertilizer as well as plastics in primary forms. For all other subsectors in the chemical industry, the cost increase corresponds to a loss of value added of less than five percent.

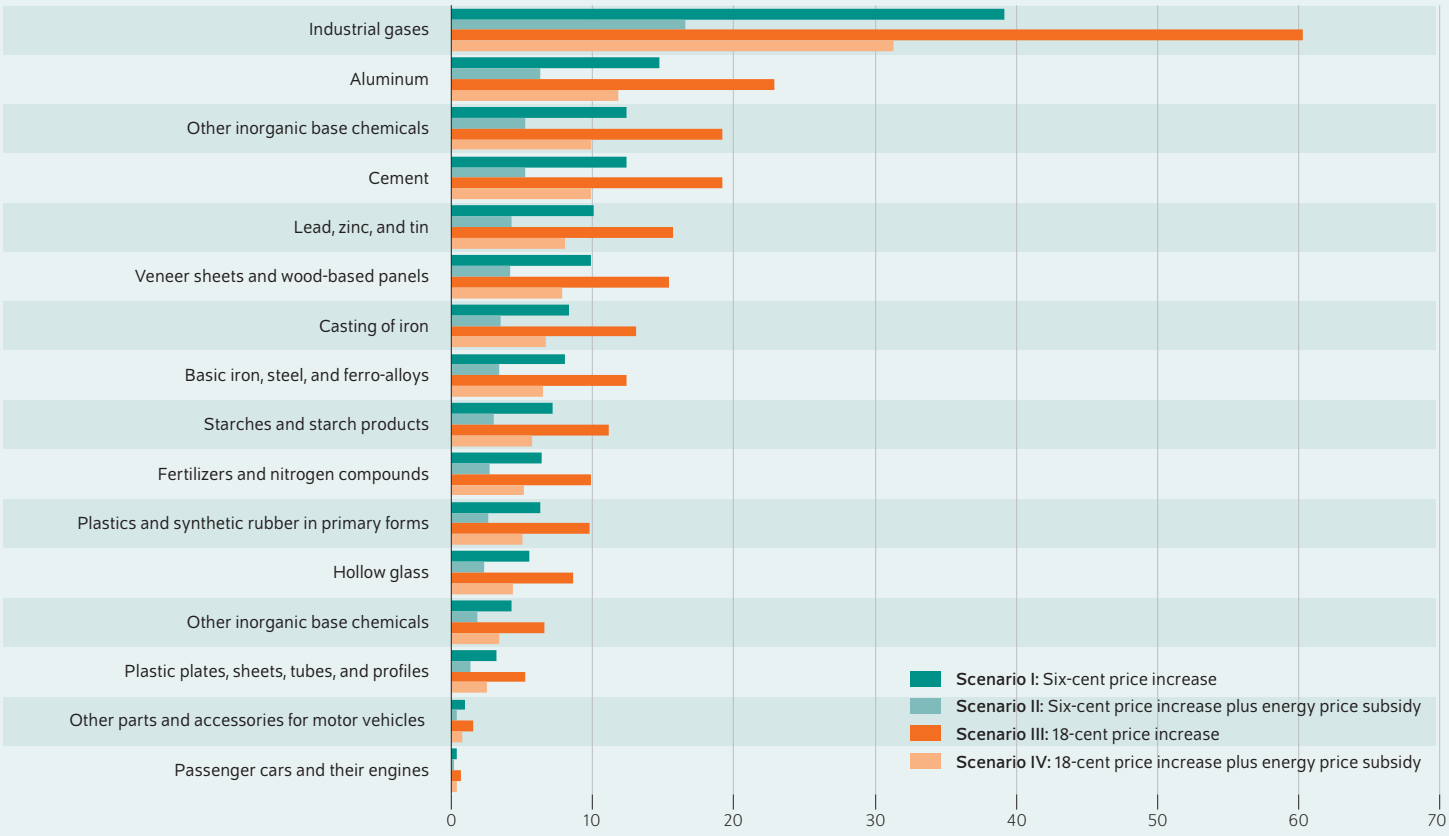
There are also major differences between the subsectors in metal production. The particularly electricity-intensive aluminum industry has the largest cost increase. With a six-cent increase in the electricity price, the costs increase by 15 percent of value added without the industrial electricity price subsidy (compared to six percent with subsidies) and by 23 percent (compared to 12 percent with subsidies) with an 18-cent increase. The production of lead, zinc, and tin also shows a cost increase of over ten percent of value added in Scenario I, while the cost increase is eight percent for basic iron, steel, and ferro-alloy production as well as iron foundries.

Except for the cement industry and wood panel production, all other industries listed have cost increases of under ten percent (15 percent) at a price increase of six cents (18 cents) without subsidies or increases by zero (one) to three (six) percent with a subsidized industrial electricity price.

16 Industrial gases include, for example, acetylene, carbon dioxide, and hydrogen, gases obtained in chemical processes.

Figure 3

Cost increase compared to value added for selected subsectors by scenario
In percent



Note: Average cost increase weighted by value added compared to the value added of individual companies at the four-digit hierarchical level.

Source: Depiction of authors' simulations using microdata from official statistics.

The subsectors of industrial gases, aluminum production, and inorganic base chemicals have the largest increases.

Few companies within subsectors affected significantly

The largest cost increases with a price increase of six cents per kWh are in the paper and paperboard production sector, with a median value of six percent but a large fluctuation margin with some upward outliers (Figure 4).[17] The situation is the same for basic iron, steel, and ferro-alloys. Here, too, the high average value of the cost increase is driven by less affected firms.

Particularly affected subsectors have low share of industrial value added

The subsectors are again juxtaposed to compare the effect of cost increases with the share of industrial value added and electricity consumption (Figure 5).[18]

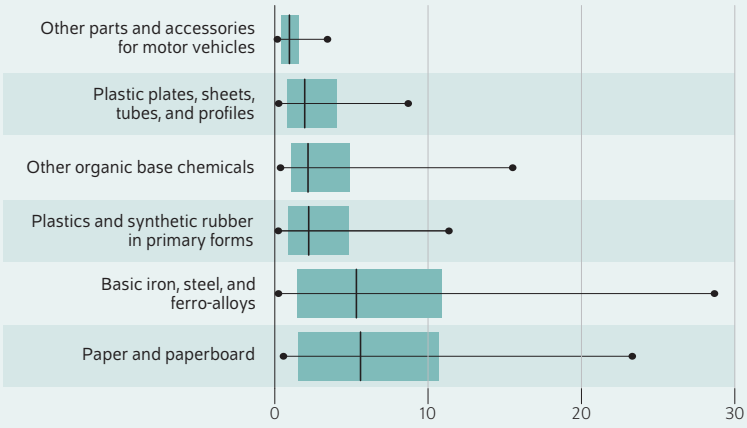
The subsector of basic iron, steel, and ferro-alloy production has the highest share of industrial electricity consumption at nearly nine percent, followed by other organic base chemicals with eight percent. These two subsectors, however, only contribute marginally to industrial value added (two and three percent). The industrial gases sector, which faces the highest cost increase, has a share of just 0.9 percent industrial value added. With a share of industrial electricity consumption of 2.46 percent, it is among the average of the industries observed.

17 The subsectors shown in Figure 4 were selected based on data availability. Due to data protection restrictions, the distribution cannot be shown for all subsectors in Figure 3.

18 Subsectors are selected according to available data. Due to data protection restrictions, a complete figure is not possible.

Figure 4

Distribution of cost increases compared to value added
In percent; for an electricity price increase of six cents per kilowatt hour for selected subsectors



Notes: The 25th percentile is at the left end of each box and the 75th at the right end. For half of the companies, the electricity price increase is in the range marked by the box. The solid vertical line shows the median, meaning that 50 percent of the companies in the sector have a higher electricity price increase and the other half a lower increase. The thin lines outside the boxes are the whiskers. The right boundary represents the 95th percentile, the left the 5th percentile, meaning that 90 percent of the companies within a sector record a cost increase in this area.

Source: Depiction of authors' simulations using microdata from official statistics.

Sharp cost increases are concentrated in a few companies within one subsector.

However, the subsectors mentioned above supply basic materials for many downstream industries. Therefore, business representatives often argue that the relocation of energy-intensive basic industries also leads to a loss of downstream industries with higher value added.[19] However, due to a lack of data availability, there is no robust evidence for this effect along the value chain.

Conclusion: Large-scale industrial power tariff for industry is not a suitable instrument

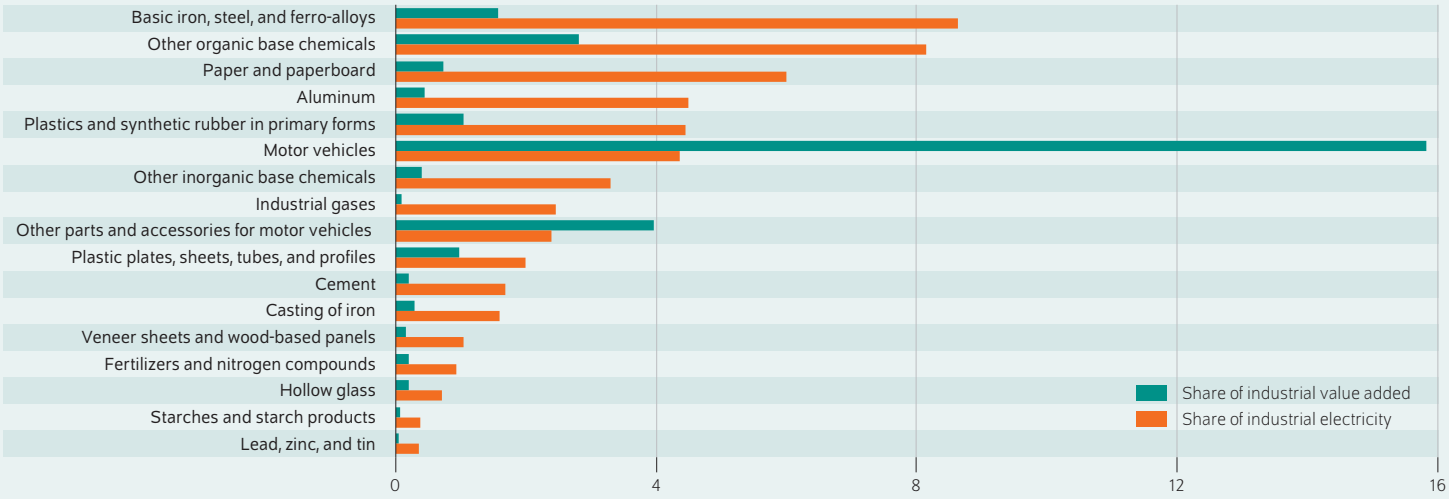
Considering the simulation results, the industrial power tariff under discussion does not appear to be a suitable instrument. Although the BMWK proposal correctly narrows down the circle of recipients based on the BeSAr, the political discussion often favors a wider group of recipients. Moreover, according to the BMWK proposal, companies from over 100 subsectors could potentially benefit from an industrial electricity price cap (see Box 1).

The simulation results show that the number of subsectors particularly affected by an electricity price increase is significantly lower. Additionally, the simulated price increases lead to no major cost increases compared to value added for many companies within this subsector. Only some indsutrial

19 IW Consult, *Fiskalischer Impact der Energieintensiven Industrien in Deutschland* (2023) (in German; available online).

Figure 5

Share of industrial value added and electricity consumption of selected subsectors
In percent



Note: Four-digit hierarchical level.

Source: Microdata from the official statistics.

The basic iron, steel, and ferro-alloys sector has the highest share of industrial electricity consumption, but its value added is comparatively low.

firms in few narrowly defined subsectors face a large cost shock. Moreover, a subsidy for industrial electricity prices would dampen cost increases for these very electricity-intensive subsectors but would not entirely relieve the firms.

An alternative form of relief, such as the abolition of the electricity tax in Germany as proposed by the Advisory Board to the Federal Ministry of Finance,[20] could probably be legally implemented.[21] Compared to the estimated costs of 4.8 billion euros for the subsidized industrial electricity prices, abolishing the tax would be expensive, yet, at the same time, it would benefit all companies and all consumers. Such broad relief would not be very targeted, but it would be more easily compatible with EU state aid law compared to the subsidy for industrial electricity prices.

Finally, the temporary nature of the subsidy should be also called into question. It is highly likely that Germany will not have the cheapest electricity prices in Europe and worldwide over the long term. A subsidized electricity price designed as a bridge electricity price only until 2030 thus appears unrealistic. Some energy-intensive industries will continue to face competition disadvantages. A thorough consideration may therefore be necessary to determine whether at all and, if so, which key sectors or companies are really of strategic importance and could therefore be supported with long-term subsidies.

This question should be answered using data-driven analyses that measure the significance of certain key sectors for national value chains. Only then can politicians decide to support these sectors in their transition to climate neutrality and beyond. Whether a bridge price or a price subsidy is the right instrument for this remains debatable. A major wave of relocation is not to be expected even without a subsidy for industrial electricity prices and even if the transition to climate-neutral production will pose challenges for a few industrial companies and some may no longer be able to produce in Germany.

20 Wissenschaftlicher Beirat beim Bundesministerium der Finanzen, *Ein Industriestromtarif für Deutschland? Stellungnahme* (2023) (in German; available online).

21 Cf. Information on the website of the Federal Ministry of Finance.

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