REPORT

# Regional reduction of grid charges during periods of strong winds

## A proposal for the temporal and regional differentiation of grid charges

This is a machine translated version of a study originally published in German. The original is available at https://www.agora-energiewende.de/publikationen/windstrom-nutzen-statt-abregeln

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Authors:
Anselm Eicke (eicke@neon.energy)
Lion Hirth (hirth@neon.energy)

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Neon Neue Energieökonomik is an energy industry consultancy based in Berlin. As a boutique, we have specialized in sophisticated quantitative and economic-theoretical analyses of the electricity market since 2014. With consulting projects, studies and training courses, we support decision-makers with the current challenges and future issues of the energy transition. Our clients include governments, regulatory authorities, grid operators, energy suppliers and electricity traders from Germany and Europe.

Contact:

Neon Neue Energieökonomik GmbH
Karl-Marx-Platz 12
12043 Berlin

Prof. Dr. Lion Hirth
hirth@neon.energy
+49 157-55 199 715

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# 1 Brief description of the instrument

This short study presents a new instrument for the use of otherwise curtailed renewable electricity: In periods and regions where substantial curtailment of renewable energy is expected, grid operators reduce the grid charges. This creates a financial incentive for regional consumption of electricity instead of curtailment. Since, according to the proposal, all load metered consumers (generally with an annual consumption of over 100,000 kilowatt hours) benefit from the fee reduction, there are no incentives for strategic bidding such as inc-dec gaming; however, consumers who do not adjust their behavior also benefit (deadweight effect).

The instrument offers a range of conceivable design options. For example, the question arises as to which consumers can benefit from reduced grid fees, in which radius of regulated installations the grid fees are reduced and how the instrument is to be financed. The options differ in terms of their practicability and feasibility. In the event of an introduction, the parameters should be continuously evaluated and adjusted over time, as it can be assumed that the load-related reactions will initially be limited, but will increase over time.

The instrument was modeled as an example for the Schleswig-Holstein and Hamburg region. According to the estimates made, a reduction in grid fees, as proposed below, would result in around 18 percent of the otherwise curtailed electricity being used for curtailments of renewable energies above 500 MW.

Recommendation: In addition to the positive effect on curtailments, this instrument represents an introduction to the dynamization of grid charges and the grid-friendly flexibilization of demand.

# 2 (Lack of) local signals in the German electricity market

The expansion of the electricity grids cannot keep pace with the rapid expansion of renewable energies in Germany. This results in structural grid bottlenecks, which means that renewable energy plants regularly have to be curtailed. In 2022, for example, eight terawatt hours of electricity from renewable energies were curtailed because it could not be transported to consumers due to grid bottlenecks[1] (). This corresponds to 3.1 percent of renewable generation. Over 92 percent of the curtailed electricity comes from wind turbines. The resulting compensation payments amounted to around 900 million euros, which are passed on to end consumers via the grid fees.

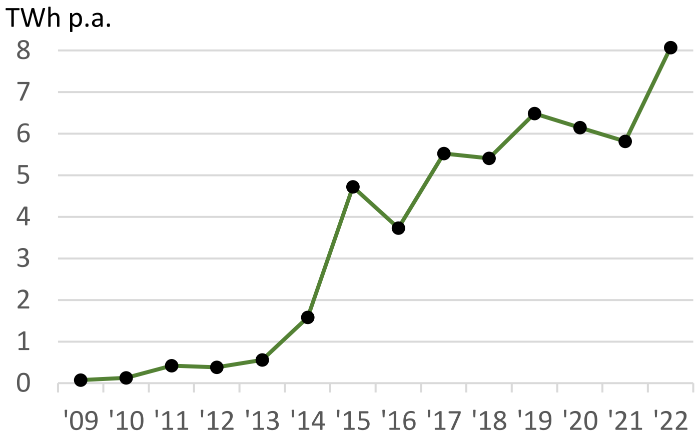


Figure 1. Curtailment of renewable energies in Germany

The German wholesale market with its uniform electricity bidding zone, which results in a uniform market price for the whole of Germany, offers no economic incentive to use the otherwise regulated electricity locally, as the local effect of an oversupply does not lead to a local price advantage. Although a division of the German bidding zone or even the long-term transition to nodal prices is discussed on a regular basis, it is unclear whether and when changes will occur.

Against this backdrop, the question arises as to how corresponding incentives can be created if and as long as no regional price signals arise from the wholesale market. In principle, there are a number of instruments that can provide local signals independently of the wholesale market (Figure 2).

This brief study focuses on local signals through grid usage fees. The signals result from a spatial and possibly also temporal differentiation of grid charges. The grid charges are

[1] Report by the Federal Network Agency on grid congestion management (July 2023)

parameterized by the grid operator and therefore do not result from the local, momentary balance of supply and demand. It is therefore in the nature of things that these prices can only approximate congestion. For example, time-variable grid charges generally only differ within a few time steps, which are also set well in advance and apply to the entire distribution grid.

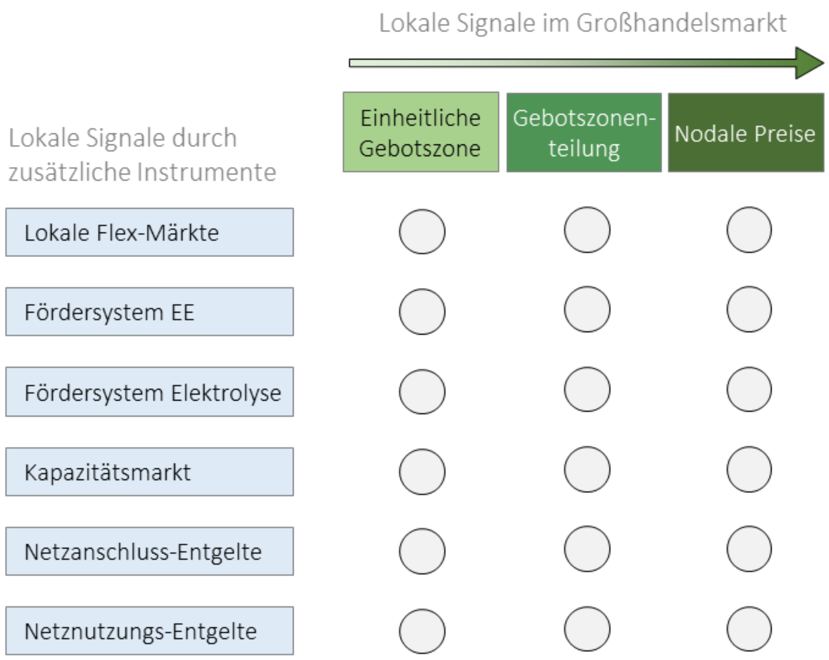


Figure 2. Possible sources of local incentives in the electricity sector

# 3 Barriers to flexibility for large customers due to the current grid fee structure

The current grid fee structure creates incentives for inflexible consumption behavior and thus a rigid consumption system design, which is contrary to the use of otherwise regulated electricity. For the group of large consumers, these incentives result on the one hand from the discounting of grid charges in accordance with §19 StromNEV and on the other hand from the capacity charges that apply to the individual peak load per year. This section explains the extent to which these two elements make additional electricity consumption more expensive in some hours.

## 3.1 Discounting of grid fees in accordance with §19 StromNEV

§19 StromNEV defines a number of reasons when reduced grid fees apply. Of these, the two listed in paragraph 2 are particularly relevant in practice. Consumers with atypical or uniform grid usage receive a reduction in grid fees of up to 90%.

- Atypical grid usage occurs when the individual annual peak load is outside of the grid peak load time windows defined by the grid operator, for example in summer or at night. Customers then receive a discount of up to 80% on the grid fees.
- Even grid usage is deemed to exist if customers have at least 7,000 hours of use[2]. Customers with an annual consumption of ten gigawatt hours or more then receive a discount on the grid fees of up to 80 percent. If the hours of use exceed 8,000, the discount can even increase to up to 90 percent. In practice, these maximum possible reductions are also utilized by the grid operators.

These exemptions are used to a considerable extent. According to the Federal Network Agency's monitoring report, such an individual grid fee was applied to 70 terawatt hours of annual consumption in 2021, which corresponds to almost a third of industrial electricity consumption. The discount volume amounted to 800 million euros, more than twice as much as five years previously. Numerous consulting firms have specialized in using combined heat and power plants and battery storage behind the metering point to raise the hours of use of large

[2] The hours of use are defined as the quotient of annual energy consumption and peak load. High hours of use therefore describe a rather even electricity consumption, whereas low hours of use characterize a consumption profile with high peak loads.

consumers above the thresholds of the exemption rules. In many companies, one of the main tasks of energy management is to keep electricity consumption as constant as possible in order to benefit from the rebates.

## 3.2 Billing system for grid fees

The structure of the grid charges itself also creates incentives for inflexible system design, which is reinforced by the discount for even grid usage. Figure 3 shows the grid charges per megawatt hour of electricity consumption using the example of a major customer in Berlin. With a flexible system design with fluctuating electricity consumption and consequently low usage hours, the grid charges are significantly higher than with a design with high usage hours and therefore inflexible base load operation. In the example chosen, the consumer with 100 hours of use pays 32 times higher grid charges per megawatt hour than a consumer who consumes the same amount of electricity every hour of the year and therefore has 8,760 hours of use.

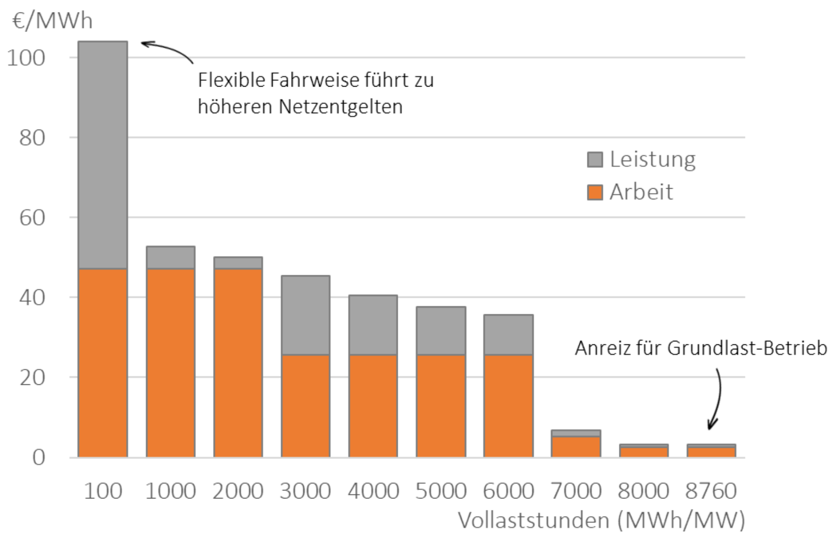


Figure 3. Grid charges for different hours of use for large customers in Berlin connected to the medium voltage grid (incl. discount for uniform grid use for over 7000 hours of use).

In addition to these fundamentally higher grid charges for flexible consumers, the grid charges incurred for an additional ("marginal") megawatt hour vary greatly within the year. In fact, there are two price levels: If electricity is purchased below the peak load, only the energy charge is due, as the power payment is determined by another hour. However, if the current electricity consumption is already at peak load, an increase in consumption leads to a higher demand payment. In other words: in these hours, the marginal grid charges due for an increase in consumption are much higher. This is a further incentive to keep consumption as even as possible.

Example: The following example of an industrial company in Berlin with a connection to the medium voltage illustrates this. Assuming that the company has the same electricity consumption every day as shown in Figure 4 (left)**Fehler! Verweisquelle konnte nicht gefunden werden.**

shown on the left. If electricity consumption increases in the morning, evening or night, only the energy charge of around €26 per megawatt hour (MWh) has to be paid. However, if the daily consumption increases evenly across all hours with peak load consumption (in the example, this is 2,920 hours, daily from 9 a.m. to 5 p.m.), a higher performance payment is due. In the example, the marginal grid charges per megawatt hour then increase to around 46 euros. So if the company increases its electricity consumption by 1 MW for every night hour of the year by introducing a new night shift, this will cost grid fees of 26 €/MWh; with a day shift, on the other hand, it would be 46 €/MWh. From this perspective, the company is already subject to a de facto time-of-use grid fee that fluctuates over the course of the day - except that the high-price window depends solely on the time of the individual peak load and is therefore unrelated to the grid load.

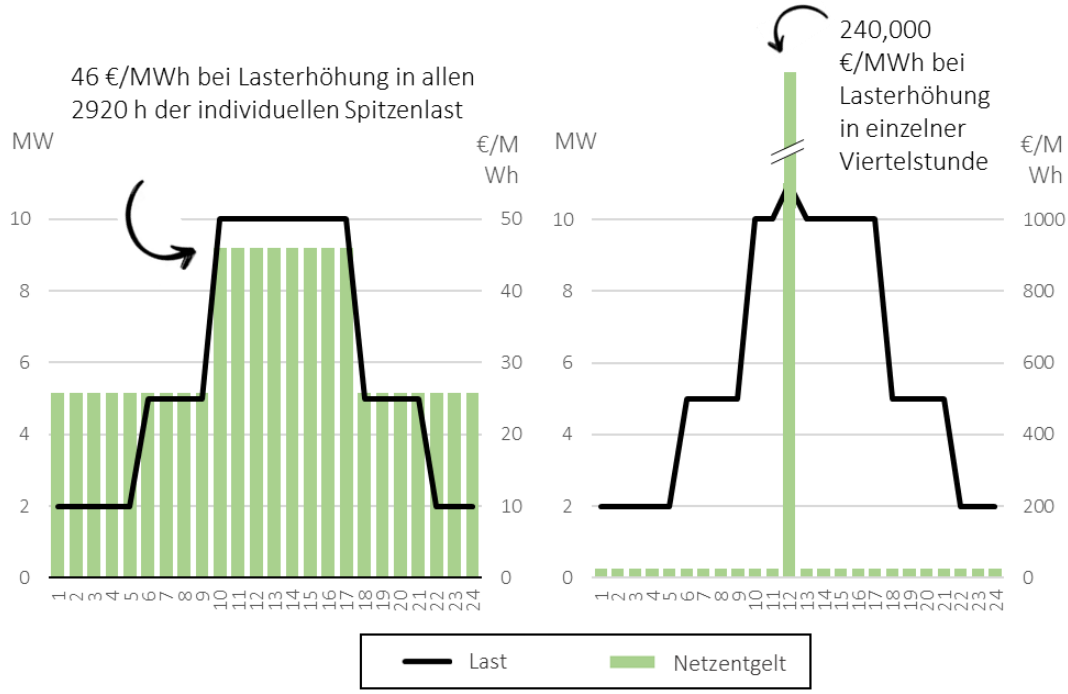


Figure 4. Grid charges for the consumption of an additional megawatt hour over the course of the day with a load increase over the year (left) and with a load increase in a quarter of an hour (right) (example)

## 3.3 Summary of the barriers to flexibility

If there is not a uniform increase in electricity consumption, but rather a flexibility provision in the form of a short-term increase in consumption, the differences in the effective grid charges are almost bizarrely high. If a consumer consumes an additional megawatt hour in just a single quarter of an hour, the capacity charge for an additional 4 megawatts must be paid; in Berlin's medium-voltage grid, this amounts to almost EUR 240,000 (see Figure 4right). The effective grid charge here is therefore just under 240,000 euros per megawatt hour - that is almost ten thousand times more than has to be paid for the energy charge. Even if the additional megawatt hour consumed is spread over 100 hours, the additional costs for the additional megawatt hour still amount to 600 euros, i.e. 20 times more than the energy charge. This example shows that it is practically never worthwhile for large customers with hourly measured and recorded consumption (German: "Registrierende Leistungsmessung")[3] in the current grid charge design to increase their electricity consumption beyond the peak output in order to consume electricity that would otherwise be curtailed, simply because of the capacity charges.

In summary, it can be said that the current grid fee structure systematically encourages the inflexible design of systems and processes. Electricity consumption that is as uniform as possible is favored by the extremely high costs of new power peaks and the incentives of massive discounts within the framework of uniform grid usage in accordance with §19 StromNEV. Capacity charges based on individual peak loads lead to bizarrely high marginal costs if consumers only increase their electricity consumption in individual hours. Industrial flexibility in the sense of using electricity at negative exchange prices or "using instead of curtailing" is thus prevented. The instrument proposed here circumvents these barriers to flexibility and creates incentives for electricity consumption that relieves the burden on the transmission grid through time-variable grid charges.

[3] RLM stands for hourly measured and recorded consumption. Consumption points with an annual consumption of over 100,000 kWh are obliged by the Electricity Grid Access Ordinance (StromNZV) to have hourly measured and recorded consumption (German: "Registrierende Leistungsmessung"). These are usually large companies and industry. Consumption is measured continuously here.

# 4 The instrument

## 4.1 Objective

The concept proposed here pursues four interrelated objectives: **Firstly**, the curtailment of renewable electricity due to grid bottlenecks is to be reduced. It should be noted that, from an economic point of view, avoiding curtailment is not an end in itself. **Secondly, the focus is** therefore on the use of the otherwise curtailed electricity. The aim is to enable local green value creation, which does not take place in the current market design. The additional electricity consumption can also substitute the alternative use of fossil resources, for example through the use of power-to-heat plants instead of fossil heat generation. **Thirdly,** the "economically correct" price of electricity at the time of and in regions with local curtailment is zero, but this is not reflected in the trading prices. With the situational reduction in grid charges, the proposal brings end customer prices closer to economically efficient prices. **Fourthly** and finally, the proposal is also the first step towards load-side grid flexibility.

The proposal can accelerate the development of technology and business models as well as investments in flexibility. Its introduction in the form of a pilot project, as an innovation policy for the flexibility ecosystem, is therefore a good idea. In this way, the regional reduction of grid charges during periods of strong wind can contribute to the broad flexibilization of demand.

## 4.2 Basic principle

The proposal is to set grid-friendly incentives for the consumption of electricity through time-variable grid fees. Specifically, grid fees are to be reduced or suspended in times and regions when a particularly large number of renewable plants have to be curtailed due to bottlenecks in the transmission grid. This is particularly the case during periods of strong winds. The reduction in grid fees creates incentives to consume the otherwise curtailed renewable electricity. It is therefore an incentive-based, voluntary instrument for "use instead of curtailment" without new intervention rights for grid operators (Figure 5).

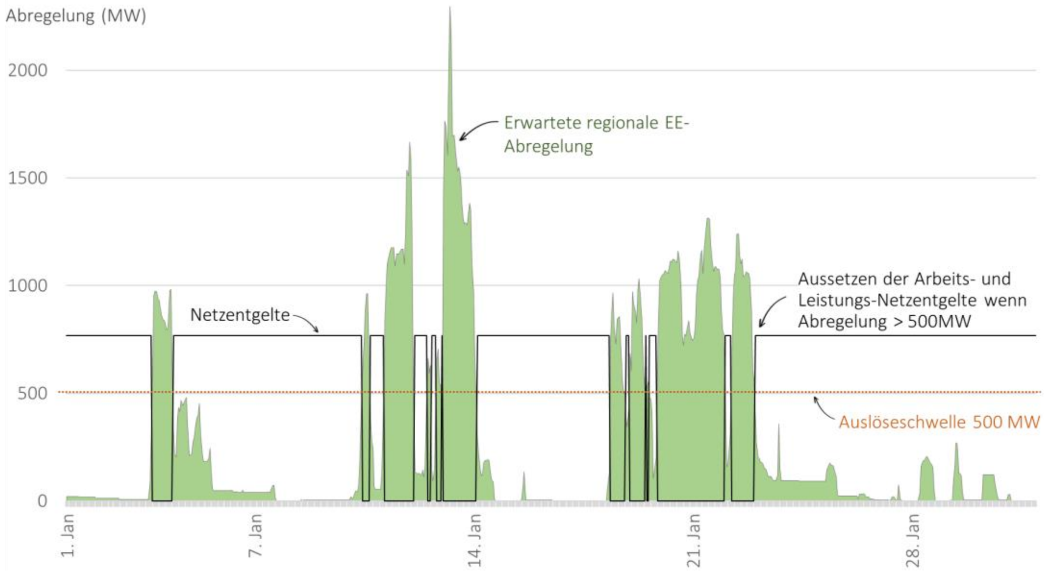


Figure 5. Regional reduction of grid charges in times of high expected curtailment of renewable energies (illustration).

Many instruments in the area of "use instead of curtailment" have the problem that they encourage strategic behavior by participants in the electricity market, particularly in the form of inc-dec gaming (see info box). The fact that no such incentives arise is a major advantage of the concept presented here. Inc-dec gaming is not possible because the grid fee reduction does not only apply to the additional electricity used, but to all electricity consumption over time and in the region. Consumers without market power therefore always have the incentive to shift their consumption to the hours with a lot of curtailment in order to benefit from the reduced grid fees. This would be different if only the additional consumption were exempt from the grid fees. Consumers would then have the incentive to initially keep their consumption as low as possible in hours with a lot of renewable curtailment in order to benefit from the reduction in grid fees for more "additional" consumption. As in classic inc-dec gaming, this behavior would even lead to an exacerbation of grid congestion.

One disadvantage of exempting all consumption in the relevant periods is the deadweight effect: Inflexible consumers who consume electricity during the affected hours benefit without responding to the instrument. This is not ideal. The only consolation is that these windfall profits accrue to those who are located in regions with a lot of renewable generation, which is generally worth supporting from an energy industry perspective.

### Box: Inc-dec gaming in markets for redispatch and local flexibility

**Call-based redispatch markets.** A call-based redispatch market is characterized by the fact that participation is voluntary for market players and compensation is paid for the call (in MWh) and on the basis of bids from these same market players. Such call-based redispatch markets have been considered problematic in previous studies, as they create incentives for strategic bidding behavior by market players[4] .

**In scarcity regions. Essentially,** a call-based redispatch market provides the following incentives: Producers in scarcity regions anticipate that (higher) profits can be generated by marketing their generation on the redispatch market. They therefore bid at higher prices on the electricity market and thus price themselves out of the zonal market in order to be available for the downstream redispatch market. These strategies can be understood as an optimization between two markets. For loads, this incentive is mirrored.

**In surplus regions.** Conversely, generators in surplus regions anticipate profits by down-regulating on the redispatch market. To make this possible, they submit low bids on the electricity market and thus push themselves into the market. They can bid at this price because they can free themselves from their supply obligations on the redispatch market that takes place later. In principle, they therefore buy back the electricity that was previously sold at a high price on the electricity market at a lower price later on. Here, too, the incentive for loads is mirrored.

**Consequences.** This strategic behavior of market participants on both sides of the bottleneck leads to worsening congestion, windfall profits, problems for financial hedging transactions, false investment incentives and poses operational risks for grid operators.

[4] Neon and Consentec (2019): Strategic bidding in flex markets

# 5 Design options

There are a variety of design options for the practical implementation of the concept:

### Target group.

- Which consumers should benefit from the fee reduction? Everyone, or only selected, particularly flexible consumers?
- Which grid fees should be reduced? The transmission grid fees and/or the distribution grid fees?

### Height of the lowering.

- Which component of the grid charges will be reduced? Work and/or capacity charge?
- How high should the reduction be in both cases?

### Trigger criteria.

- What criteria should be used to trigger the reduction in grid charges?
- How are the regions selected?
- From what quantity of curtailed energy should the grid fees be reduced?
- What types of grid congestion does the trigger threshold apply to?
- When should the reduction be announced?

### Financing.

- How will the grid operators' loss of revenue be compensated for by the reduced grid fees?

**Fehler! Verweisquelle konnte nicht gefunden werden.** lists the most important design options t ogether with the recommendations developed. In the following sections, these options are examined in more detail and the recommendations for action are explained.

Table 1: Design options and recommendations for action

| | Question | Options | Recommendation |
|---|---|---|---|
| Target | Which consumers | All RLM and/or smart meter customers | RLM in any case |
| | Which grid fees | Individual voltage levels / all | All (total grid fee) |
| Lowering | energy charge | 0% to 100% | To zero (100%) |
| | capacity charge | Do not, fully, proportionately suspend calculation | Suspension Exclusion for §19 (2) StromNEV |
| Tri | Regional resolution | Any granularity | Distribution grid areas |

| | | |
|---|---|---|
| Trigger threshold | 0 - X MW expected curtailment | e.g. 500 MW for Schleswig-Holstein and Hamburg (corresponds to about 1,300 hours per year) |
| Bottleneck | Distribution grid and/or transmission grid | Transmission grid |
| Lead time | Minutes to months before real time | Previous day, before the day-ahead auction |
| Financing | e.g. regional or Germany-wide reallocation | Nationwide reallocation |

# 5.1 Target group

## 5.1.1 Which consumers benefit

The instrument creates incentives for a temporary increase and for shifting consumption over time. Since this flexibility can in principle be provided by all consumers, the recommendation is to open the instrument to as many as possible. This also has the advantage that no limit values need to be defined to distinguish affected from unaffected consumers. Such thresholds are often difficult to justify and could lead to unwanted consumption adjustments if consumers try to exceed or fall below consumption thresholds.

However, a restriction of consumers is necessary for billing reasons: For customers who do not have hourly measured and recorded consumption (German: "Registrierende Leistungsmessung") or a smart metering system, hourly billing is not possible. It is not possible to determine what proportion of their consumption takes place in time windows with reduced grid charges. Therefore, these customers cannot benefit from the temporary reduction in grid fees.

Consumers who are fully or partially exempt from grid fees naturally have little or no incentive to use this instrument to increase load flexibility in line with grid requirements. This applies to newer electricity storage systems and electrolysers, which do not pay any grid fees at all until the transitional provisions in §118 of the Energy Industry Act expire, and large consumers, who pay greatly reduced fees in accordance with §19 (2) StromNEV.

## 5.1.2 Which grid fees are reduced (voltage levels)

In principle, it is only conceivable to reduce the tariffs of certain voltage levels - however, the strongest incentives for flexibilization arise when the tariffs of all grid levels are reduced. The recommendation is therefore to reduce all grid fees, i.e. the fees for the connection grid level and all upstream grid levels.

## 5.2 LOWERING HEIGHT

Network charges consist of up to three different components: the energy charge, the capacity charge and a flat-rate connection fee. The flat-rate connection fee cannot be reduced for selected hours and is therefore not considered further. However, this is possible for the working and capacity charge. The question here is whether and to what extent these components should be reduced.

### 5.2.1 energy charge

The easiest way to reduce grid charges in certain hours is to reduce the energy charge, which is levied for every kilowatt hour of electricity drawn from the grid. Consumption in hours with reduced grid charges is simply offset against the reduced energy charge. This creates strong and precise signals for a temporary increase in electricity consumption in the affected hours.

In principle, of course, the greater the reduction in grid fees, the greater the incentive to increase consumption and thus to use the otherwise curtailed electricity. In addition, the greatest possible price difference between hours with reduced grid charges and those without leads to stronger incentives to shift electricity consumption over time. On the other hand, the costs of the instrument (the lost grid fees) increase the more the price is reduced. From an economic point of view, there is no clearly optimal reduction level; even negative energy charges are theoretically conceivable.

**Recommendation:** In order to provide the strongest possible incentives to make electricity consumption more flexible, the energy charge should be suspended completely, by 100 percent to zero, in the affected time windows. This is also particularly easy to communicate.

### 5.2.2 capacity charge

As described in section 3 the capacity charge prevents a short-term increase in consumption for many large consumers. Even if there is a low probability that a short-term load increase will increase the annual peak load, flexibility potential will not be used because the impending costs from the capacity charge will drive up costs exorbitantly. In order to achieve a significant change in electricity consumption, the capacity charge would therefore also have to be reduced.

The capacity charge for certain hours could be reduced by excluding these hours when determining the maximum load. Alternatively, a pro rata consideration is also conceivable, for example of 50 percent of the output in the relevant time windows. In this way, the incentive to increase the load would be capped at twice the other annual maximum load. Furthermore, the question arises as to how the discount for even electricity consumption (§19 (2) StromNEV) should be dealt with, as new load peaks could potentially deprive consumers of the privileges of the exemptions. It is conceivable that the affected hours could also not be taken into account when calculating the hours of use.

Capacity charges make peak loads more expensive and thus lead to a stabilization of the consumption profile. Some distribution grid operators are therefore critical of a temporary reduction in the capacity charge and fear additional burdens on the distribution grid. This threat cannot be ruled out, but in many cases additional local consumption can also have a relieving effect on the distribution grid, for example if the transformers at higher voltage levels regularly reach their limits in times of high local renewable generation. In any case, it is unlikely that the instrument will be so successful that extreme increases in consumption will occur in the short to medium term. As a rule, the technical possibilities for this will not be available. In addition, the contractually agreed connected load sets limits for peak loads. Nevertheless, the effect of the instrument on bottlenecks in the distribution grid should be continuously evaluated so that countermeasures can be taken if necessary, for example by reducing the capacity charge to a lesser extent.

Recommendation: In order to maximize the impact of the instrument, the capacity charge should be completely suspended for the time windows with reduced grid charges, i.e. the time windows with grid charge reductions should be completely excluded from the calculation of the annual peak load. The same procedure should also be used to determine the discount for uniform electricity procurement

## 5.3 Trigger criteria

### 5.3.1 Regional resolution

With regard to the size of the regions to which the reduction in grid charges applies, a balance must be struck between the homogeneity of the effect on congestion, the distribution of renewable installations and loads within the region and the administrative and implementation costs. The instrument only reduces curtailment if the additional electricity demand reduces the load flow on the overloaded grid elements. The layout of the regions therefore depends primarily on the location of the grid bottlenecks. If overloaded line segments are located within a region affected by the grid charge reduction, additional consumption in this region does not necessarily reduce the renewable curtailment. There is therefore a trade-off between the accuracy of the incentives and the complexity of the instrument: the smaller the regions, the higher the probability that additional consumption will reduce the curtailment volume. On the other hand, a small number of larger regions (e.g. the area of a distribution system operator) reduces complexity, which makes it easier to calculate the grid fees and increases transparency regarding time windows with reduced fees.

One possibility is to define the regions on the basis of existing geographical units. One variant, for example, would be to define them along the boundaries of the distribution system operators. This would make billing easier, as distribution system operators already set and charge grid fees individually. The disadvantage of this structure is that load centers (especially larger stands) often have their own distribution grid operators. In order to achieve a significant increase in consumption through the price signal, consumption centers should be included in the regions with reduced grid charges. It therefore seems sensible to combine several distribution grid regions so that the regions of the instrument correspond to the German federal states.

With over 92 percent of the curtailed energy, wind turbines account for the majority of curtailments[5] . Almost 80 percent of curtailment in 2021 took place in Schleswig-Holstein and Lower Saxony. The focus of the instrument is therefore initially primarily on avoiding the curtailment of wind energy in northern Germany. In the future, however, it is conceivable that grid fees could also be reduced in other regions of Germany if renewable generation peaks are regularly curtailed there.

Recommendation: An analysis of current and forecast grid bottlenecks is recommended to determine the size of individual regions with reduced grid charges. It seems realistic to choose regions the size of the federal states. In this case, city states as high-consumption metropolitan areas without significant renewable generation of their own should be counted among the neighboring states with the fewest grid bottlenecks. A pilot region of Schleswig-Holstein and Hamburg, for example, seems to make sense, as it is almost always located north of the transmission grid bottlenecks, so that additional consumption is very likely to relieve bottlenecks.

### 5.3.2 Reduction trigger threshold

The trigger threshold indicates the forecast curtailment level above which the grid fees are reduced within a region. The instrument should not yet be triggered in the case of minor curtailment, as otherwise it can be assumed that the resulting additional consumption will exceed the expected curtailment. For this reason, the trigger threshold should also depend on the size of the regions - the more consumers there are in a region, the higher the curtailment threshold can be set. If the trigger threshold is set very high, the instrument would only be used rarely and would therefore have little influence on the total curtailment volume.

The trigger threshold also determines the number of hours in which reduced charges occur. The lower the threshold, the greater the number of hours with reduced charges and vice versa. However, the amount of curtailed energy fluctuates greatly between years, meaning that a forecast of the number of hours with reduced charges is associated with considerable uncertainty.

Recommendation: From an economic point of view, there is no ex-ante optimal trigger threshold. For the pilot region of Schleswig-Holstein and Hamburg, we consider a threshold of around 500 megawatts to be reasonable, as this is very likely to exceed an increase in consumption. In 2021, this threshold would have been reached in 1,289 hours (approx. 15% of all hours in the year).

[5] Report by the Federal Network Agency on grid congestion management (July 2023)

### 5.3.3 What types of grid bottlenecks

The reduction in grid fees could be triggered by curtailment of renewable energies, regardless of which grid operator initiates the curtailment. However, it is also conceivable to differentiate in which grid the cause of the curtailment lies. In recent years, bottlenecks in the transmission grid have been responsible for the majority of curtailments: in 2021, for example, 73 percent of curtailments were caused by the transmission grid[6] However, the proportion of bottlenecks in the distribution grid is likely to increase in the future due to the expansion of decentralized generators and consumers.

Recommendation: The recommendation is to reduce the grid charges only in the event of congestion in the transmission grid, because only then is it highly probable that additional local consumption will relieve the congestion. In the case of distribution grid-related congestion, however, the probability that a local increase in consumption will reduce the congestion is lower if the geographical resolution can be implemented in a reasonable manner.

### 5.3.4 Timing of the reduction announcement

The affected time windows must be published at short enough notice to be based on reliable wind, load flow and curtailment forecasts. At the same time, the longer the planning lead time, the greater the reaction of the loads is likely to be.

It is therefore advisable to do this at a time before the day-ahead auction, for example at 10:00 am. Consumers can then take this information into account when submitting their bids on the largest spot market in terms of trading volume, which is expected to maximize demand response.

## 5.4 Financing

### 5.4.1 Allocation of costs

The reduction in grid fees leads to lower income for grid operators. In addition, a temporary increase in load at lower voltage levels can lead to higher upstream grid costs, for example if there are higher peak loads when electricity is purchased from upstream grids. These reduced revenues or additional costs must be offset elsewhere so that grid operators can continue to cover their costs as determined by the revenue cap.

The reduced income of the grid operators should be compensated by reallocating the costs. The costs could be rolled over nationwide or in the same area in hours in which there is less or no curtailment.

[6] Monitoring report of the BNetzA 2022

The costs could be reallocated nationwide via a new levy, similar to the §19 StromNEV levy. The main argument in favor of supra-regional reallocation of costs is that consumers throughout Germany benefit from the avoidance of curtailment. In addition, this variant has the advantage that flexible consumers have an economic incentive to settle in regions with a lot of renewable generation, as they benefit from the temporarily reduced grid charges there. In addition to the flexibilization incentives, this also creates a useful investment incentive for the grid.

With local cost allocation, the grid charges within the region are increased in the hours in which the curtailment is below the trigger threshold. This does not lead to investment incentives in this region. On the contrary, it is even likely that inflexible consumers in the surplus region would have to bear higher costs compared to the status quo because they would have to compensate for the grid fee savings of flexible consumers. This would create an incentive for inflexible consumers to relocate to regions with little renewable curtailment. However, the incentives to make consumption more flexible would be somewhat higher in this variant, as the spread in grid fees between hours with high curtailment and other hours would be even greater.

Recommendation: The greatest benefit of the instrument is that it provides systemic incentives to make electricity consumption more flexible. These are given in both variants. However, as the grid fees in regions where renewable energies are being expanded are generally already higher than elsewhere, nationwide reallocation would be preferable. In this way, the proposal also creates an investment incentive for flexible consumers in regions with a high level of renewable curtailment.

# 6 Example calculations of the impact of such an instrument

The effect that a temporary reduction in grid fees has on electricity consumption depends on how strongly consumers react to the lower costs. This is described as the short-term price elasticity of demand. The more consumers react to price changes (the higher the price elasticity), the more curtailment can be avoided through the reduction in grid charges. There are different estimates of the price elasticity of electricity consumption. This is higher in the long term than in the short term, as consumers need time to adjust their behavior to price fluctuations, for example by adapting their operational management and retrofitting systems accordingly. It can be assumed that the instrument will drive the flexibilization of consumption, i.e. cause an increase in demand elasticity in the affected regions.

For a quantitative assessment of the effects, the example of a joint region from Schleswig-Holstein and Hamburg is used. The greatest benefit of the instrument is expected in this region due to the frequent curtailment and structurally occurring grid bottlenecks. The analysis shows what effect the instrument would have had in 2021 if work and capacity charges had been suspended in all hours with more than 500 MW of curtailment. The time series of curtailment was estimated based on the curtailments that occurred in the distribution grid in Schleswig-Holstein in 2021, which are published in the Netzampel. [7]

## 6.1 Avoided curtailment achievable in the Schleswig-Holstein and Hamburg region

Assumptions: The grid charges vary greatly between the voltage levels and consumer types. For the sake of simplicity, we assume an average energy charge of 6 ct/kWh. This corresponds to the grid charge in medium voltage for less than 2,500 hours of use at the distribution system operator Schleswig-Holstein Netz in 2021. Furthermore, we assume that 65 percent of consumers receive a reduced grid charge in hours with a lot of curtailment - this corresponds approximately to the nationwide share of customers with hourly measured and recorded consumption (German: "Registrierende Leistungsmessung") in total electricity consumption. As price elasticity, we use the increase in consumption in Germany estimated by Hirth et al. (2022) of 80 megawatts with a reduction in electricity costs of 1 €/MWh. For the Schleswig-Holstein and Hamburg region, this results in an increase in consumption of 42 megawatts for every 1 ct/kWh reduction in grid charges.

[7] https://www.netzampel.energy/home

Result: Table 2 summarizes the results of the analysis. For example, with a curtailment trigger threshold of 500 megawatts, the grid charges would have been reduced in 1,289 hours in 2021. If the grid fees were suspended completely, i.e. reduced by 6 ct/kWh in the calculation, electricity consumption would increase by 252 megawatts in these hours. This is well below the curtailment trigger threshold, meaning that curtailment is not completely avoided at any time. However, the instrument only causes additional electricity consumption from otherwise curtailed energy - so there is no "overshoot". In relation to the 1,845 gigawatt hours of curtailed wind energy in Schleswig-Holstein in 2021, curtailment will therefore be reduced by 17.6 percent.

Table 2Effect of the complete suspension of energy charges and energy charges in the Schleswig-Holstein | Hamburg region.

| | |
|---|---|
| Reduction trigger threshold | 500 MW |
| Hours with grid fee reduction | 1.289 |
| Reduction of the energy charge | 6.0 ct/kWh |
| Avoided curtailment / increase in consumption | 327 GWh |
| Reduction of the curtailment | 17,6 % |

## 6.2 Impact on the revenue situation of network operators

Effect on "grid fee account": For the same case, we also estimate the effect of the grid fee reduction on the "grid fee account". By this we mean the net effect of additional income and expenses of all grid operators, even if these are not always incurred by the same grid operator. The loss of revenue due to no longer charging grid fees is offset by the following cost savings and additional revenue: [8]

- If curtailment is prevented, the transmission system operators do not have to activate redispatch power plants downstream of the bottleneck.
- Additional electricity consumed is subject to grid charges (but only if the charges are not reduced to 0).
- If curtailment is prevented, the plant operators' compensation claims are eliminated. However, since the introduction of Redispatch 2.0, these only correspond to the market premium that the plant operators receive in any case.

Assumptions: The largest item of savings is the avoided costs for positive redispatch, i.e. the ramping up of power plants behind the grid bottleneck. As we do not have the exact costs

[8] In the calculations, we refer to the system of balance sheet compensation envisaged in Redispatch 2.0, although the estimate is similar in the previous redispatch.

for this, we estimate a lower limit: in hourly resolution, we multiply the spot price times the required ramp-up energy. However, the actual costs will certainly exceed this value, as the redispatch power plants would otherwise be activated on the spot market. As a result, we underestimate the relieving effect of the instrument on the grid fee account. Furthermore, we do not take into account the avoided compensation for renewable energy operators through the market premium, as this is incurred with and without curtailment.

Result: Table 3 summarizes the effects of the instrument on the grid fee account. In the case of a complete reduction, it can be seen that the loss of revenue due to the reduced grid charges is very unlikely to be compensated for by the relieving effects: the loss of revenue of EUR 157 million is offset by avoided costs of more than EUR 14 million. Even if we only determine a lower limit for the avoided costs here, it is clear that the instrument is very unlikely to be self-financing. However, the example figures also illustrate that the additional burden on consumers would be very low at less than 0.03 ct/kWh if the costs were reallocated across Germany. In comparison, the §19 StromNEV levy is around 14 times higher at 0.417 ct/kWh. We also examined a marginal reduction in energy charges to find out whether the picture is different if the grid charges are reduced less. However, even in this case, it is highly unlikely that the loss of revenue can be compensated for. This makes it clear that the instrument should not be implemented because of its effect on the grid fee account. However, it is conceivable in principle that the deficit will be lower in the future. This is because, with increasing price elasticity, even a smaller reduction in charges will cause greater demand effects and thus greater relief for the grid charge account.

Table 3Effects of the temporary grid fee reduction in SH / HH on the "grid fee account"

| | Reduction of 0.01 ct/kWh | Reduction to zero |
|---|---|---|
| Lower revenue due to reduced fees (in EUR million) | -0,27 | -157 |
| Avoided costs for ramp-up energy (in EUR million) | > 0,02 | > 14 |
| Additional grid fee income due to additional consumption (in EUR million) | 0,03 | 0 |
| Net debit to the grid fee account (in EUR million) | > -0,21 | > -143 |
| Debit to the grid charge account per avoided curtailment (in €/MWh) | > -391 | > -437 |
| Increase in tariffs with nationwide reallocation (in ct/kWh) | < 0,000 | < 0,03 |
| Increase in charges for reallocation in SH/HH (in ct/kWh) | < 0,001 | < 0,63 |

# 7 Conclusion

The regional reduction of grid fees in times of high curtailment of renewable energies is a supplement to the current electricity market design. The main benefit of the instrument lies in the testing of dynamic grid charges and in gaining experience in the grid-friendly flexibilization of demand. In addition, the temporary and regionally limited increase in electricity consumption enables additional green value creation through otherwise curtailed renewable electricity.

The proposed instrument will not address all challenges in the area of grid congestion. However, a major advantage is that it can be implemented in the short term and is also compatible with any future reforms, such as a bidding zone division or a comprehensive revision of grid fees.

As part of the introduction, it is recommended that the instrument is first tested in a limited pilot region. The region of Schleswig-Holstein and Hamburg is suitable for this, as additional consumption in this region at times of high curtailment is very likely to reduce the north-south congestion in the transmission grid. The experience gained would help to better assess the reaction of consumers in the future and to further develop the parameterization of the instrument based on this. In the medium term, the instrument could also be rolled out to other regions with high curtailment of renewable energies.