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1 | Introduction

By now, there is hardly any infrastructure service on whose provision society is more reliant than on electricity. With increasing duration power outages not only impair production, but also start to threaten the functioning of civil life as a whole. So far, incidents of large-scale blackouts have been rare in post-war Germany. However, for situations that did occur, damage estimates of several million Euros were published. While these ex post estimates can provide detailed information on the various sorts of damages caused by observed incidents, their particularity prevents a generalization to counterfactual scenarios. Foremost, they do not tell which regions in Germany exhibit the highest potential vulnerability towards electricity outages.

Currently, this question increasingly attracts public attention. The speed of the switch in electricity generation towards renewable energies has triggered a debate on the future security of power transmission grids in Germany. There is a consensus that stability improvements through network expansion and reinforcement of existing grids are inevitable. However, opinions vary widely to what extent and in which areas such measures should be undertaken. At the heart of this debate lies an uncertainty about the societal returns to network expansion. While the cost side of projects can be reasonably assessed, the benefits are not fully quantified yet. A serious cost-benefit analysis would require determining the monetary value of increased transmission security in terms of prevented outage costs. Given the high degree of embranchment of German distribution networks, this should be done at a sufficiently disaggregated regional level.

Recently, the economic literature has developed some interesting approaches for a macroeconomic ex-ante evaluation of power outage costs. By focusing on indirect costs in the form of losses of production and electricity-dependent leisure, they allow an assessment based on national account data. Until now, these methods have been implemented for a range of countries with national and subnational data. For Germany, valuable results have already been presented for federal states. The contribution of this paper will be to extend this analysis to the more disaggregated level of counties. We start with reviewing the existing literature in this area. Then, we establish the basic methodology for cost estimation. We continue with a presentation of our results, focusing on regional differences in the value of one kilowatt hour of electricity for both households and firms. By drawing upon time profiles of electricity usage, we use these numbers to derive estimates for the costs of a one hour blackout for specific hours of the day, specific days of the week and specific months of the year. Our paper closes with discussions of the relevance of our results for the debate on supply security and of future avenues of research.

2 | Literature Overview

The diversity of potential effects turns an ex ante evaluation of power outages into a huge challenge for researchers. Detailed technical information is required to assess the magnitude of property damage. Apart from this physical damage, a rigorous analysis demands to address the economic dimension as well. Losses due to the interruption of production have to be accounted for. Besides, consumers face a decline in well-being which can also be viewed as part of the outage costs. In the literature, a general distinction is made between direct and indirect costs. Direct costs are losses in asset value, e.g. due to computer crashes or damages to other sensitive equipment. Indirect costs comprise all consequences of the absence of electricity as a factor of production and consumption good. In addition to a decline of output and consumer welfare, these can also include contagion effects through supply chain dependencies and changes in behavior (Wenzel & Wolf, 2013). Given that the nature of direct costs is highly specific to the type of outage, economists have largely focused on indirect costs as a way to gauge an economy's vulnerability.

Over the years, a range of evaluation methods have been proposed and applied. Based on the kind of data used, they can be broadly classified into three types of categories: survey-based approaches, market- based approaches and production function approaches. The first two intend to determine the willingness to pay of electricity users to avoid the occurrence of blackouts. Survey-based attempts seek to ascertain this willingness in a direct manner by means of questionnaires. This has been done by letting respondents choose between monetized options in a hypothetical scenario or by asking affected people in the aftermath of real events. For instance, hypothetical scenarios are used by Beenstock et al. (1998) and Carlsson & Martinsson (2008), while Serra & Fiero (1997) draw upon surveys undertaken after outages in Chile. Market-based approaches instead judge the value of supply security based on actual market behavior. Brown & Johnson (1969) were the first to suggest an estimate of consumer surplus on the electricity market as a proxy for outage costs. This requires estimating demand functions by observing demand sensitivities in response to changes in electricity prices. An alternative method in this direction is to observe expenditures for precautionary measures. Beenstock (1991) suggests evaluating outage costs based on investment in back-up generators. Bental & Ravid (1982) use the costs of firms for maintaining on-side reserve capacity as a similar proxy.

In contrast, production function approaches do not directly deduce outage costs from revealed preferences, but from linkages between macroeconomic figures. To determine costs at firm level, electricity is viewed as an input in local production. By postulating a certain functional relationship, production losses in response to power shortages are estimated as the capacity decline following a reduced availability of this input. Similarly, to account for outage costs of households, electricity is seen as an input in the generation of utility during leisure-time. Both ideas were originally proposed by Munashinge & Gellerson (1979). To cope with existing data limitations, very simple functional forms for these input-output relationships are commonly adopted in the literature. The assumption of a simple proportional relationship prevails, as it merely requires calculating the ratio between period output (or period utility from leisure) and electricity consumption at an annual level. Based on this framework, de Nooij et al. (2007) and Bliem (2005) calculate outage costs for regions in the Netherlands and Austria, respectively. By drawing on time profiles of electricity use, they determine time-specific costs. Further applications have been undertaken by Tol (2007) and Leahy & Tol (2011) for Ireland, Linares & Rey (2012) for Spain and Nick et al. (2013) for federal states in Germany. More complex production function approaches incorporating the role of input-output linkages and resilience measures have been implemented by Tishler (1993) and Rose et al. (2007). Moreover, LaCommare & Eto (2006) and Reichl et al. (2013) have developed mixed approaches combining macroeconomic data with expert and consumer surveys.

To the best of our knowledge, Nick et al. (2013) is so far the only contribution that applies the dominating production function approach to an estimation of outage costs for German regions. Their framework makes optimal use of currently available official data at federal state level. Given our goal of achieving regionally disaggregated results, their work thus appears to be a natural starting point for our analysis. Precisely, we conduct our analysis at the level of counties, the next less aggregated level in Germany. In places where greater restrictions to data availability at county level prevent a direct application, we supplement the existing methodology by additional assumptions and auxiliary estimations.

3 | Evaluation methods

3.1 | Cost estimates at firm level

The choice of an appropriate evaluation method strongly hinges upon the duration of power cuts. For interruptions lasting no longer than a few hours, the presence of contagion effects can normally be excluded. In this case, firms without backup generators usually also lack the time to take effective measures of resilience. Indirect costs at firm level thus remain largely restricted to output losses. For blackouts of longer duration, additional contagion effects resulting from disruptions of local supply chains have to be taken into account. In addition, cost reductions through adaptive responses like a temporary switch to less electricity-dependent activities can become significant. The uncertainty involved in attempts of damage estimation is thus increasing with the time span of power cuts. In extreme cases of outages comprising several days (e.g. in the aftermath of natural disasters), lack of experience regarding the behavioral patterns of people precludes any sensible ex ante estimation.

We therefore limit our analysis to blackouts of a standardized length of one hour, as is common practice in the literature (see e.g. Bliem (2007), Reichl et al. (2013)). As a further limitation, we merely consider indirect costs in the form output losses. As discussed by de Nooij et al. (2009), such an approach can both be argued to over- and to underestimate the real magnitude of outage costs. An overestimation results from neglecting the existence of backup generators and catch-up effects: firms might be in the position to catch up on delayed production through overtime hours and increased stock-keeping. For the purpose of cross-regional comparisons, we consider this only a minor problem. In general, there is no reason to expect differences in the degree of preparation by firms across regions. Perhaps more serious is a potential underestimation resulting from the specific vulnerabilities of certain production processes. Most prominently, processes in the chemical and the paper industry are highly sensitive to outages lasting no longer than a fraction of a second. Even these incidents can cause complex production chains to collapse, implying that several hours can pass until processes are restarted. For our analysis, this means that the actual production losses **resulting** from a one hour power outage can be significantly larger than potential value added **generated** within that single hour. Since sensible sectors are unequally distributed across regions, this is likely to bias regional comparisons. However, on an aggregate level, there is no method yet to produce reliable ex-ante estimates of the size of these longer-term losses. We therefore merely quantify the amount of output that could have been generated during the period of power outage.

In determining this potential hourly output, we are unable to draw upon real production schedules. Hence, we require some key to distribute the annual production figures available from national accounts between the hours of a year. The literature proposes to use time profiles of electricity consumption for this task (Bliem, 2007). In doing so, time profiles for production are generated by postulating a proportional relationship between output and electricity use. Precisely, a Leontieff production technology is assumed with a zero substitutability of electricity with other factors of production. The first step is then to describe this relationship by computing the ratio between annual output and annual electricity consumption, termed as the **Value of Lost Load (VoLL):**

$$\mathrm{VoLL}_c^s = \frac{\mathrm{GVA}_c^s}{\mathrm{EC}_c^s}, \qquad [1]$$

where GVA_c^s denotes annual Gross Value Added (in Euros) of sector s in county c and EC_c^s describes annual electricity consumption (in kilowatt hours (kWh)). In general, this

VoLL tells us how much output can be traced back to the use of one kWh of electricity. In this way, it determines which sectors or regions would be most severely affected by rationing of power, e.g. in cases of network congestion. This can be used to determine production losses resulting from a blackout. To estimate the losses, information on the regular production intensity during the hour (h) of the blackout is required. Given the proportionality assumption, knowledge of total electricity consumption by firms during that time can be used to deduce total outage costs (O):

$$\mathrm{O}_{\mathrm{c,t}}^{\mathrm{s}} = \mathrm{VoLL}_{\mathrm{c}}^{\mathrm{s}} \cdot \mathrm{EC}_{\mathrm{c,t}}^{\mathrm{s}} \qquad [2]$$

Note that this methodology presupposes that no production can take place in the course of a power outage. While this might be viewed as a reasonable approximation for many energy-intensive sectors, for others like construction and labor-intensive services it might not. On the other hand, maintaining some level of productivity during outages requires a considerable amount of reorganization (workers have to be assigned to different tasks etc.), which is costly as well. In this light, we do not expect this simplification to yield a significant bias.

3.2 | Cost estimates at the level of households

For households, the damages caused by power failures are significantly harder to quantify. An intuitive microeconomic approach would be to ask consumers about their willingness to pay for one hour of electricity access. However, people generally find it difficult to assign specific monetary value to basic goods like electricity, as their availability is often taken for granted. Moreover, answers have to be differentiated carefully according to the time of day at which an incident is imagined to happen: consumers have to worry much less about outages occurring during the night or while being at work than about outages during the evening hours. This makes it even more difficult to obtain meaningful estimates based on questionnaires.

An alternative is to watch out for observable proxies for the utility received through electricity consumption. A reasonable proxy suggested by the literature is the pleasure the households gain from electricity-dependent leisure activities. To quantify its extent, information on the average number of hours devoted to leisure as well as on the monetary worth of a single hour of leisure is needed. The former can be deduced from the average amount of working hours (WH) and the total amount of available hours (T). A further restriction is that not all leisure activities require the use of electricity. Bliem (2005) proposes to deal with this issue by assuming that exactly 50 percent of all activities are electricity-dependent, total leisure time is thus simply halved in the calculation. To achieve comparability, we follow this assumption.

To determine the value of one hour of leisure, standard microeconomic theory is used. Labour supply is interpreted as the result of a utility maximizing decision in the light of a trade-off between consumption and leisure. The optimality condition is that at the margin the benefits of one hour of leisure equal its opportunity costs in terms of foregone labour income. Average net wages per hour (W) thus serve as a proxy for the value of one hour (electricity-dependent) leisure time for all employed persons.[1] For unemployed persons, this approximation would seem inappropriate. Part of the reason for their unemployment could be a low potential remuneration and thus lower opportunity costs of leisure. Besides, the presence of involuntary unemployment can lead to an overestimation of the value of leisure, as leisure consumption is higher than optimal. To account for this, we follow de Nooij et al. (2007, 2009) in assuming that the monetary value of each hour of leisure for an unemployed person is 50 per cent of an employed person. The total value of leisure (VL) for an employed (emp) and an unemployed ($uemp$) person in county c, respectively, is calculated in the following way:

$$VL_c^{emp} = 0.5 \cdot (T - WH_c) \cdot W_c$$

$$VL_c^{uemp} = 0.5 \cdot \mathrm{T} \cdot (0.5 \cdot W_c)$$

Given information on total population size (POP) and number of employed persons (POP^{emp}), the total leisure of value for all citizens of county c is thus calculated as:

$$VL_c = VL_c^{emp} \cdot POP^{emp} + VL_c^{uemp} \cdot (POP - POP^{emp}) \qquad [3]$$

In analogy to the firm case, we can determine the ratio of this value to total electricity consumption of households at county level and interpret this as a Value of Lost Load for households (h) in county c:

$$\mathrm{VoLL_c^h} = \frac{VL_c}{\mathrm{EC_c^h}} \qquad [4]$$

This measure represents the value of leisure attributable to the consumption of one kWh of electricity. To determine outage costs, information on the time profiles of electricity use has to be added, similar to the firm level. In order to attain the losses resulting from a blackout during time span t, the VoLL is multiplied by electricity consumption of households during that period:

$$\mathrm{O_{c,t}^h} = \mathrm{VoLL_c^h} \cdot \mathrm{EC_{c,t}^h} \qquad [5]$$

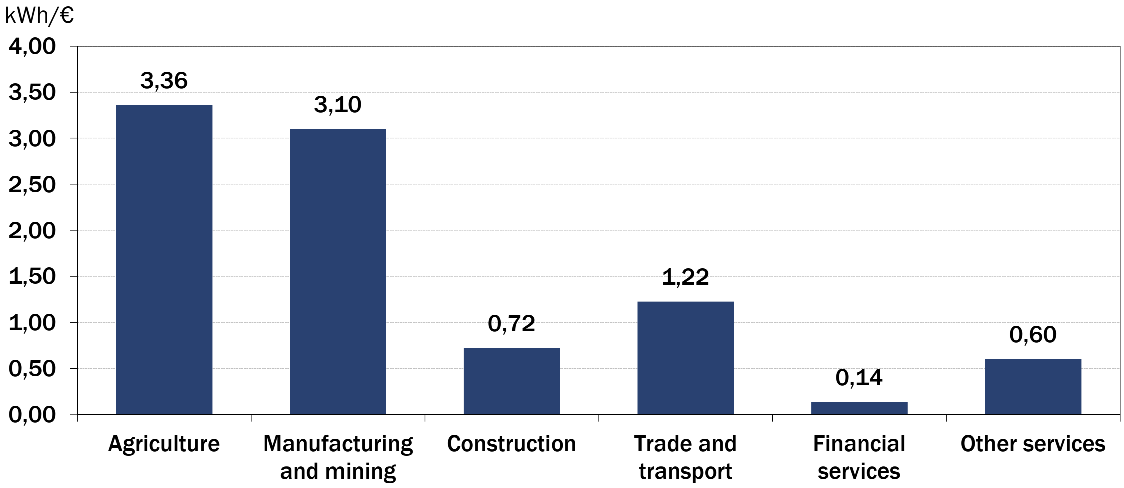
[1] Strictly speaking, this reasoning only applies to the last marginal hour of leisure consumed: However, accounting for a changing marginal utility would require estimating a household's utility function, which is impossible with the available data.

4 | Data sources and estimation

In Germany, sub-national data on electricity consumption is rather scarce, particularly at county level. At the level of federal states, annual energy balances provide information on electricity usage of different sub-sectors within manufacturing as well as on electricity consumption of households. At county level, energy balances are not regularly published. For this reason, we face a lack of precise information on the sectoral distribution of electricity usage within a county.

However, at least annual electricity usage in manufacturing and mining as a whole is published regularly at county level (Federal Statistical Office, 2013). Based on this data, an analysis of regional heterogeneity in outage costs seems worthwhile to us primarily for two reasons: the high average intensity of electricity usage within these two sectors (see figure 1) as well as the large variance of this intensity among their subsectors. Hence, a considerable share of variation in outage costs can be expected to be explained by regional differences in industry composition and overall importance of mining and manufacturing.

Figure 1: Intensity of electricity use for sectors in Germany 2010 (consumption per Gross Value Added)



Source: Federal Statistical Office (2013); own calculations

To utilize this data for our analysis, we have to treat manufacturing and mining as one sector. Calculating its sectoral VoLLs then requires information on sectoral Gross Value Added (GVA). For reasons of data privacy, production data at county level is merely published for six aggregate sectors by official statistics in Germany. In this scheme manufacturing, mining and energy are aggregated to one sector. Consequently, we have to separate out value added of the energy sector for each single county. We do this by making use of employment data provided by the German Federal Employment Agency (2013). Since the required employment figures were not available for each county[2], we supplement this information by data on the number of establishments offered by the Federal Statistical Office (2013). We adopt the two-stage strategy of de Nooij et al. (2009): for counties with relevant employment numbers at hand, their local share in energy sector production at federal state level is approximated by their local share in energy sector employment. In a second stage, the remaining share of energy sector production is divided among the remaining counties according to their local shares in the number of energy sector establishments at federal state level. Subtracting the resulting figures for energy sector production from the published production data provides us with estimates on GVA in mining and manufacturing for each county.

Based on this, we are in the position to calculate county-specific VoLLs for the year 2010 for the mining and manufacturing sector. This enables us to account for regional differences in energy intensity, which are partly due to specialization in certain subsectors. For all remaining sectors, the lack of data on electricity consumption implies that county-specific values cannot be created. To arrive at an aggregate cost measure for the regional economy, we therefore resort to the strategy applied by Bliem (2005) and Nick et al. (2013) at federal state level and adopt national VoLLs for the regional analysis. Remaining activities are split into three sectors: agriculture, construction and services.[3] For these aggregations, annual electricity consumption at national level is published in the national energy balances. We use this information together with national data on GVA to calculate national VoLLs for 2010, resulting in values of 1.98 €/kWh for agriculture, 118.15 €/kWh for construction and 10.16 €/kWh for services. As should be expected, ranges of these measures are all in line with the results of Nick et al. (2013) for 2007. Regional economies with a focus on service-related activities are thus likely to exhibit higher VoLLs for production in total, as an immediate implication of their lower energy intensities.

Transferring national VoLLs for the non-manufacturing sectors to the regional level causes only minor biases, as pointed out by Nick et al. (2013): differences in energy intensities between subsectors are considerably lower than within manufacturing and their overall shares in electricity consumption tend to be smaller as well. Dividing sectoral production at county level by national VoLLs provides us with estimates on sectoral electricity consumption at county level (see formula [1]). For each county, these estimates then enter the calculation of a weighted mean of the sectoral VoLLs as sectoral weights. In this way, we obtain county-specific measures of the average monetary loss resulting from the withdrawal of one kWh of electricity from production.

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[2] The reason for this partial unavailability is again data privacy: if there are just a few number of large manufacturing firms located in a county, regional figures could be used to infer on firm activity.

[3] Since our focus is on costs for net consumers of energy, the energy sector itself is not considered here.

Concerning the household side, we face similar obstacles regarding the determination of regional electricity consumption. Values for household consumption are only published by regional energy balances at federal state level and even there the data is incomplete. For 2010, data for the states Bavaria, Bremen, Hessen, Mecklenburg-Vorpommern and Saarland are missing. As a first step, we therefore compute the difference between national household consumption and the sum of values reported at federal state level. This residual is distributed proportionally to the regional number of households between the five states for which values are missing. Information on numbers of households for 2010 is taken from the Federal Statistical Office. Having completed household consumption data at federal state level, we distribute in a second step these consumption levels among the counties within a state proportionally to a county's population size.

To determine the household VoLLs, estimates of the individual benefits from leisure have to be added. The amount of available hours T is taken from a study by the Federal Statistical Office (2002) on time use of German citizens. It estimates the time needed for essential activities like sleeping and eating to comprise 13 hours a day, leaving consumers an amount of $T = 13 \cdot 365 = 4745$ hours per year to allocate between work and leisure. Applying formula [3] requires additional information on numbers of employed persons as well as on average values for hourly net wages and working hours. In drawing these figures from official statistics, we have to be aware that information is required according to place of residence, not place of work: the focus is on persons actually living in a region, since they enjoy their leisure time there. Data on the number of employed persons is readily available from the regional database of the Federal Statistical Office. The number of unemployed persons is thus also easily gained by figures on population size.

Still missing are numbers for average wages and working hours according to place of residence. This data would require perfect information on bilateral commuter flows between all counties in Germany. With respect to wages, we consider this only a minor problem, since commuters do not tend to travel long distances and wage differences between neighboring counties are generally low. Therefore, we choose the average hourly net wage paid within a county in 2010 as a measure of the opportunity costs of one hour leisure time for all employed residents of that county. Following Nick et al. (2013), this value is approximated as one half of the average hourly gross wages reported in the regional database. With respect to working hours, differences (relative to population size) between neighboring counties are more pronounced, as a direct consequence of commuter flows. For this reason, we approximate the number of working hours of residents in 2010 by computing the ratio of total working hours over number of employed persons **working** in a county and multiply this ratio by the number of employed persons **living** in that county (with data again taken from the regional database). The underlying assumption is thus that commuting residents exhibit approximately the same average number of working hours per worker as local workers. Finally, these estimates allow us to compute the Value of Lost Loads at household level according to formulae [3] and [4].

To determine the absolute costs resulting from blackouts at particular moments in time, information on time patterns of electricity use has to be added. So-called load profiles can inform about the characteristic distribution of annual electricity consumption across months, days and even single hours. In Germany, standard load profiles for different groups of users as defined by the German Association of Energy and Water industries (BDEW) are used as tools in load forecasting. Among the German network operators, E.ON publishes synthetic normalized load profiles derived from its customer data on an annual basis. Unfortunately, no regional differentiation is provided. We therefore stick to national data for all types of profiles. Regional variation in the time paths of total outage costs is thus purely driven by differences in annual sectoral consumption between regions. To achieve consistency with our data on production and value of leisure time, we choose profiles for the year 2010 for our analysis.

The task remains to assign sectors to profiles of certain user groups. For households and agricultural production, specific profiles are available. Concerning manufacturing, construction and services, we have to resort to non-sector-specific profiles for production. These profiles are, in turn, differentiated with respect to the temporal focus of production during the day. In addition to a standard commercial profile, profiles for businesses operating exclusively during day time and profiles for continuously producing businesses are published. Following Nick et al. (2013), we distinguish for our analysis between continuously and non-continuously producing industries, where the former ones include the following sectors: basic metals and fabricated metal products, chemical and petrochemical products, machinery and equipment, pulp, paper and print, transport equipment. The non-continuously producing industries are assigned the standard commercial profile. Since electricity use at county level is merely reported for total manufacturing, applying this concept requires us to estimate how annual regional electricity use is split between continuous and non-continuous production. To this end, we use an auxiliary regression: based on data at federal state level for the time span 2006-2010, we estimate the share of continuously producing sectors in electricity use as a function of total electricity use in manufacturing and mining per capita (details on estimation and test statistics are reported in Appendix A1). Fitting the model at county level provides us with estimated shares of continuously producing enterprises in electricity use (SH_c) for each county. Based on this information, manipulating formula [2] allows us to calculate the total costs of manufacturing firms ($O_{c,t}^{M}$) resulting from a power cut during hour h in county c in the following manner:

$$O_{c,t}^{M} = GVA_{c}^{M} \cdot (SH_c \cdot L_t^{con} + (1 - SH_c) \cdot L_t^{ncon}),$$

where L_t^{con} and L_t^{ncon} denote load factors (i.e. shares of current in annual electricity consumption for continuously and non-continuously producing enterprises, respectively).

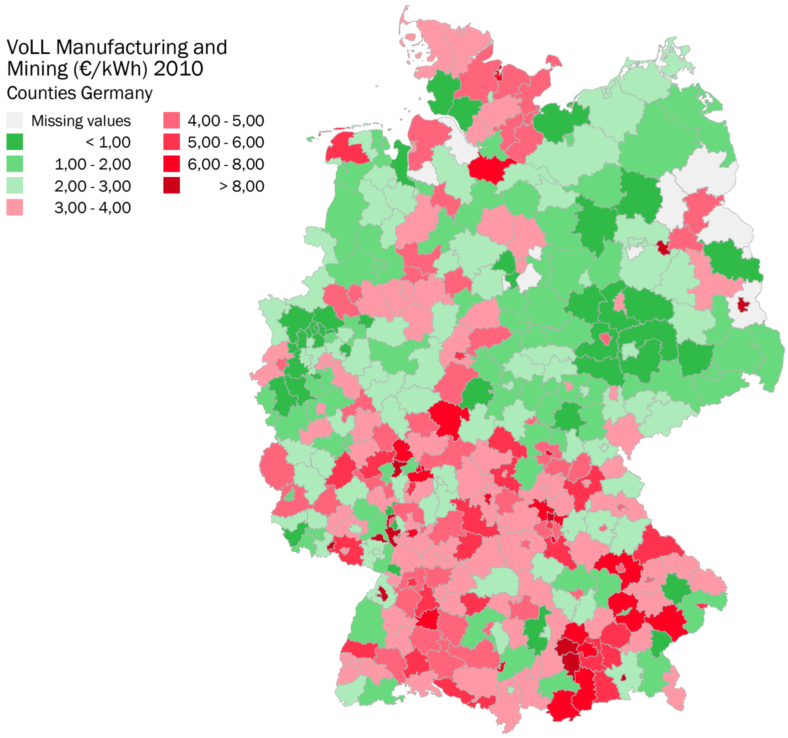
5 | Results for German counties

5.1 | The Value of Lost Loads for firms

As outlined above, calculating the average contribution of one unit of electricity to total production value represents an intuitive approach of evaluating output losses stemming from restrictions to power access. Comparisons of this measure at the regional or sectoral level yield information on which sectors/regions are most severely affected by a potential rationing of the power supply. Consequently, regional heterogeneity concerning this measure points at potential efficiency gains of implementing a non-randomized rationing strategy in times of supply shortage. This would imply cutting-off the least affected regions first. Leaving the largely unobservable indirect costs aside, these regions will be the ones with the highest intensities of electricity usage in production.

Comparing German counties, relatively low VoLLs in manufacturing are therefore to be expected for counties whose industrial structure is dominated by firms from segments like metal processing and chemistry. Figure 2 illustrates the spatial distribution of our estimates throughout Germany. It reveals a remarkable range from less than one to more than eight euros per kWh. Moreover, there is a clear North-South Divide to be noted. An even more evident discrepancy can be observed between South and East. VoLLs larger than 6 €/kWh are much less frequent in North and East than in South Germany. Nevertheless, the presence of local industry clusters entails that, in both North and South, a range of places exist whose vulnerability is distinct from those of their neighboring counties. As a consequence, spatial heterogeneity of VoLLs can also be observed at a small-scale level in Germany, which serves to justify our disaggregated approach.

Figure 2: Spatial distribution of the VoLLs for the manufacturing and mining sector in Germany



Source: own calculations

To understand the emergence of regional outliers, we need to identify the patterns of sectoral specialization. Table 1 lists the Top 5 of German counties with the highest and the lowest VoLLs in manufacturing. As it turns out, manufacturing in all of the reported counties with high VoLLs, except for Erlangen, is dominated by small to medium-size companies. In addition, total manufacturing only makes up a small share of local production. An explanation for this is the natural correspondence between size of a region and its ability to differentiate, as low levels of production are often coupled with a high degree of product specialization. In the Top 5 this is the case with products of comparatively low energy content such as wood products (Rosenheim), food and beverages (Starnberg, Neustadt) and medical engineering (Erlangen).

In contrast, local production in the counties with the lowest VoLLs for manufacturing and mining is characterized by a strong focus on mining and/or on highly energy-intensive industries. For instance, the economy of the Rhein-Erft-Kreis is shaped by the local lignite deposits, the economy of Duisburg by black coal. Altötting and the Saalekreis accommodate clusters of the chemical industry in Germany, while steel and aluminium production plays an important role in Duisburg and the Rhein-Kreis Neuss. Hence, the pattern of manufacturing VoLLs seems to be driven by a complex interplay of industrial history and the spatial distribution of resources in Germany.

Table 1: Highest and lowest VoLLs for the manufacturing and mining sector

Counties with highest VoLLs for manufacturing & mining

Rank	County	Federal State	VoLL
1	Rosenheim (City)	Bavaria	12.38 €/kWh
2	Neustadt a.d.Weinstraße (City)	Rhineland-Palatinate	12.21 €/kWh
3	Starnberg	Bavaria	11.64 €/kWh
4	Erlangen (City)	Bavaria	10.51 €/kWh
5	Baden-Baden (City)	Baden-Württemberg	10.10 €/kWh

Counties with lowest VoLLs for manufacturing & mining

Rank	County	Federal State	VoLL
1	Saalekreis	Saxony-Anhalt	0.30 €/kWh
2	Rhein-Erft-Kreis	North Rhine-Westphalia	0.32 €/kWh
3	Altötting	Bavaria	0.32 €/kWh
4	Duisburg (City)	North Rhine-Westphalia	0.37 €/kWh
5	Rhein-Kreis Neuss	North Rhine-Westphalia	0.38 €/kWh

Source: own calculations

By using these estimates together with nation-wide VoLLs for agriculture, construction and services, we can determine and assess the spatial distribution of the VoLLs for total production. The local sectoral structure is here of relevance because energy intensities of services and construction are considerably lower than average intensities in manufacturing. Economies dominated by service activities thus feature larger losses per unit of electricity. Hence, given that the counties exhibiting the highest values for manufacturing tend to have low overall densities of industry, we can also expect most of them to have high VoLLs for total production. This is confirmed in table 2, where the additional counties Fürstenfeldbruck and Cottbus likewise feature low shares of manufacturing. At the bottom end, the set of counties is joined by Ludwigshafen and Salzgitter. Both economies are dominated by energy-intensive manufacturing, especially by the subsectors chemistry (Ludwigshafen) and steel (Salzgitter).

In all, while VoLLs are still quite dispersed, their range is lower than for manufacturing alone. This is mainly an effect of the consideration of the service sector. Its output-to-electricity ratio is way higher than in energy-intensive manufacturing, but is at the same time lower than in the least energy-intensive industries. Extreme values are thus smoothed by the influence of services. Figure 3 shows that the overall result is a slightly less significant divide between North and South in Germany, a general gap is nevertheless still visible.

Table 2: Highest and lowest VoLLs for total production

Counties with highest VoLLs in total production

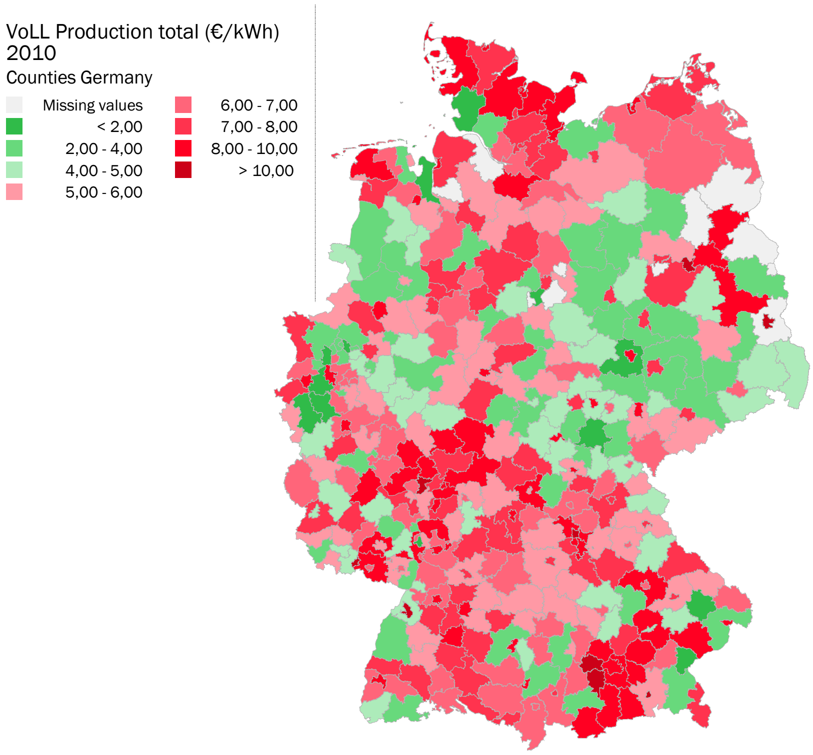
Rank	County	Federal State	VoLL
1	Rosenheim (City)	Bavaria	10.83 €/kWh
2	Starnberg	Bavaria	10.62 €/kWh
3	Fürstenfeldbruck	Bavaria	10.51 €/kWh
4	Erlangen (City)	Bavaria	10.42 €/kWh
5	Cottbus (City)	Brandenburg	10.42 €/kWh

Counties with lowest VoLLs in total production

Rank	County	Federal State	VoLL
1	Altötting	Bavaria	0.69 €/kWh
2	Ludwigshafen (City)	Rhineland-Palatinate	0.92 €/kWh
3	Saalekreis	Saxony-Anhalt	0.98 €/kWh
4	Salzgitter (City)	Lower-Saxony	1.43 €/kWh
5	Duisburg (City)	North Rhine-Westphalia	1.46 €/kWh

Source: own calculations

Figure 3: Spatial distribution of the VoLLs for total production in Germany



Source: own calculations

5.2 | The Value of Lost Loads for households

Compared to results at the firm level, a comparative discussion of household VoLLs has to cope with explanatory factors of higher complexity. In general, calculated values are the outcome of the interplay of a multitude of factors: the local wage level, average working hours, the local rates of unemployment and labour market participation as well as the level of electricity consumption per capita (as influenced again by factors like household structure and population density).

A comparison of counties at the top of the list indeed suggests different explanations for different counties. For Wolfsburg, Ludwigshafen and Ingolstadt, large household losses per kWh are primarily caused by the high level of regional wages. The opportunity costs of devoting time to leisure activities are thus estimated to be very high as well, implying households to receive a likewise high marginal utility from an hour of (electricity-dependent) leisure. In case of Salzgitter, instead, a VoLL larger than 10 €/kWh is the combined result of a comparatively low number of working hours per employee and a low level of electricity consumption per capita in Lower-Saxony. For Leverkusen, the outcome is driven by a mixture of all relevant factors.

Table 3: Highest and lowest VoLLs for households

Counties with highest VoLLs for households

Rank	County	Federal State	VoLL
1	Wolfsburg (City)	Lower-Saxony	13.44 €/kWh
2	Ludwigshafen am Rhein (City)	Rhineland-Palatinate	12.82 €/kWh
3	Salzgitter (City)	Lower-Saxony	12.72 €/kWh
4	Ingolstadt (City)	Bavaria	12.39 €/kWh
5	Leverkusen (City)	North Rhine-Westphalia	12.09 €/kWh

Counties with lowest VoLLs for households

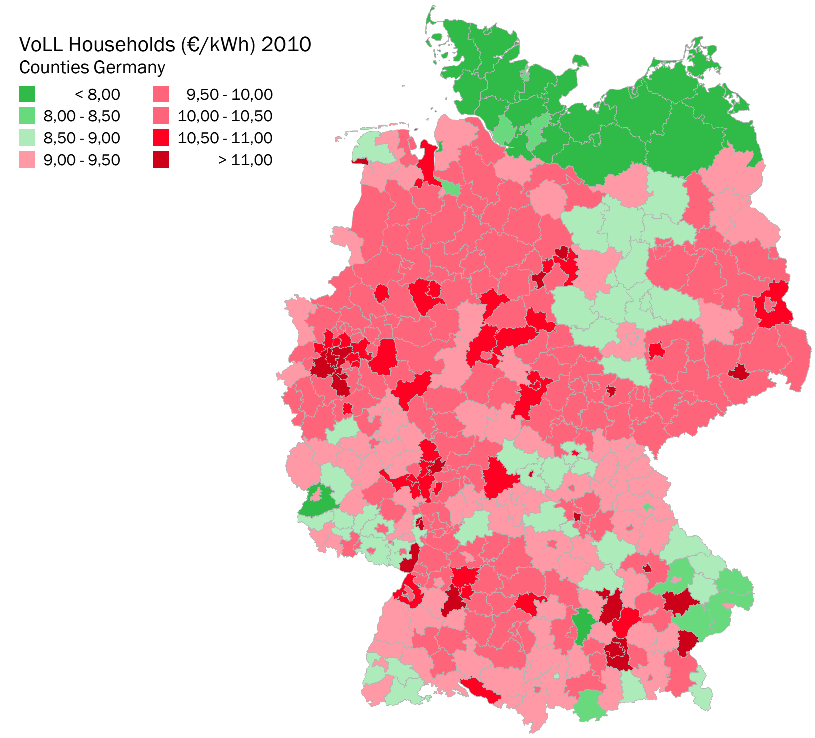
Rank	County	Federal State	VoLL
1	Vorpommern-Rügen	Mecklenburg-Vorpommern	5.85 €/kWh
2	Ludwigslust-Parchim	Mecklenburg-Vorpommern	5.88 €/kWh
3	Rostock	Mecklenburg-Vorpommern	5.93€/kWh
4	Vorpommern-Greifswald	Mecklenburg-Vorpommern	5.94 €/kWh
5	Mecklenburgische Seenplatte	Mecklenburg-Vorpommern	6.20 €/kWh

Source: own calculations

Focusing on counties with the lowest household losses per kWh, we notice a striking regional concentration on Mecklenburg-Vorpommern. One explanation for this is the low level of local wages, implicating a low marginal value of an hour of leisure time. Wages are however not systematically lower than in neighboring Brandenburg, for which significantly higher VoLLs are estimated. A second reason is related to electricity use: excluding the city states Hamburg and Bremen, Mecklenburg-Vorpommern was in per capita terms the state with the highest amount of electricity consumption by households in 2010. Consequently, the electricity intensity of leisure is estimated to be very high, i.e. its inverse is estimated to be very low.

The distribution depicted in figure 4 reveals that the area of low VoLLs also comprises counties from the state of Schleswig-Holstein, again largely due to high levels of electricity use. Households living in the outmost northern part of Germany are hence predicted to reap the lowest benefits from each kWh of electricity consumption. In contrast, existing zones of high VoLLs are more dispersed. We can find them both in a more concentrated form in the West and as single spots in North and South. Concerning their economic structure, they can mostly be characterized as regional agglomerations of industry activity. In general, the North-South divide noted for the assessment of firm VoLLs can partially be diagnosed here as well. However, this does not ensure that absolute costs of a one hour power outage are systematically higher in South than in North. For this, absolute electricity use and its distribution across time and sectors are relevant as well. This will be assessed in the following section.

Figure 4: Spatial distribution of the VoLLs for households in Germany

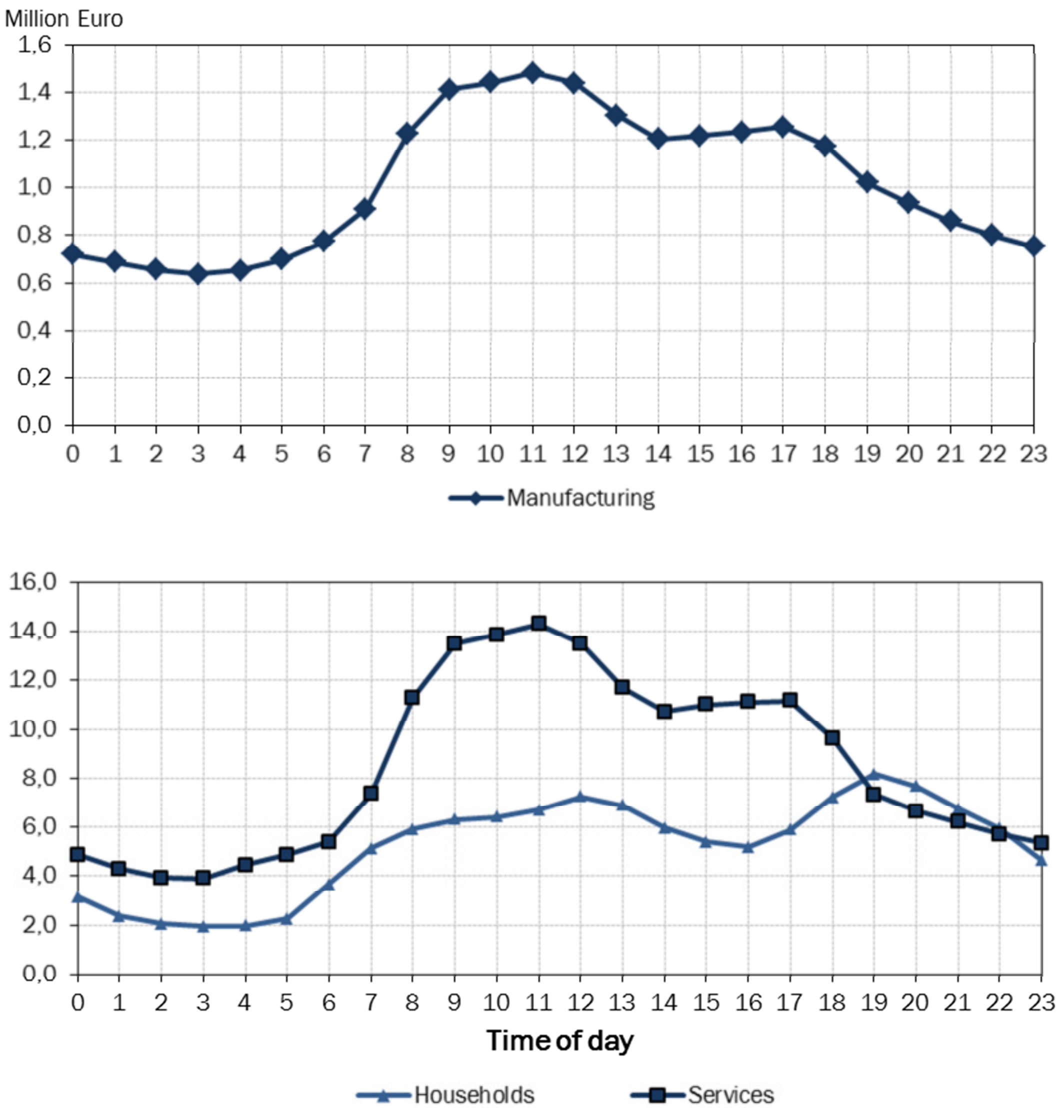


Source: own calculations

5.3 | Temporal distribution of outage costs

While VoLLs reveal the lost value per unit of electricity, it is also worthwhile to investigate the absolute costs that may emerge as a result of power outages. Such outage costs reflect the losses that would result from a complete one hour blackout in a county. The costs include production losses of firms as well as reduced leisure for individuals. Hence, counties with high GDP and large population would be expected to top an outage cost ranking. As outlined above, outage costs are calculated by means of sector-specific annual load profiles, which makes it possible to estimate outage costs for any given hour of the year.

Figure 5: Sectoral distribution of power outage costs during the day: The example of Berlin

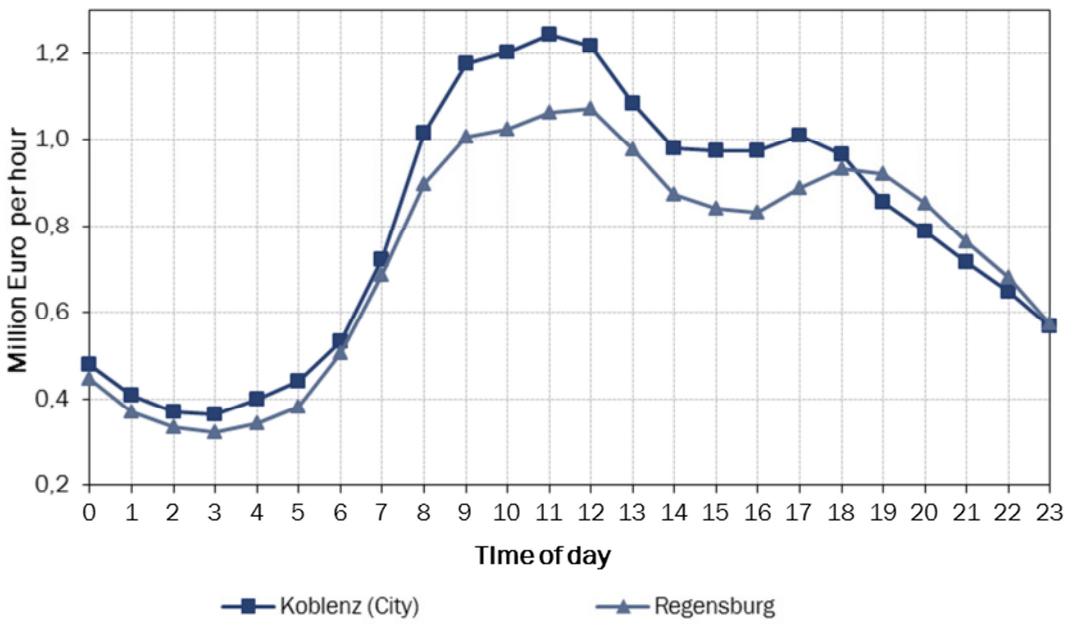


Source: own calculations

Figure 5 illustrates the characteristics of the different sectoral load profiles for the German capital Berlin. They show the changing costs of a one hour blackout at different times of the day. Costs in manufacturing are less volatile than in services. In both sectors, major peaks can be observed between 11h-12h and smaller ones between 17h-18h. The profile of the households is similar to the one for manufacturing. Nevertheless, the trough in the household profile in the afternoon is more significant and the difference between morning and evening hours is stronger. The reason is the more pronounced energy need of households in the evening hours.

These time profiles differ only in scale among counties, as we have to draw on national profiles for the single sectors. Nevertheless, regional differences in the time profiles of total costs emerge through differences in the sectoral structure. In order to illustrate the implications of this, we compare in the following Koblenz (City) and Regensburg as two characteristic examples: Koblenz has significantly higher GDP, while Regensburg has a higher number of households. First, figure 6 shows the differences in power outage costs during the day. Koblenz has higher outage costs for most of the day (0h-18h), while Regensburg has higher outage costs in the evenings (18h-24h). The simple reason for this pattern is that a dominance of production in electricity consumption during the main working hours is replaced by a dominance of consumption by households in the evening hours.

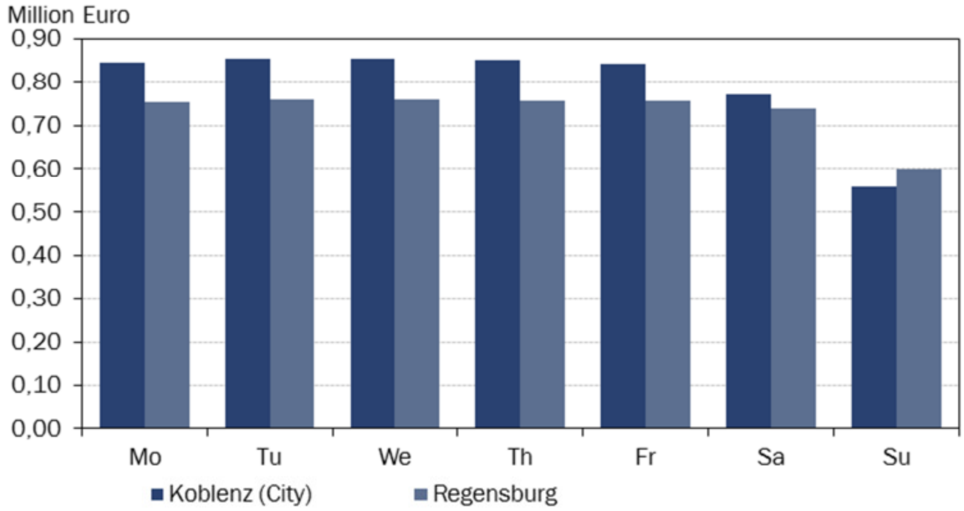
Figure 6: Regional differences in the distribution of power outage costs during the day



Source: own calculations

A similar pattern can be observed when considering the average hourly outage costs across the seven days of the week, as shown in figure 7. From Mondays to Fridays, Koblenz would experience significantly higher losses from power outages, due to its stronger economic production. On Saturdays, when economic activity is reduced, the gap between the two counties narrows. On Sundays, Regensburg has the higher outage costs as a result of its larger population and the fact that more time is spent at home.

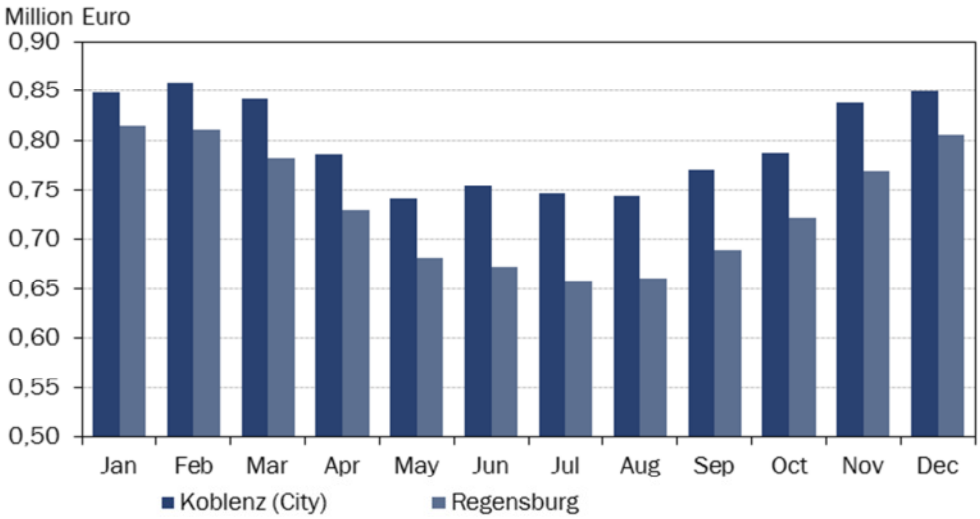
Figure 7: Regional differences in the distribution of outage costs during the week



Source: own calculations

Finally, figure 8 describes the average costs of a one hour power outage for different months of the year. While Koblenz has higher outage costs across the year, it is noticeable that the gap to Regensburg grows larger in the summer months. This is mainly due to a reduction of energy consumption by households. Manufacturing, on the other hand, is less sensitive to seasonal effects.

Figure 8: Regional differences in the distribution of outage costs during the year



Source: own calculations

In table 4, the five counties with the highest average hourly outage costs are listed. Not surprisingly, the list consists of the five most populous cities in Germany. Frankfurt's strong economy allows it to outdo the more populous city of Cologne. This highlights the fact that power outages tend to be more costly in urban than in rural areas. For outage costs in per capita terms, this effect becomes less pronounced. In fact, the ranking is topped by the county of Munich (excluding the city), while the remainder of the Top 5 is filled with small (Coburg, Schweinfurt) and large (Düsseldorf, Frankfurt) cities. Here, a high GDP per capita is apparently a crucial driving force for high general losses.

Table 4: The Top 5 counties with the highest average outage costs

Cost of one hour power outage (in Million Euro)

Rank	County	Average	06:00	12:00	18:00
1	Berlin (City)	14.99	10.05	22.74	18.40
2	Hamburg (City)	12.52	8.39	19.10	15.13
3	Munich (City)	10.50	7.02	16.00	12.78
4	Frankfurt/Main (City)	6.85	4.54	10.55	8.24
5	Cologne (City)	6.58	4.43	9.96	8.05

Cost of one hour power outage (in Euro per capita)

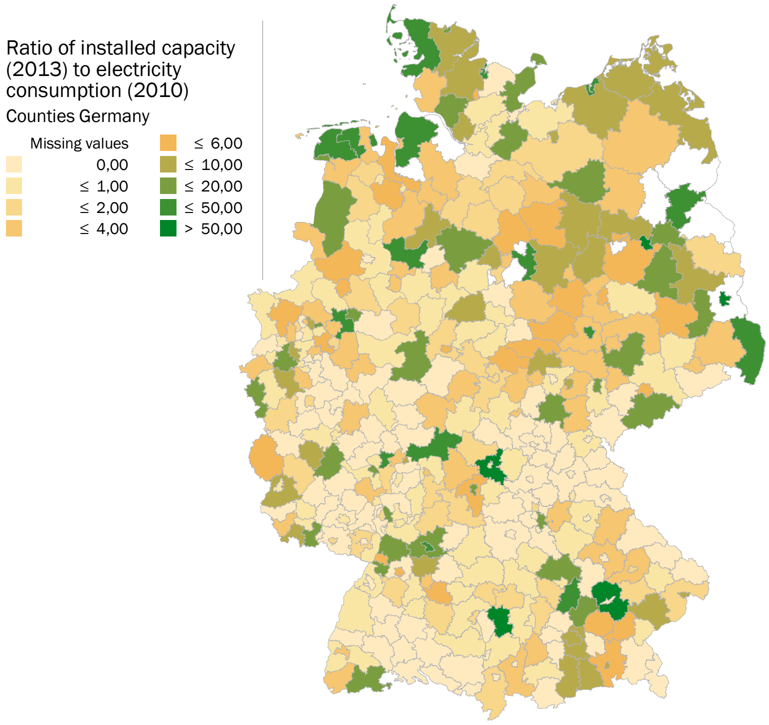
Rank	County	Average	06:00	12:00	18:00
1	Munich	10.52	7.01	16.15	12.63
2	Frankfurt/Main (City)	10.13	6.71	15.60	12.18
3	Schweinfurt (City)	9.74	7.25	13.71	11.76
4	Coburg (City)	8.88	6.10	13.32	10.73
5	Düsseldorf (City)	8.85	5.89	13.60	10.65

Source: own calculations

6 | Implications for supply security

In the light of past experiences in Germany, the scenario of a county-wide blackout underlying our analysis may seem unlikely. However, recent studies point to considerable dangers for network security resulting from the shift in German power supply towards renewable energies (Dena, 2010). In this regard, a major drawback of electricity generation through wind and solar energy is its dependence on current weather conditions. An ongoing expansion of these energy sources will thus cause overall power supply to become more volatile and less predictable. In general, this renders the task of balancing feed-in and consumption volumes at each point in time more difficult for network operators. This is aggravated by a spatial shift of generation capacities. Due to climate conditions, the installation of wind turbines tends to be more profitable in the northern part of Germany, especially when considering the potentials of offshore wind parks. Already today, the result is a gap in the supply potential of electricity between North and South. At the same time, high-demand areas are still concentrated in West and South.

Figure 9: Differences in the local ratios of generation capacity to consumption among German counties



Source: Regional database (2013); Kraftwerksliste Bundesnetzagentur (2013); own calculations

The structure of regional electricity supply and demand is summarized in figure 9, where the ratio of installed capacity to consumption is shown. This can be considered a measure of electricity autarky at county level.[4] A North-South divide is apparent, where the north appears more saturated in terms of electricity. In the South, only a few counties have high levels of electricity saturation, which are the locations of larger conventional power plants. Considering the fact that several of the nuclear power plants, primarily located in the South, have been terminated in 2011 and the remaining are set to be shut down in 2022, the level of electricity autarky in southern Germany will further be on the decline. The consequential need for long-distance power transmission will put further pressure on transmission capacities. Additional issues in

[4] While installed capacity does not necessarily reflect realized electricity production, it is a suitable proxy in the absence of more detailed information.

this context are the restricted capability of renewables to provide the necessary reactive power and the sluggish build-up of power storages in Germany.

Simulations undertaken by comprehensive studies such as Dena I (Dena, 2005) and II (Dena, 2010) have demonstrated that these weak spots can cause regional imbalances to spread through cascade effects, resulting into significant voltage drops for a wider network region. The scenario of a large-scale blackout can thus turn into a realistic threat in case of insufficient stabilization measures. It is undisputed that an integral part of such stabilization will have to consist of capacity increases through network expansion. Nevertheless, existing projects experience significant delays due to suits filed by affected citizens. This is especially worrying at the level of distribution networks, since most renewable energy plants are connected to these low- and medium-voltage grids.

Raising public acceptance of expansion projects is thus essential for a successful switch to renewables. In order to build up trust, the greater benefits of a project should be stressed by means of a thorough cost-benefit analysis. Unfortunately, existing studies almost exclusively focus on quantifying the cost side. Benefits are not presented in the form of intuitive economic figures, but merely as the fulfillment of technical constraints required for network stability. The exception is a study by the RWTH Aachen (2012), which however only considers benefits in terms of a reduction in the costs of electricity generation. Benefits in the form of a prevention of outage costs are so far not accounted for. In this respect, our results point at the usefulness of integrating such a concept into the analysis. Given the magnitude of regional discrepancies in outage costs, this is likely to exert some influence in a comparative evaluation of expansion projects. Projects in some regions might be assessed as more beneficial on the grounds of higher potential losses. A prerequisite for this is detailed knowledge on the likelihood of certain incidents. In this regard, the German Federal Network Agency could be of help: it collects data on the lengths of actual blackouts in Germany as part of its monitoring scheme. These data are published in the summarized form of an interruption index for the single network areas (the System Average Interruption Duration Index (SAIDI)). Combining this information with our outage cost estimates could create a realistic picture of regional exposure towards power outages for Germany.

7 | Conclusion

The aim of this study was to quantify the costs of power outages at a regional level of Germany. In this, we were the first to derive estimates for single counties. As our main result, we could identify a considerable degree of cost heterogeneity both with respect to time and location of blackouts. A general North-South divide observed before by estimations for federal states is also visible at county level: vulnerability tends to be higher in the southern than in the northern part of the country. However, intraregional heterogeneity in both North and South is significant as well, confirming the importance of a highly disaggregated analysis. For the current debate on network expansion in Germany, this points to a need for a careful examination of the benefits from expansion projects, especially with regard to the level of avoidable outage costs.

The significant dispersion in outage costs across counties also suggests that there is an economic case to be made for rational rationing, i.e. a non-randomized allocation of scarce electricity in times of high loads. Under the current legal framework, this may be considered an unlikely scenario, but it is worth noting that the economic gains from an efficient rationing could be quite substantive. Clearly, counties with higher VoLLs would be able to yield a higher societal return from a given unit of electricity, both in terms of output and consumption-related leisure. De Nooij et al. (2009) perform such a calculation for the Netherlands and find substantive gains through efficient rationing. Given that energy security represents one of the key factors for the growth opportunities of countries, this might be an interesting field for further research.

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9 | Appendix

A1: Estimation of shares of continuously producing enterprises

To model the relationship between share SH and potential explanatory factors x, we made use of pooled annual data at the level of German federal states for the years (t) 2006-2010. The dependent variable in this case was a share with a natural range from 0 to 1. As a functional form, we therefore used a fractional logit model (Papke & Wooldridge, 1993):

$$E\left(SH_{r,t}|x_{r,t}^{1}, \dots, x_{r,t}^{n}\right) = \mu_{r,t}$$

$$ln\left(\frac{\mu_{r,t}}{1-\mu_{r,t}}\right) = \beta^{0} + \sum_{i=1}^{n} \beta^{i} x_{r,t}^{i} + \epsilon_{r,t}$$

As explanatory factors, we had to choose variables which were also available at county level. As natural candidates, we chose the total VoLL for manufacturing and mining ($VoLL^{M}$) as well as total electricity usage in manufacturing and mining per capita (EC^{M}). Table A1 lists coefficient estimates and test statistics of three possible model variants.

Table A1: Coefficient estimates for auxiliary regression

Dep. variable: SH	(1)	(2)	(3)
VoLL	0.2643**	-0.0486	-
	(2.63)	(-0.74)	
EC	0.0004***	-	0.0003***
	(5.91)		(5.04)
constant	-1.0012**	0.8685***	-0.1588
	(2.43)	(4.55)	(-0.76)
AIC	0.929	0.921	0.900
BIC	-236.225	-238.8	-240.041
No.Obs.	61	61	61

t-values in parentheses; ***: significant at 1%-level; **: significant at 5%-level ; Source: own calculations

Given that both information criteria AIC and BIC exhibit the lowest values for model version (3), we implemented this variant in determining the share of continuously producing enterprises for each county.

Table A 2: Distribution of county VoLLs for firms and households across federal states 2010

Federal state	Ø VoLL firms	Highest VoLL firms	Lowest VoLL firms
Baden-Württemberg	6.30 €/kWh	Baden-Baden (10.24)	Waldshut (3.12)
Bavaria	6.42 €/kWh	Rosenheim (10.83)	Altötting (0.69)
Berlin	9.25 €/kWh	-	-
Brandenburg	4.42 €/kWh	Cottbus (10.42)	Oder-Spree (2.07)
Bremen	6.85 €/kWh	Bremerhaven (8.15)	Bremen (City) (5.13)
Hamburg	6.47 €/kWh	-	
Hessen	7.32 €/kWh	Main-Taunus-Kreis (10.09)	Hersfeld-Rotenburg (3.26)
Lower-Saxony	4.82 €/kWh	Harburg (9.52)	Salzgitter (1.43)
Mecklenburg-Vorpommern	7.09 €/kWh	Rostock (8.86)	Nordwestmeckl. (3.57)
North Rhine-Westphalia	4.10 €/kWh	Bonn (9.49)	Duisburg (1.46)
Rhineland-Palatinate	5.26 €/kWh	Zweibrücken (10.04)	Ludwigshafen (0.92)
Saarland	4.34 €/kWh	Merzig-Wadern (5.82)	Saarlouis (2.26)
Saxony	4.97 €/kWh	Leipzig (City) (7.99)	Meißen (2.81)
Saxony-Anhalt	2.79 €/kWh	Halle (9.98)	Saalekreis (0.98)
Schleswig-Holstein	7.12 €/kWh	Kiel (9.74)	Dithmarschen (1.90)
Thuringia	5.22 €/kWh	Suhl (8.53)	Saalfeld-Rudolstadt (1.88)

Federal state	Ø VoLL households	Highest VoLL households	Lowest VoLL households
Baden-Württemberg	9.75 €/kWh	Böblingen (11.44)	Waldshut (8.78)
Bavaria	9.50 €/kWh	Erlangen (11.85)	Aichach-Friedberg (7.98)
Berlin	10.41 €/kWh	-	-
Brandenburg	9.59 €/kWh	Spree-Neiße (10.98)	Havelland (8.67)
Bremen	8.01 €/kWh	Bremen (City) (8.21)	Bremerhaven (7.81)
Hamburg	7.70 €/kWh	-	
Hessen	9.94 €/kWh	Frankfurt/Main (11.61)	Werra-Meißner (9.13)
Lower-Saxony	10.10 €/kWh	Wolfsburg (13.44)	Aurich (8.94)
Mecklenburg-Vorpommern	6.13 €/kWh	Schwerin (6.51)	Vorpommern-Rügen (5.85)
North Rhine-Westphalia	10.28 €/kWh	Leverkusen (12.09)	Kleve (9.05)
Rhineland-Palatinate	9.60 €/kWh	Ludwigshafen (12.82)	Trier-Saarburg (8.00)
Saarland	8.97 €/kWh	Saarpfalz (9.62)	Merzig-Wadern (8.52)
Saxony	10.12 €/kWh	Dresden (11.04)	Erzgebirgskreis (9.52)
Saxony-Anhalt	8.81 €/kWh	Saalekreis (9.29)	Stendal (8.51)
Schleswig-Holstein	7.60 €/kWh	Pinneberg (8.17)	Ostholstein (6.82)
Thuringia	10.14 €/kWh	Jena (11.42)	Sömmerda (9.36)

Source: own calculations

Table A 3: Estimated outage costs for the single counties during the day in 2010

County	Federal State	Outage cost per hour at time of day 6:00 AM	12:00 PM	6:00 PM
Barnim	BB	363,914 €	798,297 €	676,748 €
Brandenburg an der Havel	BB	189,211 €	419,605 €	345,635 €
Cottbus	BB	279,627 €	638,912 €	516,714 €
Dahme-Spreewald	BB	458,098 €	1,033,263 €	841,254 €
Elbe-Elster	BB	252,822 €	543,485 €	462,948 €
Frankfurt (Oder)	BB	181,868 €	414,058 €	334,111 €
Havelland	BB	304,636 €	652,877 €	560,032 €
Märkisch-Oderland	BB	385,253 €	848,297 €	719,920 €
Oberhavel	BB	462,395 €	1,013,443 €	855,388 €
Oberspreewald-Lausitz	BB	278,411 €	588,438 €	505,125 €
Oder-Spree	BB	407,916 €	866,289 €	744,873 €
Ostprignitz-Ruppin	BB	242,769 €	527,127 €	445,784 €
Potsdam (City)	BB	500,220 €	1,160,679 €	922,138 €
Potsdam-Mittelmark	BB	449,672 €	986,955 €	836,871 €
Prignitz	BB	189,753 €	404,789 €	347,365 €
Spree-Neiße	BB	283,251 €	607,543 €	526,567 €
Teltow-Fläming	BB	421,037 €	894,756 €	762,288 €
Uckermark	BB	286,224 €	620,496 €	529,786 €
Berlin	BE	10,050,360 €	22,742,476 €	18,402,262 €
Aichach-Friedberg	BV	351,172 €	754,119 €	640,087 €
Altötting	BV	445,408 €	865,267 €	767,814 €
Amberg	BV	197,963 €	406,655 €	342,923 €
Amberg-Sulzbach	BV	307,748 €	641,121 €	559,264 €
Ansbach	BV	582,042 €	1,204,024 €	1,039,615 €
Ansbach (City)	BV	183,420 €	398,220 €	326,050 €
Aschaffenburg	BV	594,914 €	1,256,558 €	1,068,083 €
Aschaffenburg (City)	BV	368,292 €	809,972 €	651,072 €
Augsburg	BV	740,418 €	1,523,333 €	1,326,494 €
Augsburg (City)	BV	1,120,243 €	2,411,509 €	2,000,949 €
Bad Kissingen	BV	313,402 €	684,158 €	575,874 €
Bad Tölz-Wolfratshausen	BV	362,659 €	784,475 €	665,990 €
Bamberg	BV	396,943 €	839,648 €	726,546 €
Bamberg (City)	BV	370,067 €	774,401 €	638,738 €
Bayreuth	BV	286,982 €	605,773 €	527,912 €
Bayreuth (City)	BV	319,915 €	711,464 €	574,947 €
Berchtesgadener Land	BV	314,334 €	683,698 €	574,532 €
Cham	BV	443,296 €	931,510 €	788,979 €
Coburg	BV	283,169 €	569,895 €	496,985 €
Coburg (City)	BV	251,162 €	548,277 €	441,887 €
Dachau	BV	388,802 €	841,737 €	718,539 €
Deggendorf	BV	411,043 €	852,460 €	725,847 €
Dillingen a.d.Donau	BV	306,197 €	643,960 €	551,975 €
Dingolfing-Landau	BV	459,258 €	870,904 €	772,785 €
Donau-Ries	BV	511,697 €	1,041,036 €	894,125 €
Ebersberg	BV	397,431 €	870,446 €	734,057 €
Eichstätt	BV	369,292 €	781,935 €	669,064 €
Erding	BV	367,031 €	802,806 €	682,396 €

County	Federal State	Outage cost per hour at time of day 6:00 AM	 12:00 PM	 6:00 PM
Erlangen (City)	BV	615,299 €	1,295,742 €	1,072,376 €
Erlangen-Höchstadt	BV	456,880 €	941,357 €	811,829 €
Forchheim	BV	320,466 €	675,641 €	588,792 €
Freising	BV	653,394 €	1,428,721 €	1,190,398 €
Freyung-Grafenau	BV	224,584 €	478,513 €	408,735 €
Fürstenfeldbruck	BV	557,557 €	1,213,658 €	1,038,887 €
Fürth	BV	306,714 €	657,035 €	563,500 €
Fürth (City)	BV	412,060 €	888,768 €	746,750 €
Garmisch-Partenkirchen	BV	250,503 €	559,256 €	463,730 €
Günzburg	BV	417,394 €	882,344 €	748,830 €
Haßberge	BV	278,582 €	552,054 €	485,643 €
Hof	BV	337,987 €	684,309 €	595,005 €
Hof (City)	BV	187,826 €	411,088 €	336,225 €
Ingolstadt	BV	743,888 €	1,456,944 €	1,252,822 €
Kaufbeuren	BV	143,285 €	314,586 €	259,936 €
Kelheim	BV	367,478 €	753,982 €	654,136 €
Kempten (Allgäu)	BV	275,206 €	608,509 €	493,666 €
Kitzingen	BV	297,488 €	627,189 €	536,341 €
Kronach	BV	258,896 €	513,988 €	447,402 €
Kulmbach	BV	252,629 €	530,189 €	452,299 €
Landsberg am Lech	BV	353,945 €	758,878 €	646,009 €
Landshut	BV	454,475 €	957,018 €	828,599 €
Landshut (City)	BV	262,991 €	576,003 €	471,314 €
Lichtenfels	BV	248,011 €	528,188 €	441,452 €
Lindau (Bodensee)	BV	274,085 €	573,228 €	489,138 €
Main-Spessart	BV	490,722 €	981,572 €	859,393 €
Memmingen	BV	203,575 €	430,783 €	353,796 €
Miesbach	BV	306,117 €	665,341 €	557,943 €
Miltenberg	BV	436,764 €	899,068 €	773,154 €
Mühldorf a.Inn	BV	351,751 €	737,676 €	632,141 €
München	BV	2,249,332 €	5,182,395 €	4,053,146 €
München (City)	BV	7,023,873 €	15,998,974 €	12,779,160 €
Neuburg-Schrobenhausen	BV	310,131 €	658,678 €	558,756 €
Neumarkt i.d.OPf.	BV	424,899 €	912,974 €	767,107 €
Neustadt a.d.Aisch-	BV	291,430 €	615,202 €	528,810 €
Neustadt a.d.Waldnaab	BV	295,989 €	604,732 €	529,175 €
Neu-Ulm	BV	589,105 €	1,203,217 €	1,039,634 €
Nürnberg (City)	BV	2,234,321 €	4,944,350 €	4,031,600 €
Nürnberger Land	BV	542,031 €	1,130,269 €	970,697 €
Oberallgäu	BV	469,559 €	998,295 €	850,021 €
Ostallgäu	BV	449,838 €	945,539 €	808,968 €
Passau	BV	556,679 €	1,156,020 €	996,175 €
Passau (City)	BV	256,995 €	572,372 €	457,823 €
Pfaffenhofen a.d.Ilm	BV	409,950 €	851,928 €	741,943 €
Regen	BV	247,800 €	519,571 €	445,361 €
Regensburg	BV	506,273 €	1,072,404 €	933,128 €
Regensburg (City)	BV	774,847 €	1,636,091 €	1,347,834 €
Rhön-Grabfeld	BV	285,539 €	601,005 €	511,530 €
Rosenheim	BV	759,715 €	1,621,161 €	1,382,085 €

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Rosenheim (City)	BV	256,025 €	568,670 €	462,673 €
Rottal-Inn	BV	361,859 €	783,517 €	659,325 €
Roth	BV	374,094 €	800,431 €	682,560 €
Schwabach	BV	134,563 €	291,444 €	242,741 €
Schwandorf	BV	513,502 €	1,053,986 €	903,999 €
Schweinfurt	BV	276,800 €	594,803 €	516,612 €
Schweinfurt (City)	BV	387,527 €	733,096 €	628,974 €
Starnberg	BV	488,743 €	1,082,439 €	893,226 €
Straubing	BV	196,791 €	430,921 €	350,507 €
Straubing-Bogen	BV	271,691 €	572,091 €	494,408 €
Tirschenreuth	BV	242,892 €	498,739 €	433,353 €
Traunstein	BV	596,315 €	1,228,941 €	1,058,811 €
Unterallgäu	BV	454,505 €	922,554 €	803,106 €
Weiden i.d.OPf.	BV	182,953 €	408,858 €	327,050 €
Weilheim-Schongau	BV	472,756 €	951,095 €	829,900 €
Weißenburg-Gunzenhausen	BV	295,731 €	616,900 €	530,328 €
Wunsiedel i.Fichtelgebirge	BV	269,642 €	553,359 €	474,668 €
Würzburg	BV	455,775 €	981,500 €	839,902 €
Würzburg (City)	BV	588,900 €	1,334,400 €	1,069,844 €
Alb-Donau-Kreis	BW	587,796 €	1,192,884 €	1,047,804 €
Baden-Baden	BW	259,822 €	587,460 €	470,635 €
Biberach	BW	748,452 €	1,531,220 €	1,316,486 €
Böblingen	BW	1,618,297 €	3,363,959 €	2,863,485 €
Bodenseekreis	BW	830,744 €	1,726,578 €	1,476,924 €
Breisgau-Hochschwarzwald	BW	738,716 €	1,565,520 €	1,341,439 €
Calw	BW	458,769 €	977,386 €	836,295 €
Emmendingen	BW	492,196 €	1,033,554 €	888,715 €
Enzkreis	BW	633,679 €	1,291,650 €	1,126,260 €
Esslingen	BW	1,936,897 €	4,013,623 €	3,439,062 €
Freiburg im Breisgau	BW	863,793 €	1,946,492 €	1,577,539 €
Freudenstadt	BW	427,295 €	873,591 €	751,935 €
Göppingen	BW	859,339 €	1,808,040 €	1,542,945 €
Heidelberg	BW	696,901 €	1,579,219 €	1,262,774 €
Heidenheim	BW	502,132 €	1,010,913 €	881,060 €
Heilbronn	BW	1,252,941 €	2,566,112 €	2,215,378 €
Heilbronn (City)	BW	542,809 €	1,194,387 €	968,832 €
Hohenlohekreis	BW	454,562 €	937,036 €	797,498 €
Karlsruhe	BW	1,475,418 €	3,130,174 €	2,666,244 €
Karlsruhe (City)	BW	1,339,836 €	2,983,964 €	2,417,001 €
Konstanz	BW	880,953 €	1,873,745 €	1,596,876 €
Lörrach	BW	720,673 €	1,488,033 €	1,285,645 €
Ludwigsburg	BW	1,896,911 €	4,037,989 €	3,427,015 €
Main-Tauber-Kreis	BW	512,408 €	1,075,912 €	907,812 €
Mannheim	BW	1,451,546 €	3,112,709 €	2,570,857 €
Neckar-Odenwald-Kreis	BW	491,692 €	1,051,968 €	886,871 €
Ortenaukreis	BW	1,518,974 €	3,126,908 €	2,672,650 €
Ostalbkreis	BW	1,160,614 €	2,369,670 €	2,048,636 €
Pforzheim	BW	465,015 €	1,006,716 €	832,677 €
Rastatt	BW	882,676 €	1,744,120 €	1,531,982 €

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Reutlingen	BW	1,024,477 €	2,156,585 €	1,827,950 €
Rhein-Neckar-Kreis	BW	1,734,601 €	3,722,580 €	3,165,925 €
Ravensburg	BW	1,010,487 €	2,155,793 €	1,809,847 €
Rems-Murr-Kreis	BW	1,403,355 €	2,938,759 €	2,515,548 €
Rottweil	BW	522,900 €	1,060,567 €	915,488 €
Schwäbisch Hall	BW	713,615 €	1,495,367 €	1,268,677 €
Schwarzwald-Baar-Kreis	BW	739,486 €	1,541,037 €	1,311,282 €
Sigmaringen	BW	456,864 €	968,005 €	818,613 €
Stuttgart	BW	3,264,966 €	7,377,438 €	5,895,798 €
Tübingen	BW	689,006 €	1,493,463 €	1,261,846 €
Tuttlingen	BW	555,505 €	1,096,835 €	952,713 €
Ulm	BW	674,205 €	1,490,222 €	1,195,181 €
Waldshut	BW	492,715 €	1,015,356 €	879,973 €
Zollernalbkreis	BW	657,273 €	1,361,634 €	1,168,471 €
Bremen	HB	2,269,701 €	4,954,511 €	4,061,554 €
Bremerhaven	HB	409,729 €	912,663 €	746,400 €
Bergstraße	HE	794,079 €	1,716,261 €	1,460,160 €
Darmstadt (City)	HE	747,556 €	1,655,575 €	1,340,035 €
Darmstadt-Dieburg	HE	835,129 €	1,788,920 €	1,537,296 €
Frankfurt am Main	HE	4,538,871 €	10,551,900 €	8,241,900 €
Fulda	HE	786,382 €	1,686,104 €	1,412,991 €
Gießen	HE	904,426 €	1,983,132 €	1,651,813 €
Groß-Gerau	HE	954,868 €	2,015,119 €	1,717,837 €
Hersfeld-Rotenburg	HE	419,451 €	891,553 €	758,879 €
Hochtaunuskreis	HE	999,676 €	2,253,377 €	1,826,367 €
Kassel	HE	805,273 €	1,649,731 €	1,439,776 €
Kassel (City)	HE	823,637 €	1,849,154 €	1,498,294 €
Lahn-Dill-Kreis	HE	936,103 €	1,935,714 €	1,656,200 €
Limburg-Weilburg	HE	525,891 €	1,145,270 €	966,220 €
Main-Kinzig-Kreis	HE	1,326,441 €	2,847,638 €	2,413,087 €
Main-Taunus-Kreis	HE	1,121,177 €	2,571,646 €	2,051,655 €
Marburg-Biedenkopf	HE	889,981 €	1,841,449 €	1,580,825 €
Odenwaldkreis	HE	294,558 €	616,588 €	531,314 €
Offenbach	HE	1,181,034 €	2,591,088 €	2,163,440 €
Offenbach (City)	HE	460,116 €	1,019,170 €	841,232 €
Rheingau-Taunus-Kreis	HE	515,118 €	1,115,391 €	953,179 €
Schwalm-Eder-Kreis	HE	583,808 €	1,252,152 €	1,066,758 €
Vogelsbergkreis	HE	330,342 €	703,041 €	603,140 €
Waldeck-Frankenberg	HE	572,221 €	1,195,097 €	1,021,253 €
Werra-Meißner-Kreis	HE	309,871 €	663,101 €	567,054 €
Wetteraukreis	HE	920,901 €	1,998,405 €	1,695,479 €
Wiesbaden	HE	1,369,717 €	3,122,603 €	2,491,927 €
Hamburg	HH	8,394,602 €	19,098,936 €	15,125,341 €
Ludwigslust-Parchim	MV	464,048 €	997,453 €	856,429 €
Mecklenburgische Seenplatte	MV	647,884 €	1,431,762 €	1,199,743 €
Nordwestmecklenburg	MV	338,458 €	723,957 €	624,335 €
Rostock	MV	476,395 €	1,050,367 €	885,906 €
Rostock (City)	MV	572,788 €	1,307,781 €	1,054,029 €
Schwerin	MV	269,279 €	613,064 €	495,199 €

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Vorpommern-Greifswald	MV	531,130 €	1,176,782 €	988,019 €
Vorpommern-Rügen	MV	510,376 €	1,137,669 €	953,117 €
Ammerland	NI	321,906 €	693,970 €	588,556 €
Aurich	NI	456,159 €	1,003,901 €	846,949 €
Braunschweig	NI	887,497 €	1,957,484 €	1,606,268 €
Celle	NI	502,394 €	1,086,314 €	915,495 €
Cloppenburg	NI	489,797 €	1,015,123 €	880,526 €
Cuxhaven	NI	468,424 €	1,016,669 €	874,262 €
Delmenhorst	NI	188,143 €	412,971 €	346,393 €
Diepholz	NI	598,767 €	1,289,470 €	1,099,429 €
Emden	NI	237,266 €	477,449 €	405,012 €
Emsland	NI	1,074,745 €	2,220,068 €	1,903,800 €
Friesland	NI	254,883 €	547,514 €	468,156 €
Gifhorn	NI	401,666 €	856,847 €	749,798 €
Goslar	NI	397,395 €	855,686 €	725,919 €
Göttingen	NI	829,178 €	1,822,416 €	1,516,464 €
Grafschaft Bentheim	NI	372,918 €	789,783 €	675,167 €
Hameln-Pyrmont	NI	451,944 €	982,980 €	826,971 €
Harburg	NI	571,904 €	1,252,502 €	1,066,265 €
Heidekreis	NI	415,891 €	911,042 €	761,988 €
Helmstedt	NI	219,722 €	469,056 €	409,932 €
Hildesheim	NI	822,774 €	1,747,248 €	1,490,696 €
Holzminden	NI	214,942 €	438,394 €	382,911 €
Leer	NI	496,758 €	1,113,123 €	915,171 €
Lüchow-Dannenberg	NI	126,903 €	269,152 €	233,737 €
Lüneburg	NI	488,834 €	1,063,541 €	898,400 €
Nienburg (Weser)	NI	361,002 €	758,174 €	652,334 €
Northeim	NI	405,051 €	852,350 €	733,495 €
Oldenburg	NI	319,691 €	678,140 €	588,428 €
Oldenburg (City)	NI	600,170 €	1,369,746 €	1,101,925 €
Osnabrück	NI	1,017,078 €	2,109,073 €	1,821,353 €
Osnabrück (City)	NI	633,922 €	1,414,845 €	1,141,856 €
Osterholz	NI	260,836 €	568,160 €	487,438 €
Osterode (City)	NI	251,076 €	518,523 €	445,136 €
Peine	NI	321,600 €	671,712 €	586,880 €
Region Hannover	NI	4,041,840 €	9,036,471 €	7,366,539 €
Rotenburg (Wümme)	NI	482,227 €	1,053,720 €	885,649 €
Salzgitter	NI	444,996 €	834,468 €	744,593 €
Schaumburg	NI	415,676 €	889,641 €	761,235 €
Stade	NI	564,668 €	1,235,833 €	1,042,809 €
Uelzen	NI	248,334 €	538,345 €	458,380 €
Vechta	NI	496,816 €	1,021,474 €	873,293 €
Verden	NI	372,594 €	804,102 €	680,870 €
Wesermarsch	NI	280,303 €	561,164 €	494,470 €
Wilhelmshaven	NI	277,978 €	620,066 €	506,914 €
Wittmund	NI	150,423 €	330,497 €	279,143 €
Wolfenbüttel	NI	262,610 €	565,280 €	492,710 €
Wolfsburg	NI	414,426 €	929,322 €	777,216 €
Bielefeld	NW	1,149,134 €	2,512,369 €	2,089,329 €

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Borken	NW	1,199,869 €	2,537,687 €	2,154,960 €
Bottrop	NW	313,498 €	671,708 €	576,295 €
Bochum	NW	1,259,012 €	2,740,057 €	2,287,657 €
Bonn	NW	1,719,556 €	4,019,856 €	3,139,837 €
City region Aachen	NW	1,821,103 €	3,942,101 €	3,321,144 €
Coesfeld	NW	635,849 €	1,371,654 €	1,168,157 €
Dortmund	NW	1,923,679 €	4,279,366 €	3,538,569 €
Duisburg	NW	1,650,783 €	3,462,839 €	2,955,346 €
Düren	NW	1,184,110 €	2,446,679 €	2,211,756 €
Düsseldorf	NW	3,456,698 €	7,985,497 €	6,255,747 €
Ennepe-Ruhr-Kreis	NW	1,055,192 €	2,188,395 €	1,891,233 €
Essen	NW	2,055,780 €	4,565,202 €	3,767,071 €
Euskirchen	NW	546,432 €	1,164,491 €	997,391 €
Gelsenkirchen	NW	767,982 €	1,625,488 €	1,391,358 €
Gütersloh	NW	1,411,915 €	2,928,782 €	2,480,859 €
Hagen	NW	643,353 €	1,359,633 €	1,153,044 €
Hamm	NW	528,938 €	1,136,459 €	965,629 €
Heinsberg	NW	660,526 €	1,429,964 €	1,219,002 €
Herford	NW	836,114 €	1,759,489 €	1,494,523 €
Herne	NW	464,551 €	989,950 €	851,523 €
Hochsauerlandkreis	NW	920,125 €	1,884,950 €	1,620,128 €
Höxter	NW	446,025 €	948,238 €	807,188 €
Kleve	NW	958,930 €	2,118,349 €	1,762,514 €
Köln	NW	4,428,102 €	9,962,572 €	8,054,887 €
Krefeld	NW	828,163 €	1,713,273 €	1,470,810 €
Leverkusen	NW	617,977 €	1,264,893 €	1,092,900 €
Lippe	NW	1,099,975 €	2,341,699 €	1,994,267 €
Märkischer Kreis	NW	1,537,430 €	3,062,352 €	2,671,788 €
Mettmann	NW	1,751,255 €	3,743,429 €	3,162,401 €
Minden-Lübbecke	NW	1,120,468 €	2,413,517 €	2,017,947 €
Mönchengladbach	NW	829,057 €	1,807,772 €	1,515,415 €
Mülheim an der Ruhr	NW	631,533 €	1,381,566 €	1,143,966 €
Münster	NW	1,329,358 €	3,057,982 €	2,428,482 €
Oberbergischer Kreis	NW	920,299 €	1,919,284 €	1,641,258 €
Oberhausen	NW	600,541 €	1,300,854 €	1,106,800 €
Olpe	NW	504,789 €	1,008,840 €	875,639 €
Paderborn	NW	1,016,503 €	2,183,198 €	1,836,662 €
Recklinghausen	NW	1,672,244 €	3,573,711 €	3,079,372 €
Remscheid	NW	395,302 €	824,908 €	702,582 €
Rhein-Erft-Kreis	NW	1,534,173 €	3,250,642 €	2,822,638 €
Rheinisch-Bergischer Kreis	NW	794,728 €	1,713,043 €	1,457,095 €
Rhein-Kreis Neuss	NW	1,529,243 €	3,263,167 €	2,769,434 €
Rhein-Sieg-Kreis	NW	1,731,273 €	3,776,712 €	3,186,997 €
Siegen-Wittgenstein	NW	1,052,888 €	2,161,312 €	1,852,931 €
Soest	NW	996,182 €	2,075,342 €	1,777,229 €
Solingen	NW	487,235 €	1,032,209 €	879,034 €
Steinfurt	NW	1,344,646 €	2,840,049 €	2,427,204 €
Unna	NW	1,153,842 €	2,468,054 €	2,113,466 €
Viersen	NW	893,022 €	1,922,886 €	1,634,792 €

County	Federal State	Outage costs per hour at time of day 6:00 AM	12:00 PM	6:00 PM
Warendorf	NW	890,852 €	1,859,657 €	1,601,181 €
Wesel	NW	1,318,333 €	2,778,304 €	2,397,559 €
Wuppertal	NW	1,164,141 €	2,497,029 €	2,112,341 €
Ahrweiler	RP	337,549 €	733,659 €	621,581 €
Altenkirchen (Westerwald)	RP	376,413 €	790,457 €	678,452 €
Alzey-Worms	RP	320,586 €	690,637 €	596,903 €
Bad Dürkheim	RP	329,861 €	703,365 €	610,061 €
Bad Kreuznach	RP	474,739 €	1,004,831 €	857,172 €
Bernkastel-Wittlich	RP	344,398 €	710,652 €	610,152 €
Birkenfeld	RP	247,895 €	532,522 €	449,700 €
Cochem-Zell	RP	185,765 €	407,450 €	342,116 €
Donnersbergkreis	RP	224,130 €	455,212 €	399,865 €
Eifelkreis Bitburg-Prüm	RP	283,398 €	598,977 €	515,573 €
Frankenthal (Pfalz)	RP	168,510 €	346,504 €	301,530 €
Germersheim	RP	436,293 €	852,646 €	759,549 €
Kaiserslautern	RP	386,321 €	833,807 €	689,139 €
Kaiserslautern (City)	RP	249,751 €	540,830 €	464,392 €
Koblenz	RP	534,102 €	1,215,747 €	963,951 €
Kusel	RP	167,918 €	357,390 €	310,212 €
Landau in der Pfalz	RP	160,436 €	357,027 €	291,955 €
Ludwigshafen am Rhein	RP	831,497 €	1,581,195 €	1,393,463 €
Mainz	RP	877,842 €	1,988,218 €	1,599,007 €
Mainz-Bingen	RP	598,941 €	1,272,585 €	1,104,741 €
Mayen-Koblenz	RP	616,650 €	1,291,120 €	1,108,883 €
Neustadt an der Weinstraße	RP	152,394 €	339,060 €	283,058 €
Neuwied	RP	565,515 €	1,186,948 €	1,014,926 €
Pirmasens	RP	157,826 €	336,305 €	279,459 €
Rhein-Hunsrück-Kreis	RP	323,098 €	698,499 €	586,832 €
Rhein-Lahn-Kreis	RP	336,561 €	717,114 €	614,054 €
Rhein-Pfalz-Kreis	RP	327,225 €	703,739 €	612,834 €
Speyer	RP	198,364 €	428,758 €	354,665 €
Südliche Weinstraße	RP	277,996 €	590,491 €	512,724 €
Südwestpfalz	RP	212,083 €	451,581 €	394,669 €
Trier (City)	RP	386,706 €	850,453 €	695,488 €
Trier-Saarburg	RP	313,470 €	669,018 €	578,641 €
Vulkaneifel	RP	185,966 €	392,713 €	335,721 €
Westerwaldkreis	RP	645,069 €	1,376,721 €	1,157,795 €
Worms	RP	256,691 €	533,419 €	458,955 €
Zweibrücken	RP	133,313 €	284,772 €	236,627 €
Dithmarschen	SH	368,084 €	779,422 €	673,371 €
Flensburg	SH	308,349 €	693,765 €	561,710 €
Herzogtum Lauenburg	SH	454,654 €	984,974 €	842,279 €
Kiel	SH	878,529 €	1,993,442 €	1,605,918 €
Lübeck	SH	662,490 €	1,468,183 €	1,208,221 €
Neumünster	SH	249,927 €	557,324 €	455,816 €
Nordfriesland	SH	483,729 €	1,084,437 €	899,741 €
Ostholstein	SH	490,062 €	1,079,496 €	907,948 €
Pinneberg	SH	852,426 €	1,846,287 €	1,566,946 €
Plön	SH	295,745 €	643,340 €	553,926 €

County	Federal State	Outage costs per hour at time of day 6:00 AM	12:00 PM	6:00 PM
Rendsburg-Eckernförde	SH	734,013 €	1,629,428 €	1,358,414 €
Schleswig-Flensburg	SH	492,466 €	1,085,811 €	915,078 €
Segeberg	SH	754,453 €	1,639,309 €	1,380,513 €
Steinburg	SH	385,737 €	829,264 €	702,952 €
Stormarn	SH	712,521 €	1,550,601 €	1,297,675 €
Merzig-Wadern	SL	299,259 €	644,384 €	544,460 €
Neunkirchen	SL	357,124 €	764,332 €	653,960 €
Regionalverband Saarbrücken	SL	1,195,573 €	2,619,790 €	2,159,770 €
Saarlouis	SL	660,606 €	1,339,345 €	1,162,047 €
Saarpfalz-Kreis	SL	540,844 €	1,111,639 €	950,440 €
St. Wendel	SL	244,964 €	518,969 €	444,969 €
Bautzen	SN	753,300 €	1,602,002 €	1,363,882 €
Chemnitz	SN	691,232 €	1,539,560 €	1,258,339 €
Dresden	SN	1,534,010 €	3,438,354 €	2,806,609 €
Erzgebirgskreis	SN	837,867 €	1,776,384 €	1,511,499 €
Görlitz	SN	605,757 €	1,297,067 €	1,107,912 €
Leipzig	SN	1,437,296 €	3,240,884 €	2,642,447 €
Leipzig (City)	SN	571,489 €	1,222,576 €	1,048,569 €
Meißen	SN	620,839 €	1,295,707 €	1,114,566 €
Mittelsachsen	SN	823,954 €	1,739,954 €	1,480,268 €
Nordsachsen	SN	492,879 €	1,059,937 €	901,015 €
Sächsische Schweiz-Osterzgebirge	SN	551,222 €	1,177,126 €	1,007,098 €
Vogtlandkreis	SN	576,648 €	1,234,437 €	1,045,099 €
Zwickau	SN	859,495 €	1,838,320 €	1,552,687 €
Altmarkkreis Salzwedel	ST	206,773 €	435,577 €	376,946 €
Anhalt-Bitterfeld	ST	441,682 €	898,525 €	778,291 €
Börde	ST	425,391 €	875,299 €	762,120 €
Burgenlandkreis	ST	430,679 €	909,237 €	781,276 €
Dessau-Roßlau	ST	218,225 €	480,639 €	397,577 €
Halle (Saale)	ST	580,582 €	1,315,099 €	1,072,489 €
Harz	ST	516,207 €	1,097,053 €	936,900 €
Jerichower Land	ST	230,544 €	494,298 €	420,002 €
Magdeburg	ST	667,208 €	1,517,938 €	1,220,126 €
Mansfeld-Südharz	ST	318,508 €	680,412 €	581,861 €
Saalekreis	ST	492,153 €	1,008,940 €	873,836 €
Salzlandkreis	ST	459,639 €	956,354 €	826,538 €
Stendal	ST	278,390 €	596,121 €	508,758 €
Wittenberg	ST	312,246 €	643,056 €	558,424 €
Altenburger Land	TH	210,583 €	449,511 €	383,669 €
Eichsfeld	TH	235,993 €	492,338 €	423,935 €
Eisenach	TH	128,122 €	269,073 €	225,847 €
Erfurt	TH	591,251 €	1,339,976 €	1,082,291 €
Gera	TH	237,570 €	532,225 €	437,385 €
Gotha	TH	335,667 €	711,823 €	604,812 €
Greiz	TH	228,436 €	485,682 €	416,838 €
Hildburghausen	TH	152,983 €	321,677 €	276,891 €
Ilm-Kreis	TH	269,657 €	560,912 €	480,939 €
Jena	TH	311,875 €	687,338 €	565,485 €
Kyffhäuserkreis	TH	182,127 €	394,067 €	336,458 €

County	Federal State	Outage costs per hour at time of day 6:00 AM	12:00 PM	6:00 PM
Nordhausen	TH	194,404 €	419,544 €	357,619 €
Saale-Holzland-Kreis	TH	195,875 €	416,118 €	355,866 €
Saale-Orla-Kreis	TH	218,071 €	438,741 €	382,238 €
Saalfeld-Rudolstadt	TH	267,337 €	553,134 €	478,556 €
Schmalkalden-Meiningen	TH	310,589 €	655,166 €	557,572 €
Sömmerda	TH	156,151 €	328,854 €	283,541 €
Sonneberg	TH	142,161 €	288,228 €	249,898 €
Suhl	TH	102,696 €	228,657 €	187,620 €
Unstrut-Hainich-Kreis	TH	248,103 €	536,450 €	454,214 €
Wartburgkreis	TH	309,233 €	636,669 €	552,093 €
Weimar (City)	TH	161,660 €	364,422 €	298,405 €
Weimarer Land	TH	173,325 €	370,605 €	319,249 €

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