
Load Management as a Way of Covering Peak Demand in Southern Germany

Summary of intermediate findings from a study conducted by Fraunhofer ISI and Forschungsgesellschaft für Energiewirtschaft

STUDY

Agora
Energiewende



Load Management as a Way of Covering Peak Demand in Southern Germany

Summary of intermediate findings from a
study conducted by Fraunhofer ISI and FfE

IMPRINT

CREATED ON BEHALF OF

Agora Energiewende
Rosenstrasse 2 | 10178 Berlin

Project Director: Alexandra Langenheld
alexandra.langenheld@agora-energiewende.de

Editor: Nikola Bock

IN COOPERATION WITH

Ministry of the Environment, Climate Protection and
the Energy Sector Baden-Württemberg
Kernerplatz 9 | 70182 Stuttgart

Bavarian State Ministry
of the Environment and Public Health
Rosenkavalierplatz 2 | 81925 München

AUTHORS

Dr. Marian Klobasa
Fraunhofer Institute for Systems
and Innovation Research
Breslauer Strasse 48 | 76139 Karlsruhe

Dr. Serafin von Roon, Tim Buber, Anna Gruber
Forschungsgesellschaft für Energiewirtschaft mbH
Am Blütenanger 71 | 80995 München

Typesetting: UKEX GRAPHIC, Ettlingen
Cover: ©iStockphoto.com/Olivier Lantzendörffer

018/06-S-2013/EN

Publication: July 2013

Contents

1.	Objective	2
2.	Introduction	3
3.	Assessment of Current Load Management Potential	4
3.1	Current electricity consumption and peak demand	4
3.2	Cross-section technologies	5
3.3	Industrial processes	6
3.4	Heat pumps and night heat storage	8
4.	How Load Management Can Supply Reliability	12
5.	Current Obstacles	14
6.	Conclusions and Recommendations	15

1. Objective

Without timely course corrections, in just a few years Southern Germany's power system reliability could be under significant stress in certain times of the day/ year. Contributing factors include the reduction in generation capacity as a result of the nuclear phase-out, the fluctuating output from renewable generation, and the current design of the power market. To reduce the risk of power shortfalls, the focus at present is on expanding the grid and building additional generation capacity; in addition, contracts are being signed for backup capacity ("cold reserve"). In contrast, little attention is being paid to actively controlling electricity demand. Yet, load management¹ could be a clean, low-cost way of reducing peak demand and optimizing the capacity utilization of conventional power plants.

Unlike the theoretical economic estimates in the studies of potential conducted so far, this project specifically investigates whether and to what extent load management in industrial and commercial processes can increase supply security/ reliability in southern Germany, particularly in terms of temporary regional demand bottlenecks. Above all, this study aims to discover what obstacles exist and what incentives are needed for the targeted steering of electricity consumption. From these insights, we present recommendations for structuring meaningful economic incentives to tap this potential, in the context of designing the future energy market.

1 We use the term "load management" in this paper to refer to the active and controllable steering of electricity consumption, which is also referred to as "demand response".

2. Introduction

The growing share of fluctuating generation is increasing the need for system services, such as those required to provide balancing energy. Yet, the share of fossil plants, which largely provide these system services today, is shrinking. The offshore wind sector is just getting started even as nuclear power is phased out, and the combined effect will be greater power generation capacity in northern Germany, farther away from consumer centers in southern and western Germany. Already, re-dispatch demand is increasing because grid upgrades are moving so slowly. Moreover, Germany's national regulator (*Bundesnetzagentur*) recommended that transmission grid operators acquire a "cold reserve" of 2.5 gigawatts (GW) for the winter of 2012-2013 to ensure reliable grid operation.

Here, demand management can help by both providing system services and reducing peak load. Load shifting can free up balancing energy and re-dispatch capacity, thereby offsetting some of the demand for conventional system services. In addition, the demand for generation capacity can be reduced. This project therefore takes a detailed look at the existing practical potential in southern Germany. The results shown are based on an online survey of more than 200 firms and interviews with nine large companies in southern Germany. In addition, talks were held with various energy and service providers to learn more about how load management can be implemented.

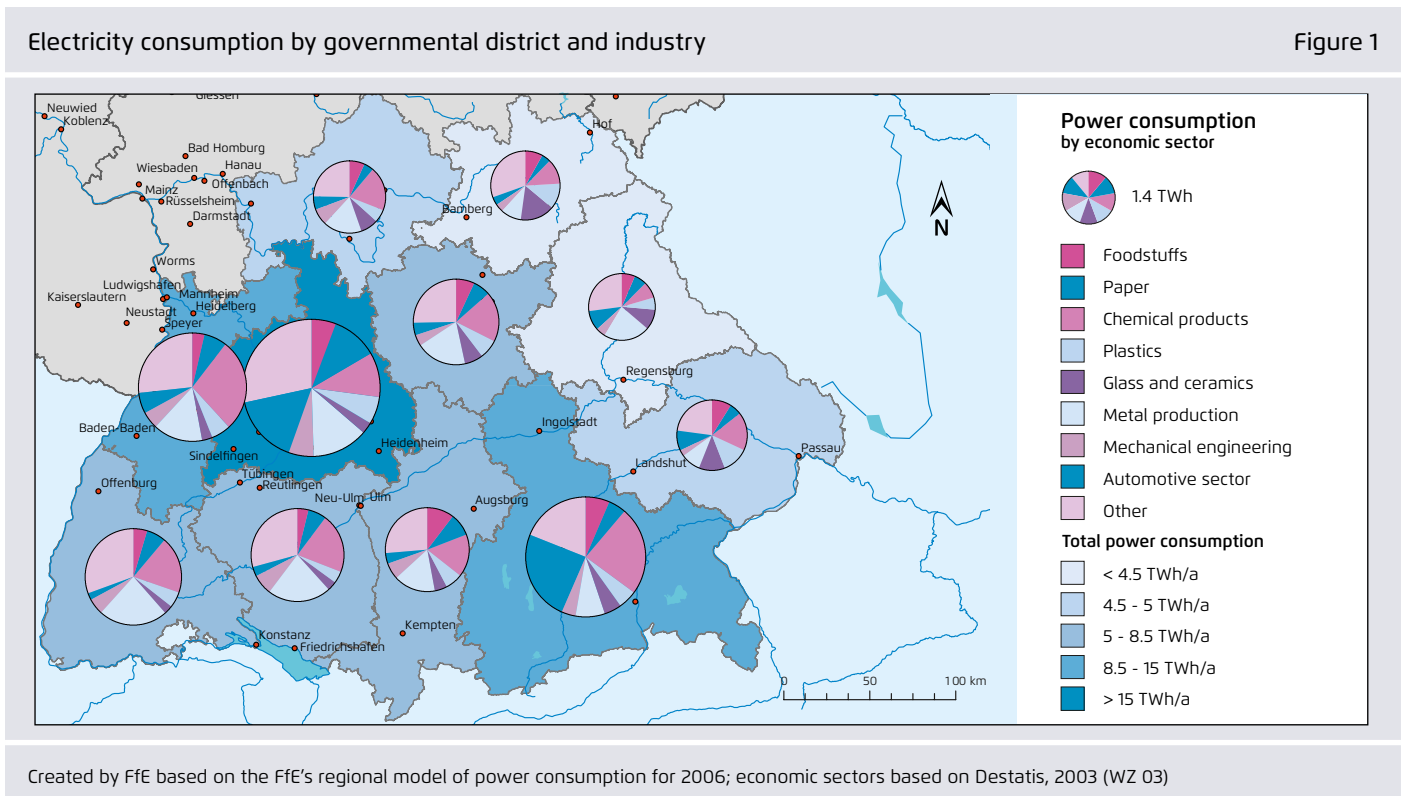
3. Assessment of Current Load Management Potential

3.1 Current electricity consumption and peak demand

Annual electricity demand (end-use energy) in Baden-Württemberg and Bavaria alone makes up nearly a third (around 30 percent) of total electricity demand in Germany. Bavaria consumed around 79 terawatt-hours (TWh) in 2010; Baden-Württemberg, around 71 TWh in 2009. Industry makes up the biggest piece of the pie at around 55 percent in Bavaria and around 60 percent in Baden-Württemberg. The remaining electricity consumption is spread roughly equally across households, on the one hand, and commerce, retail, and the service sector, on the other. Based on this level of electricity consumption, typical load profiles, and data for the vertical grid load from TransnetBW and the major distribution grids in Bavaria and Baden-Württemberg, peak demand is estimated at around 25 GW.

Annual electricity consumption by industry reaches around 43 TWh in Bavaria and around 44 TWh in Baden-Württemberg, with maximum load on the order of 14 GW for both combined. The chemicals and pharmaceutical sectors in Bavaria and the automotive sector in Baden-Württemberg comprise the largest portion of this demand. The other sectors that represent major power consumers in these two German states include paper mills, printers, mechanical engineering, metal works, foodstuffs, rubber and plastics, and quarries/soils. The load management potential was analyzed on the basis of relevant power demand fields. The automotive sector and mechanical engineering are of special economic importance in both states.

Aside from a slight increase in cooling loads in the summer, industrial load curves in these sectors do not have great seasonal fluctuations. Cumulative fluctuations during op-



eration are also only slight. The greatest shifts in loads occur between work shifts. Because of the great temporal availability and regional distribution, cross-section technologies and industrial processes are suitable candidates for participation in a load management program. The greatest regional power demand occurs mainly in conglomerate areas around Stuttgart, Mannheim, Karlsruhe, and Munich (see **Figure 1**).

3.2 Cross-section technologies

Cross-section technologies are those used not in just one economic sector, but across all industries. Examples include pumps, compressors, and ventilators.

Underlying data and methodology

Detailed surveys conducted by the Learning Energy Efficiency Networks (LEEN) of FfE GmbH serve as the basis for the assessment of the potential flexibility of loads in this project. Data concerning total electricity consumption and consumption per cross-section technology from 40 businesses were assessed. In addition, we know the rated capacity of the systems for each cross-section technology and whether the levels can be adjusted (in stages or by speed/indefinitely). Likewise, load curves are available for each business in quarter hour increments.

The businesses were first categorized by sector. The plausibility of electricity consumption per cross-section technology and sector was then confirmed based on a comparison with values from literature.

Two reference values were created for each sector for determining the potential load flexibility. The first factor describes installed capacity per cross-section technology relative to total electricity consumption within the sector. The second reflects average electricity consumption per cross-section technology relative to the production times for each sector, which were in turn calculated based on an assessment of load curves in these businesses. Other factors included in this model that limit the potential reduction/increase of loads included:

- Non-availability of systems (for maintenance, etc.)
- Systems that cannot be switched off (suction units, etc.)
- Existence, size, and type of storage
- Minimum size of business
- Switching on of systems without storage effect (lighting, ventilation, etc.) not taken into consideration because additional consumption is generated in the process

In addition to determining loads that can be made more flexible, the duration of load shifting is crucial. Information on the amount of energy available per call was gathered from the businesses in online questionnaires and on-site interviews. In addition, storage capacity was calculated, and insights from initial consultations with LEEN on the flexibility of cross-section technologies were used. To assess availability at different points in time, separate calculations were made relative to the following three types of operation:

- Normal operation: production in all areas of the company
- Reduced operation: production in parts of the company, such as third shift
- Baseload: no production

Technical potential

If we take a look at candidate businesses in accordance with the aforementioned limiting factors, the greatest power loads that can be used in demand management are found in the cross-section technologies used in mechanical engineering and the automotive sector (see **Figure 2**). The available loads (positive for loads that can be switched off and negative for those that can be switched on) are shown for the mode of „normal operation.“ Clearly, there is great load-shifting potential, especially from cooling and ventilation.

Around half of the loads that can be switched off are related to lower ventilation. The power demand for compressed air is also very high, but these loads can only be shifted over very short time spans. Just fewer than 500 megawatts (MW) could be switched off for an hour (**Figure 3**).

Overall, the greatest potential is expected to come from ventilation units and cooling systems, which can be switched

off or run at lower output for periods of 15 minutes up to an hour, often without any direct impact on production. However, a number of systems used by these businesses cannot be switched off at all for various reasons.

Interestingly, a lot of the firms indicated in the online survey that they see potential for load shifting in the field of compressed air. Upon closer inspection, however, this opinion turned out to be a bit optimistic. If compressed air is needed for production processes, reducing it would often lead to lower production. Storage is generally of a limited size, so air compressors can only shift loads by a few seconds. Therefore, the only compressed air applications that can be switched off are those not directly related to the production process, such as compressed air for cleaning purposes.

Although lighting was often indicated as an option in the online survey, this potential is limited because a reduc-

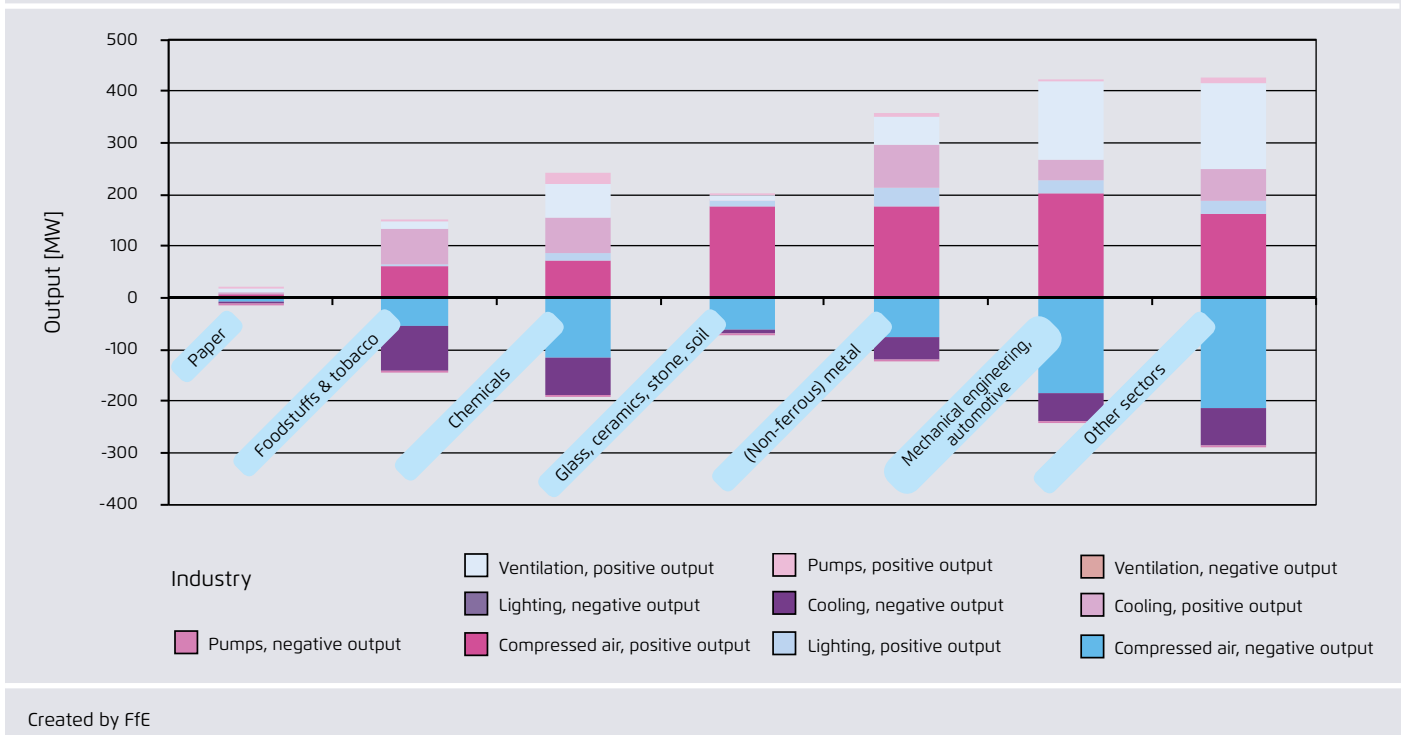
tion in illuminance is generally attributed to an increase in energy efficiency. In exceptional cases, illuminance can be dimmed over an extended period (such as four hours) if it is above what is required for the workplace, but the result can impact staff productivity.

3.3 Industrial processes

In addition to the cross-section technologies, individual energy-intensive industrial processes were analyzed. First, sites where these processes are used were identified. The available technical potential was determined based on production and electricity consumption data along with additional technical statistics, such as the ability to run at partial load. The potential determined was then extrapolated for all of the companies that use the particular process in question in Baden-Württemberg and Bavaria. The extrapolation is based on site-specific data for production volumes and/or electricity consumption that the company itself generally

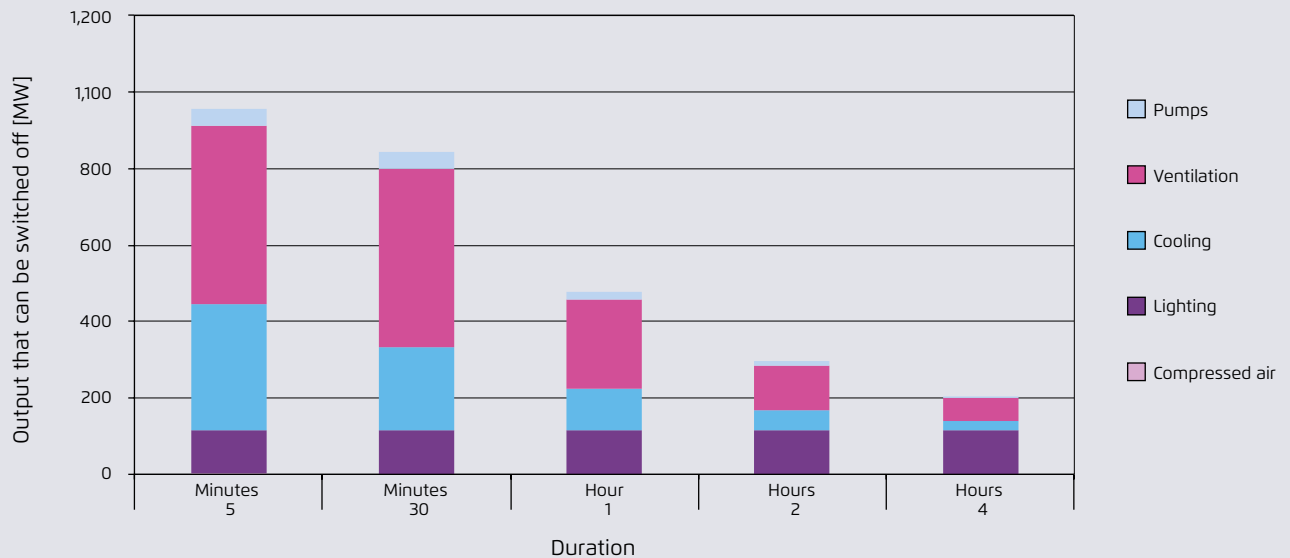
Positive (switch-off) and negative (switch-on) power from flexible cross-section technologies in southern Germany – technical potential for suitable businesses without consideration of the cost of implementation (staff and ICT)

Figure 2



Electricity consumption that can be switched off for cross-section technologies in southern Germany (normal operation) relative to duration – technical potential for suitable businesses without consideration of the cost of implementation (staff and ICT)

Figure 3



Created by FfE

publishes in environmental reports, for instance. In the assessment of potential, it was assumed that all of the companies take part in load management. Furthermore, talks were held with the firms to validate the potential determined and get an estimate of the economic feasibility.

Cement

In the cement industry, cement mills and raw meal mills are particularly suitable for load management. They are already mainly used at night and on weekends. In Bavaria and Baden-Württemberg, these applications load at a total of 13 sites comprise a total load of approximately 130 MW, roughly 50 MW of which can be used for load management. In other words, up to 30 percent of the load can be shifted at these cement plants by up to four hours. However, the time frames are sometimes much shorter at raw meal plants because of their smaller storage capacity. The plant operators would have to be notified at least 30 minutes in advance.

Paper

The application with the greatest potential for load management is wood grinders, which can make up as much as 20 percent of a mill's power demand. As with cement mills, these applications are already used to optimize power procurement. Companies from the paper sector put their potential for load management at around two to four percent of the current load. At twelve locations in Bavaria and Baden-Württemberg, the power demand of wood grinders that can be completely used for load management was estimated at around 90 MW. The load can be shifted for two hours, with notification of less than an hour being necessary. Further potential was found in the recycling of waste paper and in pulp production.

Chemicals industry and chlorine production

Within the chemicals industry, chlorine production is very well suited for load management. In southern Germany, the power demand for chlorine electrolysis is estimated at 250 MW, around 160 MW of which could be used for load

management if the plants run at partial capacity. In addition to running at partial load, load shedding is also possible, though at greater cost. In this case, 250 MW would be available. The load can be switched off for two hours, with longer periods possible in some cases.

Electric steel industry

Southern Germany has two steel plants that require 150 MW for their furnaces. This potential would also be available for load management. Steel production in electric furnaces takes place in batches, not constantly. A switch off would have to be included in production planning because processes should not be stopped once they have been started. Load management can be implemented in a batch process, which takes 50 to 120 minutes, by delaying the start of the next batch. In general, delays of up to two hours are possible.

Conclusion

Based on the survey of companies and interviews, the economic potential was estimated based on compensation in the current German ordinance governing interruptible load for industry (*Lastabschaltverordnung – AbLaV*). A cost of around 2,500 euros would be paid per month, with an additional 100 to 400 euros paid for each MWh in each case. In total, the load management potential that could be made available to increase the security of supply/ reliability for balancing energy and re-dispatching is around 400 to 450 MW (**Table 1**). Some of this potential is already used for optimized procurement, so the contribution from energy-intensive processes towards reducing peak power loads would be lower.

3.4 Heat pumps and night heat storage

Underlying data and methodology

To determine the potential, data from distribution grid operators and power providers was assessed. Not all of the data records directly indicate the annual electricity consumption of heat pumps (WP in **Figure 5**) and night heat storage sys-

tems (NSH in **Figure 5**), so consumption levels were partly adjusted based on comparable values, data from literature, and calculations. Additional adjustments were made and the values reviewed based on the penetration rates and information on installed capacity. The data records covered 67 percent of the communities in the area investigated. Once the data were harmonized, they could be calibrated for the areas for which no data were available based on 59 percent of the communities in the area investigated. Load curves were then created with respect to the temperatures during the time frames investigated and the temperature-dependent load profiles of distribution grid operators. The potential was then determined based on these load profiles. The maximum possible switch off duration and the frequency of switch offs was determined based on the temperature-relative load profiles.

The temperature-relative load profiles reflect all of the systems, which consist of various charging mode – those with forward controls, reverse controls, and spread controls. All three modes operate relative to the outdoor temperature and the remaining heat in the storage tank. The goal is to load only as much energy as is consumed in the subsequent heat transfer phase. Before energy is loaded, the temperature curve is recorded at the outdoor temperature sensor to determine how much energy should be loaded. The system operator then gives the signal (either remotely or by a schedule) to start loading. Specifically, the system operator sends out a signal either through the distribution grid itself or as a long-wave radio signal. The system that receives the signal then converts it into control information. If the mode of operation is „forward,“ storage begins at the beginning of the loading time frame. Heaters switch off one after the other depending on the amount of energy loaded and the outdoor temperature. In contrast, the „reverse“ mode of operation switches on heating systems one after the other and their target value is reached at the end of the timeframe. Finally, the „spread“ mode moves the loading cycle to the middle or to the beginning and to the end.

To understand the role that night heat storage systems and heat pumps play, talks were held on the technology, current management, market mechanisms, and optimized applica-

Load management potential in energy-intensive processes

Table 1

Application	Power demand	Duration of shift	Number of cases per year	Economic potential based on AbLaV
Cement (raw meal and cement mills)	130 MW	up to four hours, sometimes longer	20 – 50 times	circa 50 MW (30 percent of load)
Paper (wood grinding)	90 MW	2 hours, sometimes longer	20 – 50 times	circa 90 MW (20 percent)
Chlorine (electrolysis)	250 MW	circa 2 hours	20 – 50 times	circa 160 MW
Steel (electric furnaces)	150 MW	circa 2 hours	20 – 50 times	circa 150 MW
Total		circa 2 hours	20 – 50 times	400 – 450 MW

Created in-house

tions with representatives of E.ON Metering, E.ON Bayern, LEW Verteilnetz, and EnBW Vertrieb. Ways of determining load-shifting potential under various premises were derived from these talks. In the process, account was taken of methods that require prior planning and of approaches that include short-term reactions without prior planning.

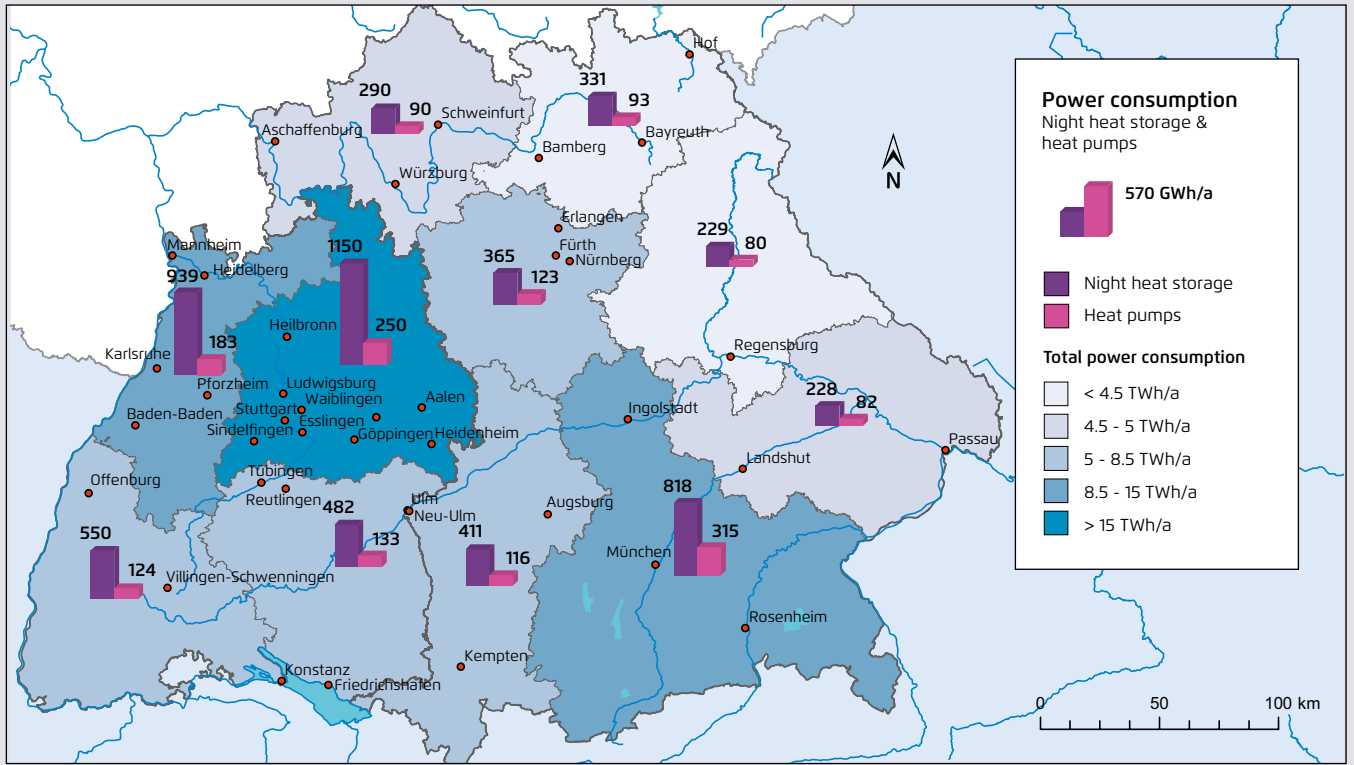
Potential

The data were used to map annual electricity consumption levels for night heat storage systems and heat pumps at the level of governmental districts (**Figure 4**).

Actual loads, which are affected by both temperature and time of day, greatly impact the potential. Therefore, load-shifting potential was determined relative to time for various temperature ranges.

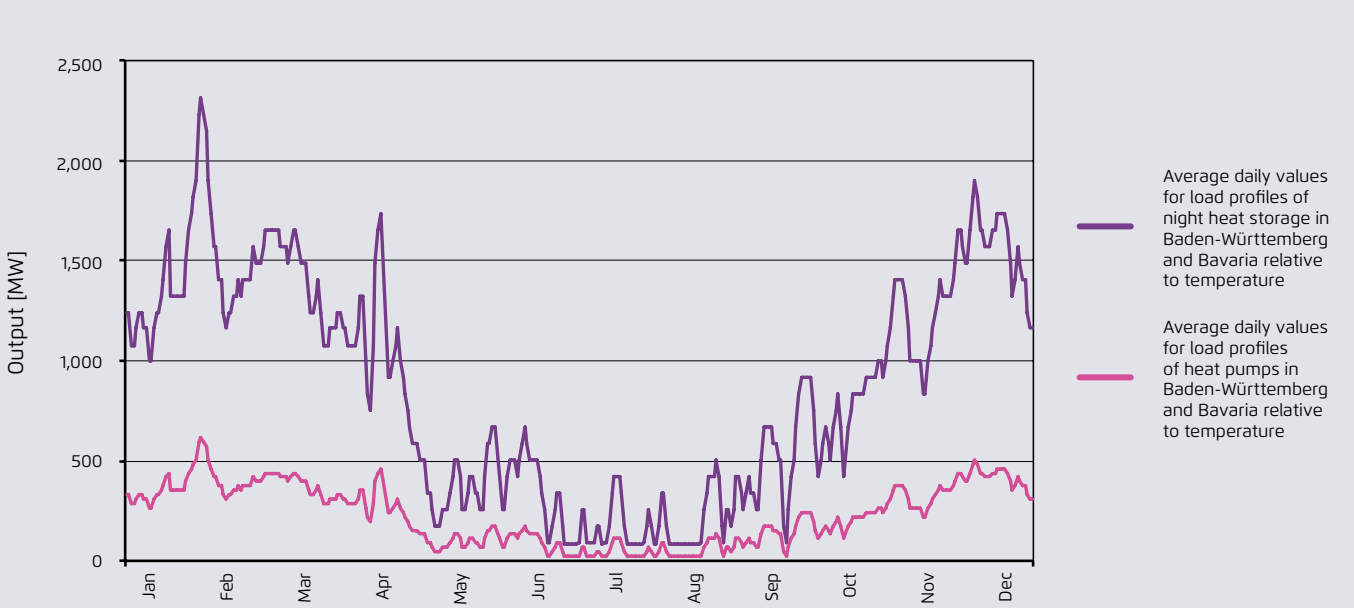
The annual curves in **Figure 5** show that the loads for overnight heating systems and heat pumps are generally the greatest in the winter and practically disappear in the summer.

Annual electricity consumption of night heat storage systems and heat pumps in Bavaria and Baden-Württemberg Figure 4



Created by FfE based on the FfE Regional Model 2012, Destatis; E.ON Bayern (distribution grid operator), LEW Verteilnetz GmbH (distribution grid operator) and EnBW Vertrieb (power provider) 2010 - 2011

Seasonal fluctuations of potential – average daily values for night heat storage systems and heat pumps across the year Figure 5



Created by FfE

As **Figure 6** shows, the highest load for night heat storage systems occurs at night. In contrast, heat pumps have a relatively constant load across the day.

Because of the different load curves and characteristics for load shifting, potential is discussed separately for heat pumps and night heat storage below. First, the potential is calculated theoretically irrespective of time for one day with a reference temperature of 0°C for heat pumps. At higher temperatures, the load-shifting potential is sometimes much lower. The demonstrated potential is based on a flexible switch-off time for heat pumps derived from the distribution grid operators' fixed interruption schedule. Before heat pumps can be blocked again, recovery of the reduced load is taken into account.

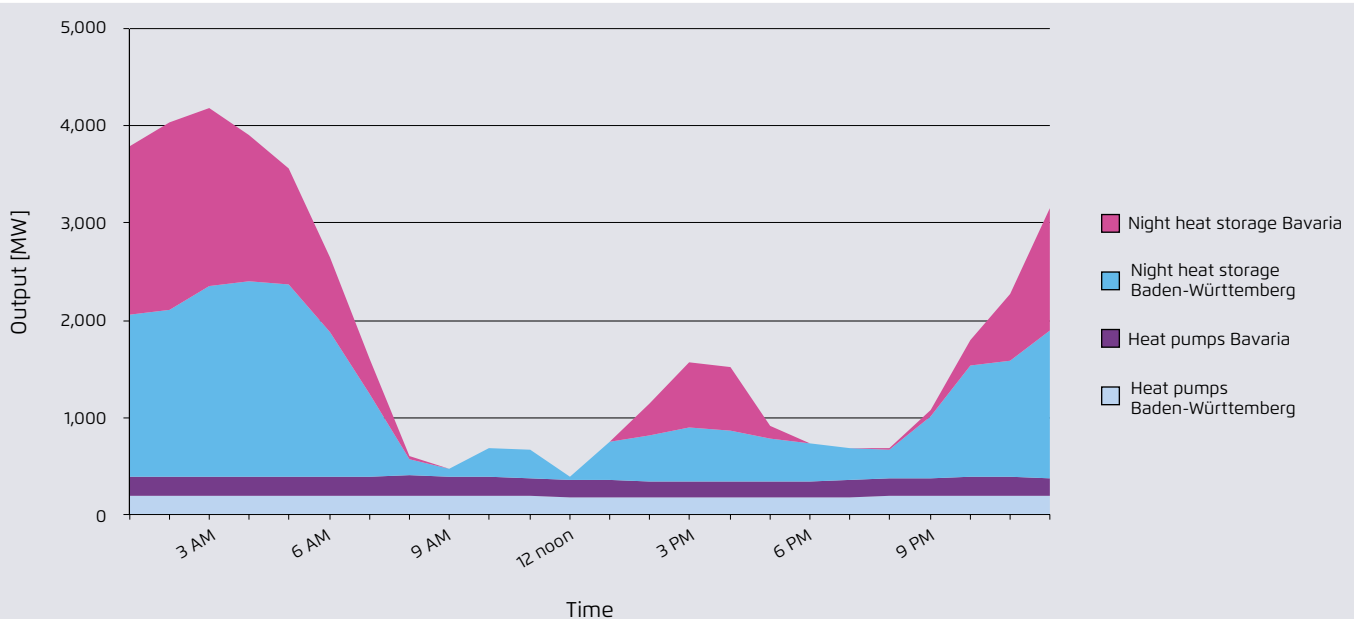
The overall load of heat pumps can be reduced for an hour. Depending on the time of day, some 340 to 400 MW can therefore be switched off. Because of the low storage capacity, load-shifting potential quickly decreases as the duration expands. Over a twelve-hour time frame, the average capacity that can be switched off is around 40 MW.

The load-reducing potential of night heat storage systems was determined based on a twelve-hour shift in the load profile. Because the loads of night heat storage systems are often close to zero throughout the day, the minimal potential is also close to zero.

On the reference day (average outdoor temperature 0°C), it was found that loads up to 3,000 MW could be reduced for an hour. But that hour cannot occur at just any time. In the worst case, there is no reduction potential at all. Over a period of twelve hours, a maximum average load of 1,800 MW can be reduced, but likewise only for a certain twelve-hour time frame. The potential is lower for all of the other 24 starting points of the day.

Fluctuations of potential by time of day – curves at 0°C for night heat storage systems and heat pumps in Bavaria and Baden-Württemberg

Figure 6



Created by FfE

4. How Load Management Can Supply Reliability

From the perspective of the grid, load management can increase the security of supply/ reliability if it is available in critical grid situations. A distinction can be made here between three situations:

- Contribution of loads that can be switched off to lessen the strain on the grid and individual grid elements (re-dispatching) – location and time of availability are relevant here
- Contribution of load management to balancing system demand and production (balancing energy services) – requires available grid capacity
- Contribution of load management towards reducing peak demand on the overall system – already reflected today in prices on the EPEX spot market

The question of when the critical grid situations occur is crucial for an assessment of which of the load management options identified will actually be available in a particular critical grid situation. Therefore, an assessment is provided below.

At present, the security of supply/ reliability is primarily threatened by an issue mentioned in the first point – an overloading of individual grid elements. Here, load management potential is not yet being tapped. Reports published by Germany's national regulator show that critical grid situations, in which the cold reserve was resorted to, occurred in the winter months of December 2011 and February 2012. The critical time frame occurred a few times between 7 and 8 p.m., when high power demand coincides with zero PV output. *Re-dispatching* took place, however, to stabilize the grid during the day and in the morning.

The „minute reserve/ tertiary reserve“ (type of balancing energy services available within a couple of minutes) is tapped across the day, though more often during daylight hours in 2012. Such events occurred with roughly equal fre-

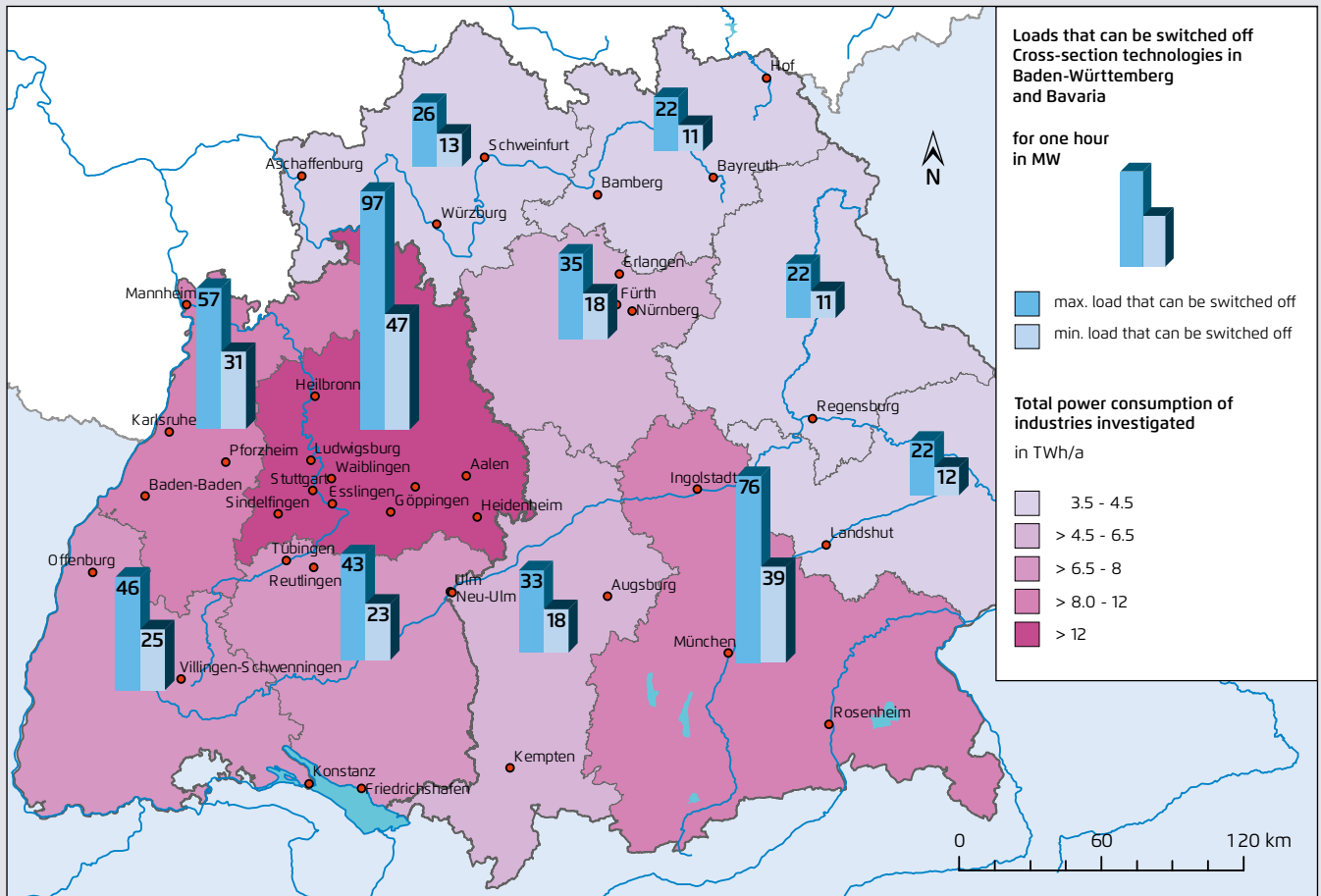
quency in the winter and the summer. On the basis of these characteristics, the contribution of load management potential towards supply security/ reliability can be initially assessed.

The load-reducing potential of cross-section technologies is relative to the particular firm's production hours. To a varying extent, they are available across the day and can be reduced at short notice for small periods up to several hours. On Sundays and holidays, the load – and hence, the switch-off potential – is the lowest. As is to be expected, it is the greatest on workdays during the main shift. The maximum and minimum switch-off potential available is shown in **Figure 7**. Seasonal fluctuations are negligible. The loads are distributed fairly homogeneously relative to the industry loads on the grid and can thus be used to bridge local bottlenecks.

Energy-intensive processes are generally continuous and are thus available for the entire year. Often, these processes are already used for in-house peak load management and optimized procurement. The load management potential identified is therefore not always available at times of high power exchange prices. On the other hand, this load management at the level of businesses is generally not completely related to the current grid situation. Situations that necessitate a re-dispatch or require a great amount of balancing energy services do not always occur at times of high power exchange prices. By linking demand to the grid situation, the security of supply/ reliability could therefore be increased. In particular, energy-intensive processes can provide additional balancing energy services and re-dispatch capacity. The survey of companies showed that only a very small number of firms sell their load management potential on the balancing energy/ reserves market. Specifically, the only firms that were found to have qualified their loads on the balancing energy/ reserves market were in Bavaria, and transmission grid operators confirmed this finding.

Maximum and minimum electricity consumption that can be switched off for cross-section technologies

Figure 7



Created by FfE based on data from Destatis and data collected in-house

The current load profiles of night heat storage systems and heat pumps are subject to tremendous temperature-related swings. They can therefore mainly be switched off at night on colder days. The potential is generally not available during times of peak demand in the winter (6 p.m. to 8 p.m.). The availability of the load-reducing potential of heat pumps is greater because of their relatively constant load profile over the course of a day, so that loads can be reduced here briefly at any time.

In addition, the loading of night heat storage systems can be increased relative to the time of day and temperature. Keep in mind that the ban on night heat storage starting in 2020

will gradually reduce this potential, however. In contrast, the potential of heat pumps can be expected to increase as the volume triples from 2010 to 2020.

5. Current Obstacles

In the course of the study, the most relevant obstacles for the further implementation of load management potential towards increasing grid stability were identified. For firms, load management programs must be tailored to their requirements. The design decides what potential is available to what extent and at what cost. According to the survey of companies, the biggest obstacle that load management faces is production downtime and effects on product quality. In some cases, there is concern that workflows might be disrupted. Furthermore, a lot of firms feel that the current requirements for participation in load management are too restrictive. A large number of firms believe that notification should be given more in advance so it can be integrated in production planning, and load shifting should not last more than two hours. Typically, loads ranging from a few hundred kilowatts to several megawatts can be switched off. These output classes should be reflected in the load management programs. Furthermore, the firms also said it would be important for them to be able to get out of a load management program at short notice in order to react to changing production requirements.

A lot of firms feel that the current financial incentives for participation in a load management program are insufficient. Some of them already have load management in-house to reduce peak loads and optimize power procurement. Only a very small number of firms take part in the balancing energy /reserves market. Upfront investments that have to be financed from revenue are required for the implementation of load management. The companies put the cost of installing the required technology and planning load management at several thousand euros. The process becomes interesting for firms if they can reduce their electricity costs by more than five percent. The percentage that could spark interest is, however, lower for large firms with high electricity costs.

The previously described requirements and obstacles show that service providers are crucial for the tapping of load management potential. By way of creating a pool of facili-

ties from individual establishments, the necessary flexibility and firm capacity can be made available at the same time to the system operator. These actors view the existing, respective roles of market participants as the main obstacles to implementation. As a result of unbundling rules, each participant has only a single role, which inhibits the ability to manage load to the benefit of the entire system. In light of these wide-ranging roles, *demand response* aggregators find it difficult to establish themselves in the market, since they must make separate arrangements with each market participant.

Current regulations are the largest obstacle in tapping the load management potential of heat pumps and night heat storage systems, in order to better integrate their application into the grid. In order to enable more flexibility from these applications, their use needs to be adapted to market/ grid conditions, rather than based on temperature-dependent standard load profiles. A shift of decision-making responsibility from the system operator to suppliers should lead to more load flexibility. After all, suppliers, who bear the economic brunt of procurement decisions, are more dependent on the exactness of forecasts and load curves based on exchange prices than distribution grid operators are. The main change that would need to be made towards this end would be that power supply and invoicing would no longer be based on standardized load profiles. Alternatively, *smart meters* and reference measurements could be used.

6. Conclusions and Recommendations

The focus in the search for major application fields is partly on energy-intensive processes, which are already used for load management within some firms (balancing energy services) but could also be expanded for load management according to grid and market price signals. There is also additional potential for cross-section technologies, especially industrial ventilation and air-conditioning applications, which often have outputs of several hundred kilowatts. In the field of electric heat generation (heat pumps and night heat storage), the existing potential could be tailored more to the market and grid.

The study's findings show that the load management potential of industrial cross-section technologies and energy-intensive processes exceeds a gigawatt in southern Germany for periods lasting from 30 minutes to as much as two hours (Table 2).

A distinction can be made between two groups in terms of notification periods. On the one hand, there are applications that can be switched on or off within just an hour; on the other, there are others that require notification further in advance (8 to 24 hours) for production planning. The typical output classes for each firm range from several hundred kilowatts to a few megawatts. Very few firms have potential exceeding ten megawatts.

The financial incentives for load management should initially be sufficient to cover the upfront investments (imple-

mentation and planning of load management along with the cost of the control equipment required). Companies expect to have to spend several thousand euros up front before they can take part in the load management program. The process becomes interesting for firms if they can reduce their power costs by more than five percent. Lower incentives may be sufficient for larger firms.

When load management programs are designed, the characteristics of load management potential need to be taken into consideration. The current starting points for load management (the German "Lastabschaltverordnung" and the balancing energy/ reserves market) are currently too restrictive for participants or offer only very limited financial incentives.

To overcome further obstacles and include applications previously not participating in load management, demonstration projects should be conducted for ventilation and air-conditioning applications, for example. They could show what the effects would be on a firm's operations and production and how participation could be implemented technically. From these insights, recommendations could be derived for structuring meaningful economic incentives to tap this potential, in the context of designing the future energy market.

The regulatory framework should also be reviewed. On the one hand, the role of load management aggregators should

Summary of load management potential in industry

Table 2

Area	Duration of shift	
	30 minutes	1 – 2 hours
Cross-section technologies, industry	> 800 MW	> 450 MW
Energy-intensive processes	> 400 MW	> 400 MW
Total	> 1,200 MW	> 850 MW

Created in-house

be defined. At present, providers are the main ones who implement load management on the power market with the support of aggregators. If the latter could act more independently, additional potential could be tapped.

In the private sector, loads could be shifted from heat pumps and night heat storage systems. Because the potential is relative to the time of day and temperature, it is not, however, reliably available at all times. At low temperatures, the loads – and hence, the load-shifting potential – are greater. For night heat storage systems, the switch-off potential

is mainly available at night but could be extended across a relatively long timeframe. The potential of heat pumps can be used relatively homogeneously across the day, though only for short periods. **Table 3** shows the load-shifting potential for a duration of two hours relative to temperature.

The most important step in tapping the existing load management potential of heat pumps and night heat storage, which currently react to standard load profiles, is to flexibly adjust consumption to suit the current power generation situation.

Summary of load management potential in private sector		Table 3
Area	Duration of shift	
	2 hours (winter 0°C)	2 hours (summer 15°C)
Heat pumps	220 – 260 MW	20 – 37 MW
Night heat storage	0 – 2,900 MW	0 – 550 MW
Total	220 – 3,160 MW	20 – 587 MW

Created in-house

Publications by Agora Energiewende

IN ENGLISH

[12 Insights on Germany's Energiewende](#)

A Discussion Paper Exploring Key Challenges for the Power Sector

IN GERMAN

[12 Thesen zur Energiewende](#)

Ein Diskussionsbeitrag zu den wichtigsten Herausforderungen im Strommarkt (Lang- und Kurzfassung)

[Brauchen wir einen Kapazitätsmarkt?](#)

Dokumentation der Stellungnahmen der Referenten der Diskussionsveranstaltung am 24. August 2012 in Berlin

[Die Zukunft des EEG – Evolution oder Systemwechsel?](#)

Dokumentation der Stellungnahmen der Referenten der Diskussionsveranstaltung am 13. Februar 2013 in Berlin

[Entwicklung der Windenergie in Deutschland](#)

Eine Beschreibung von aktuellen und zukünftigen Trends und Charakteristika der Einspeisung von Windenergieanlagen

[Erneuerbare Energien und Stromnachfrage im Jahr 2022](#)

Illustration der anstehenden Herausforderungen der Energiewende in Deutschland.

Analyse auf Basis von Berechnungen von Fraunhofer IWES

[Kapazitätsmarkt oder Strategische Reserve: Was ist der nächste Schritt?](#)

Eine Übersicht über die in der Diskussion befindlichen Modelle zur Gewährleistung der Versorgungssicherheit in Deutschland

[Kostenoptimaler Ausbau der Erneuerbaren Energien in Deutschland](#)

Ein Vergleich möglicher Strategien für den Ausbau von Wind- und Solarenergie in Deutschland bis 2033

[Kritische Würdigung des Netzentwicklungsplanes 2012](#)

Kurzstudie des Büros für Energiewirtschaft und technische Planung (BET)

[Lastmanagement als Beitrag zur Deckung des Spitzenlastbedarfs in Süddeutschland](#)

Zusammenfassung der Zwischenergebnisse einer Studie von Fraunhofer ISI und der Forschungsgesellschaft für Energiewirtschaft

[Steigende EEG-Umlage: Unerwünschte Verteilungseffekte können vermindert werden](#)

Analyse des Deutschen Instituts für Wirtschaftsforschung (DIW)

[Strommarktdesign im Vergleich: Ausgestaltungsoptionen eines Kapazitätsmarkts](#)

Dokumentation der Stellungnahmen der Referenten für die Diskussionsveranstaltung am 10. Juni 2013 in Berlin

[Zusammenhang von Strombörsen und Endkundenpreisen](#)

Studie von Energy Brainpool

All publications are available on our website: www.agora-energiewende.de

How can Germany realise its *Energiewende*? What concrete legislation, initiatives or measures are required to make the Energiewende a success? Agora Energiewende lays the groundwork to ensure that Germany makes the decisions required to set the course towards full decarbonisation of the power sector. We are a „think-and-do tank“, working to enhance a fuller understanding of the Energiewende and facilitate a convergence of views among relevant stakeholders.



Agora Energiewende

Rosenstrasse 2 | 10178 Berlin | Germany

T +49. (0)30. 284 49 01-00

F +49. (0)30. 284 49 01-29

www.agora-energiewende.de

info@agora-energiewende.de

