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Demand Response – Is the USA a Role Model for Germany?

Analysis of the Integration of Demand Response into the American Capacity and Balancing Markets

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Abstract

The management of flexible loads ('Demand Response') could constitute a cost-efficient flexibility option for integrating the rising proportion of photovoltaic and wind energy. The regulatory framework for interruptible loads in American electricity markets is often seen as the world leader and a potential role model for Germany. The present article analyses the formal market integration and the actual use of interruptible loads in the American capacity and balancing markets. The participation of interruptible loads in the capacity markets stands at one to four per cent of the unforced capacity requirement. Participating consumers pay a reduced capacity levy in return. With the exception of Texas, interruptible loads are either not allowed to take part in balancing markets or their participation is negligible. Switching off flexible loads on a temporary basis is only intended for an absolute emergency on the capacity and balancing markets. As a result, the length of time such loads are switched off has so far not exceeded 30 hours per year in any market. This occasional use is also for economic reasons, as switching off loads causes production downtime or loss of comfort with high variable costs of EUR 500 to 1 500/MWh. In the event that Germany introduces capacity markets, a capacity market programme for interruptible loads could become relevant in terms of industrial policy in order to free electricity-intensive industries from the capacity levy.

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1. Introduction

1.1 Background and objectives

As a result of the rising proportion of photovoltaics and wind power, additional flexibility options are needed in order to provide a secure supply and integrate surplus energy. Demand Response, i.e. the market-oriented management of flexible loads, can offer a cost-efficient and environmentally friendly option (BMU 2012, p. 20). Flexible loads are already partially used in Germany on a targeted basis. But this is mostly based on operational peak load management and not on participating in the energy markets (Klobasa et al. 2013b, p. 13). The regulatory conditions in the German electricity system have been identified as a significant hindrance to change on this front (SRU 2013, p. 83).

By contrast, the regulatory conditions in American electricity markets are frequently seen as exemplary (Hurley et al. 2013, p. 3). US Federal authorities such as the Federal Energy Regulatory Commission (FERC) also underline the positive qualities of Demand Response and emphasise its already realised potential. For example, according to the FERC, up to ten per cent of peak loads were met through Demand Response in 2009 and 2010 (FERC 2011, p. 10).

This article describes how the American capacity and balancing markets work and outlines the role of flexible loads. In addition, we will use various criteria (e.g. frequency of use) to examine to what extent the system could be transferred to Germany. To this end, Section 2 will analyse the market integration of flexible loads in the American capacity markets, while Section 3 will focus on the market integration of flexible loads in the American balancing markets.

1.2 Demand Response

The term Demand Response denotes the active management of flexible loads as a function of price signals (e.g. day-ahead market) or at the request of the system operators (e.g. maintaining frequency and emergency reserve) (U.S. Department of Energy 2006, p. 6). Flexible loads are loads that are capable, if needed, of increasing their power consumption (additional loads) or reducing it (interruptible loads). Interruptible loads may or may not have thermal or physical storage to pre- or postpone power consumption. If storage is available, load can be shifted (shiftable loads). If not, load can only be shedded with production downtime or comfort losses as a consequence (sheddable loads). Table 1 represents the technical properties and corresponding areas of application.

Table 1: Types of flexible loads with examples from the heating sector

Source: IASS Potsdam

Type	Power	Storage	Application example
Shiftable loads	Positive and negative	Yes	An oversized heat pump charges a heat storage during low-price times, which provides the required heat during high-price periods.
Sheddable loads	Positive	No	In high-price periods of the day the heat pump is temporarily halted. As a result, the room temperature falls and comfort is compromised.
Additional loads	Negative	No	Normally, a gas boiler is used to provide heat, but at times when prices are low, an electrical heating rod takes over.

As well as their technical properties, the cost structures of these three types of flexible loads also differ. Shiftable loads typically have high fixed costs (e.g. depreciation, capital costs), which are incurred due to the oversizing of the processes and the installation of non-electrical storage systems[1] – but variable costs are low. The situation is precisely the opposite for sheddable loads. Sheddable loads typically have very high variable costs, as reducing the load leads to production downtime or loss of comfort (Paulus, Borggrefe 2010, p. 437). The fixed costs, however, are relatively low, especially for industrial applications.
In practice, the term Demand Response is frequently used as a general term for all activities on the demand side, and it includes the active management of emergency generators and sometimes even the implementation of energy efficiency measures. In addition, Demand Response is often used as a synonym for loads that can be interrupted (as opposed to loads that can be added) and may also refer to sheddable loads with high variable costs (as opposed to shiftable loads with low variable costs). In this text we use the more precise term where possible.

1.3 Markets for Demand Response

Demand Response can participate in different submarkets in American electricity markets, which are run by a so-called Independent System Operator or ISO for short.[1] The structure shown in Table 2 is that found in PJM (Pennsylvania, New Jersey, Maryland), New England or New York. Unlike in Germany, capacity markets are integrated in these electricity markets and unforced capacity is traded on them. These capacity markets are financially the most significant for Demand Response. In PJM and New England, for example, over 90 per cent of the revenue streams for Demand Response are generated here (Monitoring Analytics 2013b, p. 165; ISO New England 2013a, p. 37). The remaining ten per cent derives from the balancing and energy markets.

[1] Many processes have overcapacity due to safety aspects or for historical reasons. There are therefore no additional investment costs associated with deferring the load.

[2] As well as operating the energy, balancing and capacity markets, the ISO also runs the transmission system.

Energy market	Balancing market	Capacity market
Day-Ahead Intraday Real-Time	Regulation Reserve Spinning Reserve Non-Spinning Reserve	Generation Interruptible loads Emergency generation

Table 2: Generic structure of US electricity markets

Source: IASS Potsdam

The German and American balancing and energy markets differ in important aspects. For example, in the USA energy can be traded on the so-called real-time market up to five minutes before physical dispatch, while in Germany this is only possible up to 45 minutes before physical dispatch. Furthermore, three products are traded on the balancing market (regulation, spinning and non-spinning reserves), which differ in their technical demands and conditions of use from German balancing market products (primary, secondary and tertiary reserves). The other criteria relevant to flexible loads are explained in the respective sections of this paper.

2. Demand Response in capacity markets

2.1 How it works

Capacity markets have been used for years in various electricity markets in the USA to keep sufficient generating capacity available in order to securely meet demand. The volume of unforced capacity required is calculated by the ISO and put out to tender. The costs incurred are passed onto the final consumer ('capacity levy'). This capacity levy is calculated based on the capacity price (market clearing price) of each grid region and the so-called peak load contribution (PLC), in other words, the final consumer's share of the peak load for the year across the electricity market.[3] If they meet certain requirements,[4] final consumers with sheddable or shiftable loads who are not dependent on an uninterrupted supply of electricity can take part in the capacity market and reduce the need for unforced generating capacity. As income they receive a refund on part of the capacity levy.

As shown in Table 3, the required volume of unforced capacity in the PJM electricity market in 2012, for example, was 157 489 MW.In the same year, 5 713 MW of interruptible loads allowed the ISO to switch off power temporarily. The requirement for unforced generating capacity was thus reduced by 3.6 per cent. Table 3 also shows the power from emergency generators, as they come under the heading of Demand Response in the aforementioned capacity markets and can participate in the same programmes as interruptible loads (Monitoring Analytics 2013b, p. 171).

Type	PJM	New York	New England
Demand Response	7 449	1 741	745
▪ Interruptible loads	5 713	*	446
▪ Emergency generators	1 736	*	299
Peak load for the year	154 344	32 439	26 903
▪ Proportion represented by interruptible loads	3.7 %	*	1.7 %
Unforced capacity requirement	157 489	35 076	31 965
▪ Proportion represented by interruptible loads	3.6 %	*	1.4 %

Table 3: Installed power, peak load for year and Demand Response for 2012 (figures in MW)

Source: IASS Potsdam on the basis of Monitoring Analytics 2013a; McAnany 2012; New York ISO 2013b; Patton et al. 2013; New York ISO 2014a; ISO New England 2013a

* For New York's Demand Response programme, information as to whether the power is supplied by interruptible loads or emergency generators is not binding (New York ISO 2013c, p. 17).

The interruptible loads act as an emergency reserve within the capacity markets. In contrast to power stations, they do not have to actively bid in the market and, as a result, are only used in extreme situations. For example, if a power station is shut down and demand cannot be met due to a heat wave and high air conditioning requirements, suppliers of interruptible loads receive an instruction from the ISO to cut their power consumption back to the contractually agreed level.

2.2 Deployment

The frequency and length of time for which this emergency reserve is called upon in the markets of PJM, New York and New England are shown in Table 4. We show the cumulative call-up duration for the year for the region of the grid within the particular market territory whose loads were called upon most frequently or for the longest periods. This means that the call-up duration in other areas of the grid was below the figures shown in Table 4. For example, the call-up duration in the capacity year 2010/2011 in PJM's Baltimore Gas and Electric Company grid area was the longest at 20 hours. The call-up duration in all other grid areas was shorter (e.g. four hours in the Metropolitan Edison Company area) and in some areas there were no call-ups (e.g. in the PPL Electric Utilities area). The data in Table 4 shows that interruptible loads were not called upon more than four times per year in the last four capacity years. The maximum call-up duration per capacity year did not exceed 28 hours in this period.

[3] To determine the PLC, the ISO calculates the hours at the end of the year with the peak load for the year across the electricity market. The average electrical power consumption in these hours (taken from the electricity meter data) is then used to calculate the PLC. In the electricity market of PJM, five hourly values are used to calculate the PLC, compared to just one in New York and New England.

[4] For example, for its 'Annual Demand Response' product, PJM demands a minimum power of 100 kW, an activation period of at most two hours and daily availability between 10:00 a.m. and 10:00 p.m. (May to October) or 06:00 a.m. and 09:00 p.m. (November to April).

Capacity year[5]	Max. call-up duration per year			Max. call-up frequency per year		
	PJM	New York	New England	PJM	NewYork	New England
2009/2010	1	4	2.5	1	1	1
2010/2011	20	16	0	4	2	0
2011/2012	10	15	7	2	3	2
2012/2013	4	28	3	2	4	1

Table 4: Maximum frequency and duration of call-ups

Source: IASS Potsdam on the basis of Monitoring Analytics 2010, 2011, 2012, 2013a, 2013b; New York ISO 2013a; ISO New England 2009a, 2009b, 2010a, 2010b, 2011a, 2011b, 2012a, 2012b, 2013b, 2013c, 2013d

2.3 Revenues

Interruptible loads receive the relevant market clearing price of their grid area if they participate successfully in the capacity market, enabling them to effectively reduce the capacity levy to be paid. Suppliers of interruptible loads are compete against generation capacity in the auction. Only the capacity price is taken into account in the auction, not the energy price. As shown in Table 5, the market clearing prices lay between USD 18 730/MW and USD 98 640/MW per year depending on the capacity market and the grid area. Suppliers of interruptible loads are free to choose the energy price up to USD 1 500/MWh or USD 500/MWh.[6] The bids are typically only a few dollars below the maximum energy price (Monitoring Analytics 2013a, p. 184; New York ISO 2013b, p. 13). It is not necessary to document or justify the energy price (Monitoring Analytics 2013a, p. 184).

	PJM	New York	New England
Capacity price [USD/MW year]	Uniform clearing price auction		
▪ Minimum	18 730	22 200	
▪ Maximum	48 399	98 640	
▪ Average	30 354		35 400
Energy price [USD/MWh]	Market price or bid price		
▪ Max. bid price	1 500	500	500

Table 5: Payment streams to interruptible loads in the capacity year 2012/2013

Source: IASS Potsdam on the basis of Monitoring Analytics 2013a; Patton et al. 2013; New York ISO 2013b; ISO New England 2013a, 2007

[5] A capacity year in PJM and New England goes from 1 June to 31 May of the following year, and in New York from 1 May to 30 April of the following year.

[6] The PJM electricity market is planning to increase the maximum bid price to USD 2 700/MWh by 2015/2016 (Monitoring Analytics 2013a, p. 183), which will enable a larger proportion of interruptible loads to participate profitably in the capacity markets.

2.4 Interpretation

The energy prices demanded, which are only a few US dollars below the maximum energy price (e.g. USD 499/MWh instead of USD 500/MWh), are an indication that the interruptible loads in the American capacity markets are almost always sheddable loads (as opposed to shiftable loads) where reduced power consumption leads to expensive production downtime or loss of comfort. Detailed figures on the actual costs of sheddable loads are not yet known. Initial estimates of the variable costs (opportunity costs) in energy-intensive industries are widely divergent. For example, the range of estimates for aluminium production stretches from EUR 164/MWh to EUR 1 500/MWh and for steel production from EUR 392/MWh to EUR 2 000/MWh (Gruber et al. 2014, p. 13; Praktiknjo 2013, p. 60; Paulus, Borggrefe 2010, p. 437). The basic common ground between the estimates, however, is that variable costs per megawatt hour are in the three- to four-digit range even for energy-intensive sectors. The economic deployment time for sheddable loads is on the 'far right' of the merit-order scale as a result. Stochastically rare, extreme situations are required to ensure that they are nevertheless deployed, such as an unexpectedly high peak load for the year (due to a heat wave) and the non-availability of power stations or elements of the grid.

The regulatory framework also has an effect on the call-up frequency of interruptible loads, and may explain the low call-up duration. The unforced capacity requirement[7] typically contains a safety margin which in PJM, for example, is around eight per cent.[8] As shown in Figure 1, the unforced capacity from power stations exceeds the expected peak load for the year. Interruptible loads form part of the safety reserve and are therefore not needed for 'normal operation' as there is sufficient generation capacity available. Two factors that influence the call-up frequency of interruptible loads can also be seen in Figure 1. The higher the ISO fixes the safety reserve, the less likely it is that interruptible loads will be deployed. The likelihood that (some of) the interruptible loads would be needed, would increase, however, if larger volumes of interruptible loads could be contracted on the capacity market (e.g. 10 per cent instead of 3.6 per cent of the guaranteed power demanded).

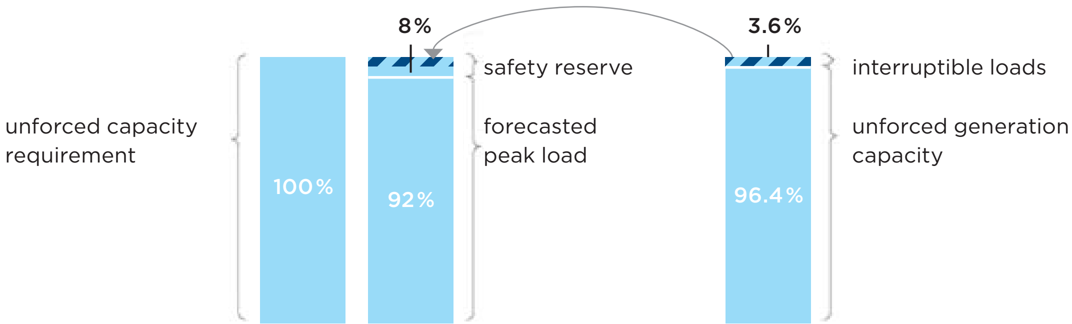

Figure 1: Composition of required guaranteed power taking the example of PJM

Source: IASS Potsdam on the basis of data from Monitoring Analytics 2013a; McAnany 12/18/2012

[7] Guaranteed power corresponds to installed power, less the proportion that is – statistically – unavailable due to faults. Installed power is typically eight to ten percent higher than guaranteed power (New York ISO 2014a; Monitoring Analytics 2014, p. 180).

[8] PJM calls the aforementioned safety reserve the forecasted pool requirement. This is the safety reserve measured against the guaranteed power (unforced capacity). The safety reserve measured against the installed power is called installed reserve margin and for PJM, it comes to around 16 percent.

Experience in the USA indicating that it is primarily sheddable loads that participate in the capacity markets matches the results of various studies conducted on the load management potential in Germany. These studies show that the energy-intensive processes examined have little or no overcapacity to enable them to make up for production downtime at a later point. The specific assessment of each author is shown in Table 6. Only Klobasa sees load shifting potential in every process. In contrast to the other studies, however, Klobasa's studies contain no explicit information on the potential for increasing loads. However, it should be noted that this analysis represents a snapshot. For example, if the demand for aluminium or chlorine falls due to economic effects, this could create load shifting potential in these processes too.

	von Scheven und Prelle	Paulus und Borggrefe	Klobasa
Aluminium	Shedding (shifting might be possible for short periods)	Shedding	Shifting
Chlorine	Shedding	Shedding (shifting might be possible for short periods)	Shifting
Paper	Shedding	Shifting	Shifting
Steel	Shedding	Shedding	Shifting
Cement	Shifting	Shedding (shifting might be possible for short periods)	Shifting

Table 6: Load shifting potential of energy-intensive industrial processes

Source: IASS Potsdam on the basis of Apel et al. 2012; von Scheven, Prelle 2012; Molly et al. 2010; Paulus, Borggrefe 2009, 2010; Klobasa 2007; Klobasa et al. 2013a

2.5 Interim conclusion

Evaluation of the data has shown that the potential for interruptible loads is significantly less than the ten per cent of peak load for the year proclaimed by the FERC in 2011 in their report *Assessment of Demand Response and Advanced Metering*. This is mainly explained by the different definition of the term Demand Response, which not only refers to the management of interruptible loads but also always includes the use of emergency generators and occasionally even the implementation of energy efficiency measures.[9]

By virtue of the particular structure of their capacity markets, which allows them to waive their right to an uninterrupted electricity supply, the aforementioned electricity markets have achieved a situation where sheddable loads cover between 1.4 and 3.6 per cent of the required guaranteed power. However, the capacity markets specified have not made demand more flexible in the sense of regular shifting of loads and adapting to the power generated by wind energy and photovoltaics. The Demand Response programmes may not create any additional incentives for shiftable loads that could avoid peak load times on a regular basis. As a consequence, they can reduce their Peak Load Contribution which is the basis for the capacity levy calculation.

[9] The aforementioned FERC study also compared the available capacity of Demand Response with the annual peak load and not with the required guaranteed power – the peak load for the year is typically several gigawatts below the guaranteed power required. In addition, the figures for Demand Response include all interruptible loads participating in programmes where interruption is voluntary (Economic Demand Response).

If a capacity market were to be established in Germany, programmes for sheddable loads could still play a part. On the one hand, it could make economic sense to reduce the power station capacity required even if it was only a matter of a few percentage points. On the other hand, there might be a political desire to exempt certain industries from the capacity levy in order to guarantee them an internationally competitive electricity price. If this were the case, sheddable loads could be taken into consideration in a similar way to American capacity markets. If a maximum energy price of USD 500 to 1 500/MWh is chosen as in American electricity markets, energy-intensive industrial processes could be considered for participation in the capacity market (see 6). The load reduction potential is estimated at 1 500 to 3 000 MW.[10] Sheddable loads could also make a corresponding contribution towards capacity markets in the low single-digit percentage range with respect to the annual peak load/required guaranteed power, similar to the USA.

3. Demand Response in balancing markets

3.1 How it works

There are typically three kinds of balancing power in American electricity markets, as depicted in Table 7. The Regulation Reserve is used to compensate for frequency deviations due to load noise,[11] thereby taking on the role performed in Germany by the primary and secondary reserves. The Spinning Reserve and Non-Spinning Reserve are used as emergency reserves to respond to unscheduled, sudden power station failures. Participating resources must provide the contractually agreed power within ten minutes. Both products are typically provided by thermal power stations. For the Spinning Reserve, the generators must be on the grid and spinning, but this is not necessary for the Non-Spinning Reserve. There are special rules for hydraulic units (e.g. pumped storage) or flexible loads that have no rotating mass.

In contrast to Germany, power imbalances as a result of generation and load forecast errors are offset not by the balancing market but by the energy market. For this purpose, the ISO operates a so-called Real Time Market where electricity can be traded in the form of five-minute products up to five minutes before its physical dispatch.

[10] Own evaluation based on Apel et al. 2012; von Scheven, Prelle 2012; Molly et al. 2010; Paulus, Borggrefe 2009, 2010; Klobasa 2007; Klobasa et al. 2013a.

[11] Load noise is the deviation between the split-second load and the quarter hourly average of the actual load.

	Energy market		Balancing market		
	Intraday	Real-Time	Regulation	Spinning	Non-Spinning
Generation and load noise		x	x		
Generation and load forecast errors	x	x			
Power station failure	x	x	x	x	x

Table 7: Role of energy and balancing markets in the USA

Source: IASS Potsdam

The Regulation Reserve is put out to tender for the positive and negative power reserve. The Spinning and Non-Spinning Reserves are, however, only put out for bids for a positive power reserve, due to their specific purpose. As a result, only interruptible loads are considered for these two products and no additional loads. The use of interruptible loads in the balancing market is relatively new[12] by comparison with their use in capacity markets. The use of interruptible loads is also not allowed in all markets (Table 8). Electricity markets with no restrictions include New York and Texas.[13] Electricity markets with some restrictions include PJM, New England and California.[14]

	PJM	New England	New York	Texas	California
Regulation Reserve	x		x	x	
Spinning Reserve	x		x	x	
Non-Spinning Reserve			x	x	x

Table 8: Certification of flexible loads in American balancing markets

Source: Own table on the basis of PJM 2014; Hurley et al. 2013; New York ISO 2013b; ERCOT 2007; CAISO 2013

[12] In PJM, for example, interruptible loads were certified for use in 2006 (Monitoring Analytics 2013a, p. 284).

[13] In the next section we analyse the part of the Texan electricity market operated by the Electric Reliability Council of Texas (ERCOT).

[14] The association of transmission system operators in the west of the USA, the Western Electricity Coordinating Council (WECC), has already submitted an application for certification to the regulatory authority responsible at national level, the FERC. Approval is still pending (CAISO 2013, p. 18).

In the sub-markets in which interruptible loads are allowed, only the markets for Spinning Reserve in PJM and Texas play any notable part. As Table 9 shows, 32 to 46 per cent of the Spinning Reserve[15] in Texas is covered by interruptible loads. So far, however, interruptible loads have played no part in the Regulation or Non-Spinning Reserves (Jones, Huynh 2014). In PJM, an average of around three per cent of the Spinning Reserve[16] came from interruptible loads. However, shares of over 20 per cent were reached on a temporary basis (PJM 2012, p. 2). The large difference between the average and maximum values is due to the specific design of the market in PJM, where only the residual volumes [17] are put out to tender on the market. Interruptible loads took part in the Regulation Reserve for the first time in 2011. The proportion remains very low, however, and is around 0.1 per cent of the power put out to tender. In New York, interruptible loads have been able to provide all three types of balancing power since 2008. At present, however, no interruptible loads participate in the balancing market. The first suppliers started the prequalification process in 2013 (New York ISO 2014b, p. 5). In California one water company is taking part in the Non-Spinning Reserve. The average power offered in 2011 was 107 MW per year (CAISO 2012, p. 6).

	Texas	PJM
Power to be kept available [MW]	2 800	2 675
Average power from interruptible loads [MW]	900 – 1 300	74
Average proportion represented by interruptible loads	32 – 46 %	3 %
Approved proportion represented by interruptible loads	50 %	33 %

Table 9: Proportion of interruptible loads in the Spinning Reserve for 2012

Source: IASS Potsdam on the basis of Potomac Economics 2013; Wattles 2012; Monitoring Analytics 2013a; PJM 2014

[15] Texas uses the term Responsive Reserve instead of Spinning Reserve.

[16] PJM uses the term Synchronized Reserve instead of Spinning Reserve.

[17] PJM views all power stations not running at their rated load as potential providers of Spinning Reserve (Tier 1). Only the residual amount (Tier 2) is put out to tender on the market. In 2013 these residual volumes averaged 252 MW for the balancing zone RTO and 154 MW for the Mid-Atlantic zone.

3.2 Deployment

As the Non-Spinning and Spinning Reserves play the role of an emergency reserve and are not used to offset power imbalances due to forecasting errors, their deployment is relatively seldom by comparison with the secondary or tertiary reserve in Germany.

Table 10 shows how often and for how long the Spinning Reserve was called upon in the PJM electricity market in the period from 2010 to 2013. In this period, the Spinning Reserve was required between 18 and 33 times per year. The call-up duration averaged between 10 and 16 minutes, and added up to between 4 and 7 hours per year.

	2010	2011	2012	2013
Call-ups	33	35	23	18
Call-up duration (hours)	7	6	4	5

Table 10: Annual call-up frequency and cumulative call-up duration for the Spinning Reserve in PJM from 2010 to 2013

Source: IASS Potsdam based on Monitoring Analytics 2014

The call-up frequency for the Spinning Reserve in Texas is higher than in PJM. However, the annual call-up duration is similar, as Table 11 shows. Texas is in the unusual situation of having different call-up signals for power stations and interruptible loads. On the one hand, interruptible loads only have to cut back their power consumption if the frequency reaches 59.7 Hertz (target frequency 60.0 Hertz), and on the other they can only be switched manually by the ISO in the event of critical grid conditions. This means that the call-up frequency for interruptible loads is normally much lower than for power stations in the Spinning Reserve.

Power stations	2010	2011	2012	2013
Call-ups	201	47	86	87
Call-up duration (hours)	14	7	5	6
Interruptible loads	**2010**	**2011**	**2012**	**2013**
Call-ups	5	7	3	3
Call-up duration (hours)	3	15	1	1

Table 11: Annual call-up frequency and cumulative call-up duration for the Spinning Reserve in Texas from 2010 to 2013 for power stations and interruptible loads

Source: IASS Potsdam based on ERCOT 2014

3.3 Interpretation

By comparison with the Spinning Reserve or Non-Spinning Reserve in the USA, the secondary and tertiary reserves have a wider range of application. As Table 12 shows, the secondary and tertiary reserves are also used to correct frequency deviations due to load noise or forecasting errors. In the American electricity markets, these two tasks are performed by the real-time market and the Regulation Reserve, but the proportion of flexible loads in these market segments is negligible or even non-existent.

	Power station failure	Forecasting error	Load noise
Spinning	x		
Non-Spinning	x		
Secondary reserve	x	(x)	x
Tertiary reserve	x	x	

Table 12: Tasks performed by German and American balancing products

Source: IASS Potsdam

As a result of the extended range of application for the secondary reserve, deployment frequency and duration of the tertiary reserve are different as well as the demands made on flexible loads.

Figure 2 shows the frequency of use of the secondary and tertiary reserves as an annual duration curve using the example of 2012. The duration curve shows on the one hand that the secondary reserve was used much more often than the tertiary reserve. Yet the graph also shows that the power put out to tender was only used (almost) in its entirety in relatively few hours of the year. For example, the tertiary reserve was used in 833 hours; but usage of the tendered power exceeded 80 per cent in only 69 hours.

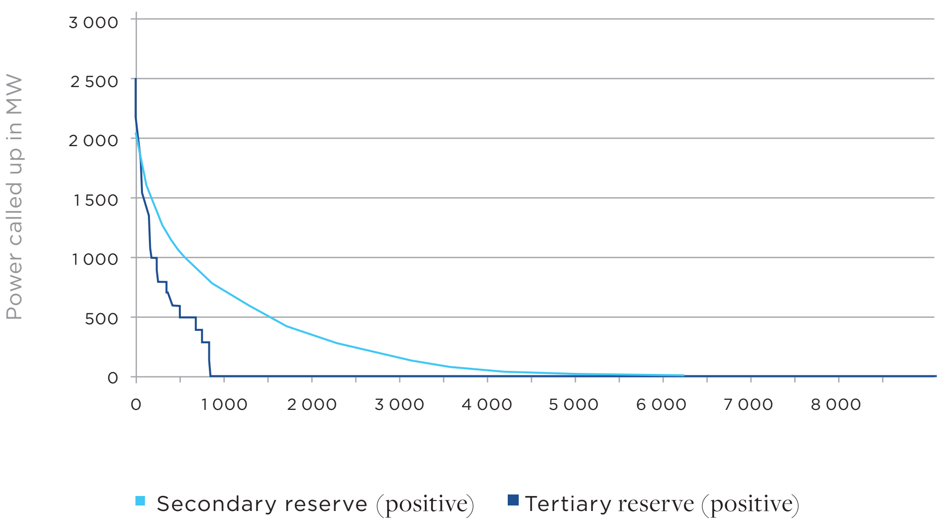

Figure 2: Duration curve of power called up from secondary and minute reserves

Source: IASS Potsdam on the basis of data from 50Hertz et al. 2014

By comparison with the Spinning Reserve in Texas and PJM, the secondary and tertiary reserves are used much more frequently. The proportion of interruptible loads in the Spinning Reserve in Texas, which looks high at first sight, can be explained essentially by the low frequency of deployment and call-up du-ration. As a result, there is practically no loss of production. These conditions seem to be ideal for the chemical industry (chlorine electrolysis), which contributes over 40 per cent of the power provided (Krein 2012, p. 5).

3.4 Interim conclusion

The evaluation shows that interruptible loads are either not allowed in American balancing markets – with the exception of Texas – or their participation is negligible. Participation in Texas, which looks high at first sight, is due to the fact that interruptible loads are called up very infrequently and only for extremely short periods. The German secondary and tertiary reserves, on the other hand, are called up much more frequently, as they are used not only as an emergency reserve but also during day-to-day operations in order to correct frequency deviations caused by load noise or forecasting errors. As a result of the major differences with regard to use and call-up duration, no recommendations can be derived for the design of the balancing markets in Germany.

4. Conclusion

Interruptible loads can take part in auctions in American capacity markets if they are not dependent on an uninterrupted power supply. However, the temporary interruption of loads is only seen as a measure for absolute emergencies, and as a result, the length of interruption has so far never exceeded 30 hours per year in any market area. The power supply is therefore guaranteed for at least 99.6 per cent of the time, even for loads participating in the capacity market.

In return, interruptible loads receive the relevant market clearing price for their area of the grid, which ranged from USD 18 730 to USD 98 640 per year in the capacity year 2012/2013 depending on the market area. This corresponds to a refund of the capacity levy already paid. As a result of this structure, interruptible loads representing power of 1.4 to 3.6 per cent (with respect to the secure power required) participated in the capacity market by waiving their right to an uninterrupted power supply. The interruptible loads in these programmes are almost always sheddable loads (as opposed to shiftable loads) where reduced power consumption leads to an expensive pro duction downtime variable, the costs of which are in the three- to four-digit range per megawatt hour.

In spite of the relatively low volume and very rare deployment, capacity programmes for interruptible loads could be an option for Germany in order to reduce the burden placed by the capacity levy on electricity-intensive industries in Germany. This procedure would be preferable to a blanket exemption with nothing in return (as in the case of grid fees or the EEG levy), because if it is properly implemented, a small amount of power station capacity could be saved.

Interruptible loads are either not allowed to take part in American balancing markets – with the exception of Texas – or their participation is negligible. At first sight, Texas has a high share of interruptible loads amounting to 32 to 46 per cent of the so-called Spinning Reserve. If we look at the deployment times, however, we can see that the length of deployment is even shorter than in the capacity markets and has not exceeded 15 hours per year in the last few years. The Texan Spinning Reserve cannot be seen as a role model for Germany due to the completely different tasks performed by the American balancing markets. The analysis also shows that expectations of flexible loads in the USA and Germany are very different.

The regulatory conditions for flexible loads in the USA aim to ensure that interruptible loads switch off their power consumption in emergency situations. However, this is only one possible use of flexible loads at a time of energy transition. As the proportion of photovoltaic and wind power rises, it is becoming increasingly important to postpone power consumption on a regular basis (!) and to adapt it to the supply of renewable energies. It will also become increasingly important in the future to reduce the minimum generation of conventional power stations (must-run capacity), for example, by ensuring that flexible loads take over a larger share of reserve power.

Germany should pursue the fundamental goal of reducing the barriers to load management in the current market structure. For example, the regulatory barriers in the balancing market are largely known and relate among other things to prequalification criteria, tendering conditions, the grid fee structure and the role of independent aggregators. The implementation of additional funding instruments such as the ordinance governing interruptible loads, where the system benefit is marginal, is not necessary, however, and would tend to be counterproductive when it comes to promoting competition for the most efficient flexibility option.

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