Electricity Markets Working Papers

WP-EM-16

Price Formation and Market Power in the German Electricity Wholesale Market – Is Big Really Beautiful?

Hannes Weigt and Christian von Hirschhausen

TECHNISCHE UNIVERSITÄT DRESDEN

EE²

Dresden University of Technology

Chair for Energy Economics and
Public Sector Management

Price Formation and Market Power in the German Electricity Wholesale Market – Is Big Really Beautiful?

Hannes Weigt and Christian von Hirschhausen

Corresponding author:

Hannes Weigt
Dresden University of Technology
Department of Business Management and Economics
Chair of Energy Economics
D – 01069 Dresden
Germany
Phone: +49-(0)351-463-39764
Fax: +49-(0)351-463-39763
Hannes.weigt@ tu-dresden.de

Abstract:

During 2004 and 2006 German wholesale electricity prices nearly doubled. The purpose of this paper is to estimate the factors for this price increase differentiated by fuel costs, CO_2-emission allowances, and market power. We develop a competitive benchmark model, taking into account power plant characteristics, fuel and CO_2-allowance-prices, wind generation, and other market characteristics. We estimate the difference between generation costs and observed market prices for a limited number of load data, between 2004 and 2006. We find that the prices at the German wholesale market (EEX) are significantly above the competitive levels for most of the observations. The robustness of the results has been verified by carrying out sensitivity analyses.

Key words: electricity, Germany, market power, competitive benchmark
JEL-code: L13, L94, D 43

1 Introduction

Market power is an important aspect of restructured electricity markets around the word. At the same time, the question of resource adequacy of investments in generation has resurged recently, both in the U.S. and in Europe, driven by concerns about supply security. The German electricity market has undergone significant changes in the last decade, but the scientific discussion about the appropriate market design is not yet very developed. Since the first EU liberalization directive 96/92/EC, it has taken Germany almost a decade to address issues such as network tariff regulation or market monitoring. Since 2006, the newly established regulator ("Bundesnetzagentur") has issued cost-based revisions of transmission and distribution network tariffs, and is beginning to ponder alternative instruments of congestion management, cross-border trading, etc; incentive regulation should be in place by 2008. Therefore, the current political discussion has shifted to the generation sector: Average spot prices at the European Energy Exchange (EEX) have increased from 2002 to 2005 by about 80%, prices in the first half of 2006 are about 140% higher than in 2002. However, a price increase is no proof of malfunctioning markets or market power abuse as fuel prices have increased significant over the last years and the emission allowance trading scheme has been implemented. On the other hand, the oligopolistic structure of the generation market lends itself to market power abuse, with a duopoly controlling over 55% of market share, and the largest four firms owning almost 90%.

This paper analyzes the level of competition at the German wholesale electricity markets, by comparing the observed prices with estimated costs and clearing prices under the hypothesis of perfect competition. We develop a competitive benchmark model testing the observed EEX market prices for selected hours and days between 2004 and 2006. Our hypothesis, based on international experience and recent research on Germany, is that the oligopolistic structure of electricity generation in Germany leads to significant mark-ups of the prices when compared to real costs. In the next section, we provide a survey of market power analysis in other countries (mainly the U.S. and the UK) and summarize the existing studies on Germany. Section 3 presents the competitive benchmark model and introduces the data. Our analysis is based on publicly available data on electricity prices, generation capacities and costs, and other variables such as wind intensities, for a number of representative days between January 2004 and 2006. We find that the observed prices exceed marginal costs by high margins for most of the observations in mid-load and peak-load, with an average mark-up for these periods of 17% (Section 4). By way of contrast, we do not find a particular periodical or seasonal pattern in these mark-ups that could be related, for example, to the introduction of CO_2 emission allowance trading in January 2005. Our results are confirmed by sensitivity analyses. We conclude that market power seems to be an important feature of German electricity markets, and should be addressed by more competition-oriented market design.

2 State of the Literature

2.1.1 International empirical literature on market power

Market power normally is defined as the ability to profitably alter prices away from competitive levels (Mas-Collel et al. 1995, p. 383). Thus one of the main questions of estimating market power abuse is the “right” approximation of competitive levels. The model approach is often referred as competitive benchmark. Technically more complex approaches like Cournot or Supply Function Euqilibria often use the competitive benchmark as a starting point or additional information to classify the model results.[1]

The main aim of the benchmarking approach is to estimate a competitive supply function in terms of marginal costs. In a filly competitive market no player can influence the clearing price; thus the simulated supply function in combination with a given demand level yields the competitive benchmark. This is mainly done by collecting data on the generation facilities and calculating marginal costs for each plant. Arrange the plants according to increasing marginal costs yields the competitive supply curve. The difference between simulated and observed market prices allows to quantify the extent of market power. Stoft (2002, p. 129) shows that marginal cost pricing suffices to cover the capital cost of investment, because price spikes will occur in case of shortages. An in-depth discussion of the issue is provided by Hogan (2007) and Crampton and Stoft (2006). At this point, we notice that the marginal costs should set the competitive prices when the market is characterized by overcapacity.

At the time of monopolistic, oftentimes vertically integrated electricity companies, there was neither room nor need for any market power analysis. The restructuring of the U.S. and the British market have opened the way to rigorous market power analysis. Thus Wolfram (1999) was among the first to apply a competitive benchmark analysis to the electricity market of England and Wales. Wolfram finds significant markups during the observed period covering 18 month in 1992, 1993 and 1994, although the generators are not taking full advantage of the inelastic demand as oligopoly models predict. Borenstein, Bushnell and Wolak (2002) and Joskow and Kahn (2002) use the competitive benchmark approach to analyze the California market. Both find that in summer 2000 observed prices differ from the competitive benchmark price levels which can not be explained by load, imports, gas prices or NO_x-allowance prices. Mansur (2001) undertakes an analysis of the PJM market calculating a demand-weighted Lerner index of 0.293, which indicates significant market power abuse.

A drawback of competitive benchmark analysis is the necessary simplification when estimating the supply curve. As electricity markets are highly complex while access able information is generally spare models have to make assumptions that may influence the outcome. Typically the simulation is static neglecting start up and shut down costs or minimum load constraints. Missing information about plant outages may add to the error. Also, in general, the grid is not considered as part of the market.

Thus network congestion which can lead to market prices above marginal costs is not considered. The simplifications can lead to a general underestimation of marginal costs. Harvey and Hogan (2002) undertake a sensitivity test of competitive benchmark analysis, by reproducing the results and estimating the impact of varying assumptions. They conclude that the differences obtained by the simulation can come from the real-world constraints omitted from the model.

2.1.2 Literature on the German Wholesale market

In Germany the wholesale electricity market is dominated by four companies owning about 85% of conventional power plant capacity. The German antitrust agency assumes a dominant Duopoly consisting of E.ON and RWE owning about 60% of generation (Bundeskartellamt, 2006). Thus the question arises if despite such an oligopolistic structure the observed market outcomes represent competitive behavior or if market power is applied.

Müsgens (2006) is the first to simulate a comprehensive marginal costs model of the German market for the period of June 2000 to June 2003. Using a linear optimization model Müsgens estimates the competitive market prices. Starting in 2000 the observed and modeled market prices coincide until fall 2001, follow by a break leading to a divergence between both that lasts until the end of the observation period. Strategic company behaviors as well as learning effects are assumed to be the main reasons for the observed differences. Ellersdorfer (2005) uses a two periodic Cournot model to analyze the German market. The main focus is on the impact of long term contracts on the oligopolistic model. Nevertheless, a competitive benchmark is presented as well, again concluding that a significant difference between modeled and observed market prices exists.

In a more recent study, Schwarz and Lang (2006) analyzed the German electricity prices by estimating the impact of fundamental price components such as fuel price development and allowance prices influence the electricity price. For the period from 2000 up to 2005 they prove that increasing fuel prices and in 2005 allowance prices are the main price component. However, starting in 2003 the impact of market power increases and becomes an important factor of electricity prices. Our paper follows Schwarz and Lang (2006) by reproducing the years 2004 and 2005 and extending the analysis to the first half of 2006. Kemfert and Traber (2007) apply a strategic model of the German electricity sector to combine market power and climate policy analysis. They find that the German electricity wholesale market attained full competition (which, from an ecological perspective, is a blessing because withholding leads to reduced electricity consumption). Last but not least, the Sector Inquiry of the European Commission (2007) draws the following conclusions (most of which can be easily applied to Germany): wholesale markets show a high degree of supplier concentration; vertical integration is a dominant factor in many electricity markets; international trade is insufficient to provide pressure and domestic producers; there is a high degree of in transparency in the electricity

---

[1] For a comprehensive overview about different approaches of measuring and modeling market power see Twomey et al. (2004).

markets; price formation on electricity markets is complex and consumers have little confidence in the competitiveness of these markets.

3 Model and Data

This section describes the approach to the competitive benchmark analysis and the data used, the objective being to derive estimates for the true marginal costs, which are then to be compared to the market prices. The model simulates a wholesale market in which all demand is cleared via one single market process the German wholesale electricity market EEX. About 20%.of total consumption is traded via the EEX, and it is the only source of prices available, also serving as a marker price for OTC trading. Demand (load) data is provided of selected days (3rd Wednesdays of a month) by UCTE. We assume that trading is a competitive activity, so that market power is exercised by the generators only.

3.1 Generation capacity

Generation capacity is characterized by significant overcapacity. Total generation capacity is about 120 GW (VDN, 2005). The basic plant list is obtained from VGE (2005, 2006) which covers all conventional plants in Germany with more than 100 MW generation capacities; in addition the plant and fuel type are given. The available capacity of a plant can differed from the installed according to weather conditions, maintenance or outages. Thus an adjustment is necessary to prevent an overestimation of available plant capacity and therefore underestimated prices in the simulation. To cover these effects seasonal availability factors for each plant type are used according to Hoster (1996). Since the analysis is based on single hours the generalization can lead to divergences in specific cases, such as a plant outage of a large coal block. Part of the available capacity may be sold in another country and therefore can not be used to cover the German demand. Lack of publicly available information restricts the possibility to deal with this issue directly within the plant list. About 7 GW are held back for the reserve market [a figure that we consider to be too high but that we take as given in this exercise]. We subtract the capacity of electricity from wind (explained below). Further impacts on the actual demand level are not considered in the model.[2] This leaves us with a readily available flexible capacity of more than 85 GW, which is significantly higher than the highest peak load (about 77 GW).

3.2 Assessment of wind

The simulated competitive market outcome can be obtained by combining the supply curve information with the demand level. Due to large amounts of renewable energy sources in Germany

---

[2] As mentioned above there are no information about which plant produces for foreign sales. Thus the plant list can not simply be adjusted by leaving a certain amount of plants out. This may lead to an underestimation of market prices as there may be less capacity available in the real market than in the model; on the other hand imports lead to a reduced demand level that has to be met by German power plants. Due to changes in the congestion management mechanisms in the observed period no consistent database exists. Therefore, imports are not considered directly in the model

especially wind energy the actual demand level to be satisfied by conventional plants can vary significantly. Therefore the demand is reduced by calculating the hourly wind input for the analyzed days. Other renewable sources like solar and bio mass are neglected due to the relatively small installed capacities. Wind capacities range from about 15 GW in 2004 up to 19 GW in 2006. As the energy input of wind plants is determined by wind speed the actual output varies accordingly. Thus, historic wind speed information from the German Weather Agency (Deutsche Wetterdienst, DWD) is used to estimate the wind energy input. Therefore Germany is split up in seven zones (North Sea coast line, Baltic Sea coast line, western Germany, eastern Germany, low mountain range, southern Germany). Using the logarithmic height correlation (Hau, 2003) the wind speeds in an average turbine height of 60m can be calculated:

$$v_H = v_{ref} \frac{\ln \frac{H}{z_0}}{\ln \frac{H_{ref}}{z_o}} \qquad (1)$$

mit v_H *wind speed in H (60m)*

v_{ref} *wind speed in reference height* H_{ref} *(10m)*

z_o *surface roughness (0,2)*

Using an average wind turbine characteristic the calculated wind speeds can be transformed into an energy output. The actual wind capacities on regional basis are obtained from DEWI (DEWI, 2004a, 2004b, 2004c, 2004d, 2005a, 2005b). With the beginning of 2006 the four TSOs publish predicted and actual wind input for each day. Thus a separate calculation using wind speeds becomes obsolete for 2006.

3.3 Cost estimates

We have to estimate the marginal cost curve (“merit order”) for electricity generation. In addition to the fuel type used, we also estimate the efficiency of each plant, using the age as a proxy: for coal, lignite, oil/gas fired steam plants, ccgt plants and gas turbines, the link between the age and the efficiency are taken from Schröter (2004). Nuclear plants are assumed to have an average efficiency of 33% (Müller, 2001) and hydro plants have 100% efficiency. Pump storage plants have a chronologically staggered efficiency according to Müller (2001).[3]

Fuel prices for imported oil and gas on a monthly basis and quarterly plant coal prices are obtained from Bafa (2006). For nuclear plants fuel costs of 3 €/MWh are assumed leading to generation costs of 9 €/MWh.[4] As there exists no global market for lignite extraction costs of 1.76 €/GJ are used as presented in the high price scenario in Schneider (1998); this figure over- rather thand underestimates the real costs. Hydro plants are assumed to have no fuel costs. Pump storage plants are assumed to

---

[3] Pump storage plants build before 1950 have 60% efficiency, before 1960 65%, before 1970 70%, before 1975 75% and plants built afterwards have 82% efficiency. If there was no information about the year of construction, we assume 1980 to be the relevant date.

[4] Nuclear is not the marginal supplier in the relevant periods, so that the estimate of its marginal costs do not change the results.

store water during off peak hours and are available during peak hours. Thus the off peak price at the EEX is considered as “fuel price” and the generation costs are calculated using the plants efficiency. Hydro and pump storage plants act as price takers like every other plant. In addition to fuel costs an uplift payment for variable operating expenses is used for each plant type (EWI, 2005). Coal plants have addition expenses of 2 €/MWh, nuclear plants 3 €/MWh and gas fired plants 0.5 €/MWh. Hydro plants are assumed to have operating expenses of 1 €/MWh. Start up costs as well as ramping costs are not considered.

With the introduction of the emission allowance trading scheme in 2005 an additional cost element has to be considered. Allowance prices can be taken into account as opportunity costs of production. Therefore the plant specific CO_2-emissions are calculated based on efficiency and plant type according to Gampe (2004). These emissions are valued with the average allowance price of the analyzed month and added to the fuel and operation costs.

4 Results and Sensitivity Analysis

4.1 Results

We compare our marginal cost estimates to the market prices for the period from 2004 until the summer of 2006 (total of 30 days data). We find that the prices exceed the cost estimates consistently. In particular, mark-ups occur during peak hours, whereas in off-peak the prices more or less correspond to the cost estimates. Hence we focus our analysis on the mid- and peak-load periods (8am-8pm).

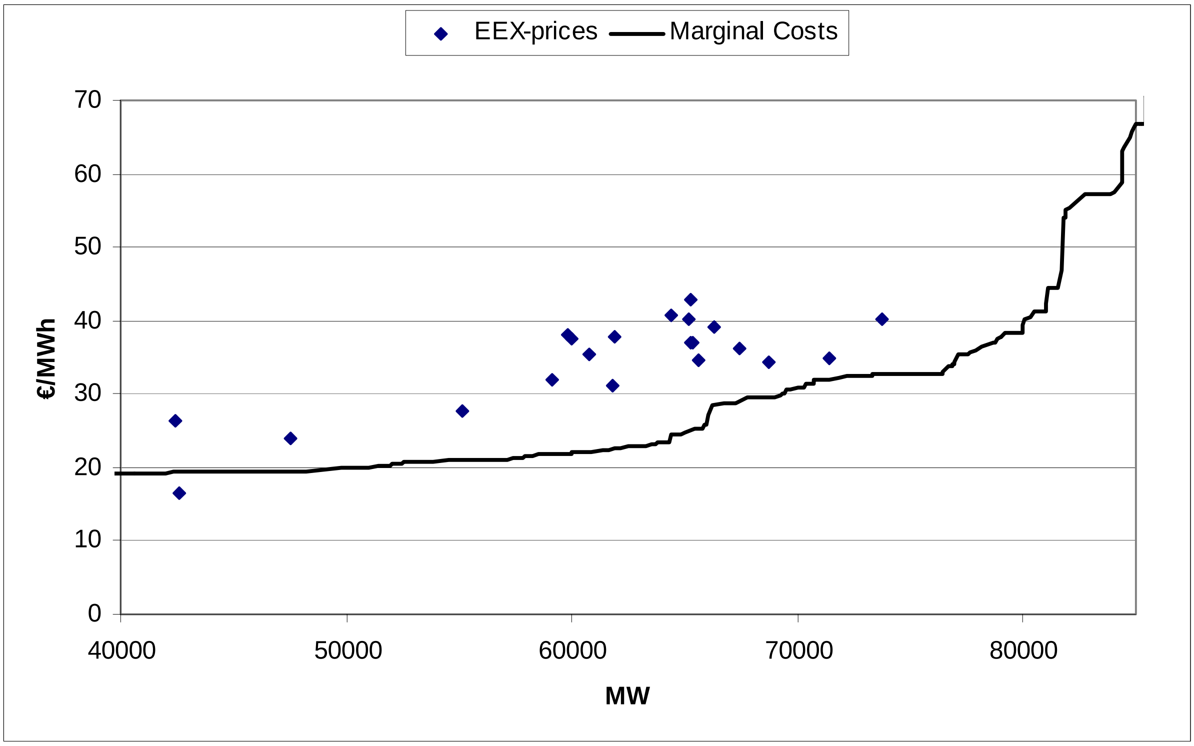
For the year 2004, the average Lerner index, i.e. the gap between prices and costs relative to the costs, is 0.21. Interestingly, the Lerner index increases with increasing load levels: The analyzed days show the highest margin in a range between 80 to 90% of daily peak load with Lerner indices of more than 0.4.[5] [6]

---

[5] This corresponds to the results of Schwarz und Lang (2006). The September day is an example of the unexpected price development (Figure 1): the highest mark-ups are observable during mid term while they drop slightly near the days peak load.

[6] The results also show that startup costs have a significant impact on market decision for base load plants. Especially in the summer days market prices during off peak hours are below the modeled competitive prices. This seems to hold true whenever the load level drops below 50 GW. This effect can be explained by the necessary time and costs of shutting down a base load plant during the night and restarting it the next morning. Plant owners seem to prevent this procedure by bidding below marginal costs and therefore secure that their plant is running all time. Another explanation for this effect may be the contract cover for base load plants. If one has a contract with a fixed price for a base load or off peak product, he does not care about the market price. Thus the modeled supply curve may have to be shifted to the right reducing the simulated market clearing prices.

Figure 1: Results for September 15, 2004

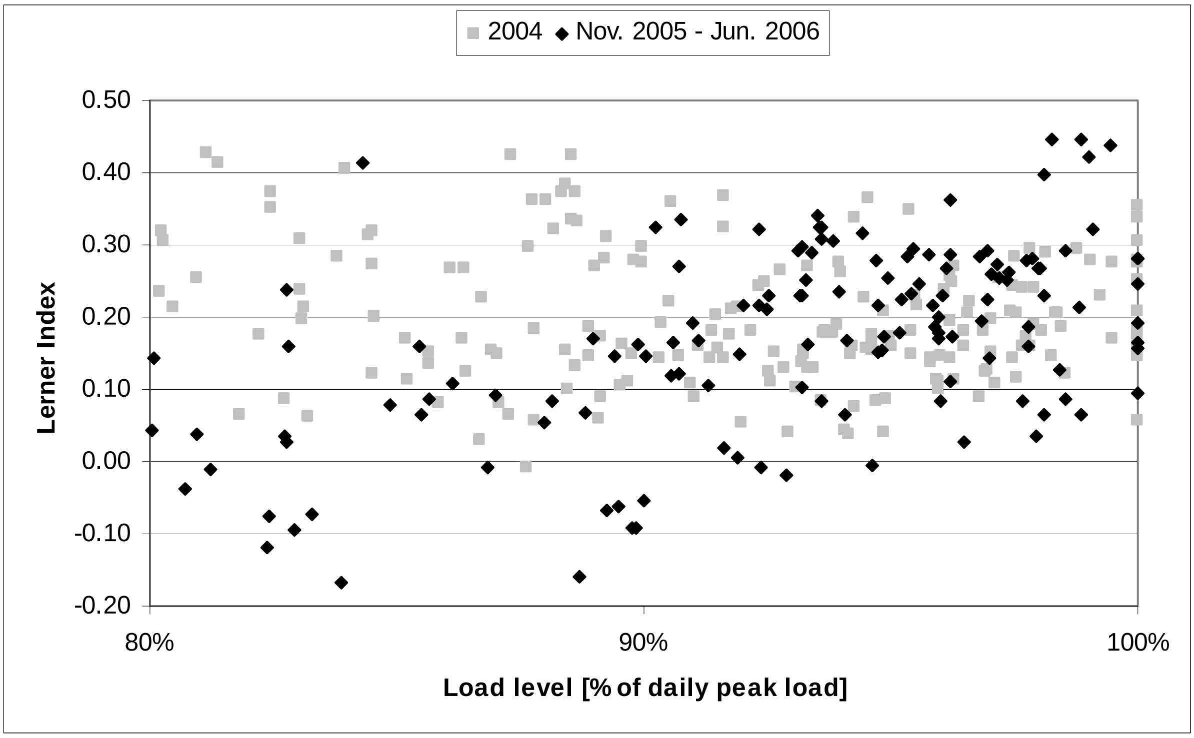


Source: Own calculation

With the introduction of emission allowances in 2005 the situation changed. The clear situation of 2004 with a general positive mark-up during peak times is replaced by unsteady results with positive and negative mark-ups. In 2005 the average Lerner index is about 0.1 during peak times and in 2006 the average Lerner index is 0.19 during peak hours. The development can be summarized in three phases: First the continuation of the former situation from 2004, the second phase marks a period of varying positive and negative mark-ups, and third a stabilized trend towards negative mark-ups during off peak and significant positive mark-ups during peak hours.

In the first half of 2005 (January till May) the analysis shows a similar pattern as in 2004 with negative Lerner Indices during off peak and positive indices during peak hours. The main difference is the increased price level of the supply curve due to the opportunity costs of CO_2-emissions. Thus the calculated Lerner indices are smaller compared to the same period in 2004. The situation changes noticeable during the following months in 2005 (June till October). The average Lerner index drops to -0.13 and even during peak hours negative mark-ups can be observed. Neglecting the opportunity costs for emission allowances yields that the observed market prices are still above the fuel and operation expenses. Thus the market participants seemed to be uncertain whether to fully include the allowance prices or not. Starting with November 2005 stabilization in the model outcome can be observed. The Lerner indices are throughout positive during peak hours (expect for a few hours in April) and the average values indicate a significant mark-up. The results are comparable to the simulation of 2004 (Figure 2). The main difference is a shift in mark-ups during mid term and off peak hours. In both periods, high Lerner indices can be observed near peak load. However, below a level of about 90% of daily peak load, mark-ups drop somewhat. One explanation can be that during mid term and off peak hours market participants include CO_2-allowance prices only partly. The observed market prices are nearly all above fuel and operation expenses.

Figure 2: Lerner indices, 2004 and November 2005 till June 2006



Source: Own calculation

4.2 Sensitivity analysis

Harvey and Hogan (2002) have shown that benchmarking analysis is sensitive to the data and the assumptions. Thus proper testing is needed to verify the obtained results. As the presented model is based on public available data, some key information may be missing to explain the observed differences. In our case the absence of reliable data on the imports and exports is a real drawback of the model. Our sensitivity analysis looks at shifts in demand or in plant availability that would be required to obtain a fully competitive solution. The obtained values show how far the supply curve has to be shifted to intersect with demand to obtain the observed market results. Thus if these values are relatively high, the basic conclusion is valid while only little differences would suggest missing information as explanation. As the main focus lies on market power abuse, only peak hours have been considered.

For 2004 the sensitive analysis yields an average gap of about 9 GW. Thus the simulated supply curve would have to be shifted to the left by 9 GW or the demand level was 9 GW higher than assumed.[7] In July the average difference is about 2.5 GW and the maximum error is 5.3 GW. For May and September the average difference amounts to 14 and 15 GW respectively with maximum divergences

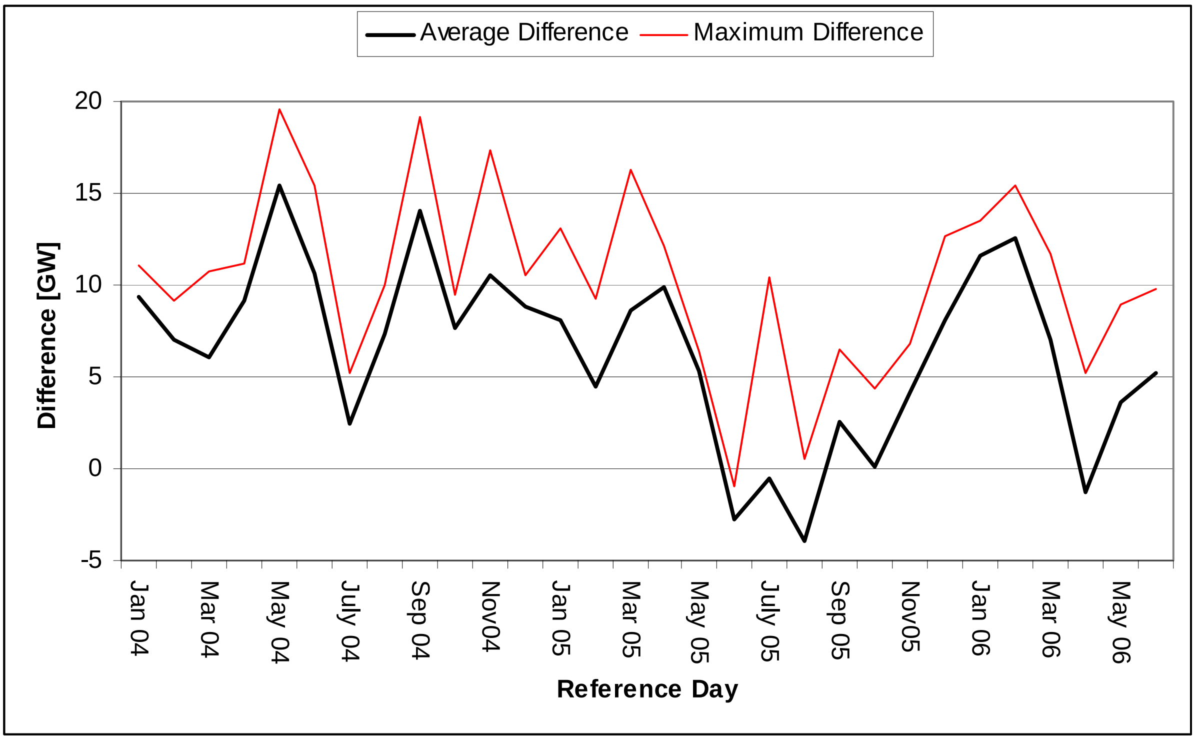
---

[7] Given that the demand values are more likely to be smaller than assumed as imported energy and smaller renewable energy sources have not been considered the value indicates a possible overestimation of available plants.

of more than 19 GW. These errors can hardly be explained by data issues and suggest that strategic behavior by market participants might have played a role.

Figure 3 shows the average and maximum differences between the real supply and the (hypothetical) market-clearing supply. Except for the summer of 2005 these differences are significantly high, with values of more than 10 GW on average. This shows the general robustness test to be valid: underestimation of load and overestimation of generation capacity in a height of more than 15 GW is unlikely.

Figure 3: Results of sensitivity analysis



Source: Own calculation

5 Conclusion

This paper analyzes the intensity of competition in the Germany wholesale electricity markets between 2004 and the summer of 2006. We test the hypothesis of the previous literature that systematically finds that the market prices are significantly above marginal cost. We find significant price mark-ups for mid-load and peak-load, for almost the entire period of observation. These results suggest strategic behavior of the oligopolistic market players and a market that is not sufficiently competitive.

The robustness of the results has been verified by carrying out a sensitivity analysis to estimate the gap between estimated load level and market-clearing load level. The sensitivity analysis finds an average "generation gap" of about 10 GW, going up to values of almost 20 GW at times; these results clearly confirm our findings. The paper presents a relatively simple approach to estimate the competitiveness of the German electricity market. Further steps are necessary to validate the obtained results and overcome drawbacks of the current model including missing data on import and export as well as extending the number of analyzed days.

References

Bafa (2006): http://www.bafa.de/1/de/aufgaben/energie/, retrieved 21.08.06.

Borenstein, Severin, James Bushnell and Frank Wolak (2002): Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market, *American Economic Review*, Vol. 92, No. 5, pp. 1376-1405.

Bundeskartellamt (2006): *Sachstandspapier zur Vorbereitung der mündlichen Verhandlung in Sachen Emissionshandel und Strompreisbildung.* Bundeskartellamt, 8. Beschlussabteilung, Bonn.

Crampton, Peter, and Steven Stoft (2006): *The Convergence of Market Designs for Adequate Generating Capacity with Special Attention to the CAISO's Resource Adequacy Problem.* Berkeley, California, White Paper for the Electricity Oversight Board.

DEWI (2004a): *Wind Energy Use in Germany - Status 31.03.2004.* abgerufen am 04.09.2006: http://www.dewi.de/dewi_neu/englisch/themen/statistic/html/040331.htm

--- (2004b): *Wind Energy Use in Germany - Status 30.06.2004.* abgerufen am 04.09.2006: http://www.dewi.de/dewi_neu/englisch/themen/statistic/html/040630.htm

--- (2004c): *Wind Energy Use in Germany - Status 30.09.2004.* abgerufen am 04.09.2006: http://www.dewi.de/dewi_neu/englisch/themen/statistic/html/040930.htm

--- (2004d): *Wind Energy Use in Germany - Status 31.12.2004.* abgerufen am 04.09.2006: http://www.dewi.de/dewi_neu/englisch/themen/statistic/html/043112.htm

--- (2005a): *Aufstellungszahlen der Windenergienutzung in Deutschland - Stand 30.06.2005.* abgerufen am 04.09.2006: http://www.dewi.de/dewi_neu/englisch/themen/statistic/html/050630.html

--- (2005b): *Aufstellungszahlen der Windenergienutzung in Deutschland - Stand 31.12.2005.* abgerufen am 04.09.2006: http://www.dewi.de/dewi_neu/englisch/themen/statistic/html/051231.html

DWD (2005): *Datenabgabe 439/05,* stündliche Windgeschwindigkeiten von 8 Stationen, erworben vom Deutschen Wetterdienst (DWD).

Ellersdorfer, Ingo (2005): *A Multi-Regional Two-Stage Cournot Model for Analyzing Competition in the German Electricity Market.* Proceedings of the 7th European Energy Conference 2005 "European Energy Markets in Transition", Bergen.

European Commission (2007): Untersuchung des europäischen Erdgas- und des europäischen Elektrizitätssektors gemäß Artikel 17 der Verordnung (EG) Nr. 1/2003 (Abschlussbericht). Mitteilung der Kommission an den Europäischen Rat und das europäische Parlament, KOM(2006) 851.

EWI (2005): *Energiereport IV. Die Entwicklung der Energiemärkte bis zum Jahr 2030.* Oldenburg Industrieverlag, Energiewirtschaftliches Institut an der Universität zu Köln.

Gampe, Uwe (2004): *Umweltaspekte von Energieanlagen.* Institut für Energietechnik, Technische Universität Dresden, Vorlesungsunterlagen.

Harvey, Scott and William Hogan (2002): *Market Power and Market Simulations.* Cambridge, Massachusetts.

Hogan, William (2007): *Electricity Resource Adequacy: Reliability, Scarcity, Markets, and Operating Reserve Demand Curves*, Conference on "The Economics of Energy Markets", Toulouse, France, January 15-16, 2007.

Hoster, Frank (1996): *Auswirkungen des europäischen Binnenmarktes für Energie auf die deutsche Elektrizitätswirtschaft.* Oldenbourg, München.

Joskow, Paul, and Edward Kahn (2002): A Quantative Analysis of Pricing Behavior in California`s Wholesale Electricity Market During Summer 2000. *The Energy Journal,* Vol. 23, No. 4.

Kemfert, Claudia, and Thure Traber (2007): *Investment in Climate-Friendly Fossil Energy Technologies in Germany: The Impact of Strategic Behavior and Emission Trading Investors*, German Institute for Economic Research.

Mansur, Eric (2001): *Pricing Behavior in the Initial Summer of the Restructured PJM Wholesale Electricity Market*, POWER Working Paper PWP-083, University of California Energy Institute.

Mas-Colell, Andreu, Michael Whinston, and Jerry Green (1995): *Microeconomic Theory.* New York, Oxford, Oxford University Press.

Müller, Leonhard (2001): *Handbuch der Elektrizitätswirtschaft. Technische, wirtschaftliche und rechtliche Grundlagen,* 2. Auflage, Berlin, Springer.

Müsgens, Felix (2006): Quantifiying Market Power in the German Wholesale Electricity Market Using a Dynamic Multi-Regional Dispatch Model. *The Journal of Industrial Economics*, Vol. 54, No. 4, S. 471-498.

Schneider, Lambert (1998): *Stromgestehungskosten von Großkraftwerken. Entwicklungen im Spannungsfeld von Liberalisierung und Ökosteuern.* Institut für angewandte Ökologie, Freiburg.

Schröter, Jochen (2004): *Auswirkungen des europäischen Emissionshandelssystems auf den Kraftwerkseinsatz in Deutschland*. Diplomarbeit, Berlin University of Technology, Institute of Power Engineering.

Schwarz, Hans-Günter and Christoph Lang (2006): *The Rise in German Wholesale Electricity Prices: Fundamental Factors, Exercise of Mmarket Power, or Both?* IWE Working Paper Nr. 02, Institut für Wirtschaftswissenschaft, Universität Erlangen-Nürnberg.

Stoft, Steven (2002): *Power System Economics: Designing Markets for Electricity*. Piscataway, New Jersey, IEEE Press, Wiley-Interscience.

Twomey, Paul, Green, Richard, Neuhoff, Karsten, and David Newbery (2004): *A Review of the Monitoring of Market Power.* CWPE 0504, University of Cambridge, Cambridge Working Papers in Economics.

VDN (2005): *Leistungsbilanz der allgemeinen Stromversorgung in Deutschland zum Zeitpunkt der Jahreshöchstlast 2005.* Berlin, Verband der Netzbetreiber (VDN).

VGE (2005): *Jahrbuch der europäischen Energie- und Rohstoffwirtschaft 2005.* Essen,Verlag Glückauf GmbH.

--- (2006): *Jahrbuch der europäischen Energie- und Rohstoffwirtschaft 2006.* Essen,Verlag Glückauf GmbH.

Wolfram, Catherine (1999): Measuring Duopoly Power in the British Electricity Spot Market. *American Economic Review*, Vol. 89, No.4, S. 805-826.