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ABSTRACT

Many technologies that produce electricity from renewable energy sources are currently not competitive. This is due to the fact that their generation cost is higher than that of conventional thermal power plants. Nevertheless, since using renewable energies has a number of positive effects, these installations have been supported by German public policy for many years. This support is currently demonstrated very successfully by the German Renewable Energy Act (EEG), which provides for fixed feed-in tariffs (FITs). The costs of this support scheme are distributed to the electricity consumers. Due to the so-called EEG levy, electricity costs of industry are increased and as a result their competitiveness is decreased. Consequently, electricity intensive enterprises have protested against the levy on a regular basis and finally achieved a reduction of the levy. However, the potential effect of the EEG on the wholesale price for electricity has not yet been considered. Against this background, we analyze the effect of the EEG on electricity prices in a perfect market. We will show that the support of electricity production from renewable energy decreases the wholesale price of electricity. Consequently, electricity costs of companies that are subject to the reduced EEG levy may decrease too.

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1 INTRODUCTION

The Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG) has proven to be a very successful instrument for increasing the share of renewable energies in the electricity production in Germany. A number of countries have meanwhile adopted similar policies (e.g., Sijm 2002, Meyer 2003). Nevertheless, the EEG is more or less constantly being criticized for a variety of reasons. The main argument is its actual or alleged cost. It is claimed that the EEG will cause an increase of electricity prices and will therefore compromise the competitiveness of German industry (e.g. E&M 2005, Gammelin 2005, VEA 2006). Consequently, the EEG levy has been capped and reduced for energy intensive companies (Bundesrat 2006).

When talking about "the electricity price", one has to clearly define what type of price is referred to. One has to distinguish between

- the wholesale or exchange price,
- the price of bilateral trades, which is mostly based on the exchange price, and finally
- the electricity supply cost (end user price) paid by business and private customers, which consists of the wholesale price and additional components such as taxes and levies.

Furthermore, it is important to distinguish the wholesale prices - which in the end determine the supply costs for customers - from the electricity production costs, i.e., the cost of generating electricity in individual power plants. In the almost completely regulated energy system that dominated until the late 1990ies, there was a simple relation between the two parameters: wholesale prices were more or less set as the average production cost of various power plants plus a moderate profit margin. In today's liberalized electricity markets however, price formation works in a completely different way and is driven by supply and demand (e.g. BMU 2006, p. 21)

In the following, we will describe the fundamental market mechanism. Then we will analyze the influence of electricity from renewable sources on the exchange price and on the supply costs of end users.

2 THE COST OF ELECTRICITY PRODUCTION

The public support for installations that produce electricity from renewable sources via the EEG is justified by the fact that these technologies would not succeed in the market due to their higher production costs. However, society is in favor of an extended use of these technologies due to their benefits, e.g., for the environment and security of supply. [1]

Figure 1 indicates the specific electricity production costs of three typical new power plants in Germany: a coal-fired power plant, a combined gas- and steam-turbine (CCGT) plant and a wind farm. Investment shares of the specific costs are determined with the annuity method.[2] Thus for a new coal-fired power plant with 5000 full-load hours per year, capital costs will contribute some 60% to the total production costs of 40 €/MWh. With an assumed coal price of 6 €/MWh(fuel), fuel costs make up another 31% of the total costs. The share of fixed and variable

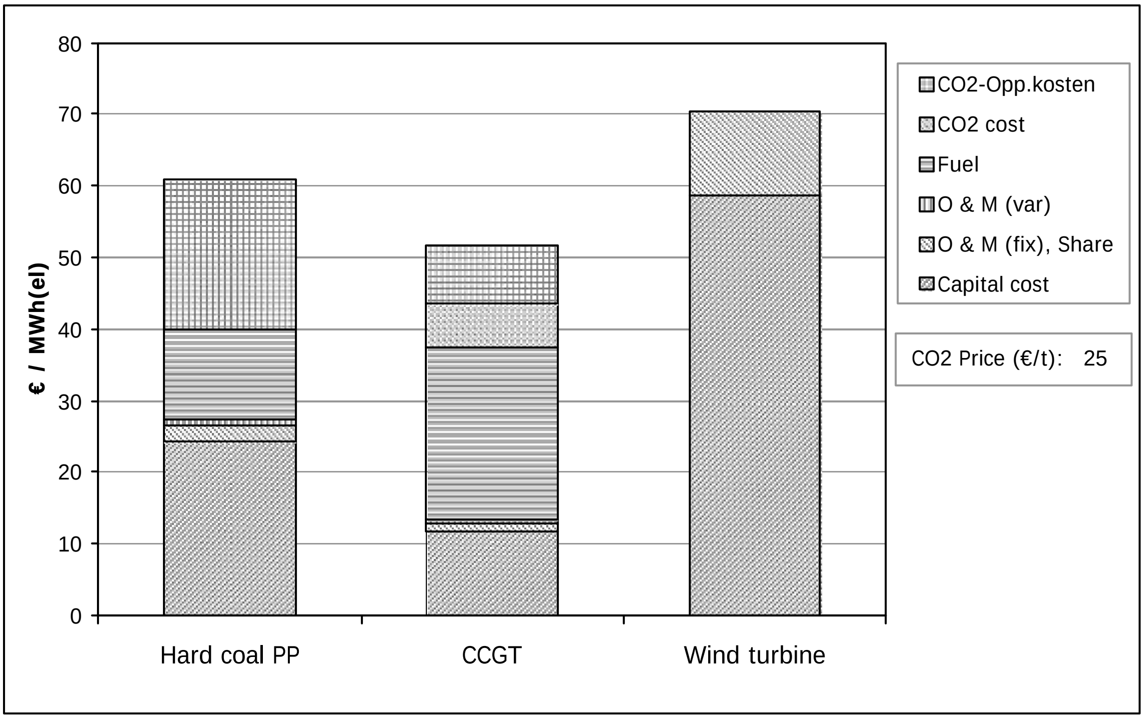

Figure 1: Sample calculation of the electricity production costs of three typical power plants. (Data and source can be found in Table 6 of the appendix).

1 Cf. § 1 of the EEG revision of July 21, 2004.

2 In a profit and loss calculation, there are no extra costs for emission allowances if these are allocated free of charge. If emitters are able to pass their opportunity costs on to their customers they may realize additional revenues (cf. sub-section "The view of operators" below).

operation and maintenance costs is only 8%.

For CCGT plants on the other hand, fuel costs are the dominating factor at a gas price of 14 €/MWh (fuel). They contribute 54% of the total specific costs of 44 €/MWh, while capital costs make up only 27%. The productions costs are increased by another 16% due to the German tax on natural gas.

The specific costs of windfarms (onshore, 2000 full-load hours) of 71 €/MWh are almost completely determined by capital costs (83%), while there are no fuel costs.

3 THE GERMAN RENEWABLE ENERGY ACT (EEG)

Supporting electricity from renewable energy sources has a long tradition in Germany.[3] In 2000, the former Feed-in Law (Stromeinspeisegesetz, StrEG) was substituted by the EEG which was itself updated in 2004. Currently, another minor revision is under way (Bundesrat 2006).

Under the EEG, operators of installations that produce electricity from renewable sources will receive a fixed tariff per unit of electricity produced and will be fed into the public grid over a certain period of time, usually 20 years. The size of the tariff depends on several factors, such as energy source, technology, and capacity of the installation. Figure 2 shows the success of the EEG: the production of electricity from wind energy, biomass, photovoltaics and small hydro plants has increased from 3% to 10% of the total electricity production within 5 years. It is expected to rise up to 20% over the next 5 years.

Simultaneously, total EEG payments have risen from 1 to 4 billion Euros and will continue to rise to almost 9 billion Euros (Figure 3). The average specific EEG payment will increase from 8.5 c€/kWh to 9.9 c€/kWh before it decreases to 9.4 c€/kWh.

[3] For a more detailed overview, please refer to Wüstenhagen et al. 2006.

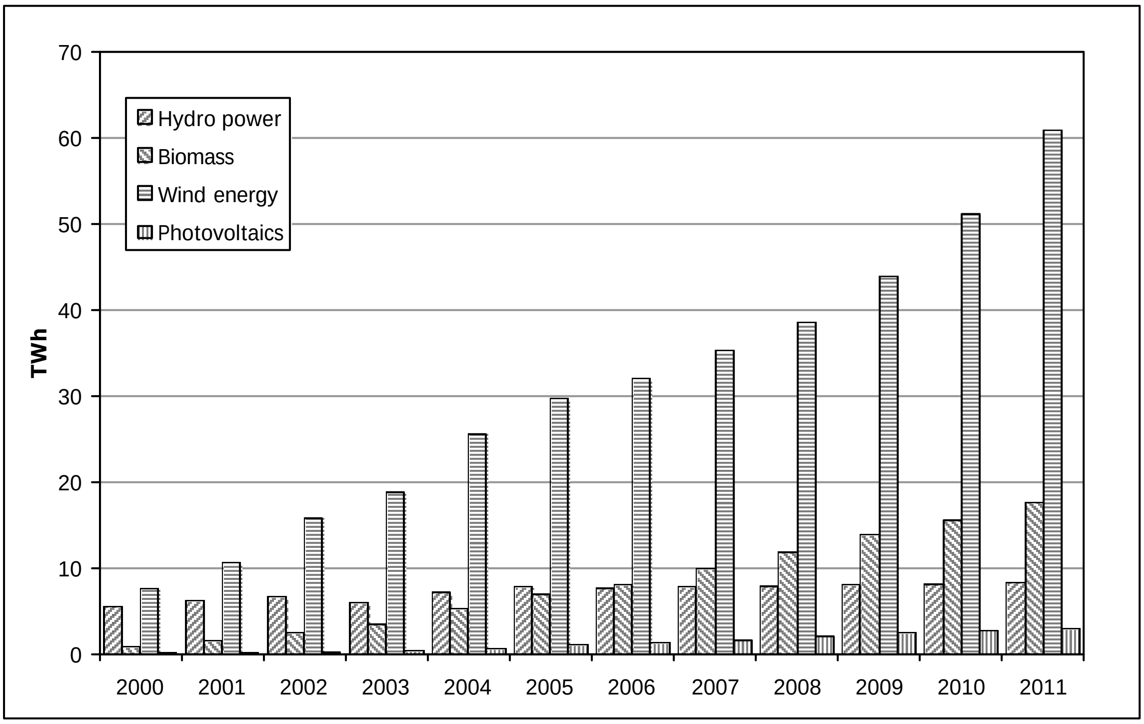

Figure 2: Historical (til 2005) and expected electricity production und the EEG (Source: VDN 2006).

The payments to operators are refinanced by a levy on the final consumption of electricity. This levy is calculated as [4]

$$EEG\ levy = (average\ EEG\ payment - wholesale\ price) * EEG\ quota$$

Unfortunately, there is no standardized method to determine the reference wholesale price in this formula (IfnE 2006; BMU 2006, p. 20+21 & p. 24+25). Thus, the levy may vary for different electricity suppliers. In the justification of the latest EEG revision, the German Ministry of the Environement (BMU) estimated that the levy for private households would increase from 0.35 c€/kWh in 2004 to 0.45 c€/kWh in 2010, and then decrease to 0.20 c€/kWh in 2020 (BMU 2003). However, Vattenfall Europe Hamburg already charges 0.56 c€/kWh in its electricity bills for 2006.

[4] The EEG quota is the ratio of electricity payed for under the EEG and the total electricity consumption.

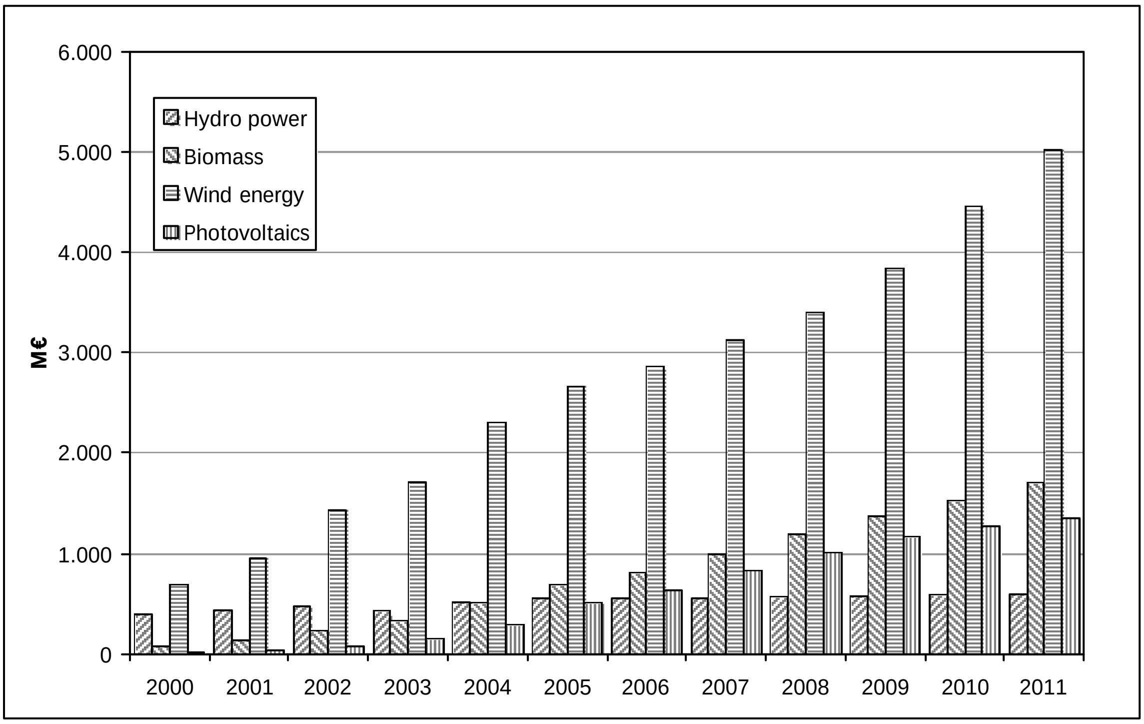

Figure 3: Sum of FITs paid according to the EEG (Source: VDN 2006).

Large electricity consumers may call upon a special hardship clause (§ 16 EEG). In short, it rules that companies with an electricity consumption of more than 10 GWh/a or electricity costs of more than 15% of their gross value added will have to pay the full levy only for the first 10% of their electricity consumption. Beyond that, the levy is reduced to 0.05 c€/kWh. Companies with an electricity consumption of more than 100 GWh/a or where electricity costs exceed 20% of the value added, will pay only 0.05 c€/kWh for their total consumption.

To calculate the net effect of the EEG, it is necessary to not only look at the EEG levy, which increases electricity supply costs, but to also examine the impact of the EEG on the wholesale price of electricity itself.

4 ELECTRICITY COSTS FROM THE CONSUMER'S POINT OF VIEW

Electricity supply costs of end users comprise additional elements like taxes and levies etc. in addition to the wholesale price of electricity. A detailed analysis reveals substantial differences between private and large business customers.

Private customers

The actual energy cost makes up only 20% of the electricity supply costs of a typical German household (Table 1). Taxes and levies such as VAT, eco tax and concession fees contribute the largest share, adding up to 38% of the total electricity bill. The second largest contribution comes from grid access fees, amounting to 36% of the bill (including metering). Only 5% of the electricity costs stem from the support of renewable energies and cogeneration. These figures lead to two conclusions:

- Private households are hardly feeling the support of renewable energies in their budget, compare to other cost elements.
- Changes of the wholesale price effect private customers' costs underproportionately

Table 1: Components of the electricity supply costs of private households in Hamburg, Germany, based on a consumption of 4 000 kWh/a (Source: Vattenfall Europe Hamburg 2006, BWE 2004 or BMU 2006, p. 30).

Cost component	c€ / kWh	Share
Grid access	5.5	32%
Energy (Wholesale price)	3.4	20%
V.A.T.	2.4	14%
Concession fee	2.1	12%
Eco tax	2.1	12%
Metering	0.8	4%
EEG levy	0.6	3%
Cogen levy	0.3	2%
Sum	*17.1*	*100%*

Business customers

The picture changes substantially for an enterprise that needs, e.g., 20 GWh per year (Table 2). First of all, it is reimbursed for VAT. Next, it will fall under the hardship clauses of the EEG and cogen levies. Finally, it draws electricity at a higher voltage level and thus at a lower grid access fee. Altogether, the electricity costs amount to 5.65 c€/kWh, which is roughly a third of what private customers have to pay. In this case, the "electrons" make up some 60% of the electricity bill.

Therefore, changes of the wholesale price will have a larger impact on business customers than on private households. In addition, the former are more sensitive to price hikes due to concerns over their competitiveness.

Table 2: Components of the electricity supply costs of a typical business customer (hardship clause according to § 16 EEG) in Germany, based on a consumption of 20 GWh/a (Source: Vattenfall Europe 2006 and own calculations).

Cost component	**c€ / kWh**	**Share**
Energy (wholesale price)	3.40	60%
Eco tax	1.23	22%
Grid access	0.75	13%
EEG levy	0.11	2%
Concession fee	0.11	2%
Cogen levy	0.05	1%
Sum	*5.65*	*100%*

For the figures stated above, one has to keep in mind that today's electricity supply costs are based on the wholesale prices of a year or more ago. Changes to current wholesale prices will thus only hit customers in the future. Only very large customers have supply contracts which are directly linked to wholesale prices, or trade at the electricity exchange themselve.

5 FORMATION OF WHOLESALE PRICES

As mentioned above, it is important for the assessement of the EEG to not only look at the additional cost in form of the levy for consumers, but to assess possible impacts on the wholesale price for electricity.

The view of operators under perfect competition

Operators of power plants strive to maximize their profits. Under a short-term perspective, they will therefore try to operate their installations whenever the proceeds from electricity sales are higher than the operating costs. In a first order approximation, this is the case if the ratio of the fuel costs and the efficiency of the power plants (i.e., the marginal cost of production) is smaller than the electricity price. Capital costs are not relevant in this respect.

It is often claimed that emissions trading should not have an influence on electricity prices since emissions allowances are allocated free of charge. This view is incorrect. If the power plant is not operated, the allowances, which were received for free, may nevertheless be sold in the CO_2 market. If , on the other hand, the power plant is running, these potential revenues are not realized and have to be considered as opportunity costs. Therefore the operator will only run his installation if he earns the full CO_2 costs in addition to the fuel costs.[5]

Figure 4 shows the consequences of this way of thinking. The varialbe costs of the coal-fired power plant of 34 €/MWh are dominated by CO_2 costs. However, due to the tax on natural gas, CCGT plants are still more expensive - even at this rather high CO_2 price. Their variable costs amount to 39 €/MWh. For a wind farm, there are no variable costs. It should run whenever sufficient wind speeds are available.

5 For a more detailed analysis refer, e.g., to Bode (2006).

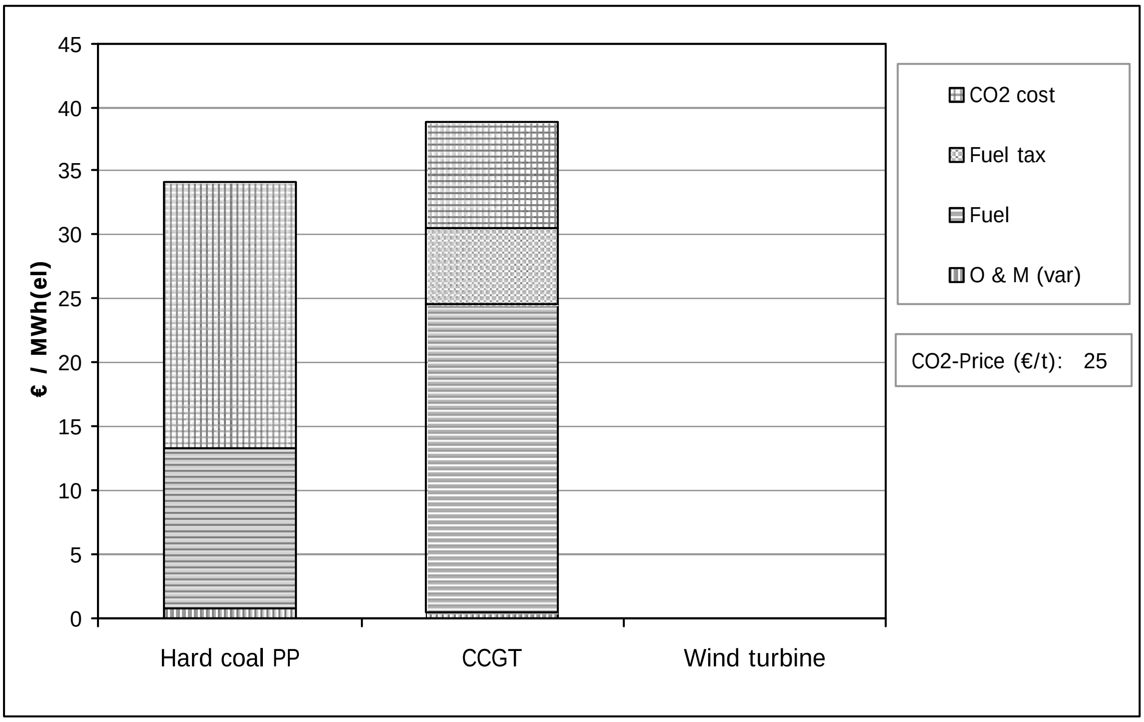

Figure 4: Variable production costs (or marginal costs) of the sample power plants at a CO_2 price of 25 €/t.

Accumulated supply and demand

Since each operator will want to run his own plant as long as possible, there has to be a mechanism that decides which plants are actually producing and what price they will receive.

When describing the price formation at the exchange in the following, we are focussing on the spot market at which electricity for the individual hours of the next day is traded ("day-head trading").[6] This market represents the actual procedure best. In addition, it is assumed that all electricity is traded in a single market.

For each individual hour of the following day, each operator has to submit a bid that comprises a price and the amount of electricity which can be supplied at this price. As described above, each operator will normally bid the maximum power of his plant at its marginal costs. In a first order approximation, we assume these marginal costs to be constant. The exchange will collect all bids and sort them in accending order according to their costs. This will result in the so-called merit order of power plants.

Figure 5 shows such a merit order for a synthetic, but typical set of power plants. On the left-hand side you find the plants with zero or very low marginal costs, such as hydro power, PV and wind energy. To the right are the cogen plants, which draw part of their revenues from selling heat. Then there are nuclear plants, followed by new and old coal-fired plants. On the far right-hand side, we see the gas-fired plants, which have low investment but high marginal costs.

The exchange will reward the individual power plants with supply contracts, starting with the lowest bid, until the predicted demand is satisfied. The bid of the last plant that receives a contract will determine the electricity price, which is then paid for all contracts awarded. Consequently, power plants will not be paid according to their own bid, but according to the bid of the marginal power plant.

Figure 6 shows this mechanism for a situation with high and low electricity demand, respectively. The staircase curve is a condensed version of the bars in Figure 5, where individual power plants are assigned with their capacity. In this example, the demand is rather inelastic, which means that the demand will decrease only slightly when prices increase. This assumption is realistic as most consumers will not reduce their demand on a short term basis.

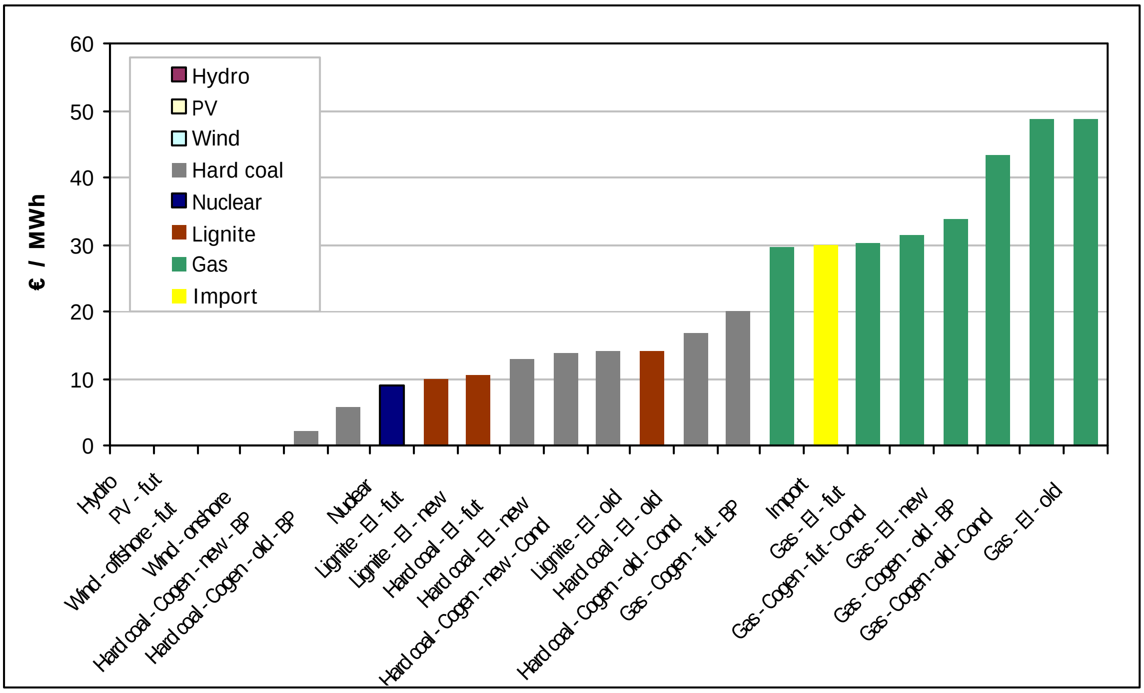

Figure 5: Example for a merit order of power plants

(Source: Own calculation for a synthetic, but typical set of power plants).

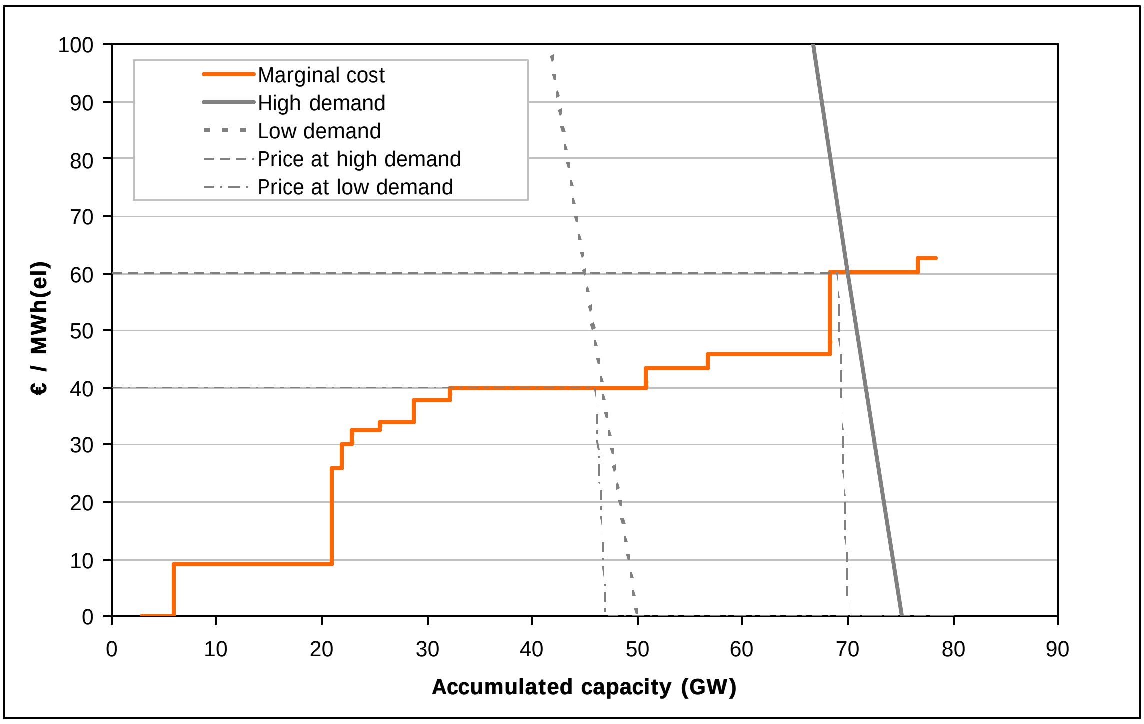

Figure 6: Price formation mechanism at a power exchange (Source: own calculations).

The electricty price is determined by the intersection point of the supply and demand curves. At a high demand, the marginal plant will be a gas-fired power plant and the electricity price will be as high as 60 €/MWh. In times of low demand, the marginal plant will be coal-fired and the price will decrease to 40 €/MWh.

Thusfar we have considered an individual hour. In order to estimate the average price for a whole year, one has to take into account the fluctuations of the demand in detail and integrate these over all the hours of the year. Figure 7 shows typcial load curves, which indicate the demand at different times of day for European countries.

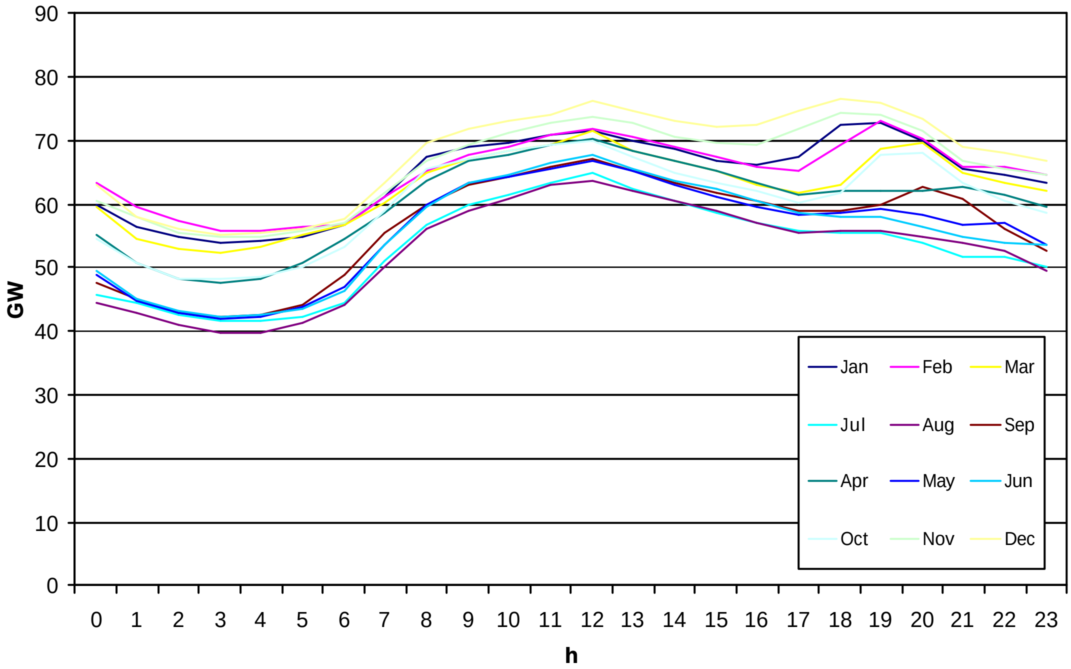

Figure 7: Typical diurnal load curves for the electricity demand in Germany (Source: UCTE 2006).

6 THE IMPACT OF THE EEG ON THE ELECTRICITY PRICE

When discussing the impact of the EEG on the electricity price, one has to distinguish between a direct and an indirect effect.

The direct effect

After having dicussed the formation of electricity prices in general, we can now assess what will happen if more electricity from renewable energies is supplied. We assume that additional electricity from renewable sources is offered compared to the situation in Figure 6. If it stems from wind turbines, their electricity will be offered at the exchange for a price of 0 €/MWh. This additional supply will appear on the far left-hand side of the merit order and will shift the rest of the curve to the right (dashed stair case curve in Figure 8). Thus a new equilibrium is formed in the electricity market. In our example, the price will fall from 60 to 46 €/MWh. The magnitude

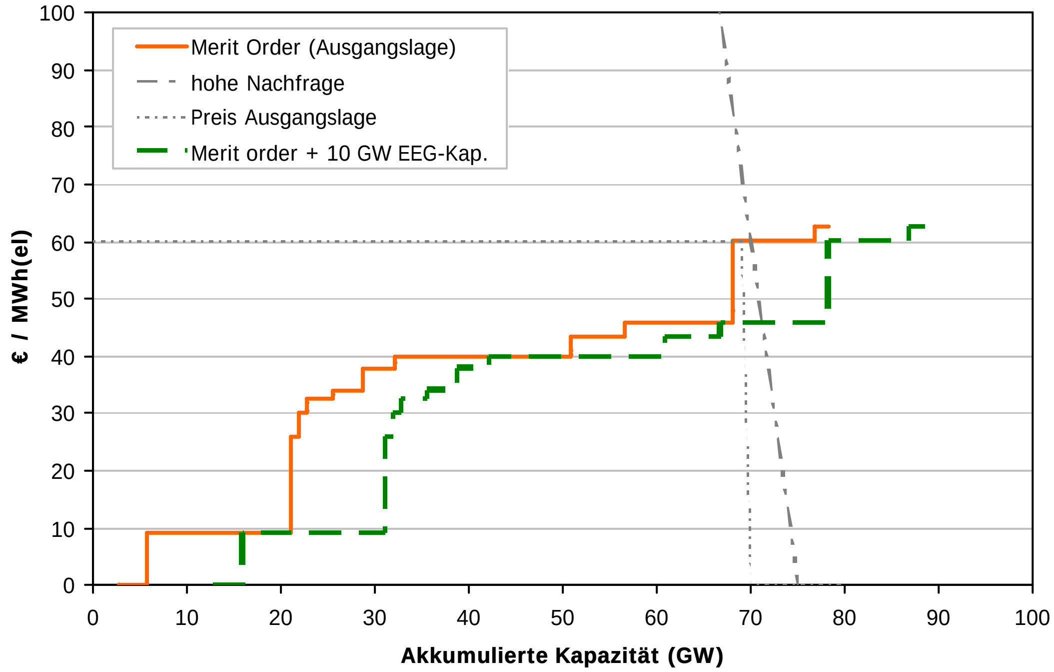

Figure 8: Impact of additional EEG capacity of 10 GW on the merit order (Source: own calcualtions).

of the effect depends on the wind energy supply and the electricity demand.[7] Both will vary considerably over the day and during the year. Thus, to calculate the average effect, it is again necessary to integrate over the load curve and the fluctuations of the wind energy supply.

If the additional electricity is not traded at the exchange, but is used to meet part of the demand ahead of trading, it will shift the curve of the remaining demand in Figure 6 to the left. The effect on the electricity price is identical with the effect of trading the same amount of electricity at the exchange.

Consequently, we may conclude that additional electricity from renewable source will definitely not increase the spot market price for electricity, but may decrease it. Interestingly enough, this effect has not been paid any attention in the political debate so far (cf., e.g., BET 2002, BDI w/out date, BMU 2006). However, for existing wind energy capacity it has been demonstrated empirically (Neubarth et al. 2006). In the next chapter, we will analyze the effect quantitatively using a simple electricity market model.

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[7] Fluctuations of the wind energy supply will shift the dashed merit-order curve to the left or to the right. Fluctuations of the load will move the demand curve to the left or to the right. In both cases, this will result in a new intersection point of both curves, which determines the electricity price. In addition, the elasticity of demand and supply is relevant.

The indirect effect

In addition to the direct price effect, there is a second, indirect effect, which will also lead to a decrease of spot market prices when additional electricity from renewable source enters the market. The latter will substitute electricity from conventional power plants. As long as these are fossil fuel fired plants, this will decrease the CO_2 emissions of electricity production. Assessments of the volume of this reduction vary due to the method of calculation (BMU 2004, p. 15). But the CO_2 reduction included by the EEG need no longer be realized by other measures and will therefore reduce the price of emission allowances in the CO_2 market (Rathmann 2006). Since CO_2 prices have a significant impact on electricity prices, we have here a second way in which electricty from renewable sources reduces spot prices. A quantitative estimate of this effect is difficult. Firstly, the share of CO_2 reductions by the EEG depends on the total reduction in the EU emissions trading system. Secondly, the CO_2 price is currently dominated by political and psychological effects, which makes it hard to identify the influence of an individual effect.

7 MODELLING THE EFFECT OF THE EEG

In the previous chapters we have looked at the impact of the EEG on the electricity price more generally. This part of the paper analyses a synthetic electricity market where different amounts of electricity from renewable energies are supplied. It should be noted that the price formation on real markets is more complicated than is assumed here.[8]

Model description

On the supply side, 199 conventional power plants are at disposal. The supply from numerous local renewable energy facilities is aggregated to one virtual power plant. Thus, 200 power plants offer electricity on the market.

An overview of the conventional power plants can be found in Table 3. The cumulative capacity of these power plants is about 76.2 GW. Contrary to the schematic illustration in the figures shown above, the marginal costs of the power plants (more precisely, their technical efficiencies) vary. The supply curve no longer has a stepwise characteristic, but a continuous run. Concerning renewable energies, different sizes of installed plants as well as different effective capacities are assumed. The latter are chose at random.

Table 3: Overview of thermal plants used in the model

Type	Number	Max. capacity (MW)	Efficiency (%)	Average marginal costs (EUR/MWh)
Nuclear	20	600	35.1	20,0
Lignite	50	550	36.3	27,8
Coal	71	400	41.2	44,6
Gas	58	150	45.1	52,7

Demand in the reference scenario, i. e., the situation with no production under the EEG, is based on UCTE (2002). Detailed values can be found in the annex. Total annual demand in the reference scenario amounts to 500 TWh. Based on the demand curve and the supply curve in the reference scenario the price for each of the 24 hours of a day can be determined (cf. Figure 9). If one single representative load curve for all the days in a month is assumed, this results in a total

8 As mentioned above, contracts are not only closed on the spot market but also on the forward markets. Furthermore, price changes are induced by external effects like e.g. capacity deficiencies caused by a lacking amount of cooling water in warm periods. Finally, a perfect market is assumed, which presumably does exist in Germany today.

of 288 (24 hours times 12 months) values per year for each equilibrium price. Through multiplication of the results for one day in one month with the number of days in this month, it is possible to project specific values like, e.g., the production in a whole year.[9] Besides the data for the supply side, it is necessary to also make assumptions about demand. To simplify matters, linear demand curves are assumed.

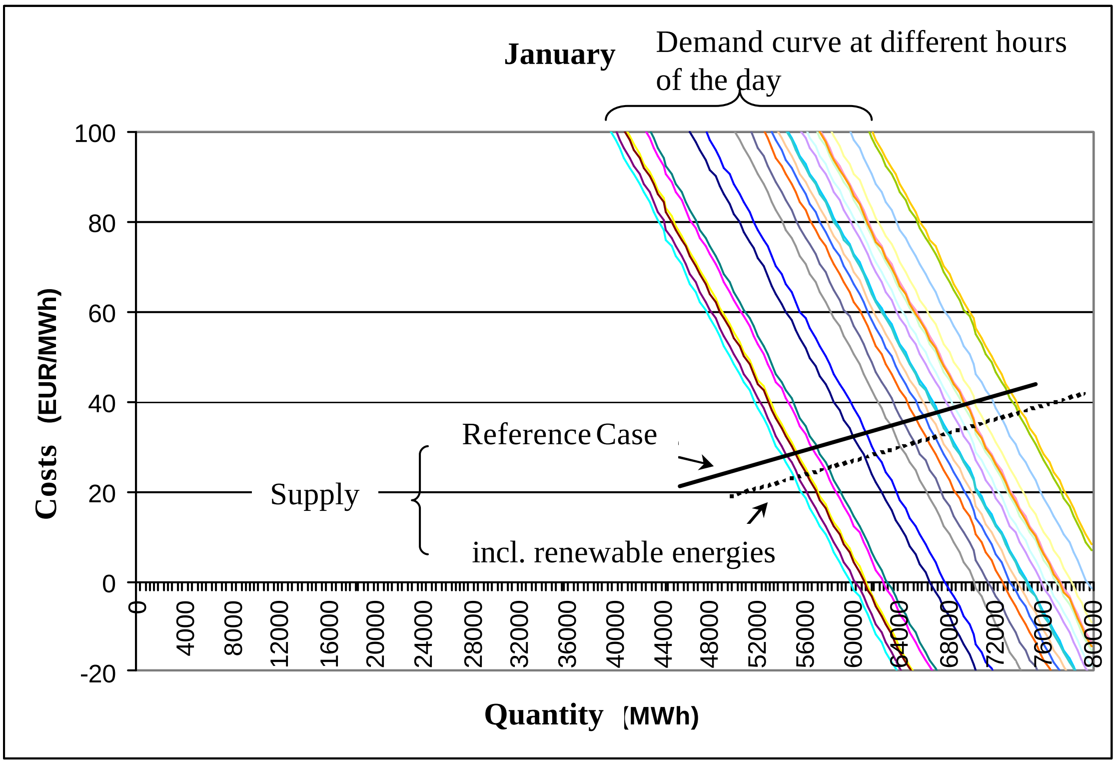

Figure 9: Schematic representation of supply and demand curves for the numerical analysis.

9 In this respect, the fact that the demand varies according to the days (e.g. working days and holidays) is neglected.

Results

As mentioned, the EEG induced increase of electricity generation from renewable energies leads to a reduction of electricity prices on the spot market. In contrast, however, the EEG levy leads to an increase in end user costs. The net effect of these two single effects depends on the assumptions made in the model as well as the exact design of the levy.

Table 4 and Table 5 show the effect of the current EEG design (Bundesrat 2006) on the wholesale price as well as the electricity costs for companies that consume more than 100 GWh per year and that have electricity costs higher than 20 % of the gross value added. Two different elasticities of demand are studied. As mentioned, these companies pay a reduced EEG-levy of 0.05c/kWh.[10]

Apparently, a rising electricity production from renewable energies leads to falling wholesale electricity prices. To give an example: With a rather elastic demand and an installed renewable capacity of 20 000 MW, annual RE electricity production increases from 0 to 36 714 GWh. At the same time, the price decreases from 45.3 Euro/MWh by 2.4 Euro to 42.9 Euro/MWh (cf. Table 4). Adding the reduced EEG-levy for electricity intensive companies (0.5 Euro/MWh) to the decreased whole sale price results in end user costs of 43.4 Euro/MWh. Despite the EEG-levy, these costs are still 1.9 Euro/MWh or 4.2% lower than the wholesale price in the reference scenario without renewable energies.With a rough estimate one can see that the whole sale power price decrease by about 0.55 Euro/MWh per additional effective 1000 MW RE capacity. [11]

As can also be seen, the price reduction increases with rather inelastic demand (cf. Table 5). In this case, a simple estimation results in a price reduction by about 0.61 Euro/MWh per additional 1000 MW effective capacity of renewable energy installations. Correspondingly, CO_2 reductions increase as more power from thermal plants is crowded out of the market.[12]

[10] Companies with electricity consumption higher than 10 and lower than 100 GWh per year and electricity share of 15 % of the gross value added, face an average EEG-levy which is higher than the 0.05c/kWh.

[11] The decrease is smaller that the one provided by Neubarth et al. 2006, who calculate a decrease by 1.90 Euro/MWh per additional 1000 MW effective capacity.

[12] This would have to be considered in an analysis of the impacts of the support scheme on the market for CO_2 allowances.

The effect of additional costs for balancing energy that is required with higher market penetration of renewable energies[13], or the indirect effects due to the CO_2 reduction have not been considered in this analysis.

With elastic demand, the reduced power price also leads to higher consumption. With regard to the meeting of a certain target for renewables, e.g. a market share of 20%, the higher demand implies that absolut RE capacity must also increase compared to situations with complete inelastic demand.

[13] For more details see Nitsch et al. (2005).

Table 4: Effects of the EEG on whole prices and end user costs [*)] for consumers with a reduced EEG-levy according to § 16 EEG („hardship cases”, i.e. consumption > 100GWh, levy: 0.05 c/kWh); demand rather ***elastic****; price for* CO_2 *allowances: 0 Euro/t).*

Installed capacity under the EEG (MW)	Total el. annual production (GWh)	Annual el. production under the EEG (GWh)	Effective capacity of EEG (MW)	Average price, spot market (€/MWh)	Price change[**)] (€/MWh)	Price +EEG-levey (hardship cases) (€/MWh)	Price change (%)[**)]	Share of EEG production (%)	Emissions (Mio. t CO_2)
0	500,000	0	0	45.3	0.00	45.8	1.1	0.0	377
2,000	500,460	3,671	419	45.1	-0.26	45.6	0.5	0.7	374
4,000	500,898	7,343	838	44.8	-0.51	45.3	0.0	1.5	372
6,000	501,316	11,014	1,257	44.6	-0.75	45.1	-0.6	2.2	369
8,000	501,742	14,686	1,676	44.3	-0.99	44.8	-1.1	2.9	367
10,000	502,165	18,357	2,096	44.1	-1.24	44.6	-1.6	3.7	364
12,000	502,558	22,028	2,515	43.9	-1.46	44.4	-2.1	4.4	362
14,000	502,992	25,700	2,934	43.6	-1.71	44.1	-2.7	5.1	359
16,000	503,397	29,371	3,353	43.4	-1.94	43.9	-3.2	5.8	357
18,000	503,816	33,042	3,772	43.2	-2.18	43.7	-3.7	6.6	354
20,000	504,212	36,714	4,191	42.9	-2.40	43.4	-4.2	7.3	351
22,000	504,603	40,385	4,610	42.7	-2.63	43.2	-4.7	8.0	349
24,000	505,010	44,057	5,029	42.5	-2.86	43.0	-5.2	8.7	346
26,000	505,421	47,728	5,448	42.2	-3.09	42.7	-5.7	9.4	344
28,000	505,822	51,399	5,867	42.0	-3.32	42.5	-6.2	10.2	341
30,000	506,210	55,071	6,287	41.8	-3.54	42.3	-6.7	10.9	338
32,000	506,600	58,742	6,706	41.6	-3.77	42.1	-7.2	11.6	336
34,000	506,989	62,413	7,125	41.3	-3.99	41.8	-7.7	12.3	333
36,000	507,381	66,085	7,544	41.1	-4.21	41.6	-8.2	13.0	330
38,000	507,759	69,756	7,963	40.9	-4.43	41.4	-8.7	13.7	328
40,000	508,199	73,428	8,382	40.7	-4.68	41.2	-9.2	14.4	325

[*)] Only energy costs; eco tax, grid access, concession fee, cogen levy etc. are not considered.

[**)] Compared to reference szenario with EEG production = 0 GWh

Table 5: Effects of the EEG on whole prices and end user costs [*)] for consumers with a reduced EEG-levy according to § 16 EEG („hardship cases", i.e. consumption > 100GWh, levy: 0.05 c/kWh); demand rather **inelastic**; price for CO_2 allowances: 0 Euro/t).

Installed capacity under the EEG (MW)	**Total el. annual production (GWh)**	**Annual el. production under the EEG (GWh)**	**Effective capacity of EEG (MW)**	**Average price, spot market (€/MWh)**	**Price change[**)] (€/MWh)**	**Price +EEG-levey (hardship cases) (€/MWh)**	**Price change (%)[**)]**	**Share of EEG production (%)**	**Emissions (Mio. t CO_2)**
0	500,000	0	0	45.3	0.00	45.8	1.1	0.0	377
2,000	500,049	3,671	419	45.1	-0.28	45.6	0.5	0.7	374
4,000	500,098	7,343	838	44.8	-0.56	45.3	-0.1	1.5	371
6,000	500,144	11,014	1,257	44.5	-0.82	45.0	-0.7	2.2	368
8,000	500,190	14,686	1,676	44.3	-1.08	44.8	-1.3	2.9	366
10,000	500,236	18,357	2,096	44.0	-1.35	44.5	-1.9	3.7	363
12,000	500,285	22,028	2,515	43.7	-1.62	44.2	-2.5	4.4	360
14,000	500,329	25,700	2,934	43.5	-1.88	44.0	-3.0	5.1	357
16,000	500,376	29,371	3,353	43.2	-2.14	43.7	-3.6	5.9	354
18,000	500,419	33,042	3,772	42.9	-2.39	43.4	-4.2	6.6	351
20,000	500,463	36,714	4,191	42.7	-2.64	43.2	-4.7	7.3	348
22,000	500,509	40,385	4,610	42.4	-2.90	42.9	-5.3	8.1	346
24,000	500,552	44,057	5,029	42.2	-3.15	42.7	-5.8	8.8	343
26,000	500,598	47,728	5,448	41.9	-3.41	42.4	-6.4	9.5	340
28,000	500,642	51,399	5,867	41.7	-3.66	42.2	-7.0	10.3	337
30,000	500,684	55,071	6,287	41.4	-3.91	41.9	-7.5	11.0	334
32,000	500,726	58,742	6,706	41.2	-4.15	41.7	-8.0	11.7	331
34,000	500,768	62,413	7,125	41.0	-4.38	41.5	-8.6	12.5	328
36,000	500,818	66,085	7,544	40.7	-4.67	41.2	-9.2	13.2	325
38,000	500,858	69,756	7,963	40.4	-4.90	40.9	-9.7	13.9	322
40,000	500,900	73,428	8,382	40.2	-5.14	40.7	-10.2	14.7	319

[*)] Only energy costs; eco tax, grid access, concession fee, cogen levy etc. are not considered.

[**)] Compared to reference szenario with EEG production = 0 GWh

8 SUMMARY

Electricity production from renewable source is in most cases in Germany still more expensive that in conventional power plants. Therefore, it is supported via the Renewable Energy Act (EEG). The feed-in tariff paid to operators is financed by the so-called EEG levy. The levy increase the electricity supply costs of energy intensive industry and compromises its competitiveness. Therefore, this industry has intervened against the EEG and the respective levy on the political level on a regular basis. Currently, there is a hardship clause (§ 16 EEG), which reduces the levy for electricity intensive enterprises, depending on their acutal consumption.

In this debate, the impact of the EEG on the wholesale price for electricity, which is one component of the total supply costs, has so far not been considered. We have shown that this price may be decreased by the EEG in a perfect market. We argue that the low marginal costs of renewable energy installations, which are support by the EEG, will shift the supply curve (merit order) in such a way, that conventional power plants will be driven out of the market. Consequently, there will be a decrease of the spot markt price. The magnitude of the price effect depends on a number of assumptions. A first estimate yields a decrease of the whole sale price by 0.50 to 0.60 €/MWh per 1 000 MW of additional effective capacity based on renewable sources. Since the EEG levy is capped for energy intensive enterprise, the described effect may in total lead to a reduction of the electricity supply costs of these businesses. Additional costs of expanding the use of renewable sources such as grid reenformement and balance power as well as indirect price reduction due to the decreased CO_2 price are not included in this estimate.

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APPENDIX

Table 6: Sample calculation of the electricity production costs of three typcial power plants (Based upon: EEX 2006, IEA 2005; Pfaffenberger et al. 2004; UBS 2003, own estimates).

			Coal	**Gas (CCGT)**	**Wind**
Interest rate	1/a	10%			
CO_2 price	€/t	25			
Capacity	MW(el)		850	500	500
Investment cost	€/W		1.1	0.5	1.0
Investment cost (total)	M€		*935*	*250*	*500*
Economic life time	a		25	20	20
Full load hours	h/a		5000	5000	2000
Power production	TWh/a		*4.3*	*2.5*	*1.0*
Efficiency			48%	58%	100%
Fuel input	MWh(f)/a		*8.9*	*4.3*	0
Specific. CO_2emissions	t/MWh(f)		0.40	0.19	0
CO_2 emissions (total)	Mt/a		*3.5*	*0.8*	0
	t/MWh(el)		*0.8*	*0.3*	0
Fuel price	€/MWh(f)		6	14	0
Capital costs	€/MWh		*24.2*	*11.7*	*58.7*
O & M (fix)			*10%*	*10%*	*20%*
	€/MWh		*2.4*	*1.2*	*11.7*
O & M (variable)	€/MWh		0.8	0.4	0.0
Fuel costs	€/MWh		*12.5*	*24.1*	*0.0*
Fuel tax	€/MWh		0.0	6.0	0.0
CO_2 costs	€/MWh		*20.8*	*8.2*	*0.0*
Without CO_2 costs					
Production costs	***€/MWh***		***40***	***44***	***71***
Average var. costs (= marginal costs)	***€/MWh***		***13***	***31***	***0***
With CO_2 costs					
Production costs	***€/MWh***		***61***	***52***	***71***
Average var. costs (= marginal costs)	***€/MWh***		***34***	***39***	***0***

Table 7: Electricity demand (load) for the numerical analysis in MW (Source: UCTE 2002).

Hour	January	February	March	April	May	June	July	August	September	October	November	December
0	57109	60433	56705	43620	42435	45412	52612	46696	47023	51980	57708	60036
1	53726	56636	51998	42256	40817	42928	48327	42703	43055	48280	55344	55215
2	52386	54552	50571	40552	39081	40969	45957	40846	41143	46083	52934	53532
3	51208	53017	49889	39678	37721	40374	45441	39948	40261	45822	52305	52509
4	51563	53198	50711	39544	37778	40414	46056	40285	40415	46214	52209	52855
5	52207	53796	52391	40340	39446	42200	48280	41847	41538	47721	53211	53560
6	54035	53892	54153	42352	42035	46441	51962	44725	44087	50707	54195	54754
7	58230	58236	57210	48674	47830	52877	55877	51008	50938	56100	58938	60275
8	64285	62029	61694	53972	53533	57055	60766	57044	56772	62292	63663	66413
9	65678	64558	64039	57114	56220	59997	63513	60228	60207	64005	66099	68493
10	66370	65716	64937	58668	57970	61338	64530	61079	61466	64934	67869	69638
11	67396	67426	66114	60182	60020	62795	66084	62357	63375	66054	69203	70666
12	68173	68322	68234	61854	60595	63960	66869	63589	64532	66524	70079	72645
13	66675	67077	65179	59304	59226	62277	65175	62175	62421	64178	69178	71071
14	65279	65569	63629	57669	57476	60353	63518	60005	60724	61779	67329	69647
15	63567	64124	62133	55980	56090	58866	62190	58216	59503	60165	66341	68818
16	63083	62738	60134	54264	54342	57471	60311	56887	57559	59029	65982	68963
17	64159	62180	58800	53034	52942	56014	58642	55465	55890	57240	68379	71073
18	69034	65863	60139	52849	52967	56110	59100	55709	55199	58821	70905	72924
19	69254	69751	65508	52848	53021	57163	59003	56349	55277	64470	70368	72411
20	66556	66853	66262	51309	52389	59772	59013	55477	53759	64736	68230	69992
21	62440	62745	61936	49316	51477	57790	59665	53925	52272	60335	63669	65788
22	61428	62634	60263	49238	50040	53526	58550	54201	51352	57694	62386	64658
23	60376	61656	59230	47658	47067	50038	56794	51028	50954	55766	61395	63544