VALUATION OF ELECTRICITY MARKET REVENUES OF FLUCTUATING RENEWABLE ENERGY SOURCES

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INTRODUCTION

Various price indices are available for assessing electricity market revenues: baseload, peakload, market value and sales value developed by Energy Brainpool. However not all price indices are equally suitable to evaluate the revenue of fluctuating renewable energies like solar or wind during the time after financial payments through e.g. the renewable energy act (EEG) have ended.

In the following the existing price indices are assessed with regard to their adequacy in the assessment of the revenue potential.

DEFINITION OF TERMS

**Baseload**: is the average non-weighted price for electricity in the day-ahead market from Monday to Sunday, 0 to 24h. Thus it is the average price of all hours in a defined period of time.

**Peakload**: is the average non-weighted price for electricity in the day-ahead market from Monday to Friday, 8 to 20h.

**Market Value**: is the average weighted price of a technology in the spot market at all hours during which the corresponding technology is fed in. Negative prices are taken into account.

**Sales Value**: is the average weighted price a technology (solar or wind) can achieve in the spot market at all hours during which the corresponding technology can be fed in. Only positive prices are taken into account though. However sales value is only meaningful in combination with the marketable quantities which can be marketed at a positive market price. The share of year production, which cannot be marketed due to prices less than 0 EUR/MWh, is not taken into account when determining the sales value.

The monthly market value provides the basis for the calculation of the market premium as part of the marketing of renewable energies in subsidized direct marketing under EEG\(^1\). Using the example of direct marketing, the average value of a wind or solar power plant is indicated by the market value.

\[ \sum \text{value of single-hour contract} \times \text{marketed volume of wind energy} \]

\[ \text{total volumes of wind energy} \]

\(^1\) (Compare appendix 1 Nr. 2 EEG 2017 and appendix 1 Nr. 2 EEG 2014).
Equation 2: Calculation of sales value

\[
\sum_{\text{if } \text{EPXE-price} \geq 0} \frac{\text{EPXE-price} (t) \times \text{Feed of wind or solar}}{\text{Sales volume of wind or solar}}
\]

Sales volume: describes the amount of electricity of one technology (solar or wind) which can be marketed at prices higher than or equal to 0 EUR/MWh.

Equation 3: Calculation of sales volume

\[
\sum_{\text{if } \text{EPXE-price} \geq 0} \text{marketed volume of wind or solar} (t)
\]

To use the sales volume for individual assumptions of annual production, the sales volume is given relative to total annual production. This quotient can be multiplied by the individual assumptions regarding the expected annual production. This means that the average sales volume can be calculated for each renewable energy installation or for different portfolios.

Sales Revenue: describes the revenue that a technology (wind or solar) can receive at the electricity market (energy only market) without additional payment. The value refers to country specific average full load hours as well as sales values and sales volumes.

REVENUE CALCULATION USING THE EXAMPLE OF A WIND POWER PLANT

In the following Energy Brainpool’s approach to calculate the revenues of not subsidized fluctuating renewable power installations, using the example of a wind energy installation, is described.

Details of the example wind power plant:

- Installed capacity: 3 MW
- Expected full load hours: 2,000 h/a
- Expected generation: 6,000 MWh

Annual average for Germany, modeled by Energy Brainpool:

- Full load hours: 1,964 h/a
- Sales volume relative to total generation: 80 %
- Sales value: 70 EUR/MWh

Revenue estimation based on installation specific full load hours

Full load hours x installed capacity x (sales volume / total generation) x sales value

- \(2,000 \text{h/a} \times 3 \text{MW} \times 80 \% \times 70 \text{EUR/MWh} = 336,000 \text{EUR/a}\)
At 2,000 full load hours the wind power installation given here has more than the above modeled average full-load hours in Germany of 1,964 h/a, leading to negligible deviations. For an exact number an hourly revenue calculation based on the feed-in profile and spot market prices can be realized on demand.

**ASSESSMENT OF THE PRICE INDICATORS WITH REGARD TO THEIR SUITABILITY TO EVALUATE REVENUES**

Current annual price indices such as peakload or baseload indicate the potential revenue of fluctuating renewable energies not sufficient as they are weather-dependent and do not feed in continuously throughout the entire assessment period. Furthermore, times of negative prices will increase during baseload and peakload times which will lead to greater uncertainty in the assessment of revenue.

Market value is the average weighted price of a technology in the electricity market at all hours during which the corresponding technology is fed in. For the assessment of revenues in periods without additional payments (e.g. EEG remuneration), the market value is not appropriate since negatively priced hours during which the technology feeds in, are taken into account as well. However if these losses are not balanced through market premium under EEG they can only be avoided by switching off the power plants.

For a realistic calculation of the potential profit of renewable energies on the electricity market Energy Brainpool has established the sales revenue. The underlying sales value takes into account that plants are switched off in times of negative prices to avoid losses (cf. Figure 1, shaded area). Sales value is the average weighted price a technology (solar or wind) can achieve in the spot market in all hours during which the price is higher than or equal to 0 EUR/MWh. However it is only significant in combination with the sales volume since, due to the shutdown in times of negative prices, not all kWh of the annual production are marketed.

![Figure 1: Example of a typical feed-in behaviour of subsidised and non-subsidised fluctuating renewable energies](image)
Table 1 shows the differences between market value and sales value: Market value is below sales value as negative prices are also included. On the other hand the market volume is higher than the sales volume as it is assumed that installations also feed in times of negative prices. However the total sales revenue is higher despite a smaller sales volume.

<table>
<thead>
<tr>
<th>Table 1: Comparison of market and sales value</th>
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<tbody>
<tr>
<td>Price</td>
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<tr>
<td>Market value</td>
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<tr>
<td>Sales value</td>
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**CONCLUSION**

For a realistic assessment of the revenue potentials in periods without additional payments such as EEG remuneration the sales value in combination with the sales volume should be chosen. This characteristic is reflected in the sales revenue. On the one hand it takes into account that fluctuation renewable energies do not feed in continuously due to their weather-dependency and on the other hand that operators of power plants switch off in times of negative prices.

**ABOUT ENERGY BRAINPOOL**

Energy Brainpool GmbH & Co. KG offers independent energy market expertise with a focus on market design, price development and trade in Germany and Europe. In 2003, Tobias Federico founded the company with one of the first spot price forecasts on the market. Today, the offer includes fundamental modeling of the electricity prices with the software Power2Sim as well as diverse analyzes, forecasts and scientific studies. Energy Brainpool advises on strategic and operational issues and offers expert training since 2008. The company combines knowledge and competence in business models, digitalization, trading, procurement and risk management with long-term practical experience in the area of steerable and fluctuating energies.

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