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Procedia CIRP 26 (2015) 235 – 240

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12th Global Conference on Sustainable Manufacturing

Energy Flexible Production: Saving Electricity Expenditures by Adjusting the Production Plan

T. Rackow[a]*, J. Kohl[a], A. Canzaniello[a], P. Schuderer[b], J. Franke[a]

[a]*Institute for Factory Automation and Production Systems, University of Erlangen-Nürnberg (FAU), Egerlandstraße 7-9, 91058 Erlangen, Germany*
[b]*Technische Hochschule Ingolstadt (THI), Esplanade 10, 85049 Ingolstadt, Germany*

* Corresponding author. Tel.: +49-9131-85-27176; fax: +49-9131-302528. *E-mail address:* tobias.rackow@faps.uni-erlangen.de

Abstract

The energy turnaround in Germany increases the share of renewable energies. Since the amount of renewable energy supply is immanently subject of variation, the electricity price at the European Energy Exchange EEX is highly volatile. If companies would purchase the electricity directly at the EEX instead of from a wholesale power supplier along with price fixing, companies would benefit from increasing production in times with low electricity costs and reducing production in high-cost times. This paper shows, that influencing respectively shifting the time of electricity consumption –e.g. by adjustment of process parameter, shift period, order of jobs or machine utilization, by pausing of processes or delaying of job starts – can theoretically reduce electricity expenditures. The measures are being explained and discussed, followed by a description of company in-house and external requirements for the energy flexible production.

Peer-review under responsibility of Assembly Technology and Factory Management/Technische Universität Berlin.
Keywords: Factory control; energy flexibility; flexible production; energy management; energy expenditures

1. Companies‘ electricity expenditures are rising

The German pioneering role in renewable energies, initiated by the nuclear phase out, leads to new challenges in terms of energy policy, which both politics and companies have to face. Especially from an economical perspective, the topic „electricity” plays a more and more important role for the industrial location Germany. In 2012, German industrial customers paid 15 % more per kilowatt hour (kWh) compared to the European average. Furthermore, the share of energy costs per gross value added in Germany went in recent years 1.5 % up to an average share of 5.7 % in the industrial sector. [1]

With the liberalization of the European electricity markets, new possibilities of electricity procurement for companies were developed. A participation, which is overall cost efficient, requires a flexibilization of the production, since the electricity market is highly volatile due to the growing solar- and wind power feed-in along with distinct pricing mechanisms.

The approach of an energy flexible fabric, which entails an efficient alignment of the production to the electricity price, could help to counteract the site-specific competitive disadvantage of heightened electricity costs and will be discussed in the following.

2. Generating and trading electricity

While the conventional power generation is in general independent from external factors and the demand can be met with increased resource input subsequently, the feed-in of renewable energies (especially from photovoltaic and wind power facilities) is immanently subject of constant variation.

2.1. Renewable energy share of Germany’s power mix

The strategic reorientation along with specific subsidization has led to a continuously rising renewable energy share of electricity generation in Germany since 1992. With taking

Peer-review under responsibility of Assembly Technology and Factory Management/Technische Universität Berlin.
doi:10.1016/j.procir.2014.07.179

effect of the Renewable Energies Act (EEG) in 2000, the expansion of wind-, biomass- and photovoltaic power facilities could be increased constantly, leading to a 23 % share of renewable energy feed-in (along with hydropower) in 2012. Due to the enacted nuclear phase out in June 2011, the changeover to renewable energies was accelerated further. Additional measures like enhanced government aid for offshore wind farms aim to ensure, that the incremental shut down of German nuclear power plants is compensated by renewable energies. Beyond that, the Federal Government's long term plan intends to increase the share of installed capacities for the power generation from renewable energies up to 60 % in 2023 and even 72% in 2050 (figure 1). [1,2,3]

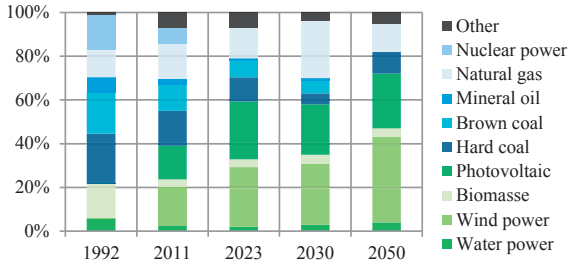

Fig. 1 Trend of the German power mix: installed power plant capacity [1,2,3]

2.2. Electricity price formation

Since the liberalization of the electricity market, the formation of electricity prices follows market-based principles of supply and demand. At the established merit-order-principle, the capacities of the various power generation components are prioritized by their incremental costs in order to determine the most economic composition of power plants for any capacity demand. The intersection point of the demand curve with the continuous incremental cost curve defines the derived electricity price subsequently, which every power plant receives for their produced electricity.

As described by Groscurth [4] and Borgmann [5], Power generation from renewable energies have the lowest incremental costs, which are even close to zero for photovoltaic and wind power. Increasing feed-in from renewable energies leads to a shifting supply curve, resulting in a lower electricity price – and vice versa.

2.3. Correlation of renewable energy feed-in and el. price

Figure 2 exemplifies, that this principle also finds itself in the real pricing mechanism of electricity.

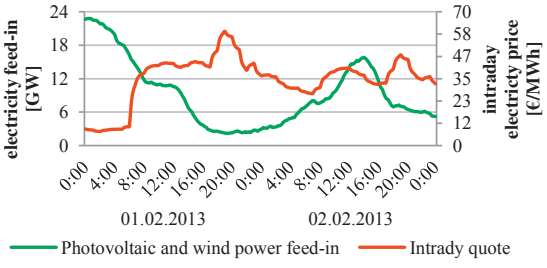

Fig. 2 Electricity feed and intraday electricity price quote (source EEX)

In times of high photovoltaic and wind power feed-in, the electricity price per megawatt hour (MWh) is on a comparatively low level. The spot-market reaches the highest market value of almost 60 €/MWh in a time slot of very low feed-in, albeit other influencing factors like demand structure or a disorder of power plants play a role as well.

2.4. Trading at the European energy exchange EEX

Panos [6] explains, that the trading activities at the electricity exchange EEX can be basically divided into spot-markets (short-term transactions for base-, peak- and hourly products; segmented in day-ahead auction-markets and intra-day-trading) and future-markets (space between completion of a contract and its fulfillment has to be at least one week for option-, future and forward products). The derived stock prices fluctuate considerably within a day as well as over the course of a month (figure 3). In October 2013, the electricity price development for day-base and day-peak products show high standard deviations with yields of over 35 % in a deviation interval between 11,89 €/MWh and 64,91 €/MWh.

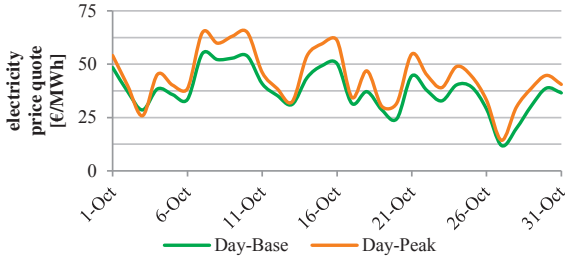

Fig. 3 EEX electricity prices in October 2013 (source EEX)

3. Electricity procurement of industrial customers

According to Oschmann et al. [7], the choice of a procurement strategy depends, among other things, on the height of the annual electricity consumption. Decision criteria are price-, supply- and quantity risks, which endanger a successful trading.

3.1. Full power supply and index oriented procurement

From the current consumer perspective, there is a low quantity- and price risk along with minor personnel- and time effort for both the common full power supply – at which a fixed electricity price, stipulated on an effective date for a defined amount and a determined duration – and the index oriented procurement – at which the whole electricity demand (segmented in tranches) is purchased in fixed intervals at a predefined base-/peak load ratio. However, the consumer is not only dependent on the contracting partner, there is also no option to react actively on changing electricity prices.

3.2. Tranche procurement

At the tranche procurement strategy, the electricity demand is also segmented in periods which are purchased in different points of time, leading to a volume weighted mean