POWER TO HEAT AS A COMPONENT OF GERMAN ENERGY TRANSFORMATION

Prof. Dr. Dieter Oesterwind; M. Sc. Philipp Riegebauer; M. Sc. Lukas Volkmann
Centre of Innovative Energy Systems, University of Applied Sciences Duesseldorf
Georg-Glock-Str. 3, 40474 Duesseldorf, Germany
E-Mail: philipp.riegebauer@fh-duesseldorf.de, Phone: +49 (0) 21143519502

Overview

Reliable and sustainable power supply is becoming of crucial importance with increasing share of renewable energies. The challenging task for the power system in future is the permanent balancing between energy availability and demand over time and distance. Fig. 1 shows the fluctuating energy production of wind turbines and photovoltaic for Germany in 2032. To integrate the fluctuating energy into the power supply and ensure the stability of the electric grid different approaches exist. They can be classified as demand side management, generation management, storage and grid optimization. Due to the requirement of large equalization capacities a combination of these integration options are indispensable. Therefore it must be ensured that the most economical option is chosen.

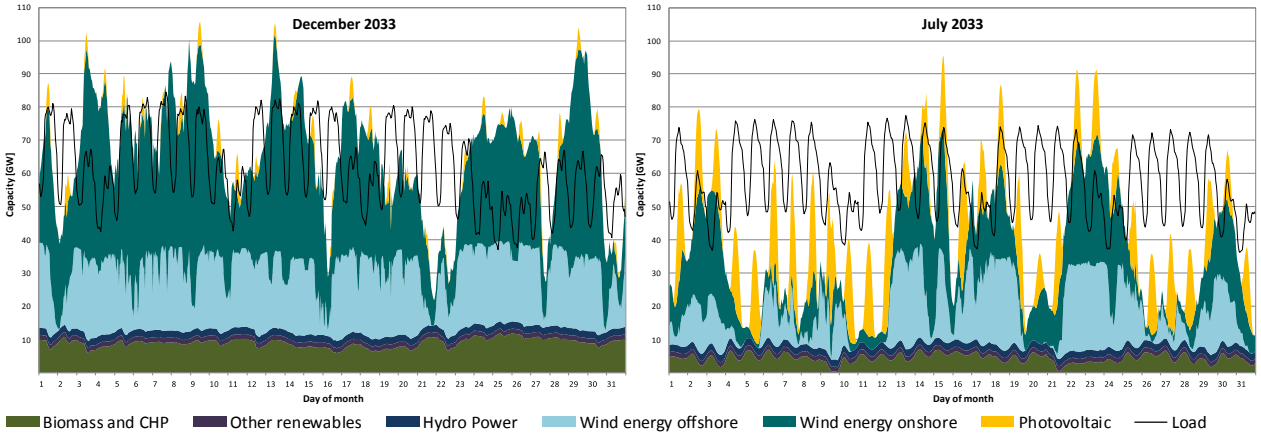

Fig. 1: *Fluctuating renewable energy generation scenario for Germany 2032 [Data: 1st draft NEP 2013, ENTSO-E]*

Method

Research is focused on short-term price formation of demand side management options in liberalized electricity markets with sufficient guaranteed capacity. Spot price formation can be described by the ascending short-term marginal cost curve of all available generation capacities (merit-order) and demand. In future, negative residual load is expectable during surplus periods of renewables when demand is completely covered by wind turbines and photovoltaic. As shown in Fig. 2 (left) feed-in from renewables reduces the spot price level due to their negligible marginal costs. If the capacity of flexible demand is higher than available renewable surplus spot price formation is determined by customer's willingness to pay for additional consumption. As shown in Fig. 2 (right) this leads to higher spot prices and uprated marginal returns created only by market-based incentive mechanisms.

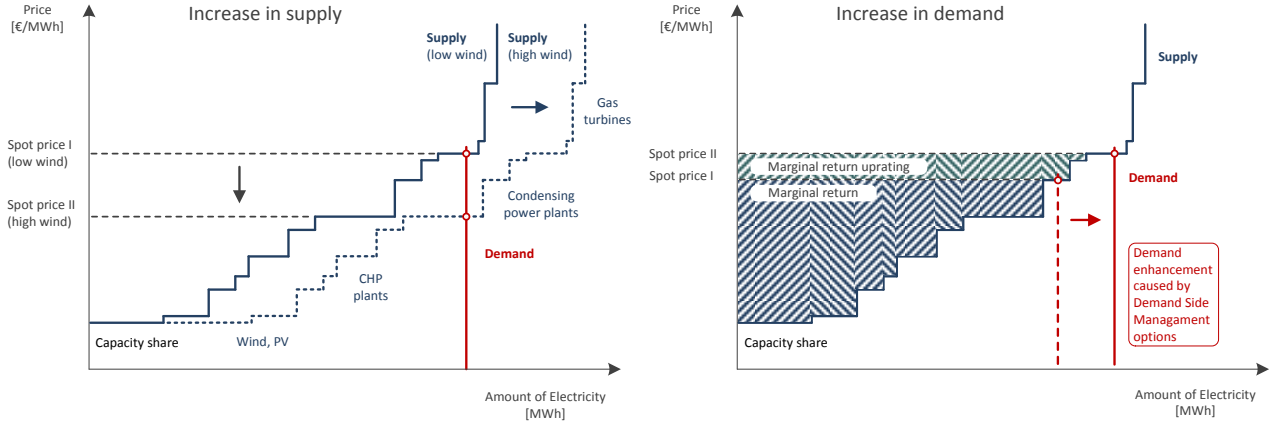

Fig. 2: *Systematic of short-term pricing mechanism with high renewables feed-in and flexible demand*

To calculate the pricing effects an economic model is necessary which considers the available potential of specific demand side management measures and which indicates the cost factors for implementation. A promising option is to link the electricity and heat market. With Power to Heat energy from renewables can be used for heating processes instead of fossil fuels in periods of renewable surplus energy. Fossil fuels will be saved and can be used on their part for energy generation to bypass periods of high demand and low renewable energy production. Beside the influences of demand side management measures on the spot pricing mechanism the cost efficiency of the specific options is calculated in the study. The cost effectiveness for the usage of electric energy instead of fossil fuels for heat production depends on the ratio of gas prices and dues for renewable surplus energy such as costs for grid use.

Results

Most scenarios evaluate high cost effectiveness using Power to Heat as a specific option of demand side management. E.g. in the field of combined heat and power plants the calculations show a higher cost effectiveness for electric heat production below spot prices of 45 $/MWh. This means that the plant is shut down and no electricity will be fed into the grid as well as the requested heat is generated by electricity. Overall, the objective must be the reduction of economic costs, resulting from the minimized expansion of the grid and generation capacities. Further fields of research are the sectors of industry and households.

Conclusions

Spot price formation will more and more be affected by willingness to pay of flexible demand. The fluctuating renewable power supply is balanced by cutting capacity peaks. A load extension of renewables is associated with the use of renewable surplus energy and improves the cost effectiveness of renewables. For this reason flexible demand is a key factor for simplified integration and therefore sustainability of renewable energy generation. Options which may be used to ensure an economic integration of renewables should be market-based and non-discriminatory and a competitive pricing must be guaranteed. The preexisting of the mentioned conditions is necessary to enable a significant impact of demand side management options like Power to Heat on spot price formation.

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