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FLEXIBLE DEMAND AS A KEY FACTOR FOR COST EFFICIENT RENEWABLE ENERGY INTEGRATION

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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. Figure 1 shows the fluctuating energy production of wind turbines and photovoltaic. 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 integration option is chosen.
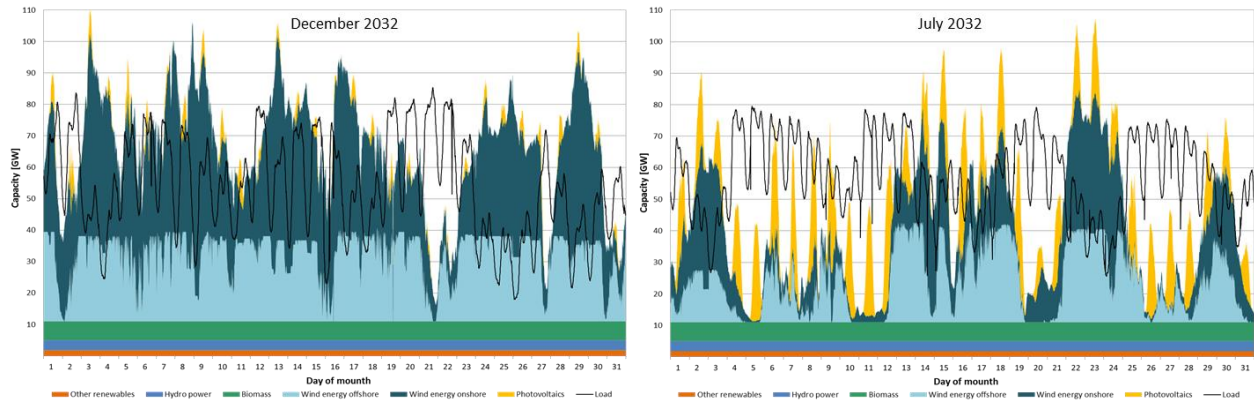

Figure 1: Fluctuating renewable energy generation scenario for Germany 2032

Method

Research is focused on short-term price formation of demand side management options in liberalized electricity markets. Figure 2 shows the classification of the pricing mechanism in times of energy shortage (demand > supply) as well as surplus capacities (supply > demand) supposing a flexible demand. With demand side management revenues for generation capacities are created only by market-based incentive mechanisms on the basis of the merit-order principle. Due to a reduced demand in times of energy shortage the spot price rises. This enables higher marginal returns for generation capacities which are named "Values of lost load". The opposite case of surplus capacities demand side management measures lead to higher spot prices and the marginal return is also uprated.
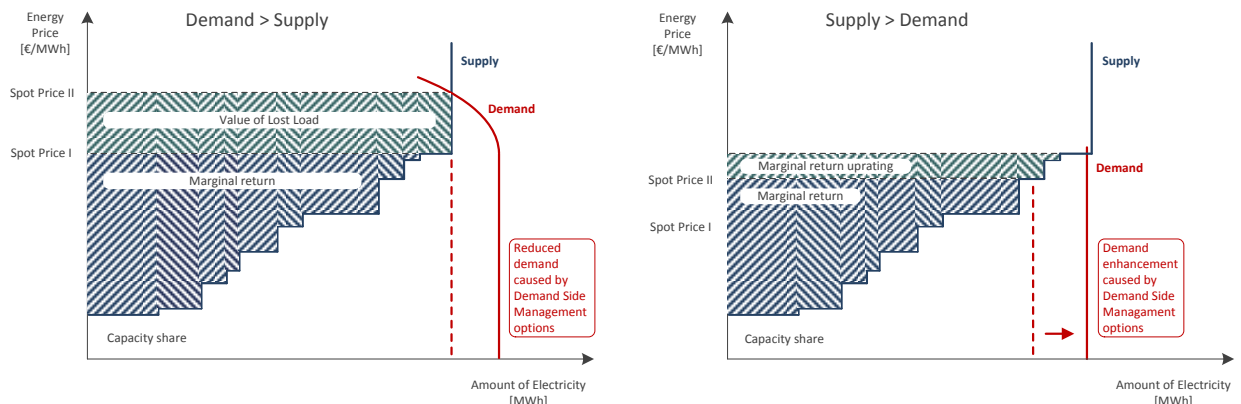

Figure 2: Systematic of pricing mechanism with flexible demand

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 with high potential in the field of industry, households and combined heat and power generation are electric heating processes. Energy from renewables can be used for heating processes instead of fossil fuels. Switching to electric heating in periods of renewable surplus energy, fossil fuels will be saved. This 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 electric heating processes as a specific option of demand side management. For example, 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.

Conclusions

Flexible demand is a key factor for cost efficient renewable energy integration due to creating revenues for generation capacities only by market-based incentive mechanisms. On the one hand the fluctuating power supply is balanced by cutting capacity peaks from sources like wind turbines and photovoltaic. A load extension of renewables is associated with the use of renewable surplus energy and improves the cost effectiveness of renewables. This leads to a simplified integration and therefore sustainability of renewable energy generation. On the other hand flexible demand can reduce the peak load and secure energy supply in times of renewable energy shortage. 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 on spot price formation.

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