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# Wind Farms with Energy Storages integrated at the Control Power Market

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## SUMMARY

Wind energy is one of the most popular sources for renewable energy. Worldwide, but especially in Germany, an extensive growth of installed wind energy plants can be traced. In Germany, the installed power of wind energy plants in 2007 was about 22 GW. The aim of the government is to raise this amount to 47 GW to the year 2020, what will be equal to 60 % of the total load of Germany. One problem is that some large conventional power plants have to shut down because of the priority feed in of wind energy, so problems concerning grid stability may appear. A contribution to the grid stability is control power, which is today supplied from conventional power plants or storage units. At the moment, wind energy plants have not the duty to support the grid stability, but it is unavoidable they have to do it already in near future.

This work shows on the one side the technical possibility of wind energy plants to supply control power and on the other side the possible economical benefit. First it is demonstrated, that both types of today's wind generators (double-fed induction generator, synchronous generator) are able to supply positive and negative control power to the grid. To enhance the ability to support the grid with control power and also to increase the revenues of the wind park owner, an energy storage unit is combined with the wind farm. At the moment, the supplied wind energy is paid with a fix amount of money according to governmental directives, independent of day-time, grid load or conventional energy prices. In the future this system has to be rejected and an open competition of renewables energy sources to conventional power plants will take place. One option is to take part at the market of ancillary services and here especially at the control power market. In this work, the generated energy by the wind farm is sold to different sources depending on an optimization using mixed integer linear programming, which also takes into account the technical limitations of the modeled system. Various scenarios show the results of participating at the control power and also the difference between using a storage unit to support the system.

## KEYWORDS

wind energy, control power, energy storage, energy market, optimization

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