Integration of Wind Generation in Electricity Markets under Uncertainties

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INTRODUCTION

The challenge of lowering the emission from greenhouse gases is one of the most important topics in today's society. It is not rocket science, that an increased integration of renewable energy will result in a more sustainable and healthy environment compared to today's use of fossil fuel. Renewable energy sources act by nature different from traditional coal power plants, and uncertainties often influence the power generation. This project faces the problems of uncertainty in the wind power production, when clearing the electricity market with a high penetration of stochastic production.

THEORY

Clearing of the electricity prices are an optimization problem where the total cost of generation is minimized, or equivalent social welfare is maximized. A market operator takes care of price clearing in the electricity. Dependent on the strategy a market operator has the outcome of the estimated optimal production and reserve capacity will turn out different.

Methods

A comparison of different strategies for minimizing the total production cost under uncertainties in a two-stage electricity market. The strategies are as follows:

1. Deterministic approach
2. Stochastic Model optimizing expected wind power generation
3. Robust Model optimizing the worst-case scenario

Results

	Deterministic (worst-case realization)	Stochastic (expected)	Robust (worst-case)
Energy dispatch costs	950	1578	950
UC costs	23	23	15
Reserve costs	630	197	312
Total day-ahead	1603	1797	1277
Energy redispatch costs	840	-520	720
Load shed costs	0	26	0
Total balancing costs	840	-494	720
Total aggregate costs	**2443**	**1304**	**1997**

Table 1: Results for each approach on a small case example

Conclusion

The three approaches give different results, and each reflect a strategy for the risk in the electricity market. Further results show that the approaches differ in sensitivity and outcome for different scenarios of the realized wind generation.