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Optimization of wellfield operation in a variable power price regime

E. Sleire[1]
[1]DTU Space, Technical University of Denmark

Supervisors: Peter Bauer-Gottwein – DTU Environment
Raphael Schneider – DTU Environment

INTRODUCTION

The idea behind the project is to see how one can couple the highly variable power prices of the Danish electricity-market with a model of wellfield operations to minimize the cost of pumping groundwater into storage.

From the stochastic price regime, it is possible to use Stochastic Dynamic Programming (SDP) to create a set of decision rules which determine whether it would be economically beneficial to pump or not, depending on the time of the day, the amount of water in storage and the price level. This is as an alternative to present practice of constant pumping.

THEORY & METHODS

A wellfield has a characteristic relationship between energy footprint of the pumped water and the pumping rate. The pumped water can to a certain extent be stored for some time, and there will be a given demand every hour. As with the demand, the power prices are also an hourly variable, with both deterministic and stochastic components. The volatile nature of the Danish electrical market comes from high penetration of intermittent wind power.

For management of groundwater pumping in this semi-stochastic environment, Stochastic Dynamic Programming (SDP) can be used. Here SDP will be used together with operational data from the Søndersø Wellfield to see if it can yield a more cost-effective performance structure.

RESULTS (PRELIMINARY)

Preliminary simulations have found that there is a possible saving of 19 % of cost with a perfect foresight, and 11.4% of this by using adapting pumping.
More results will follow from further analysis performed during June.

CONCLUSION

There is clearly an economic incentive for implementing a more adaptive pumping strategy of groundwater; Moreover, the power generation will move to the renewable sources, making power prices on the wholesale market even more variable. This method follows one of the ideas of the “smart grid” philosophy, i.e. making power demand more flexible in order to be able to fully use varying electrical power supply from a renewable and uncertain power source.