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Energy markets and sustainable water management: pumping and demand response in the Dutch delta.

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Due to climate change and a desire for sustainable solutions, renewable energy is on the rise. The intermittency of this type of energy together with its unpredictable supply are a big hurdle for the energy transition. Two methods are promising solutions to this problem: large scale energy storage and demand response. The market price is a good indicator of scarcity and abundancy.

This case study examines participation in Demand Response as a way to use renewable energy in water management in the Netherlands. The subject of the study is a large pumping station in IJmuiden. As there is a correlation between renewable energy supply and a low market price, there is also a business case for the use of demand response. There are multiple energy markets where Rijkswaterstaat, the Dutch ministry of Infrastructure and Water Management, might buy energy for the pumping station in IJmuiden. The Day Ahead Market, called the APX in the Netherlands, is where energy is bought and sold the day before consumption. The Intraday market, also called the flexibility market is where energy can be bought and sold up to 15 minutes before consumption.

Model Predictive Control (MPC) was used to minimize energy costs based on energy market data. A strategy combining these two markets was evaluated. This was done by using a predicted day ahead price, generated by a SARIMA model, to create a plan. In principle this plan was followed, but deviations from the plan were allowed against intraday market price. The effects of expected future development, like sea level rise and energy market changes, were analyzed and simulated as well.

A higher sea level would result in more pumping, and less discharging under gravity. Which could cause the pump schedule to become less flexible. The results show that it is possible to apply demand response to a pumping station. The intraday market makes it possible for the MPC to adjust its energy use during the day. The conclusion is that Rijkswaterstaat can certainly save energy costs on pumping. Based on a reference scenario where MPC only minimizes energy use and a fixed energy price provided by Rijkswaterstaat is assumed, the proposed method, based on the day ahead market and intraday price, has lower total energy cost when. In the Netherlands there is not much correlation between low energy prices and renewable energy yet, since renewable energy is not a big part of the energy mix in the Netherlands. This correlation is expected to become more visible when the Dutch energy mix becomes more sustainable.