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Research stay and sustainable hydropower coordination

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Research stay at KTH

As part of my doctoral research at NTNU, I undertook a research stay at KTH in Stockholm to develop methods for more efficient and sustainable hydropower operation. The research focuses on river systems in which several power plants or owners depend on the same water resources. In these systems, one plant's release decisions can affect water availability, reservoir levels and generation opportunities at other plants. The work examines how mathematical optimization and practical coordination arrangements can improve water use while respecting operational and environmental requirements.

Power Swaps research paper

A central activity was further development of the research paper "Power Swaps: A Coordination Mechanism for Operation of a Shared Energy Storage." The paper investigates a Swedish coordination arrangement in which producers retain their individual electricity market decisions, while a water regulation body reconciles requested releases with feasible river operation. Virtual water accounts and power swaps are used to account for differences between requested and actual production. The study models this arrangement under uncertain inflows and market conditions and examines its operational value, environmental restrictions and limitations for independent decision making. The manuscript has been developed and revised; the publication process is ongoing.

Further research on water utilization

Alongside the Power Swaps study, I am investigating alternative ways to coordinate the use of water across reservoirs and hydropower plants. This includes comparing independent and coordinated reservoir operation, considering how water can be stored or released at different times, and analysing environmental minimum flows, changes in river discharge and hydropeaking. Another focus is how different inflow forecasts and wet or dry conditions affect the value of coordination. The aim is to identify when better coordination can improve electricity production flexibility and water resource utilization without weakening environmental obligations.

Results and next steps

The research stay contributed to the development and refinement of the Power Swaps manuscript and to the design of related studies on coordinated water management. The next phase is to extend the optimization models and evaluate alternative coordination approaches using comparable operational and environmental scenarios. I thank Vannforeningen for its support of my research and academic development.

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