Geophysical Research Abstracts
Vol. 18, EGU2016-12694-6, 2016
EGU General Assembly 2016

Using climate response functions in analyzing electricity production variables. A case study from Norway.

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This study analyses whether and to which extent today's hydropower system and reservoirs in Mid-Norway are able to balance new intermittent energy sources in the region, in both today's and tomorrow's climate. We also investigate if the electricity marked model EMPS gives us reasonable results also when run in a multi simulation mode without recalibration.

Climate related energy (CRE) is influenced by the weather, the system for energy production and transport, and by market mechanisms. In the region of Mid-Norway, nearly all power demand is generated by hydro-electric facilities. Due to energy deficiency and limitations in the power grid the region experiences a deficit of electricity. The region is likely to experience considerable investments in wind power and small-scale hydropower and the transmission grid within and out of the region will probably be extended, so this situation might change. In addition climate change scenarios for the region agree on higher temperatures, more precipitation in total and a larger portion of the precipitation coming as rain instead of snow, as well as we expect slightly higher wind speed and more storms during the winter. Changing temperatures will also change the electricity demand.

EMPS is a tool for forecasting and planning in electricity markets, developed for optimization and simulation of hydrothermal power systems with a considerable share of hydro power. It takes into account transport constraints and hydrological differences between major areas or regional subsystems. During optimization the objective is to minimize the expected cost in the whole system subject to all constraints. Incremental water values (marginal costs for hydropower) are computed for each area using stochastic dynamic programming. A heuristic approach is used to treat the interaction between areas. In the simulation part of the model total system costs are minimized week by week for each climate scenario in a linear problem formulation. A detailed representation of hydropower is included and total hydro power production for each area is calculated, and the production is distributed among all available plants within each area. During simulation, the demand is affected by prices and temperatures.

6 different infrastructure scenarios of wind and power line development are analyzed. The analyses are done by running EMPS calibrated for today's situation for 11*11*8 different combinations of altered weather variables (temperature, precipitation and wind) describing different climate change scenarios, finding the climate response function for every EMPS-variable according the electricity production, such as prices and income, energy balances (supply, consumption and trade), overflow losses, probability of curtailment etc .