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INFLUENCE OF LARGE SCALE WIND POWER AND INCREASED ENERGY SYSTEM FLEXIBILITY ON THE OPTIMAL LONG-TERM POWER PLANT PORTFOLIO

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The study analyses how large wind power penetration will affect investments in the power system with an investment model using hourly time scale. The long-term costs of switching to power plants with lower average utilization are estimated. Taking this into account and with other assumed parameters wind power is competitive with fuel based alternatives, but faces competition from nuclear power. Situation is somewhat changed by the introduction of additional flexibility to the power sector from transport and heating through plug-in electric vehicles and heat storages using heat produced with electricity.

Several studies have been made to asses different aspects of integrating wind power into power systems. One major aspect is the analysis of additional costs that rise from the operation of the power system with this variable and partly unpredictable power source. While this has been the dominant part of the research on wind power integration, greater share of wind power in the systems will also change the cost optimal system-wide power plant portfolio in the long term. We analyse the investment and operational costs associated with this change. By changing assumptions about the relative costs of producing electricity and heat with different technologies we get different power system configurations and can demonstrate situations where wind power becomes dominant source of power production. If the power system is more flexible, wind power integration is cheaper. Therefore, we include the effect of two new forms of flexibility: plug-in electric vehicles and heat storages operated in liaison with heat pumps or electric heat boilers.

With the assumed parameters and sensitivity runs wind power is a competitive source of power and heat against energy sources based on fossil fuels. However, the variability of wind power forces the system to have other power plant capacity. This is a complex mix of power plants optimised for different full load hours and is naturally dependant on the assumed investment, fuel, and CO_2 emission costs. If nuclear power plants are allowed at the assumed price level, they take over a large part of wind and fossil fuel powered production. Since wind power requires more low utilization power plants in the system than nuclear, the cost of wind power needs to be some cents per kWh lower than the cost of nuclear in order to be competitive in the long-term system optimisation.

Results from the investment model are compared with a more detailed stochastic dispatch model to decrease uncertainty in the results. The benefit of plug-in electric vehicles for peak shaving is limited due to the rather small size of storage even with large number of vehicles. On the other hand, they could be useful for contingency reserves, although relatively low number of vehicles can saturate the reserve market.

The possible contribution of wind power to meeting the demand for primary energy is larger than it appears at first sight. Increasing fuel prices and advancing technologies are giving wind power access to the two other major forms of energy use: heat and transport. If this happens, there could be cheaper tools to cope with the variability and prediction errors of wind power.