***Revising the trading arrangements of the Nordic electricity market?***

Lars Bergman, Professor emeritus and Former President, Stockholm School of Economics, Phone: +46 8 7369052, e-mail: lars.bergman@hhs.se

Eirik S. Amundsen, Professor emeritus, University of Bergen and University of Copenhagen, Phone: +47 55589718, e-mail: eirik.amundsen@econ.uib.no.

[2nd Author’s Name, Affiliation, Phone, email]

[Other Author’s Name, Affiliation, Phone, email]

[Format: single space, 10 point font, Times New Roman]

## Overview

The purpose of this paper is to analyze the need for reforming the trading arrangements of the Nordic electricity market as the electricity supply system develops into to a largely renewable one, i.e. an electricity supply system based on renewable energy sources such as hydro, wind, solar and biomass. According to current projections the share of all kinds of renewable electricity in the Nordics will increase from around 65 % in 2017 to around 85 % in 2045. Moreover, the share of (intermittent) wind and solar power is expected to increase from around 10 % to close to 40 % during the same period.

By “Nordic electricity market” is meant the integrated Danish, Norwegian, Swedish and Finnish electricity markets with common day-ahead and intra-day markets. By “trading arrangements”, or “market design”, is meant the set of market places, i.e. day-ahead, intra-day etc., and the types of contractual arrangements used by producers, retailers and consumers. The concept also covers the market places and contractual arrangements used by the system operator to balance the system in real time.

The current trading arrangements in the Nordics are designed for a dispatchable electricity supply system. However, as indicated the expected development of the system implies significantly increasing shares of wind and solar power, i.e. a development towards a system with a large share of non-dispatchable power. With increasing shares of intermittent power production, the pattern of electricity market related risks changes in at least two ways. One is that electricity price volatility, both in terms of frequency and amplitude, is likely to increase. The other is that wind and solar power producers are likely to face quantity risks to a much larger extent than power producers have in the past. From a system point of view these quantity risks on the part of the individual producers amount to peak capacity shortage risks.

## Methods

## Our analysis is based on standard microeconomic theory in conjunction with surveys of relevant literature and data sources.

## Results

The analysis suggests that current trading arrangements in the Nordic electricity market are not fully conducive for efficient handling the price and quantity risks emerging as the system develops towards one with a considerably higher share of intermittent power. In order to cope with these challenges a combination of measures by the system operators and the market participants are needed. These measures include increased granularity of prices, shifts of trading from day-ahead to intra-day and real-time markets and PPAs (power purchase agreements) and other types of forward contracts designed to handle quantity risks are needed. Under certain conditions a capacity market (“capacity mechanism”) needs to added to the currently existing set of markets. However, the extent of these changes depends on the development and implementation of cost-efficient storage technologies and technologies enabling consumers to actively participate in the electricity market and thus increase instantaneous demand response.

## Conclusions

## A key conclusion is that the ample supply of hydro power in the Nordics makes it possible to adopt a “wait-and-see” strategy with respect to major market design reforms such as implementation of a capacity mechanism.