

# Trading arrangements in a renewable electricity system: The case of the Nordics

Eirik S Amundsen, University of Bergen, Norway

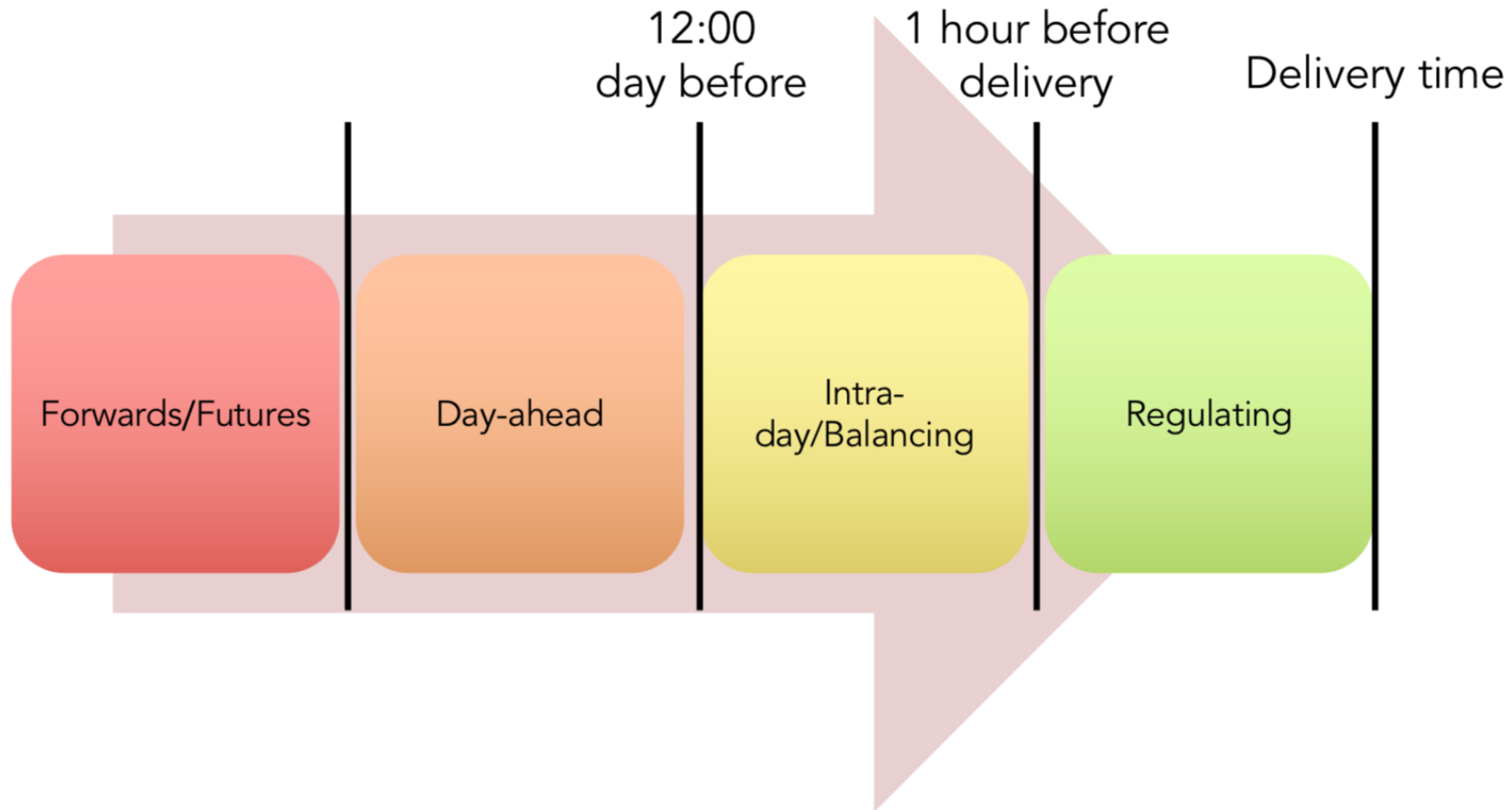
Lars Bergman, Stockholm School of Economics, Sweden

IAEE, Ljubljana, August 25-29, 2019

# Renewable electricity systems

- By a "renewable electricity system" is meant an electricity supply system with a very high share of production based on renewable energy sources
- The technologies in question may be dispatchable, such as hydro power with reservoirs, or non-dispatchable (or intermittent), such as wind and solar power
  - The paper deals with the increasingly renewable electricity system in the Nordic countries, with high shares of intermittent wind and (some) solar power
- The particular features of wind and solar power have implications both for system operation and for the electricity trading arrangements
  - The paper deals with the implications for trading and trading arrangements

# The electricity market: A sequence of markets



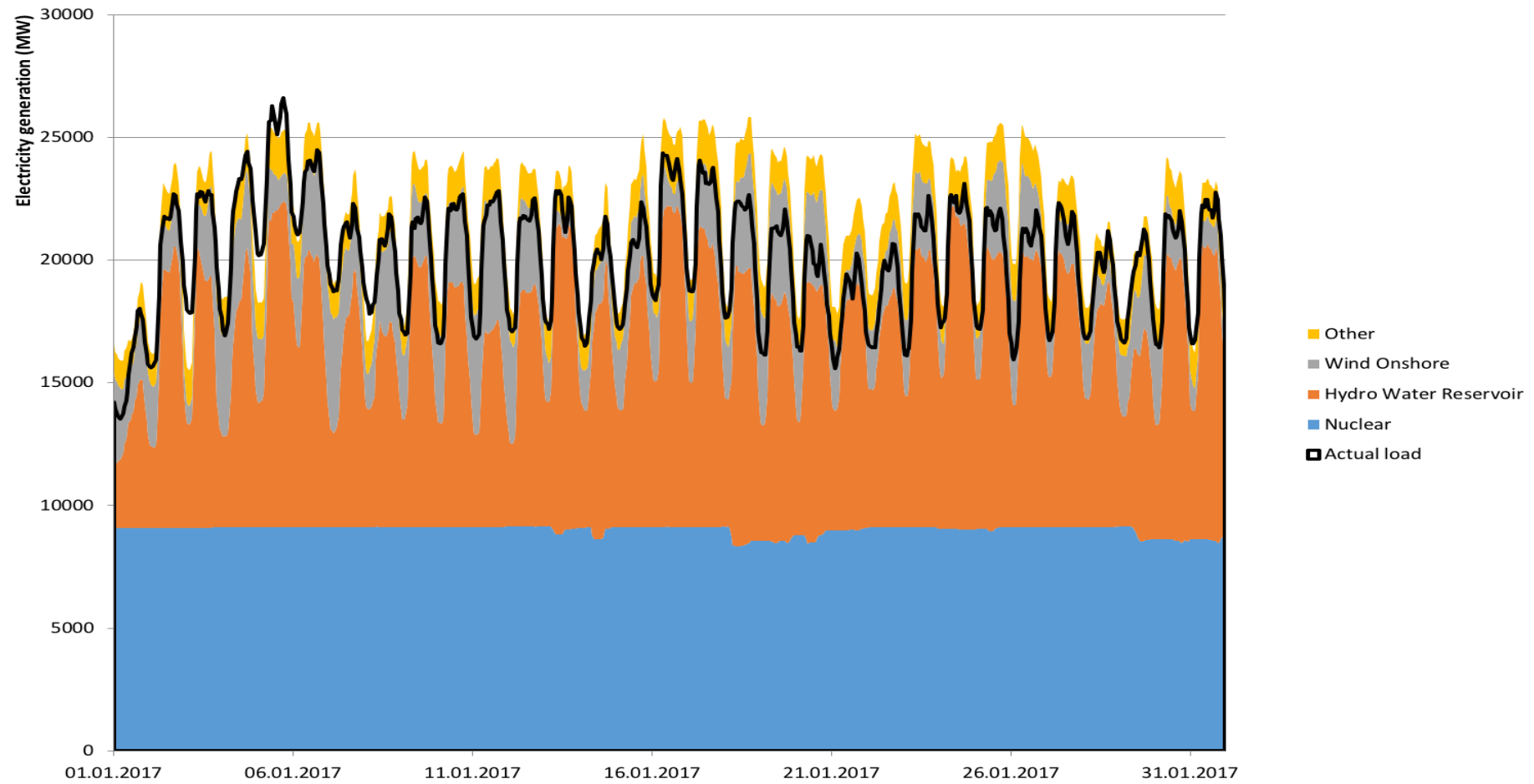
# Some numbers: The Nordics and Sweden

|                        | Nordics, 2017<br>% | Nordics, 2045<br>% | Sweden, 2017<br>% | Sweden, 2045<br>% |
|------------------------|--------------------|--------------------|-------------------|-------------------|
| Hydro                  | 54,9               | 49,2               | 40,2              | 48,8              |
| Nuclear                | 21,0               | 4,0                | 39,3              | 0,0               |
| Wind + Solar           | 10,0               | 36,5               | 10,9              | 38,9              |
| Fossil + Bio<br>+Waste | 14,1               | 10,3               | 9,5               | 12,2              |

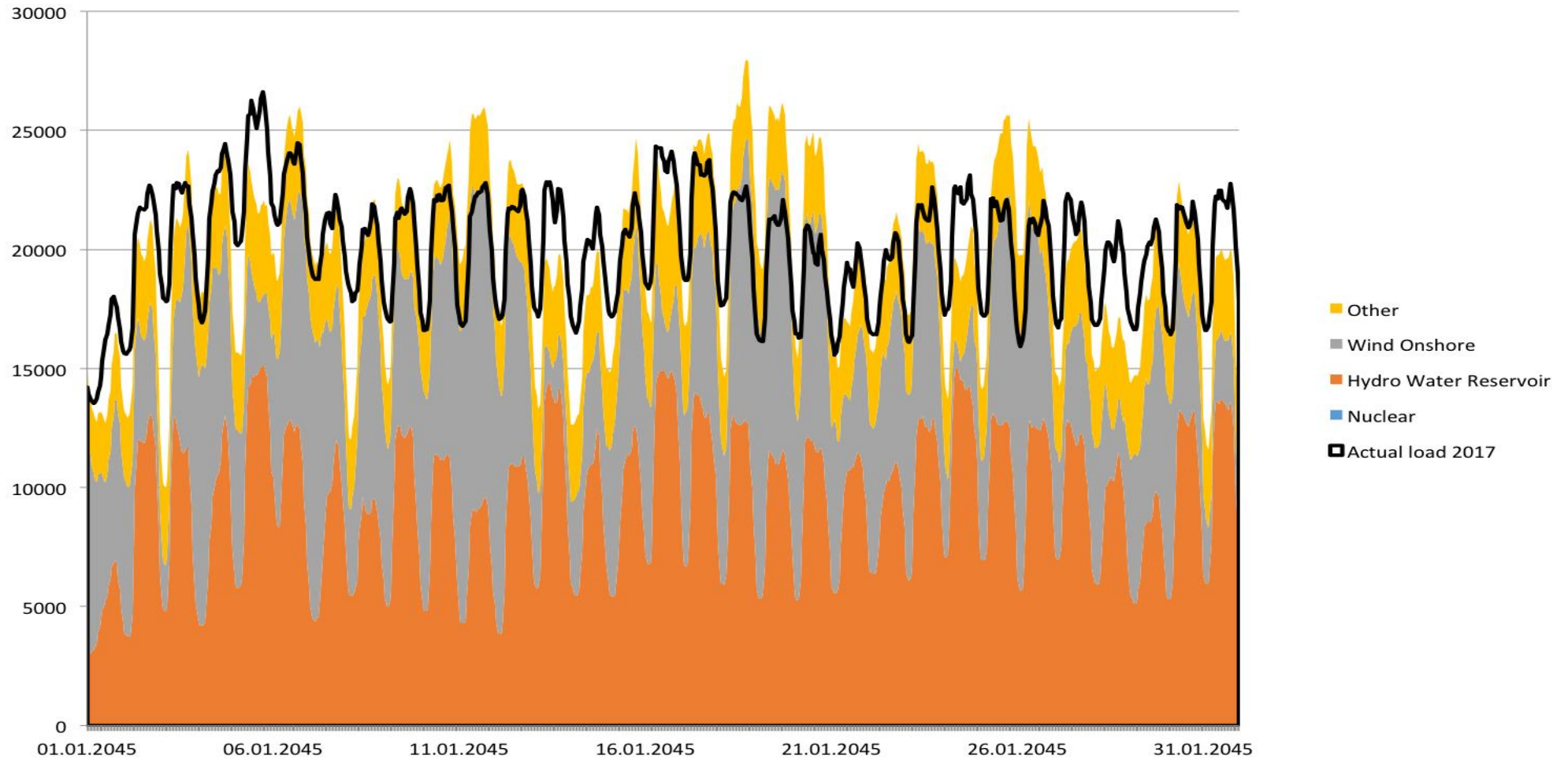
# What is the problem?

- The challenge created by large shares of wind and solar power can be illustrated by the situation in January 2017 and 2045 (projected) in Sweden.
- What the pictures indicate is that:
  - While nuclear and much of the hydro power production was quite stable over time in 2017, it will have to vary significantly in 2045 to balance short term variations in wind power production.
  - These variations *ceteris paribus* lead to increased price volatility.
  - Thermal power plants may suffer loss of revenues due to a lower number of hours in operation combined with regulated caps on prices during periods with low wind and solar power production.
  - This may lead to security of supply problems.

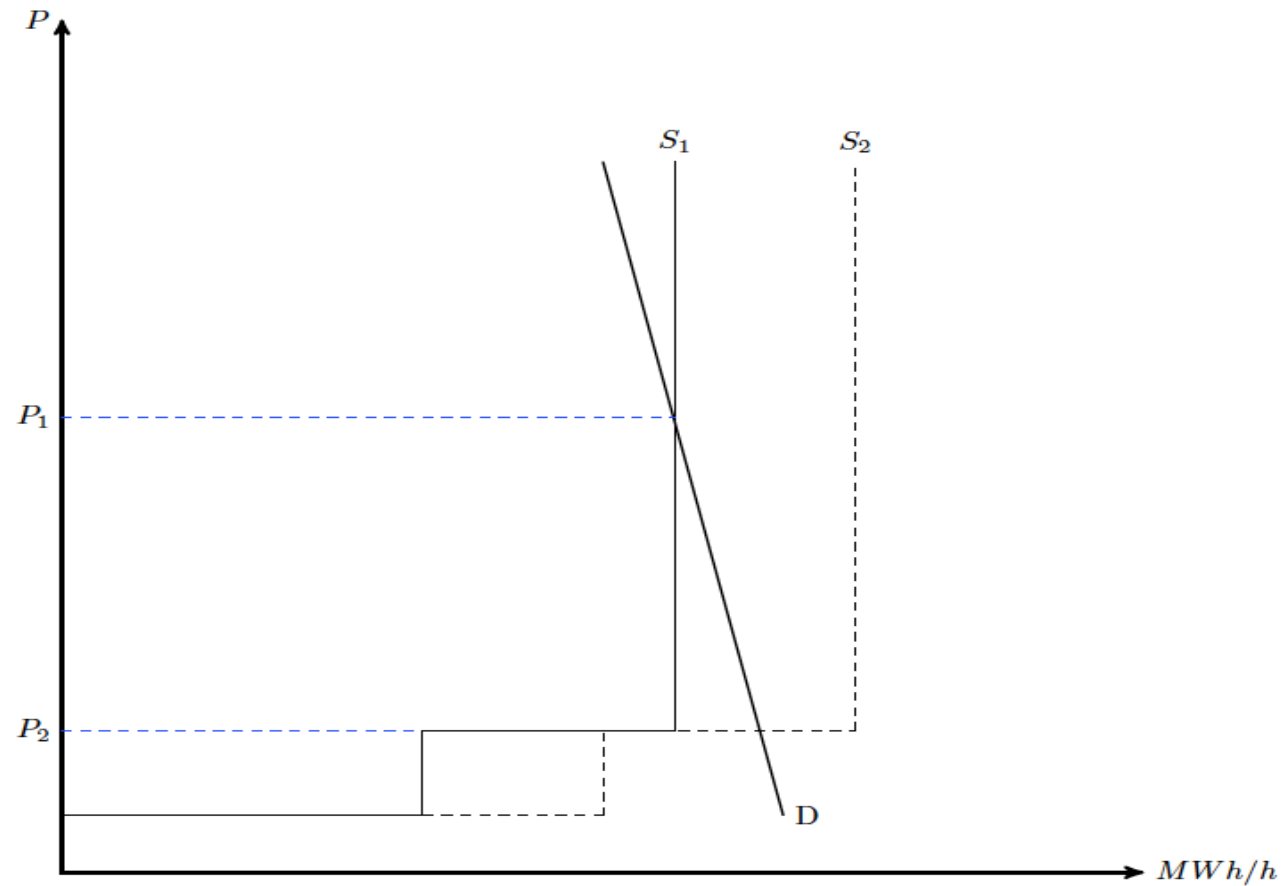
# Sweden, January 2017



# Sweden, January 2045



# Prices at low (1) and high (2) wind power output





# Key challenges

- The Nordic Electricity market is designed as an “energy-only market” (EOM), i.e. markets where producers are paid for the MWhs they deliver but not for the MWs they keep available.
- To efficiently accommodate large-scale introduction of intermittent wind and solar power are often considered to require market design reform
- But this is not necessarily the case in the Nordics, where there is plenty of hydro power.
- The key challenges to the current trading arrangements are:
  - The additional price risks created by the intermittency of wind and solar power
  - The quantity risks faced by wind and solar power producers, leading to security of supply risks at the system level

# Security of supply: Two alternative strategies

- Alternative 1: Introduce a capacity mechanism managed by the TSO, i.e. a regulation of system-wide peak load capacity and a system of payments to generators, storage providers and flexible (large) consumers who keep capacity (MWs) available
  - This is the alternative chosen by several EU countries.
- Alternative 2: Rely on the market mechanism, i.e. that markets for MWs and suitable financial derivatives will emerge in the interest of (primarily) wind and solar power producers wanting to safeguard their security of supply
  - This is the alternative explored in our paper

Från: Lars Bergman

Skickat: den 27 augusti 2019 10:19

Till: laee@laee.org

Ämne: Eurasia

# What the "market" alternative amounts to

- On the market or system level
  - A matter of managing increased price risks
- On the level of individual wind and solar power producers
  - A matter of managing quantity risks, i.e. the risks that contractual delivery obligations cannot be honoured or that excess power cannot be sold at reasonable prices

# Managing increased price volatility

- With increasing price volatility the demand for derivatives such as futures and options will increase.
- The question is whether the supply of these instruments will increase to the same degree.
  - The analysis in the paper suggests that the so called proprietary traders, i.e. traders without direct connection to the electricity market, will play a key role.
  - That is, will more volatile electricity prices make electricity derivatives more of less attractive for proprietary traders?

# An "endogenous" market for MWs

- The back-up capacity needed to balance the short term variations in wind and solar power output in general will run only a small number of hours per year.
- Unless prices are very high during these hours the revenues will not be sufficient to cover the capital costs of the plants.
- Thus these plants will not be built unless there is a payment for MWs kept available
- That is what a "capacity mechanism" does.
- But payment for MWs could also be the result of voluntary agreements between wind and solar power producers and providers of back-up capacity
- These agreements can be bilateral, but one could envisage a market for a particular kind of standardized options

# A new type of standardized option?

- A provider of back-up capacity issues and sells standardized options giving the holder the right to, under certain conditions, have a given amount of the issuer's MWs at his disposal during a specified period of time.
- For the holder the option is an insurance against the quantity risk associated with the unpredictability of the wind/solar power output during a specific future period
- By selling the options the issuing agent gets a revenue per unit of MW that he keeps available during the period in question.
- In "normal" options there is a "strike price". In the case of these options there are "strike weather conditions", i.e. wind speeds below a certain limit or solar radiation below a certain intensity.

# No need for fundamental reform

- The analysis in the paper suggests that the basic structure of the electricity market will remain as it is, but much of the trading will move from the day-ahead to the intra-day and balancing markets
- New financial instruments are likely to help wind and solar power producers to hedge quantity risks
- But the need for reforming the trading arrangements also depend on
  - Digitalization, enabling consumers to actively participate in (near) real-time trading and thus increase short term price elasticity of demand
  - Introduction of cost-efficient large-scale storage facilities, able to absorb power surpluses and release power in times of imminent power shortage

# Summary and concluding remarks

- The expected wind and solar power investments in the Nordics will convert the Nordic electricity supply system to a "renewable electricity system"
- From the point of view of trading and trading arrangements this will be a major change, with increased price volatility and, possibly, security of supply problems as key features
- Yet, with significant hydro power capacity, the Nordics is in a better position to handle these problems than many other European countries
- A capacity mechanism will probably solve the security of supply problem, but also lead to other problems (overcapacity, barriers to cross-border trade, etc.)
- The increased price volatility will create incentives to develop efficient technologies for storage and customer short term participation in the electricity market, and thus help to reduce the security of supply problem
- And a market for MWs is likely to emerge and allow wind and solar power producers to hedge the quantity risks they are facing.