



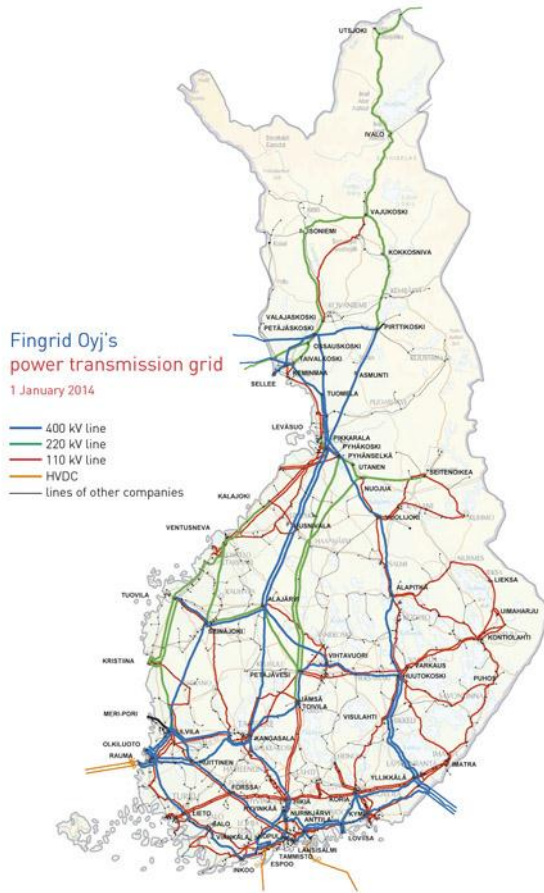
# Balancing the Grid in Nordic power system

IEA Seminar, Tuesday 10th June 2014, Rovaniemi, Arktikum

Development manager Jonne Jäppinen

Fingrid Oyj

# Fingrid is the Finnish transmission system operator (TSO)



We are responsible for the functioning of the entire power system in Finland. We keep the transmission grid in a good condition and construct it on the basis of the needs of the electricity market.

We transmit electricity continuously from electricity generating companies to distribution network companies and industrial companies. 75% of the electricity in Finland is transmitted in our grid.

We take care of the cross-border connections of electricity transmission. There are direct connections to Finland from Russia, Sweden, Norway and Estonia.

We promote the functioning of the electricity market by keeping the transmission connections between various countries in working order.

# Fingrid Oyj in brief



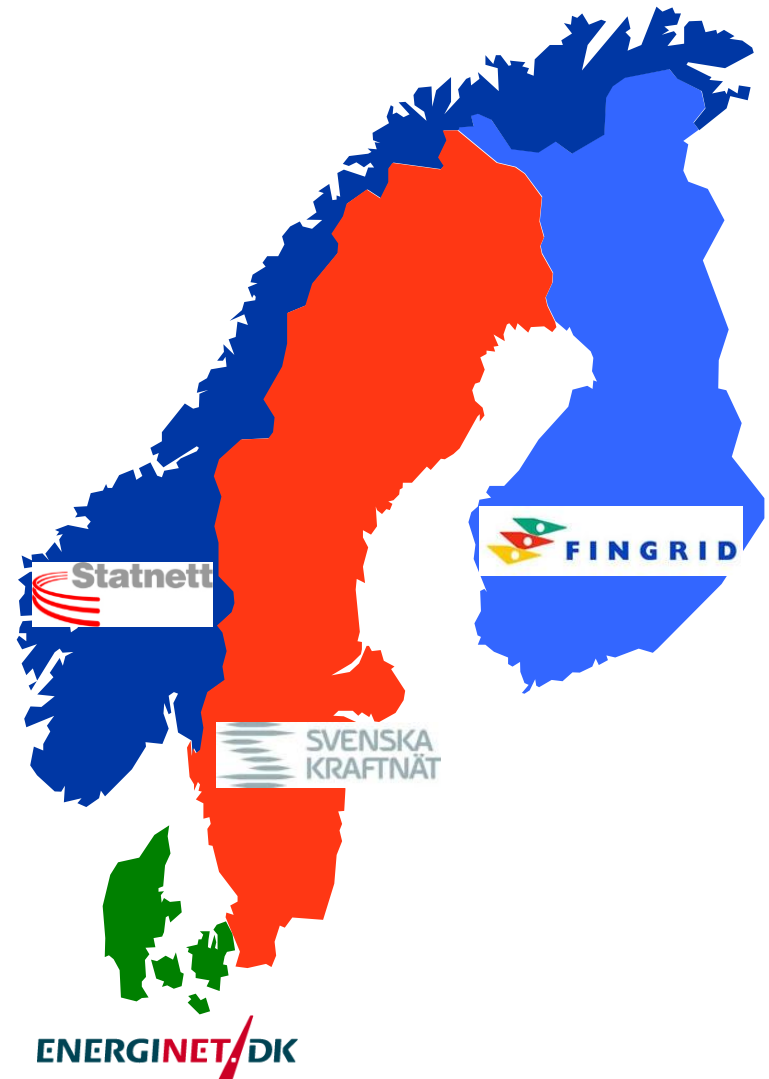
- Fingrid owns the Finnish main grid and all significant cross-border connections.
- Independent and impartial player. Operations are based on the Finnish Electricity Market Act. Pricing is supervised by the Energy Authority.
- Fingrid is a pioneer. Based on the results of international benchmarking studies, Fingrid is among the best TSOs in the world in cost efficiency and system security.
- Customers comprise electricity producers, electricity market parties, major industrial enterprises, and regional and distribution network companies.

## **Fingrid Oyj's grid assets:**

- 14,300 km of transmission lines and cables
- 113 substations
- 67 power transformers, with total capacity of 21,000 MVA
- 935 MW of reserve power capacity

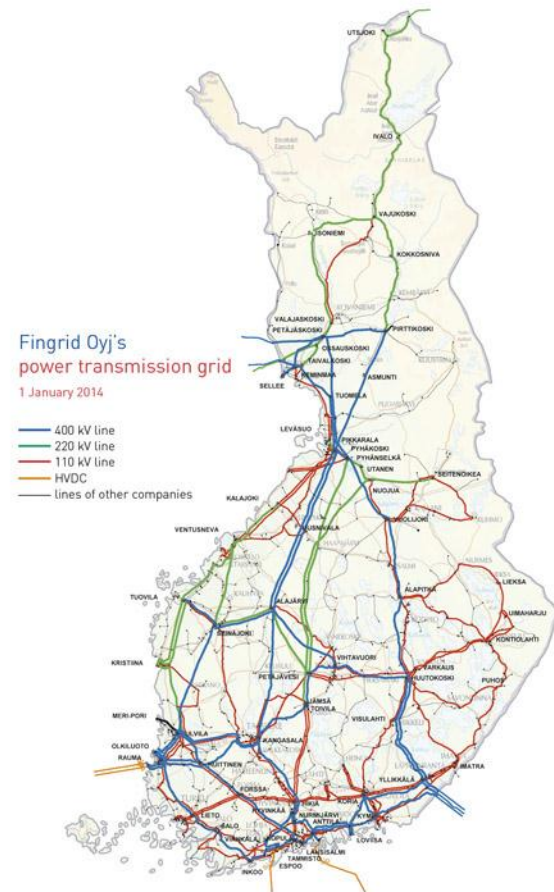
## Nordic grid forms one unit

- The Nordic electricity transmission grid is operated jointly.
- There are shared Nordic criteria for grid planning and operation (Grid Code).
- The power system has to withstand a fault in any individual component (N-1).
- After a disturbance, the operating situation is restored to normal by using reserves so that the system can withstand a dimensioning fault in 15 minutes.

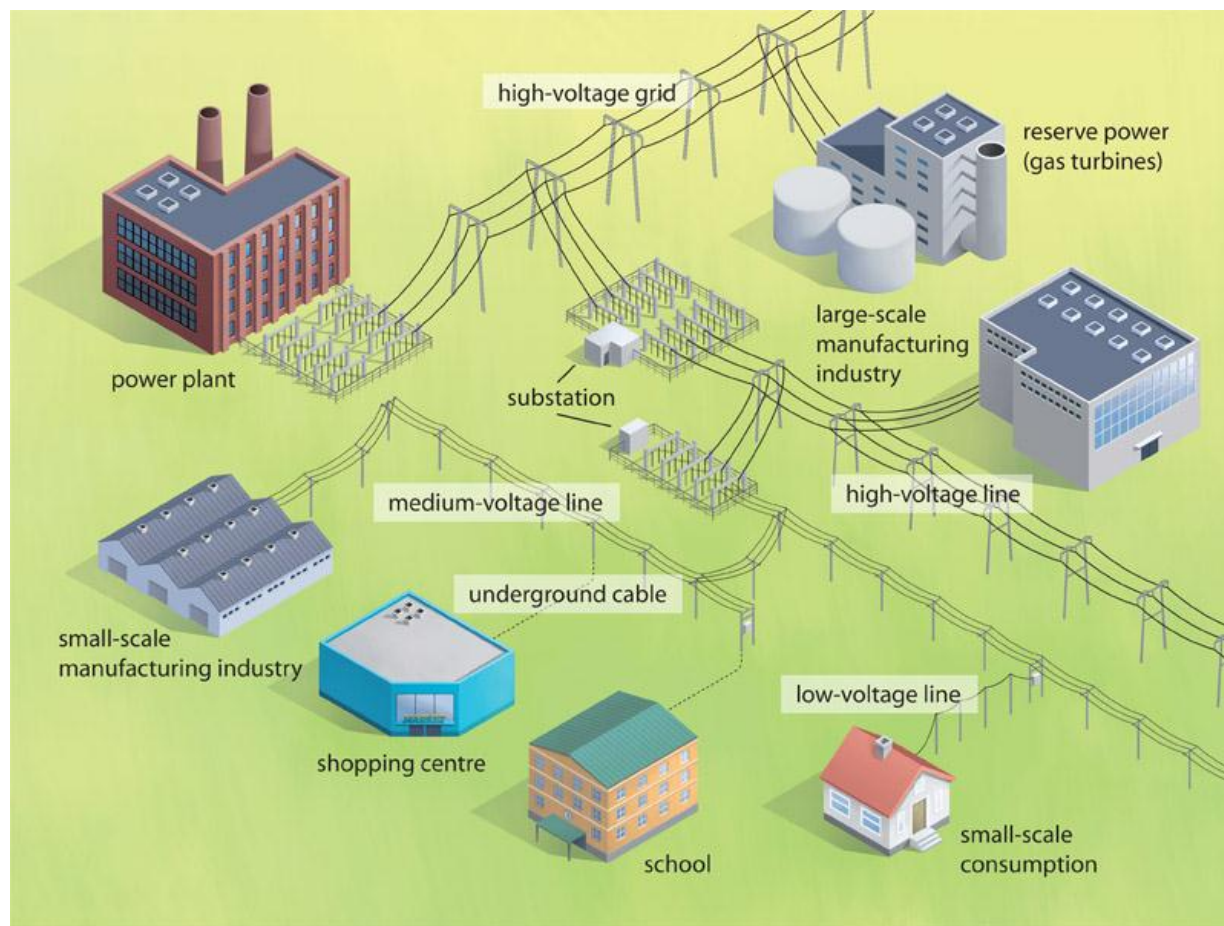


# Power system in Finland

- Production plants, transmission grid, distribution network and consumption points make up the Finnish power system.
- The power system in Finland is part of the Nordic power system.
- Finland has cross-border transmission connections to all of its neighbouring countries.
- Benefits of a shared power system:
  - efficient use of production resources
  - international electricity trade
  - efficient utilisation of transmission grid and reserves
- Fingrid is responsible for the main electricity transmission grid in Finland.



# Power system in Finland !



## Power plants

production capacity

installed 16,900 MW

available 12,800 MW

## Transmission grid (Fingrid) 400 – 110 kV

transmission lines 14,500 km

## Distribution network

medium-voltage lines 225,000 km

low-voltage lines 135,000 km

## Number of electricity users

3.2 million



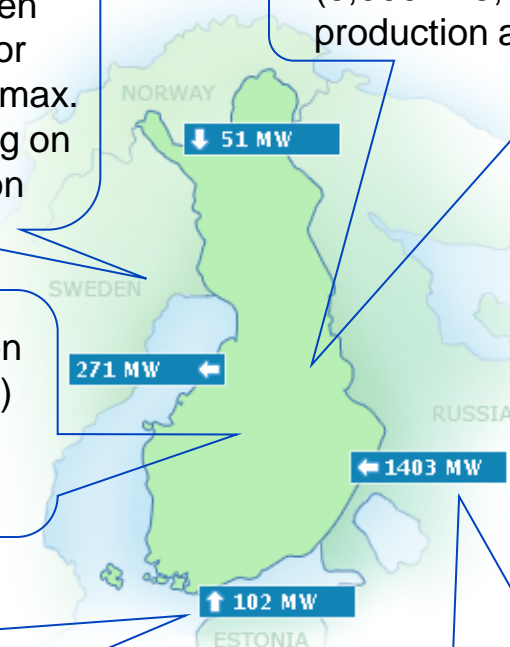
# The operating situation varies constantly based on consumption and market situation

Electricity is imported into Finland from Sweden (max. 2,700 MW) or exported to Sweden (max. 2,300 MW) depending on the market situation

Domestic production (xxxx...13,000 MW) depending on the market situation

Electricity is imported from or exported to Estonia (max. 1000 MW) depending on the market situation

The variation in domestic consumption (6,000...15,000 MW) is covered by production and imports



Last updated: 14 Jul 2009 16:06

Temperatures in Finland: Helsinki +22°C, Jyväskylä +22°C, Oulu +22°C, Rovaniemi +22°C

## Consumption and production in Finland [Info](#)

Consumption	7717 MW
Production	6432 MW
- hydro power	1233 MW
- nuclear power	2662 MW
- condensing power	845 MW
- cogeneration district heating	541 MW
- cogeneration industry	1113 MW
- other production (estimate)	38 MW
- peak load power	0 MW
Net import/export	1285 MW

## Electricity price in Finland [Info](#)

Elspot price area Finland	35.09 e/MWh
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## Power balance [Info](#)

Production deficit/surplus in Finland	154 MW
Surplus/deficit, cumulative	10 MWh
Instantaneous freq. measurement	50.05 Hz
Time deviation	9.31 s

Electricity can be imported from Russia (max. 1,400 MW), export possibility under investigations

# The grid is operated and its state is monitored in the Main Grid Control Centre



## Power system control

- supervision of the main grid
- overall management of disturbances

## Balance control

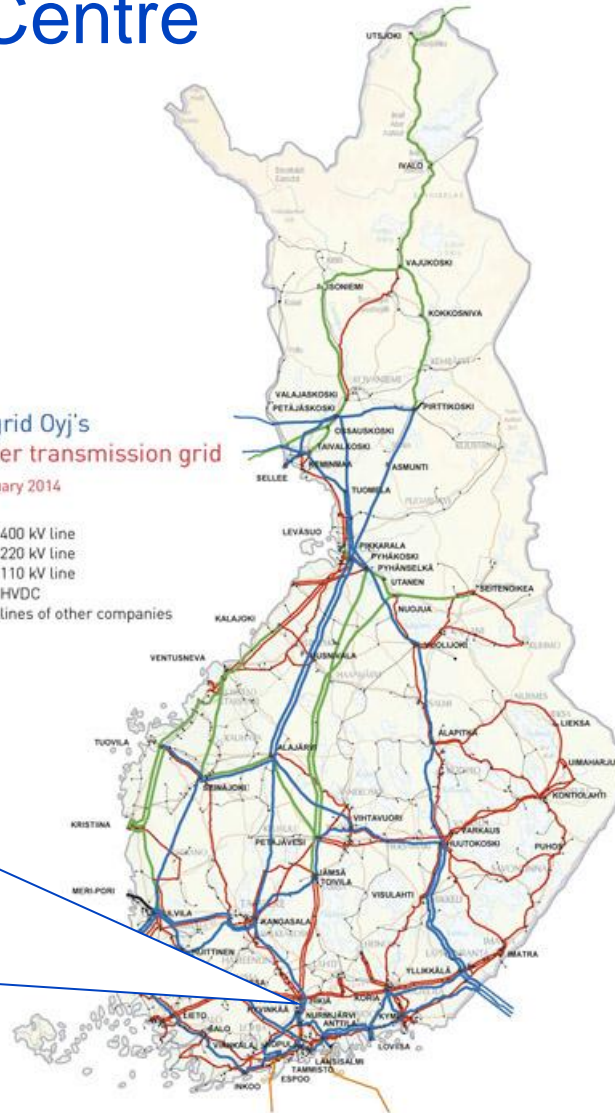
- balance between production and consumption
- reserve management

## Network control

- planned switchings
- fault clearance

Fingrid Oyj's  
power transmission grid  
1 January 2014

— 400 kV line  
— 220 kV line  
— 110 kV line  
— HVDC  
— lines of other companies



Fingrid's SCADA system contains real-time information on:

- the main grid including transmission lines, transformers and other equipment

- power plants

Including:

- status information
- power, current, voltage...
- events and alarms
- maintenance data



# Electricity trade takes place within the technical boundaries of the transmission grid

Transmission capacities are calculated and published to the market

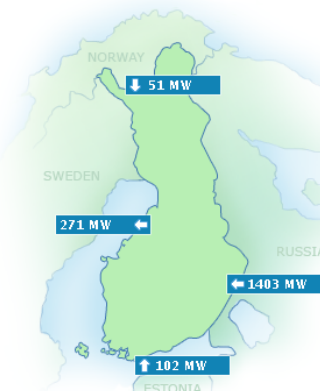
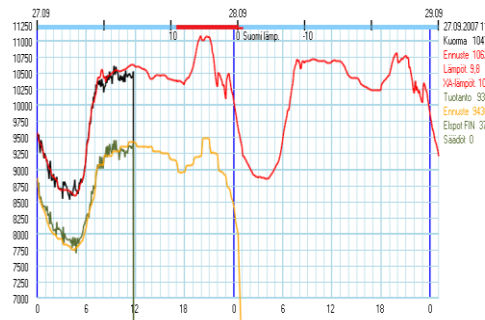
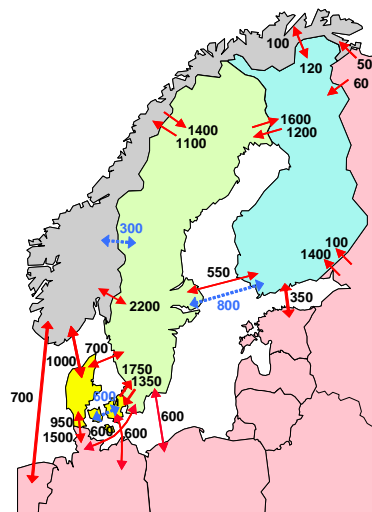
3 years...previous day

Production and consumption are determined on the electricity market, a forecast is drawn up for consumption in the next day

previous day

Fingrid maintains system security and power balance

operating hour



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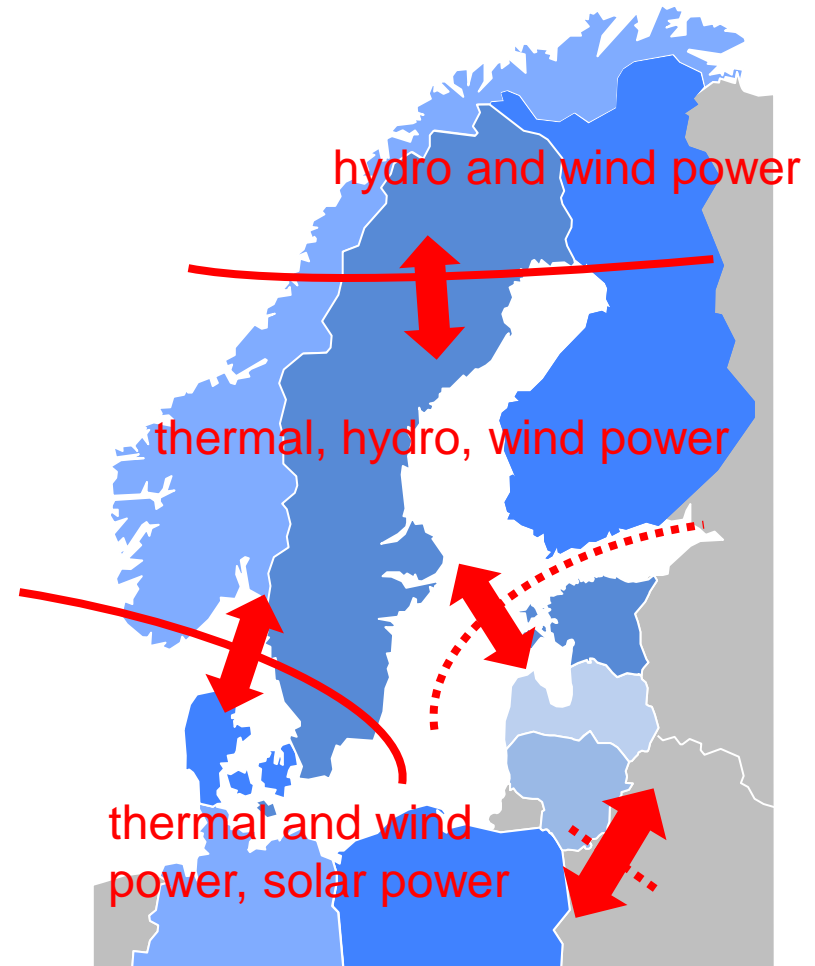
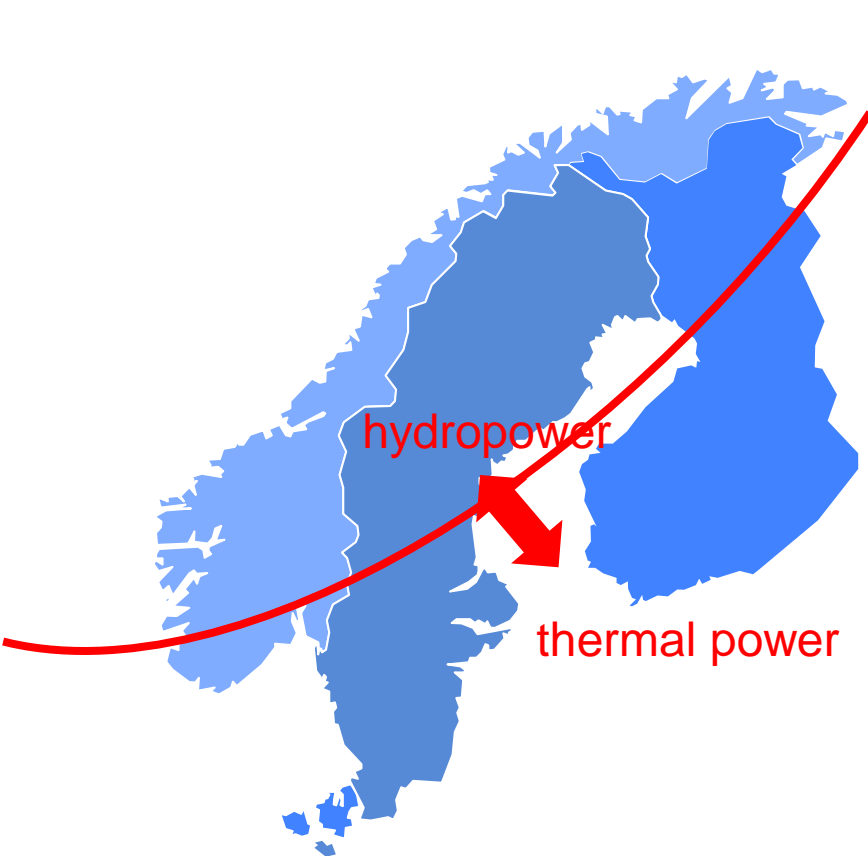
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Old challenges: changes depending on season and hydro situation

New challenges: daily and hourly changes



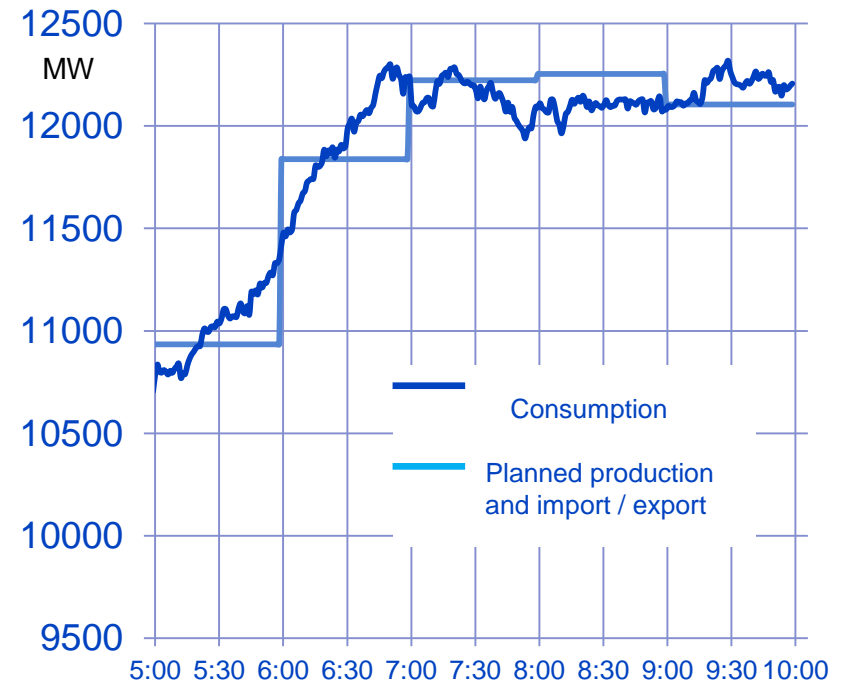
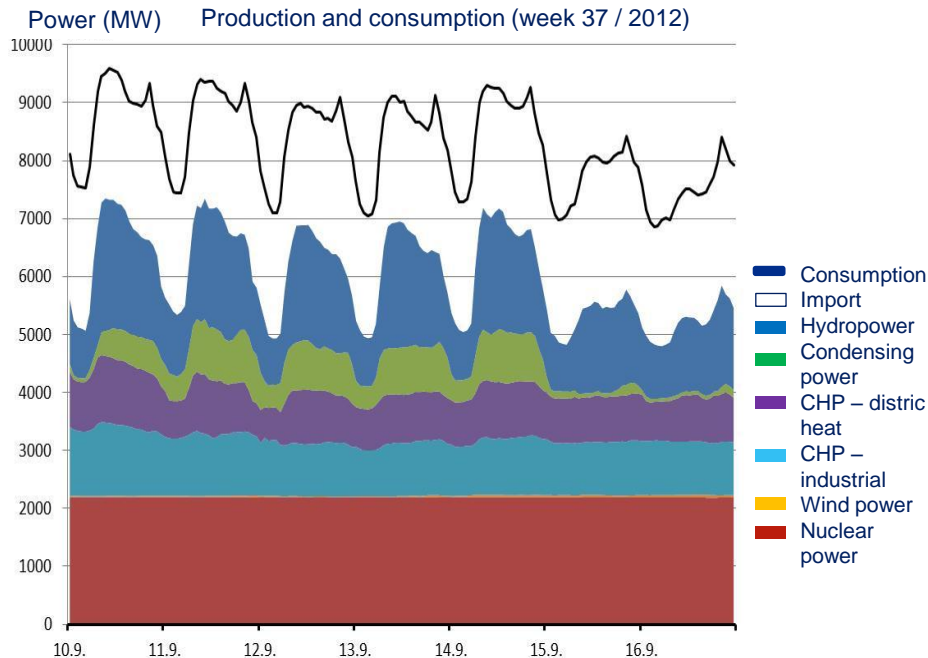
# Balance between production and consumption must be kept in any moment!

## Daily changes

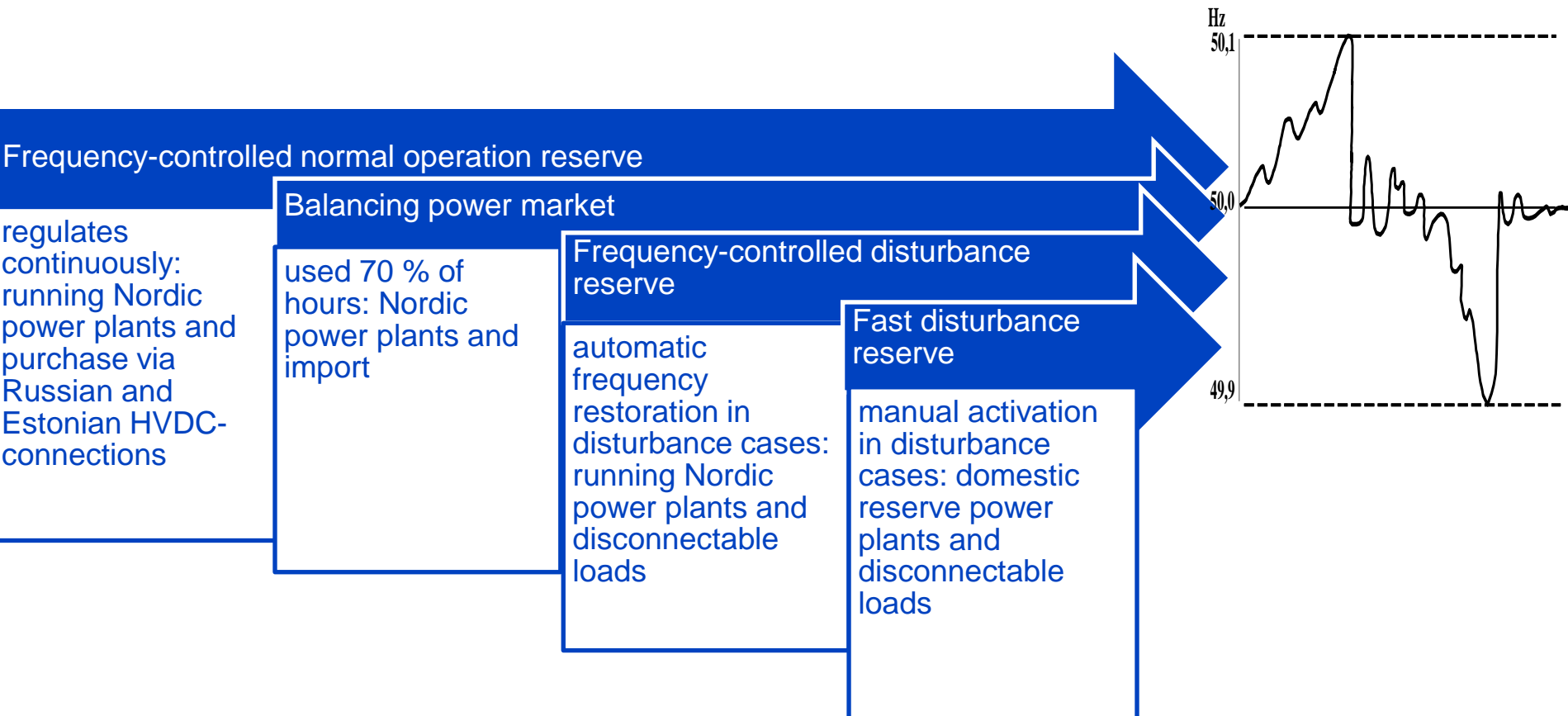
Responsibility: Market participants

## Changes during operating hour

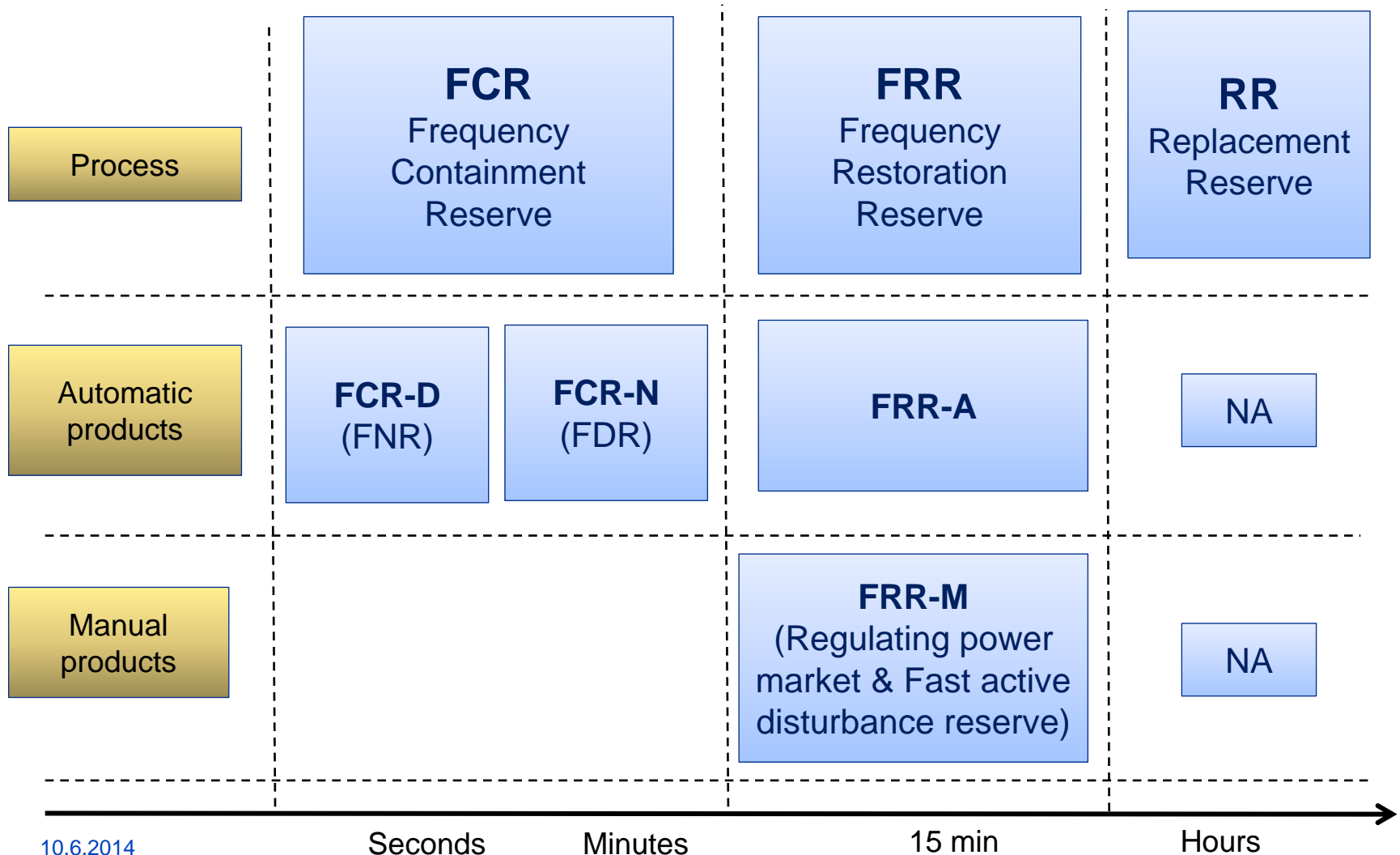
Responsibility: Fingrid



# Balance during operating hour is maintained by using reserves and balancing power market



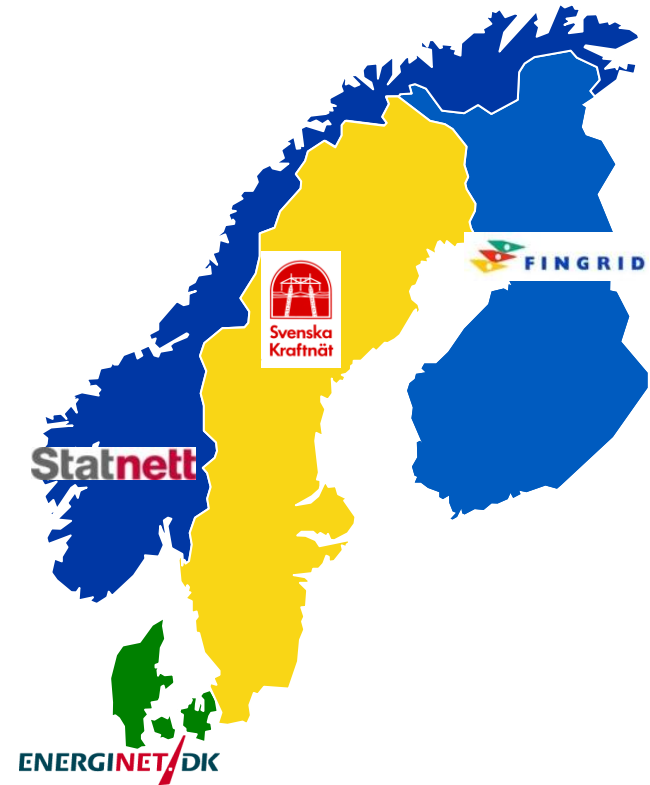
# Reserve products in the Nordic power system





# The Nordic countries have common reserves!

- The Nordic countries have agreed commonly the total amount and obligations by country
- Each TSO maintains agreed share
- Reserves can be exchanged between TSO's
- Certain amount of reserves have to be maintained nationally to secure operation also in rare disturbance cases, when a country is separated from other parts of common system



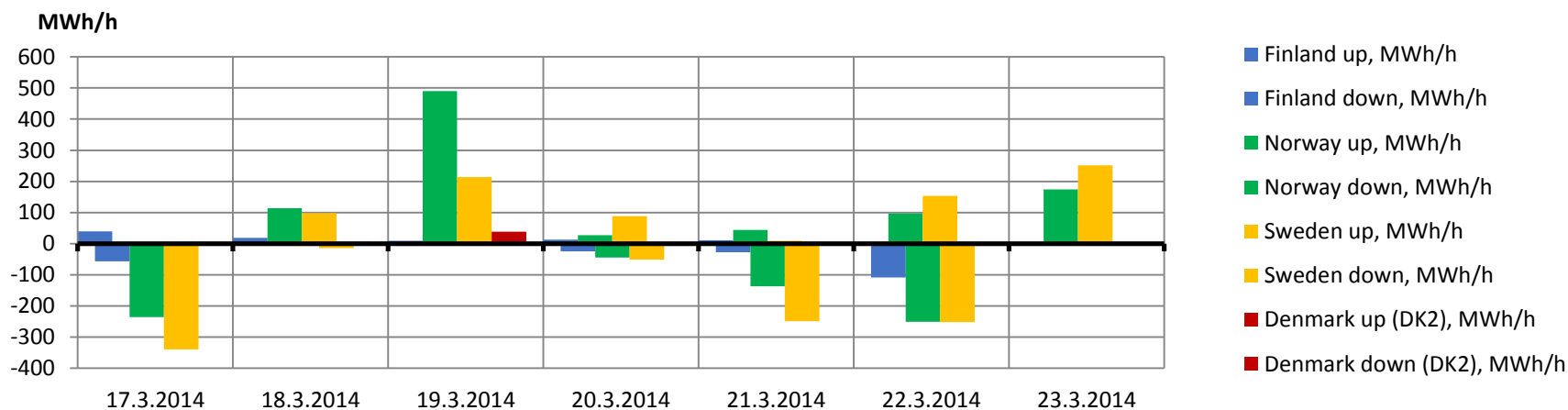
# Reserve obligations for 2014

Reserve product	Finland	Total amount in Nordic
Frequency Containment Reserve for Normal operation (FCR-N)	138 MW	600 MW
Frequency Containment Reserve for Disturbances (FCR-D)	about 260 MW	about 1200 MW
Automatic Frequency Restoration Reserve (FRR-A) (test period)	69 MW	about 300 MW
Manual Frequency Restoration Reserve (FRR-M)	about 880 MW	about 4000 - 4500 MW

# Nordic Regulation Power Market



- A common market
- Both production and consumption can participate
- Minimum bid 10 MW
- Activation time 15 minutes
- Dominated by hydropower, especially in Norway and Sweden



# Many types of reserves are needed



## 1. Frequency controlled normal operation reserve

- keeps the frequency automatically within the normal limits
- Nordic obligation on Finland: ca140 MW
- power plants, Russian connection, Estlink

## 2. Frequency controlled disturbance reserve

- corrects the frequency automatically in a disturbance situation
- Nordic obligation on Finland: 220-240 MW
- power plants and industrial loads which can be shed

## 3. Fast disturbance reserve

- activated manually in a disturbance situation in 15 minutes
- Nordic obligation on Finland: a volume corresponding to a dimensioning fault, approx. 900 MW
- Fingrid's own and rented gas turbines and industrial loads which can be shed, approx. 1,000 MW

# Many types of reserves are needed

## **4. Regulating power market**

- used almost every hour to supplement frequency controlled reserves
- players can offer their available capacity (min. 10 MW)
- activated manually in 15 minutes
- Nordic market

## **5. Peak power**

- procedure based on the Power Reserve Act for the peak consumption period in the winter
- agreements on 600 MW of reserves with producers
- starting time 12 hours
- started in a strained power situation



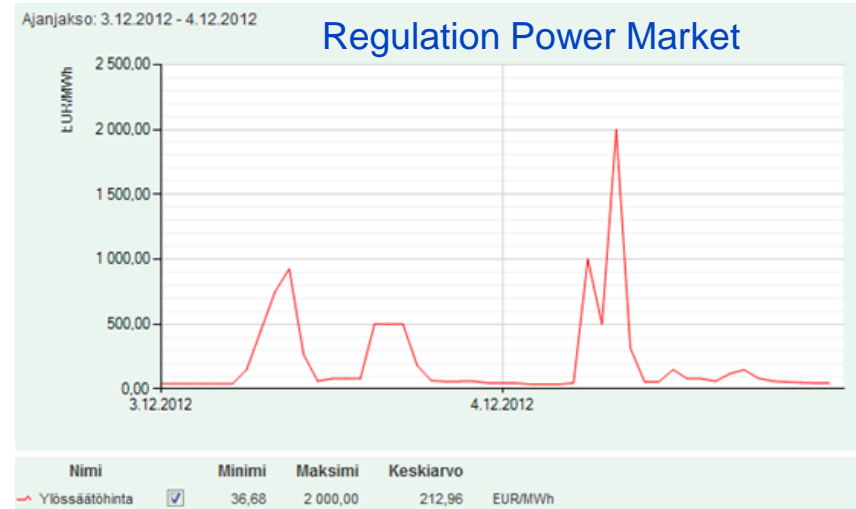
# Power system needs more flexibility in the future!



The amount of non-price sensitive production is increasing.



High price peaks exist, especially in regulation power market. Probably also more negative prices in the future!



# Summary

- The change in production structure brings new challenges for balancing production and consumption in Finland
- Increasing transmission capacities between countries makes possibilities for a wider co-operation in reserve exchange
- Challenges remain to keep good frequency quality in the power system. There is a need for better co-operation, planning and sufficient amount of flexible capacity capable of fast changes
- Because of its good regulation capabilities, hydropower is one of the essential sources for the need of power system reserves



# Powering Finland.

