Energy balances 2011

Power balances 2011/2012

May 2008

CONTENTS

Prepared by Nordel's Balance Group May 2008

SUMMARY OF THE FORECASTS

Energy balance 2011

The annual electricity consumption in the Nordic market is estimated to grow to about 420 TWh by the end of year 2011 from 398 TWh in 2007 (not temperature corrected, including electrical boilers). The production in the Nordic market in a year with normal conditions is estimated to be 421 TWh in year 2011.

Power balance 2011/12

The Nordic peak demand in a winter with normal temperature (1 of 2 years) is estimated to 70 300 MWh/h. The Nordic peak demand in a cold winter (1 of 10 years) is estimated to 73 900 MWh/h. All time high is 69 000 MWh/h (February 2001).

New production

Investments in production capacity by the end of 2011 are estimated to increase the installed production capacity by about 7 000 MW. The decided and planned investments would increase the production capability by about 41 TWh/a, including the new nuclear unit in Finland, 13 TWh/a.

The new nuclear unit in Finland is expected to be in operation in 2011, and is included in the energy balance (part of the year) and in the power balance 2011/2012.

Iceland is presented separately and it is not included in the other figures.

CONCLUSIONS

Energy balance 2011

The Nordic electricity system is able to meet the estimated consumption and the corresponding typical power demand pattern in average conditions even without imports.

The energy balance in 2011 is better than the former Nordel estimates. This is due to (1) investments in new generation capacity and (2) adjusted prognosis for temperature and precipitation, which leads to lower consumption and higher hydro production.

In order to meet the energy demand in low inflow conditions the Nordic power system needs to import from neighbouring countries. Some areas in Norway can be exposed to a risk of rationing in case of extremely low precipitation.

Power balance 2011/12

The Nordic power system is sufficient to handle the peak demand situation even in very cold conditions (1 of 10 years). As for the energy balance the power balance has improved due to investments in new generation capacity.

In practice, the balance between Nordic supply and import/export will be based on the prevailing market situation between the Nordic electricity market and the neighbouring markets.

Security of Supply 2011/12

Analysis on security of supply show that all the Nordic countries fulfil the criteria of Nordel for both normal winter temperatures and ten year winter temperatures.

Chapter 1

FORECASTS

CONSUMPTION

	Energy 2007 TWh/a	Energy 2011 TWh/a	All time peak MWh/h	Peak 2011/12 MWh/h Cold
Denmark	36.1	39	6 480	7 300 1)
Finland	90.3	95	14 900	15 800 1)
Norway	127.4	133	23 050	24 000 1)
Sweden	146.4	153	27 300	28 500 1)
Nordel	400.2	420	69 000	75 600 2)

1) Probability once in 10 years

2) The peak for the whole system is calculated to be 97,7 % of the sum of the country specific peak.

NET ADDITIONS IN GENERATION CAPACITY [MW]
2008 to 2011 (decided and planned)

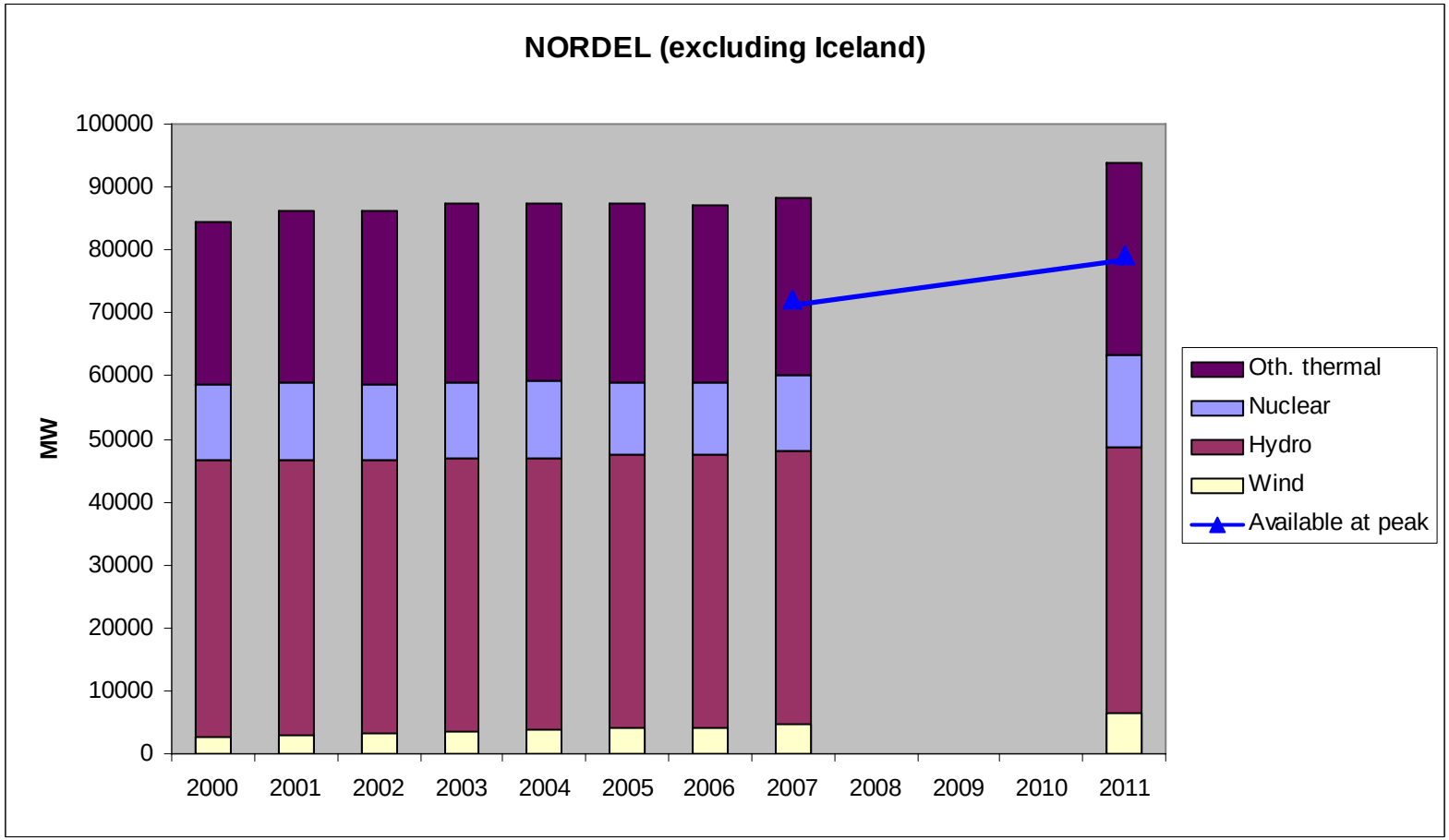
	Hydro	Nuclear	Other thermal	Wind	Installed capacity	Available capacity at peak[2)]	Investment decided
Denmark			36	512	548	36	90 %
Finland	90	1650	520	40	2300	2260	95 %
Norway	600		280	320	1200	880	75 %
Sweden		1165	1000	1240	3405	2165	50 %[1)]
Nordel	690	2815	1836	2112	7453	5341	

1) Many small projects (green certificates)

2) Available wind capacity at peak is 0% for each country but 6% for Nordic countries together

INSTALLED PRODUCTION CAPACITY

(at the end of year)



CHANGES IN INTERCONNECTIONS

Interconnections

New interconnection between Norway and the Netherlands (NorNed, commissioned in May 2008) has increased the transmission capacity to outside Nordel by 700 MW.

The five prioritised Nordic grid investments are scheduled as followed:

Nea – Järpströmmen, 420 kV line between Norway and Sweden is expected to be commissioned in autumn 2009.

Great Belt, 600 MW connection between Eastern and Western Denmark, is expected to be commissioned 2010.

Fenno-Skan 2, 800 MW new capacity on the connection between Finland and Sweden, is expected to be commissioned at the end of 2011.

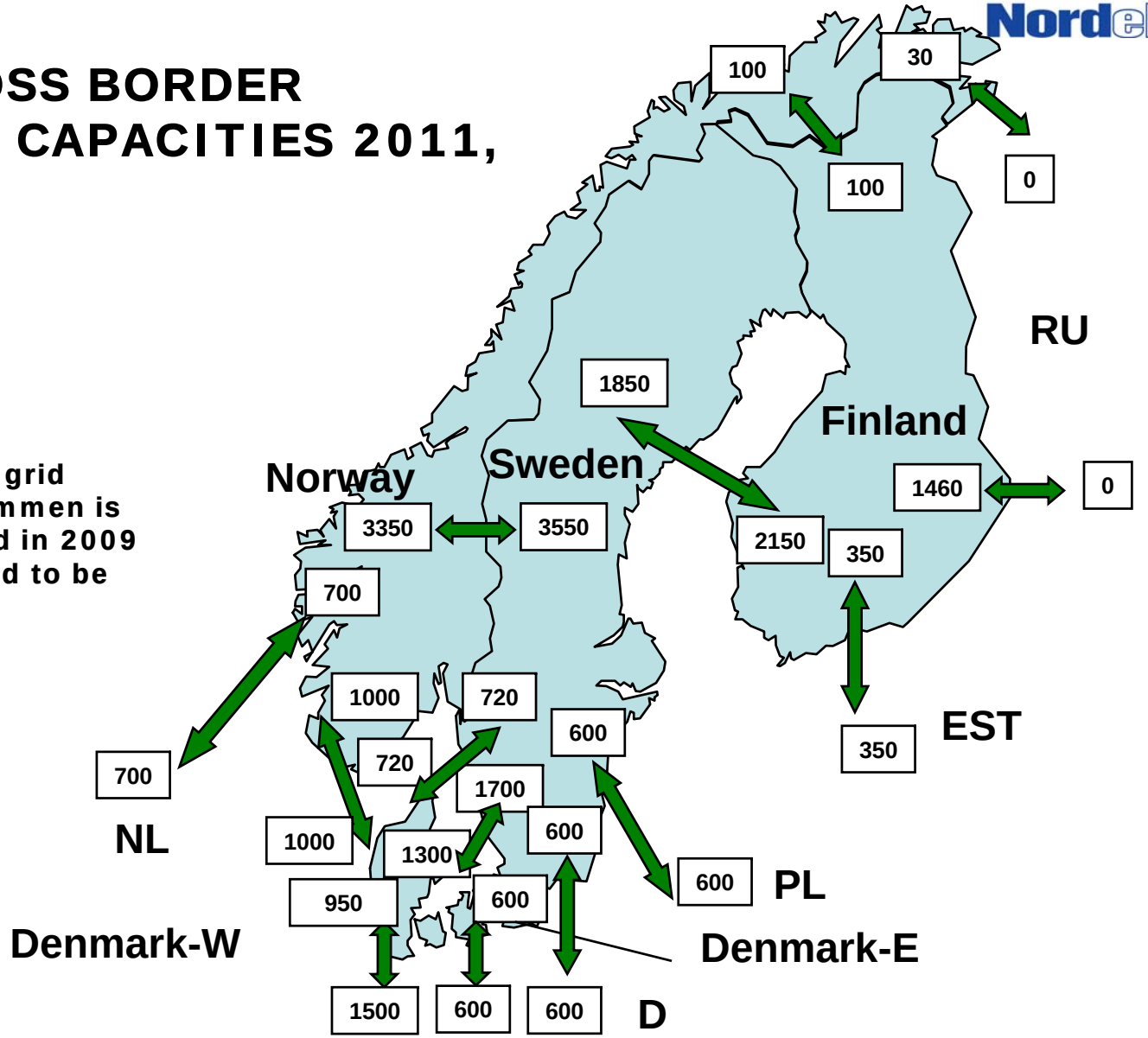
SouthWest link (earlier South link), a new project proposed in Nordic Grid Master Plan 2008. HVDC-link Southern Sweden – Norway.

Skagerrak 4, a Letter of Intent for the project is signed. According to the time schedule connection can be commissioned earliest in 2014.

The interconnection between Jutland and Germany is expected to be upgraded to 1500 MW northbound and 2000 MW southbound by the end of 2011.

AVAILABLE CROSS BORDER TRANSMISSION CAPACITIES 2011, MW

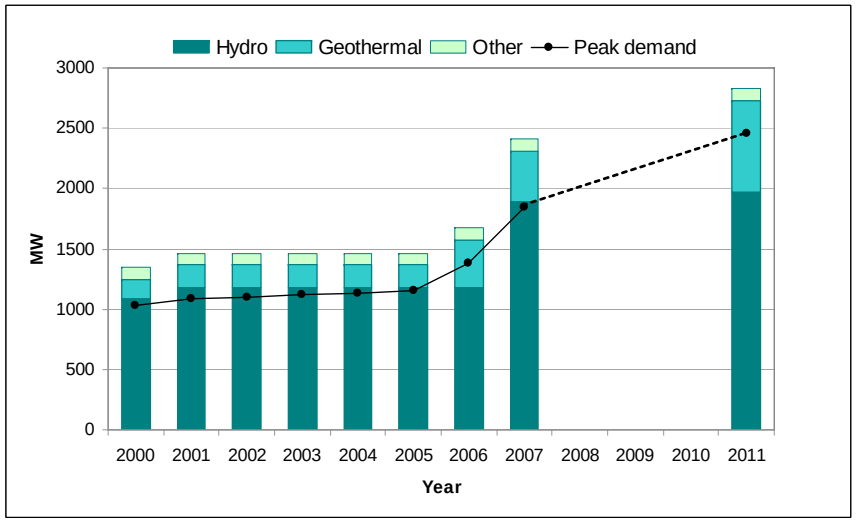
Of the five prioritised Nordic grid investments, Nea – Järpströmmen is expected to be commissioned in 2009 and the Great Belt is expected to be commissioned in 2010.

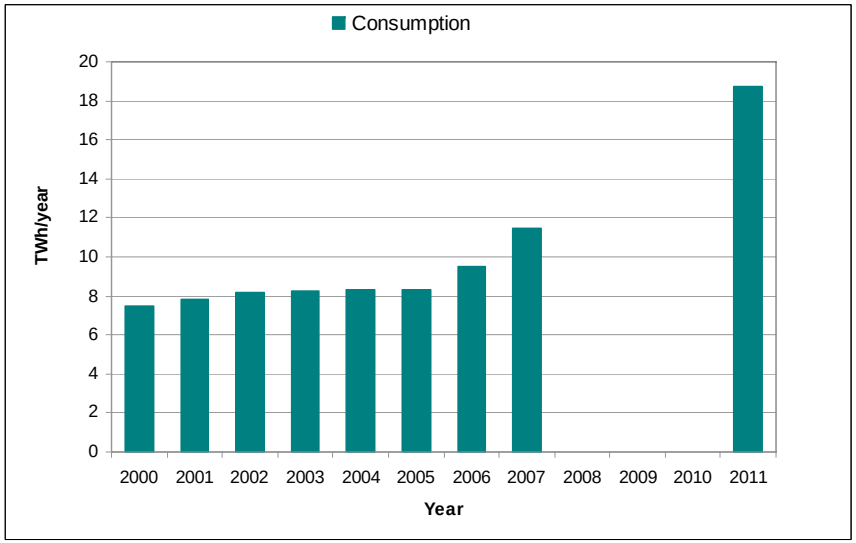


ICELAND

Iceland is not included in the figures elsewhere in the report.

The annual energy consumption in Iceland is estimated to grow by about 7.2 TWh by year 2011 (13 % / a) due to aluminium foil plant, new aluminium plant and data center to be started in the period from 2008 to 2010. The consumption growth will be balanced by existing plants, extensions in existing plants and new power plants.





Chapter 2

ENERGY BALANCES 2011

Energy balances

ENERGY BALANCE 2011
Average conditions

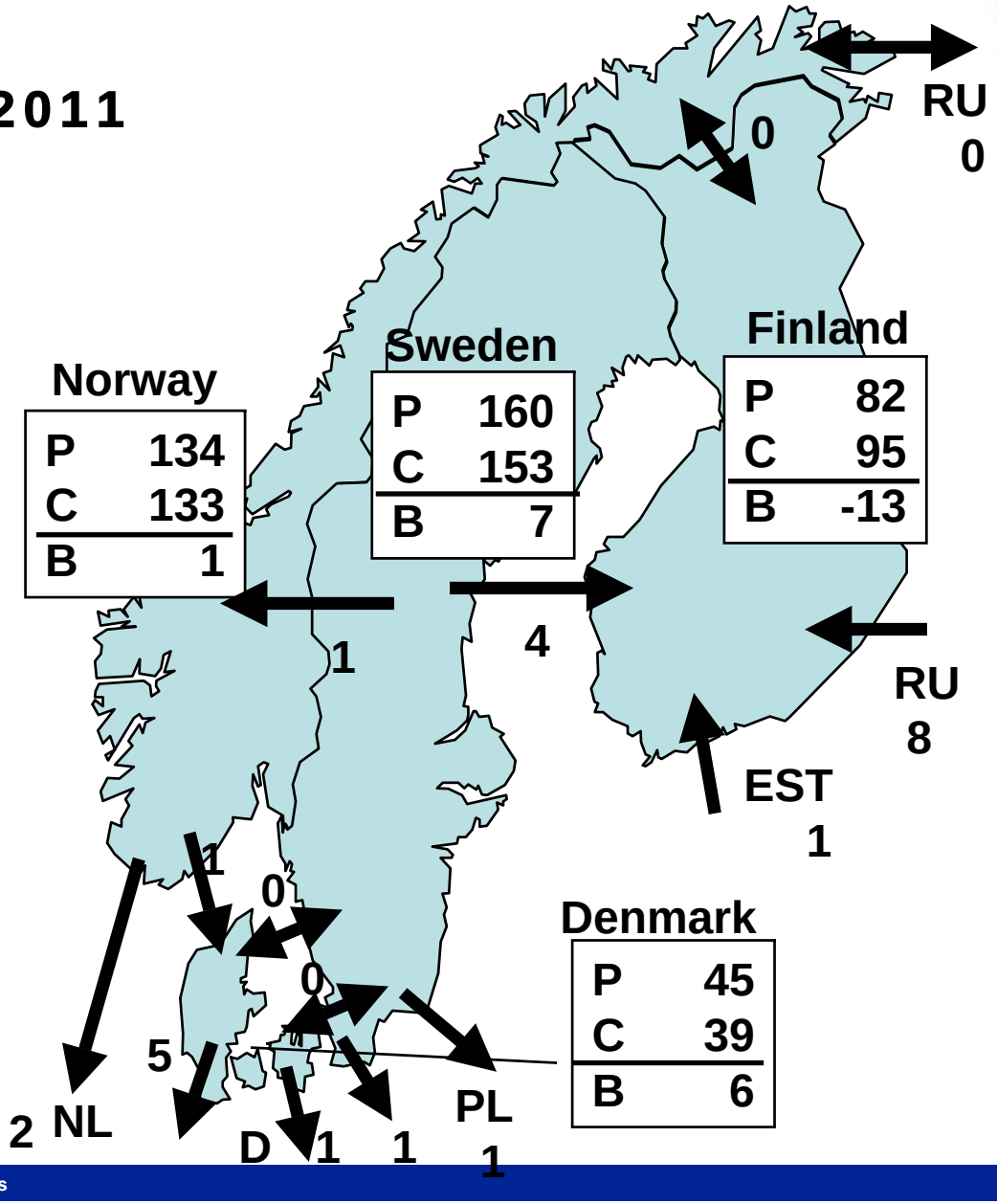
The *Energy Balance* on pages 14 to 15 illustrates the market-analysed physical exchanges between areas in a normal year. The exchange between the Nordic and Continental markets is based on market-analyses of the Nordic market and price forecast for the Continental market. The analysis assumes the fifth nuclear power plant in Finland coming in operation during the year.

- ⇨ **There is remarkable import from Russia.**
- ⇨ **Net export towards Central-Europe is increasing, with large export in peak situations and some import in off-peak situations.**
- ⇨ **It is expected that import from Estonia continues despite the closing of the nuclear power plant Ignalina in Lithuania 2009.**

ENERGY BALANCE 2011

Average of all inflow years

P = Production
C = Consumption
B = Balance without energy exchange
All units in TWh

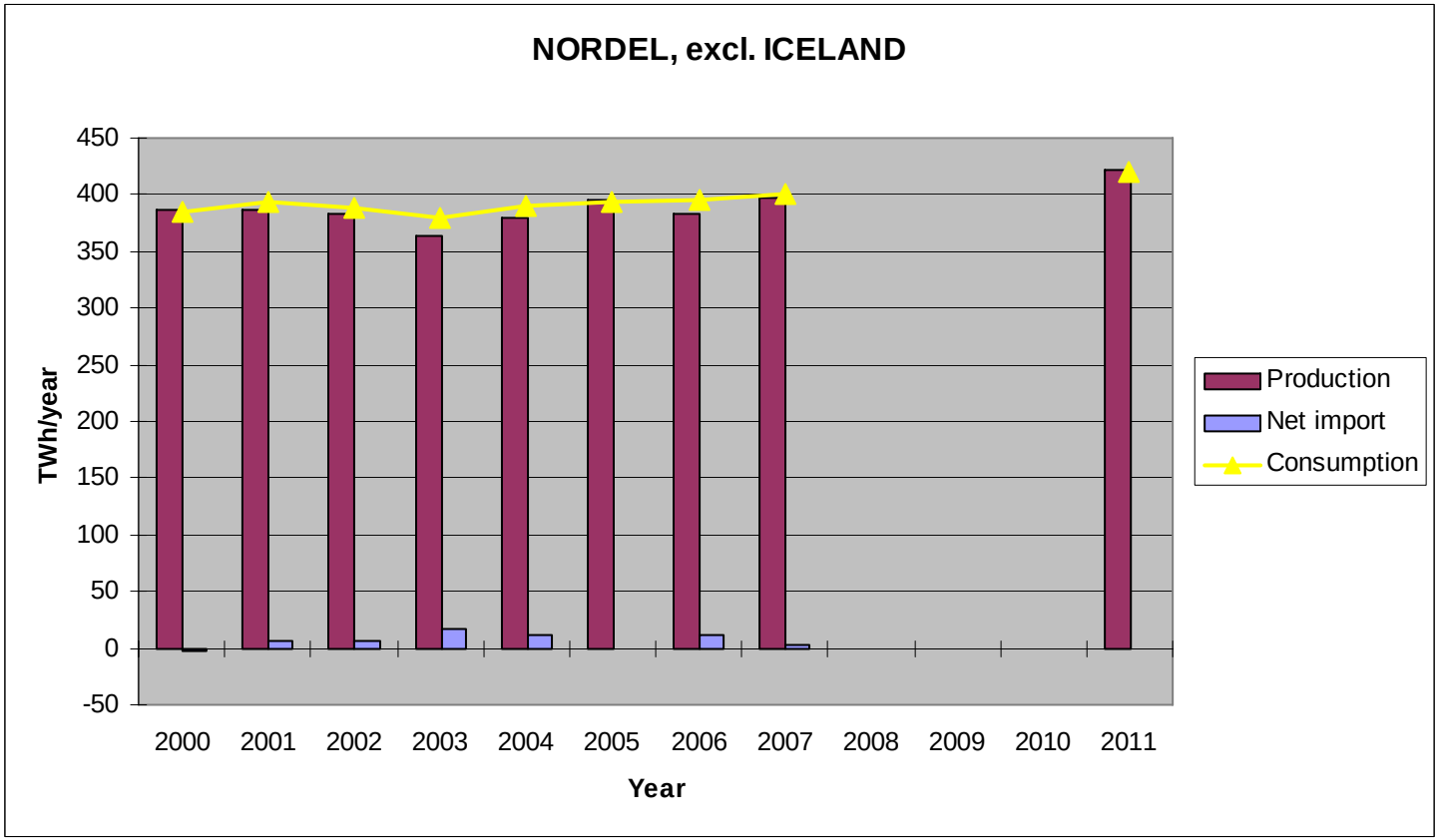


Nordel

P	421
C	420
	1

ENERGY BALANCE 2011

Average of all inflow years



2000 to 2007 actual values

ENERGY BALANCE 2011
Low inflow

The *Energy Balance* on page 17 illustrates the market balance in low inflow conditions (1 of 10 years). The inflow series used is 1978.

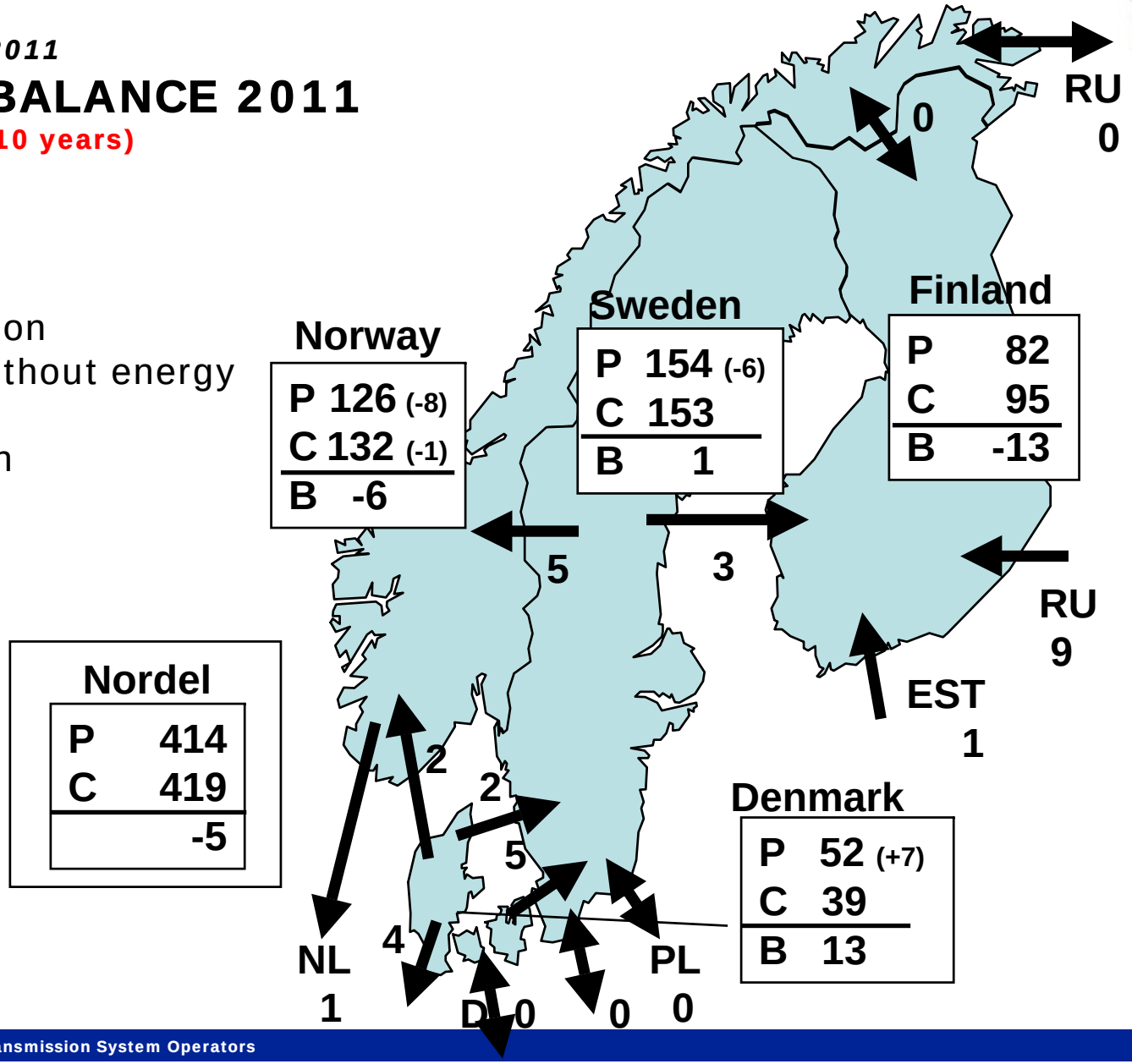
Compared to an average situation the analyses show:

- **hydro production is decreased by 18 TWh**
- **thermal production is increased by 12 TWh**
- **demand is decreased by 1 TWh (demand response)**
- **import from outside is increased by 6 TWh**

ENERGY BALANCE 2011

Low inflow (1 / 10 years)

P = Production
C = Consumption
B = Balance without energy exchange
All units in TWh



ENERGY BALANCE 2011
Extremely low inflow

The *Energy Balance* on page 19 illustrates the market balance in a year with extremely low inflow conditions (1 of 50 years). The year used is 1970 which followed another low inflow year 1969.

Compared to an average situation the analyses show:

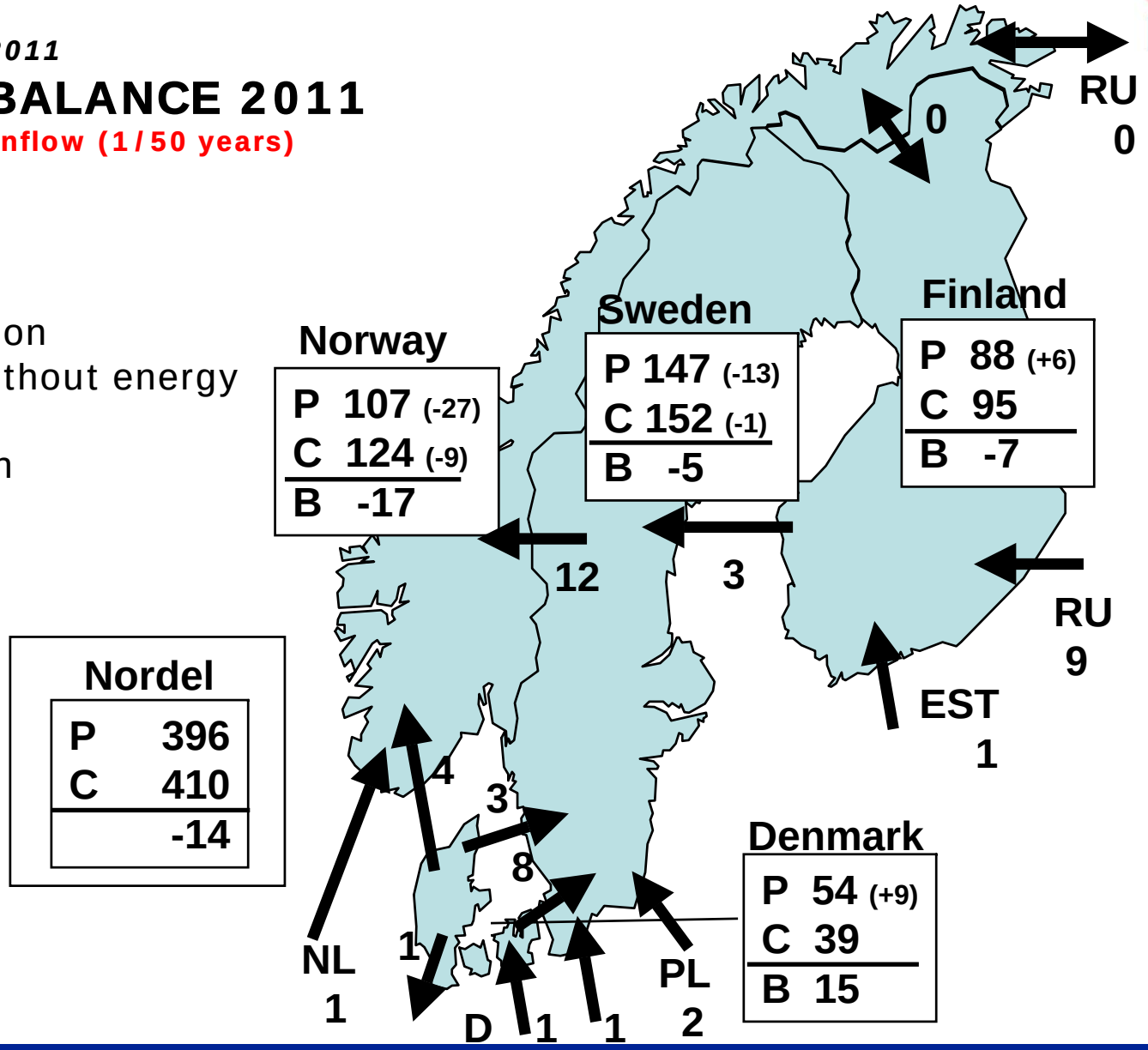
- **hydro power production is decreased by 44 TWh**
- **thermal production is increased by 21 TWh**
- **demand is decreased by 10 TWh (demand response, depends however on economical cycles)**
- **import from outside is increased by 15 TWh**

⇨ **In a hydro-based system the market price can be very high during dry years.**
⇨ **Some areas in Norway can be exposed to a risk for rationing or other measures in case of extremely low precipitation.**

ENERGY BALANCE 2011

Extremely low inflow (1/50 years)

P = Production
C = Consumption
B = Balance without energy exchange
All units in TWh



Chapter 3

POWER BALANCES 2011/12

AVAILABLE POWER CAPACITY AND PEAK DEMAND 2011/12

Average winter temperatures

The maximum available production capacity exceeds the peak demand by over 7 000 MWh/h. Both sum of national peak demands and simultaneous peak demand is used in the forecasts. The simultaneous peak is estimated to be 1600 MWh/h lower. Considering this the capacity margin is even bigger and exceeds export capacity outside the area.

- ⇨ **Peak load situation is, like last years balance, remarkably easier than in previous power balances due to investments in new generation capacity .**
- ⇨ **Every Nordic country is able to meet an average winter day peak demand with its own production capacity. As a whole the Nordic area is able to export to the continental market during the peak load.**
- ⇨ **New nuclear unit in Finland is included in the power balance. This gives a positive balance also for Finland.**

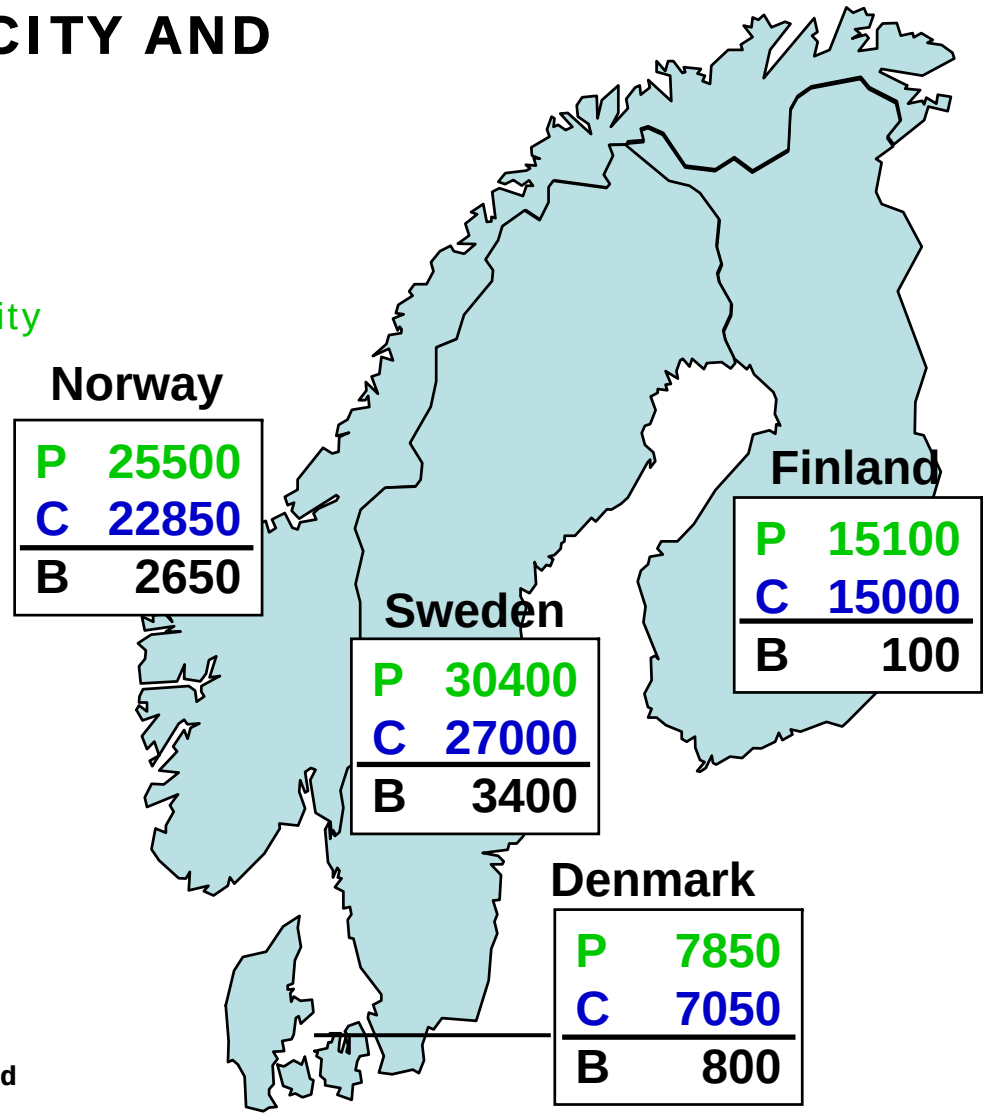
AVAILABLE POWER CAPACITY AND PEAK DEMAND 2011/12

No exchange between areas

Average winter temperatures

P - maximum available production capacity (operational reserves excluded)
C - peak demand in each country
B - power balance

All units in MWh/h



Nordic peak values[1]

P	79200
C	70300
B	8900

[1] Total Nordic values with coincident factors for both wind and demand

AVAILABLE POWER CAPACITY AND PEAK DEMAND 2011/12

Cold winter day

The national peak demands correspond a probability of once in ten years.

The sum of peak demands in cold conditions is estimated to be 3750 MWh/h higher than in average temperature conditions. The simultaneous peak is estimated to be 1750 MWh/h lower. The power balance is expected to be positive for the Nordic countries in this situation.

⇨ **Nordic production capacity is sufficient to cover the simultaneous peak demand without import.**

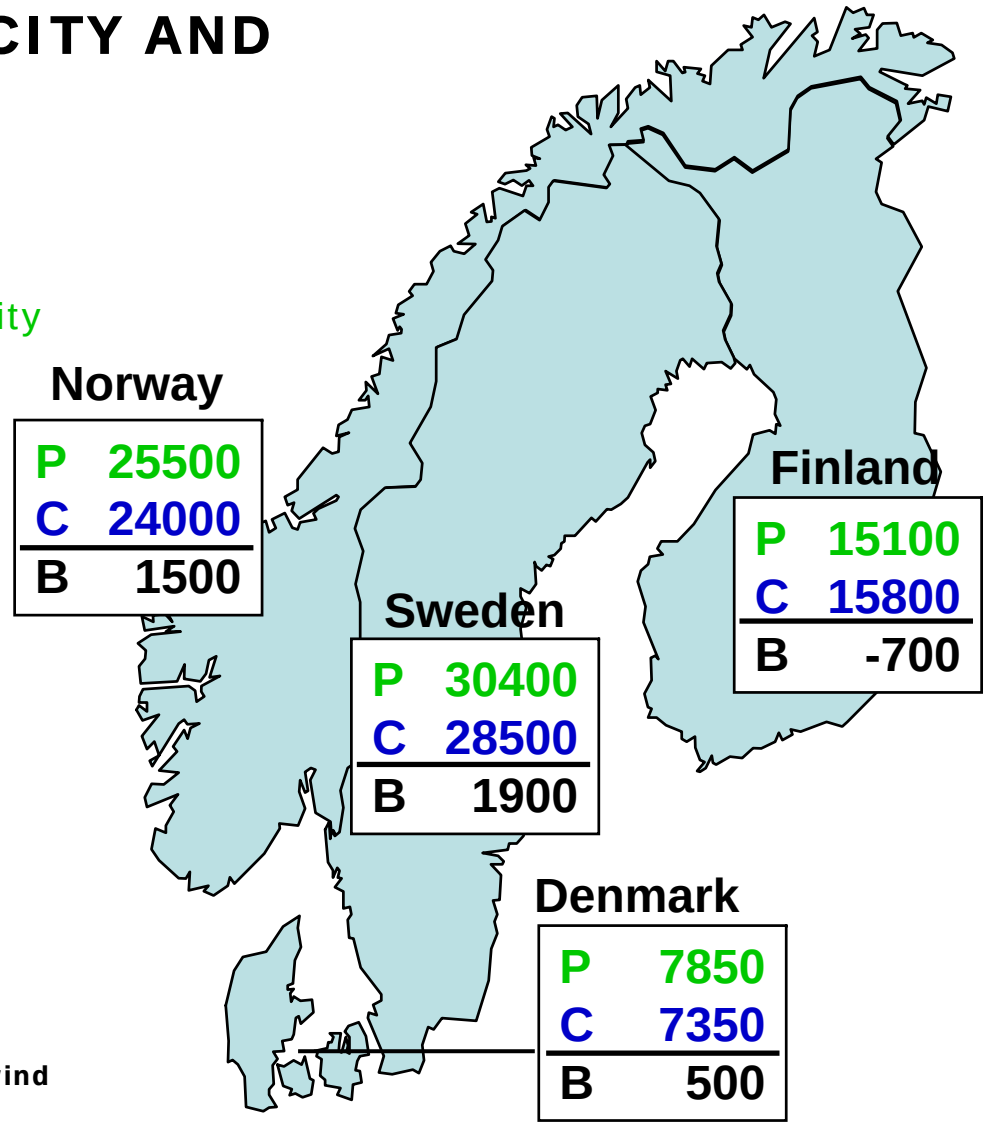
AVAILABLE POWER CAPACITY AND PEAK DEMAND 2011/12

No exchange between areas

Cold winter day (1 of 10 years)

P - maximum available production capacity (operational reserves excluded)
C - peak demand in each country
B - power balance

All units in MWh/h



Nordic peak values[1]

P	79200
C	73900
B	5300

[1] Total Nordic values with coincident factors for both wind and demand

Chapter 4

SECURITY OF SUPPLY

SECURITY OF SUPPLY

MARKET FAILURE AND SYSTEM FAILURE 2011/12

The probability of market failure is calculated as the expected probability that supply and demand do not meet in the day ahead spot market. Production units used for system reserves are not taken into account.

The probability of system failure is calculated as expected loss of load probability, which is the probability that loads have to be disconnected to maintain system security. In this calculation only 1500 MW in total are kept for disturbance reserves for system security.

The calculations are made taking internal transmission capacities between areas into account. The Nordel region (excl. Iceland) consists of the usual 17 areas in these calculations.

Import possibilities from neighbouring systems are assumed to be half of the existing capacity.

The calculations are done for three scenarios:

- ⇨ **Load level corresponding to average winter temperature (1 of 2 years)**
- ⇨ **Load level corresponding to cold winter temperature (1 of 10 years)**
- ⇨ **Largest type of nuclear power plant out of operation during normal winter conditions (Common mode failure, Nuclear BWR units in Finland and Sweden, 8953 MW)**

SECURITY OF SUPPLY

MARKET FAILURE AND SYSTEM FAILURE 2011/12

Conclusions:

- **The probability of market failure is below the required 1 ‰ in all areas during normal winter temperatures and during ten year winter temperatures. The probability of market failure also stays well below 1 ‰ even without import from outside Nordel.**

- **During normal winter temperatures, the margins to the tolerated 1 ‰ probability of market failure are between 2200 and 3000 MW in Norway, Finland and Sweden. In Denmark the margin to market failure is 1000 MW.**

- **In the unlikely event that approximately 9000 MW nuclear units in Finland and Sweden are shut down due to a common mode failure, the probability of market failure is higher than 1 ‰ in mid and southern Sweden. This means that in order to solve the situation some of the operational reserves have to be used.**

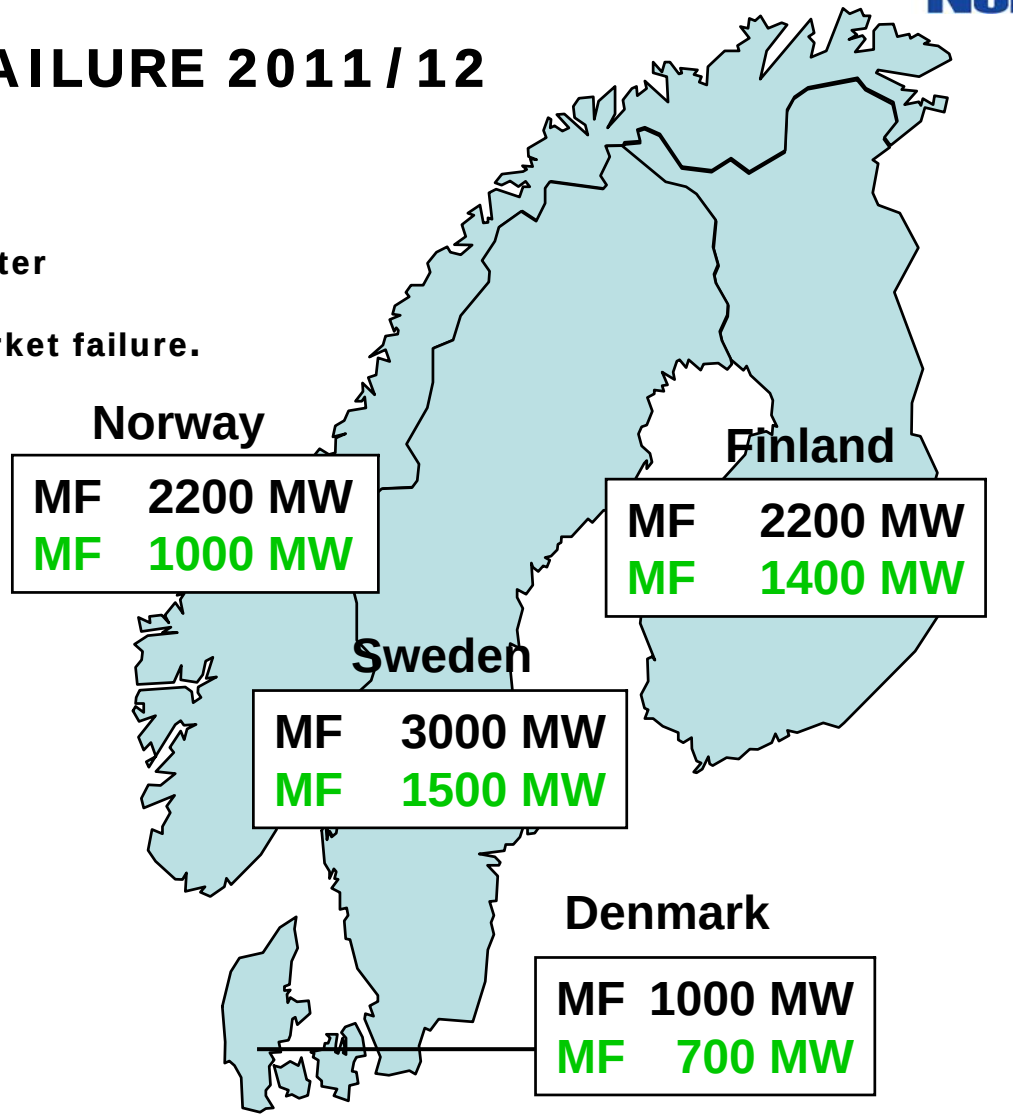
All the Nordic countries fulfil the criteria of Nordel for security of supply.

MARGIN TO MARKET FAILURE 2011/12

Average winter and cold winter

MF - Margin to market failure average winter
MF - Margin to market failure cold winter
Margin to Nordel's criteria of 1 ‰ for market failure.

In a market failure situation the supply capability is not sufficient to meet the demand in the day ahead market without use of some system reserves.

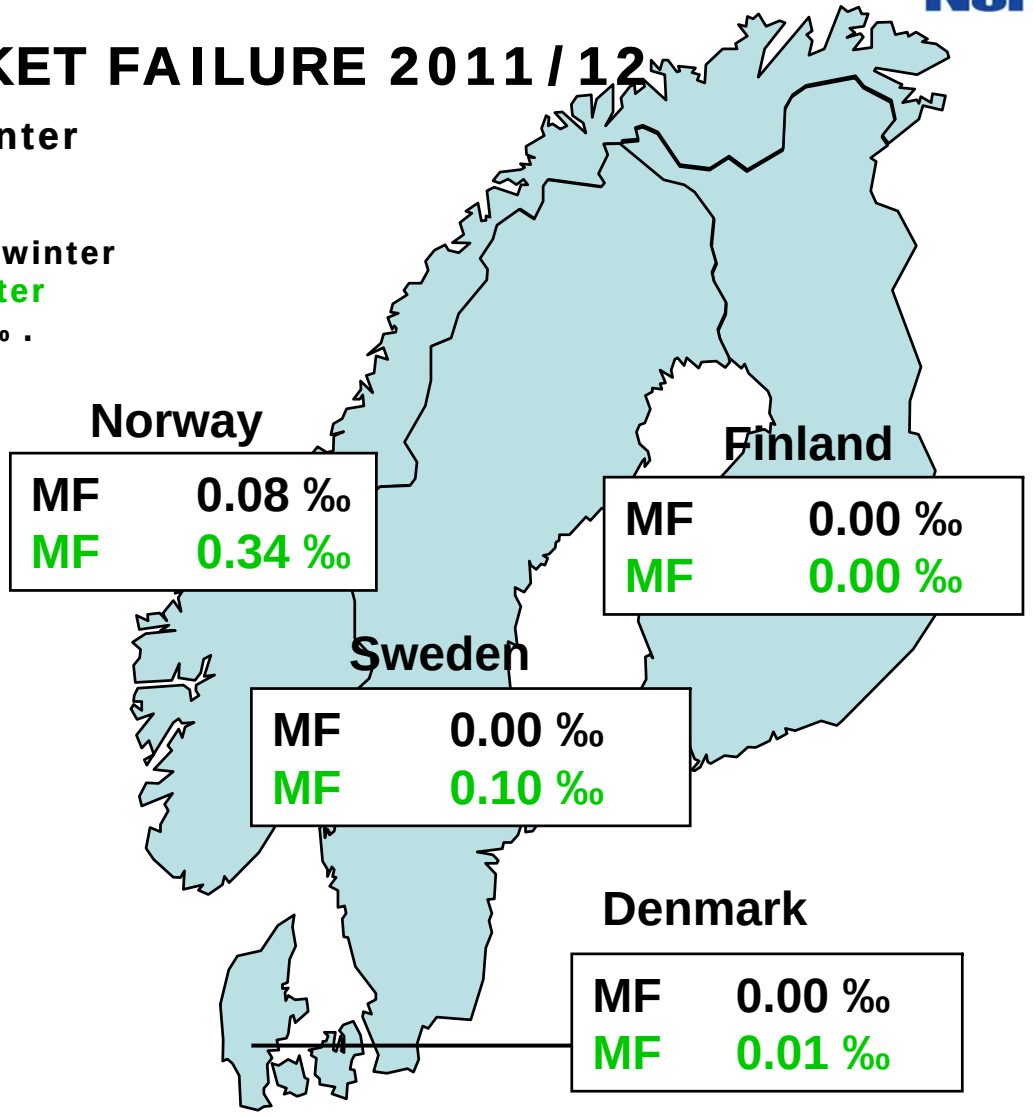


PROBABILITY OF MARKET FAILURE 2011/12

Average winter and 10 years winter

MF - Probability of market failure average winter
MF - Probability of market failure cold winter
Nordel's probability criteria maximum 1 ‰ .

In a market failure situation the supply capability is not sufficient to meet the demand in the day ahead market without use of some system reserves.

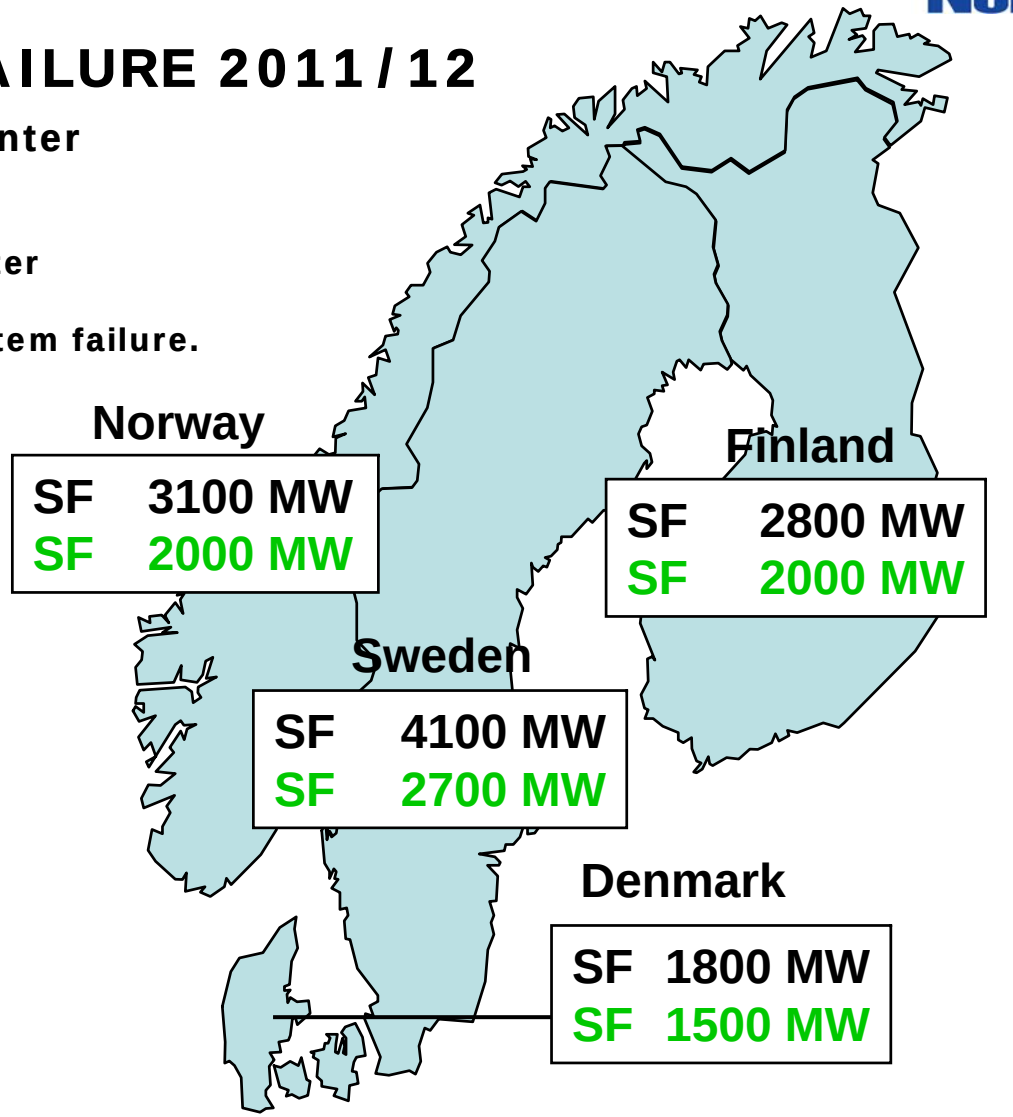


MARGIN TO SYSTEM FAILURE 2011/12

Average winter and 10 years winter

SF - Margin to system failure average winter
SF - Margin to system failure cold winter
Margin to Nordel's criteria of 1 ‰ for system failure.

In a system failure situation the supply capability is not sufficient to meet the demand in the operational hour without disconnection of some load. The system reserves (except 1500 MW) are included in the supply capability.

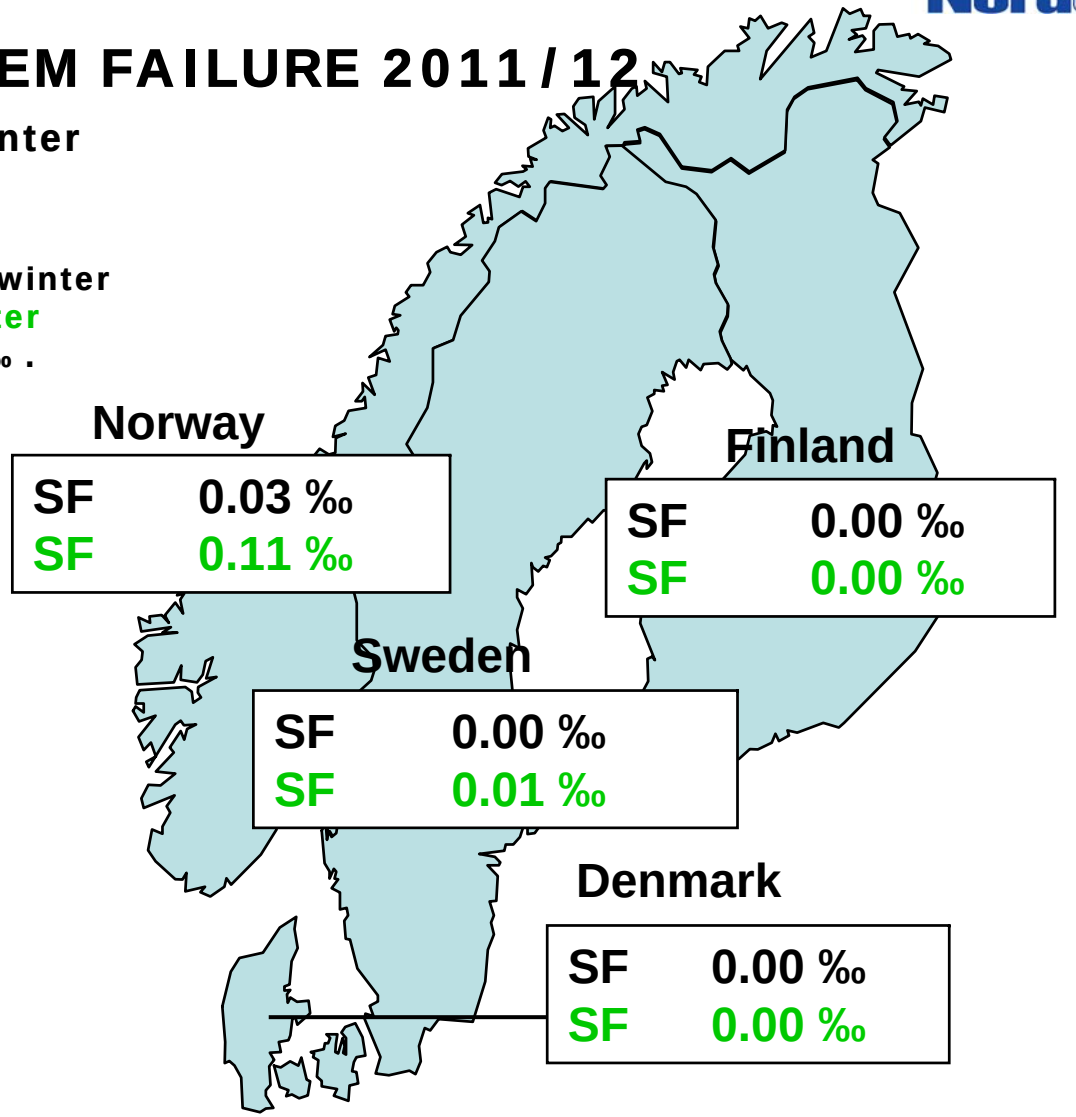


PROBABILITY OF SYSTEM FAILURE 2011/12

Average winter and 10 years winter

SF - Probability of system failure average winter
SF - Probability of system failure cold winter
Nordel's probability criteria maximum 1 ‰ .

In a system failure situation the supply capability is not sufficient to meet the demand in the operational hour without disconnection of some load. The system reserves (except 1500 MW) are included in the supply capability.



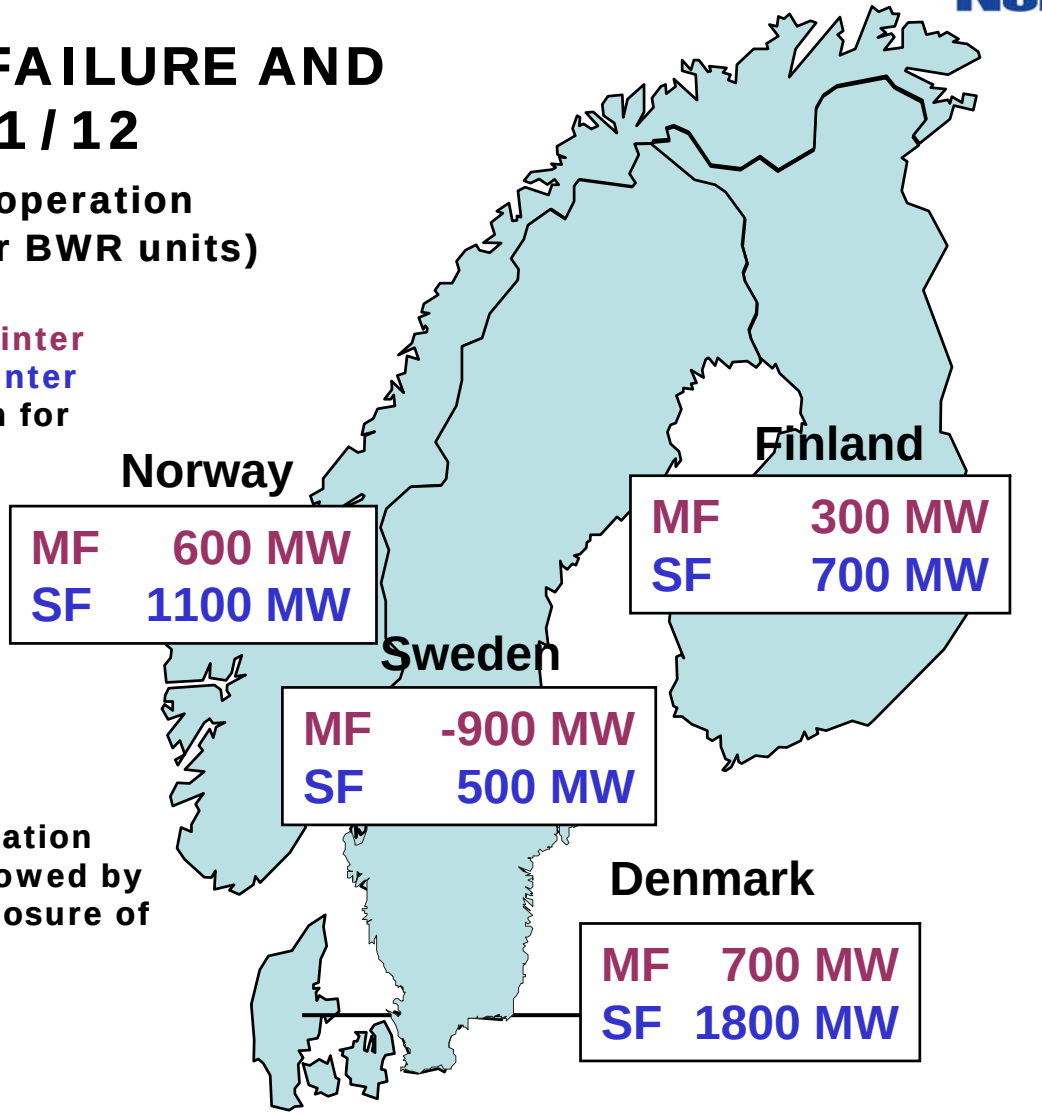
MARGIN TO MARKET FAILURE AND SYSTEM FAILURE 2011/12

9000 MW nuclear units out of operation
(Common mode failure, Nuclear BWR units)

MF - Margin to market failure average winter
SF - Margin to system failure average winter
Margins to Nordel's criteria of 1 ‰ both for market failure and system failure.

The scenario is very unlikely and has a very low probability. In order to solve the situation some of the system reserves have to be used.

Common mode failure describes the situation when a failure in one power plant is followed by a (for security reasons) governmental closure of all similar power plants.



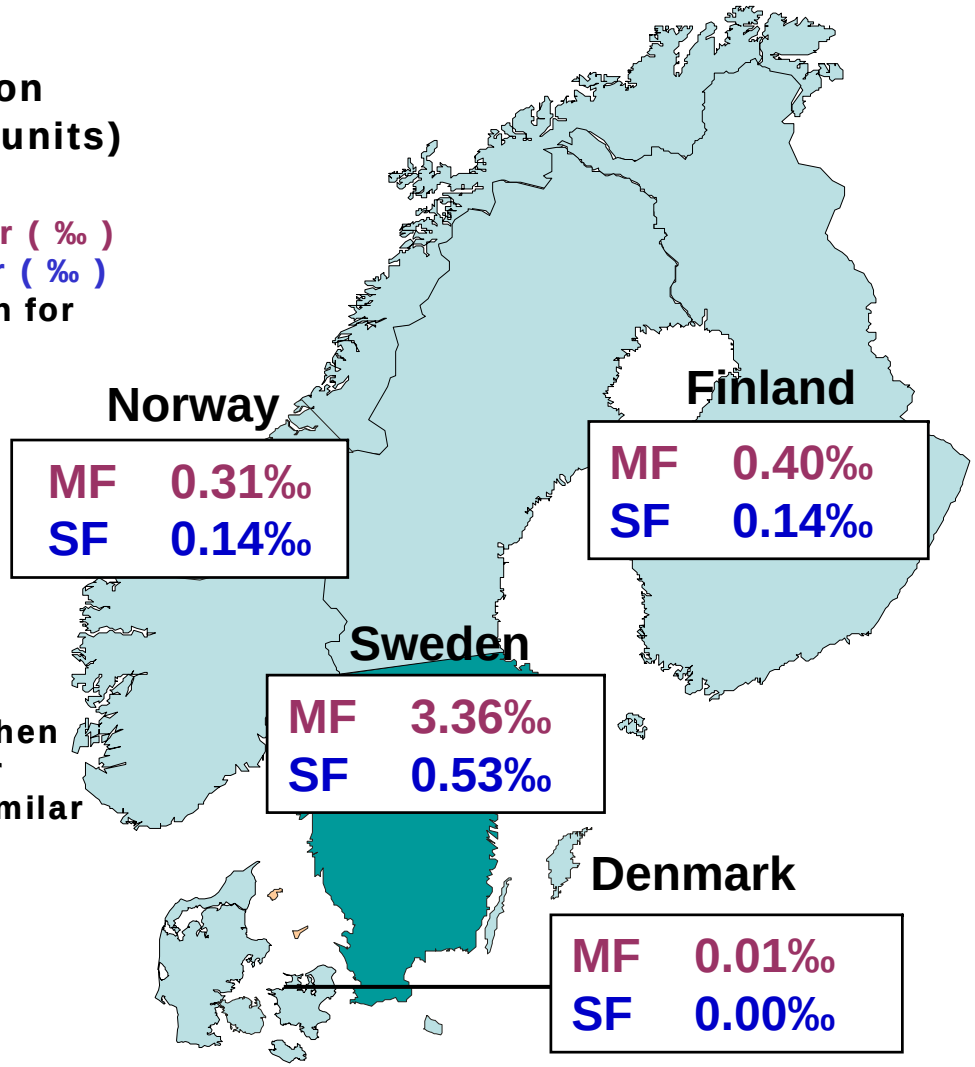
PROBABILITY OF MARKET FAILURE AND SYSTEM FAILURE 2011/12

9000 MW nuclear units out of operation
(Common mode failure, Nuclear BWR units)

MF - Probability of market failure average winter (‰)
SF - Probability of system failure average winter (‰)
Nordel's probability criteria maximum 1 ‰ both for market failure and system failure.

The scenario is very unlikely and has a very low probability. In order to solve the situation some of the system reserves have to be used.

Common mode failure **describes the situation when a failure in one power plant is followed by a (for security reasons) governmental closure of all similar power plants.**



APPENDICES

Appendix 1
ENERGY

Purpose

The purpose of this presentation is to give a picture of the energy balance for each country and the whole Nordic electricity market. Focus is set on production capacity and need for import from the neighbouring countries outside Nordel.

Definitions

Low inflow = There is a probability of 10 % to obtain energy below the estimated value.

Extreme low inflow = There is a probability of 2 % to obtain energy below the estimated value (1 of 50 years)

Fundamentals

The exchange between the Nordel countries are market based. Hence it is the spot price that decides flow directions and volumes. The exchange between the Nordel countries and its neighbours is developing towards a market based operation.
The method does not necessarily indicate possible problems in certain areas.
Forecasted consumption/demand includes demand response during extreme dry years.
Forecasted production in the energy balance does part of the year include the 5. nuclear plant in Finland.
Consumption/demand includes network losses.

Appendix 2.1
POWER

Definitions

Available capacity = installed capacity - unavailable capacity - reserves

Reserves = frequency controlled momentary and fast disturbance reserves.

Peak Demand = maximum one hour load in temperature circumstances with occurrence probability one winter during respectively two and ten years, denoted as an average winter day and a cold winter day.

Ten years winter. The peak demand is based on a temperature that has an occurrence of one out of ten years in each country separately. A simultaneous peak demand in all the countries at a working day has an occurrence probability less than 7 %.

Appendix 2.2
POWER

Fundamentals

Estimated power exchange takes into account limitations both in transmissions and production capabilities. The method does not necessarily indicate possible problems in certain areas.

Generation

Unavailable capacity is based on experiences from earlier peak demand situations. Not available hydropower is approximately 13 % (6000 MW) of installed capacity.
Nuclear power output is supposed to be 100 % of full capacity.
Availability of other thermal power is reduced by e.g. forced outage rate,
max heat production in combined heat and power plants, use of fuel other than oil etc.
The available wind power during peak load is assumed to be 0 % in each Nordic country individually, and due to coincidence factor, 6 % for the total of the Nordic countries.

Demand

The coincident factor used for the total consumption of the Nordel is 97,7 % of the sum of the country specific demands.

Demand forecast for ten years peak load includes demand response.

Reserves

Nordel has recommended common fast disturbance reserves. From a total of 5 200 MW (3 200 MW in production capacity and 2 000 MW in dispatch able load) it can be reduced to a minimum of 600 MW in a connected system without severe bottlenecks before load shedding is executed. The recommended reserves have been subtracted from available production capacity.

Appendix 3.1

ENERGY
Retrospect 2007

Total consumption in 2007 was 400.2 TWh (395.3TWh in 2006). The reservoir levels were higher than the long term median, because of high precipitation during the year.

Demand increased considerably in Norway. The increase of demand in Norway was almost 5 TWh, mainly because of considerable more inflow, better power balance and lower energy prices in 2007 than in 2006. Finland, Denmark and Sweden showed minor changes.

The total production in 2007 was 397.4 TWh (383.9 TWh in 2006 and 394.9 TWh in 2005).
The hydro power production was 214 TWh (199/222 TWh), wind power 9.7 TWh (8/8 TWh), thermal power excluding nuclear was 86 TWh (97/73 TWh) and nuclear power was 87 TWh (87/92 TWh).

In 2007 the Nordel countries together had a net import of 2.8 TWh
(11.4 TWh import in 2006, 0.9 TWh export in 2005). The import from Russia was 10.1 TWh, Estonia 1.9 TWh, while there was a net export of 1.9 TWh to Poland and 7.3 TWh to Germany.

Appendix 3.2

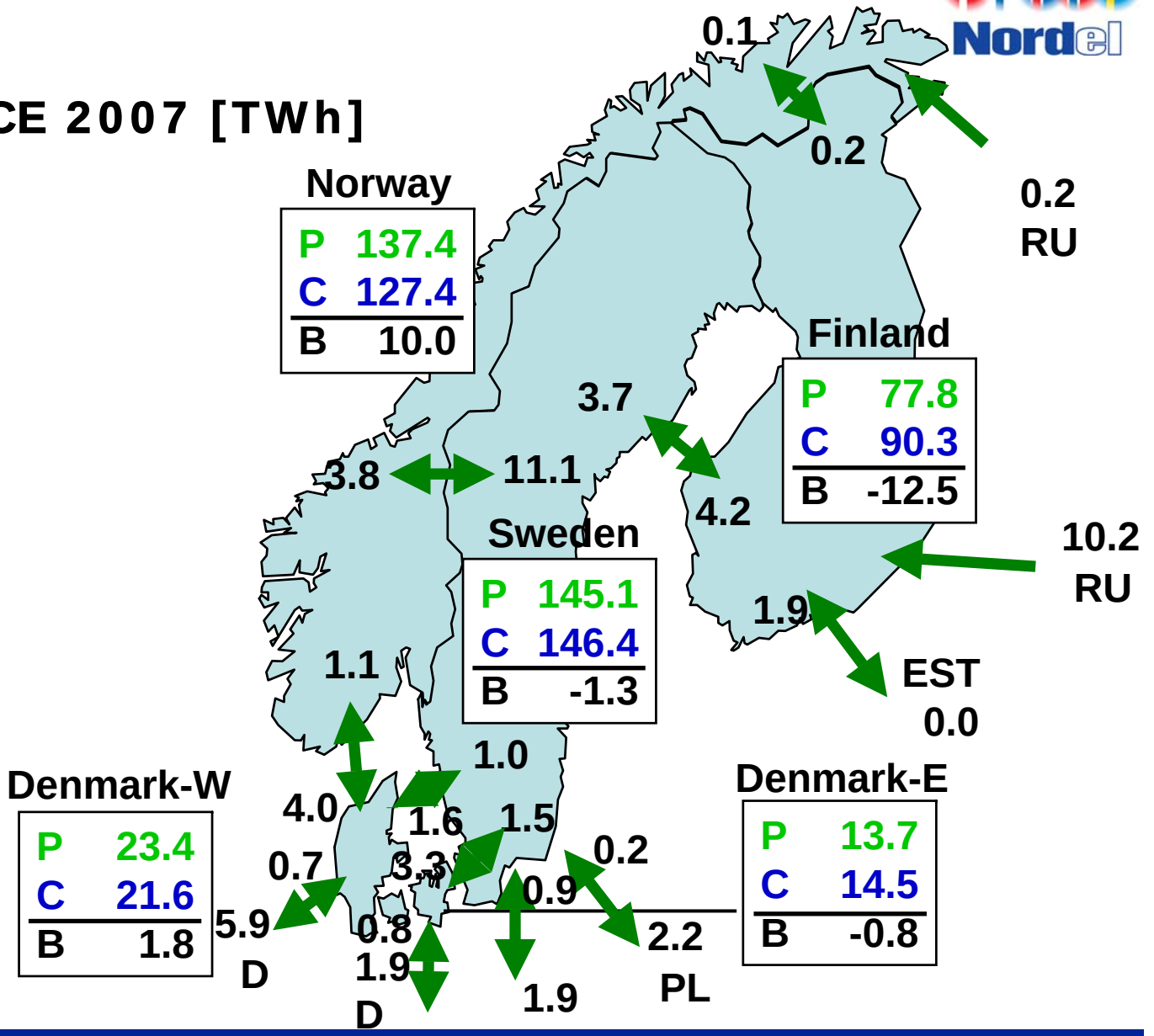
ENERGY BALANCE 2007 [TWh]

Retrospect

P - production
C - consumption
B - energy balance (P-C), export (+) / import (-)

Total Nordel

P	397.4
C	400.2
B	-2.8



Appendix 4.1

POWER BALANCE, Retrospect 2007/08

Synchronous Peak Demand
12 December 2007, hour 18-19

Peak demand this winter was 64 050 MWh/h, while a peak demand with a ten years temperature was estimated to 73 200 MWh/h. The total maximum winter peak demand 2000/2001 was 69 000 MWh/h, which is the all time high peak demand in the Nordel system.

None of the Nordic countries had the country specific peak demand in the same hour as the synchronous peak.

Compared to estimated peak demand for ten years winter the difference was between 10% and 25% in the individual areas.

Country specific peak demands

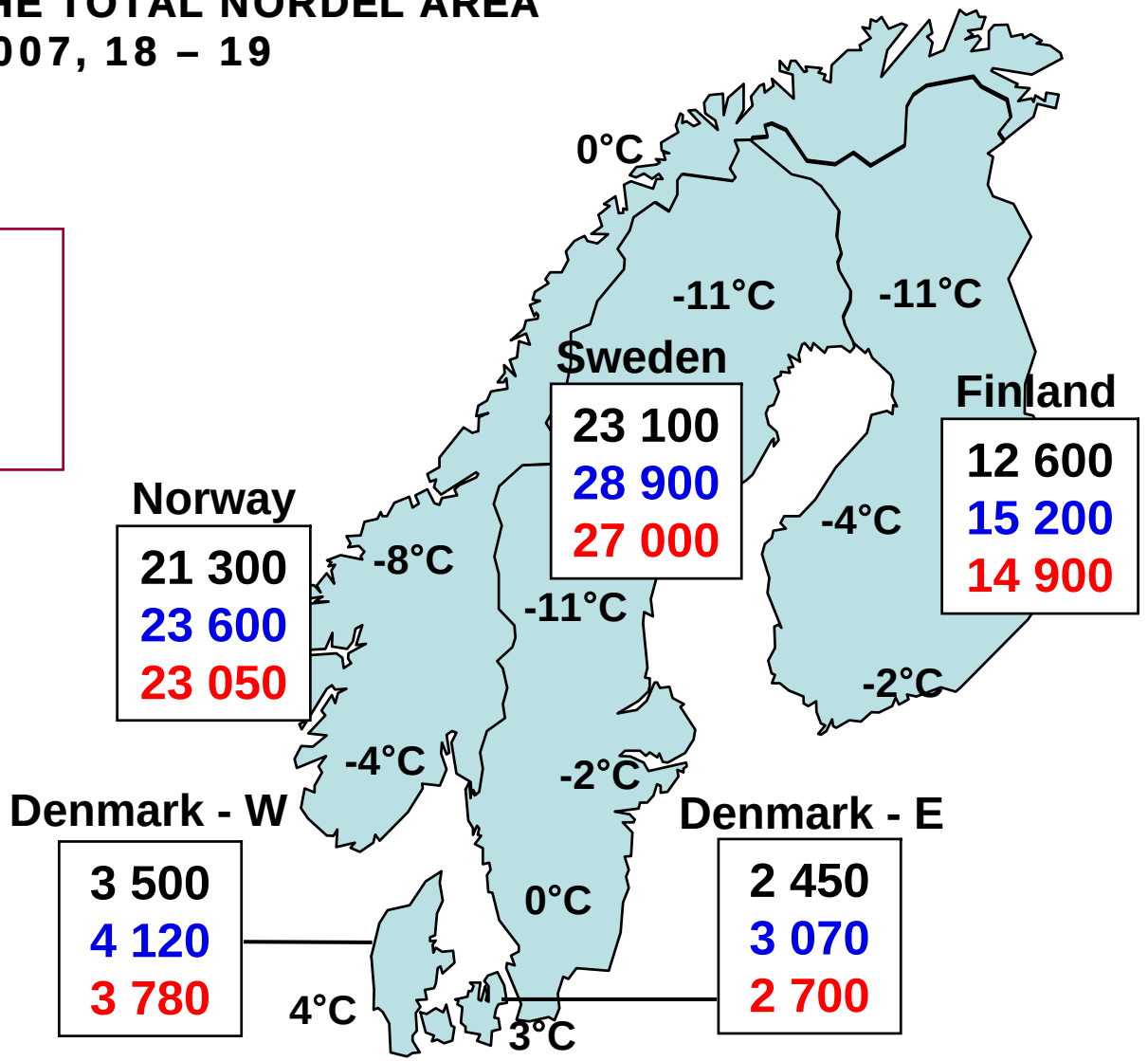
The different Nordic countries had their peaks between December 13, 2007 and February 14, 2008. The sum of the individual peaks is 2,6 % higher than the synchronous peak.

Appendix 4.2
PEAK LOAD 2007/2008 IN THE TOTAL NORDEL AREA
Measured on 12 December 2007, 18 – 19

Measured consumtion [MWh/h]
Forecasted peak demand [MWh/h]
(one of 10 winters)
All time high [MWh/h]
Simultaneous all time high;
5 Feb 2001 [MWh/h]

Nordel
62 950
73 200

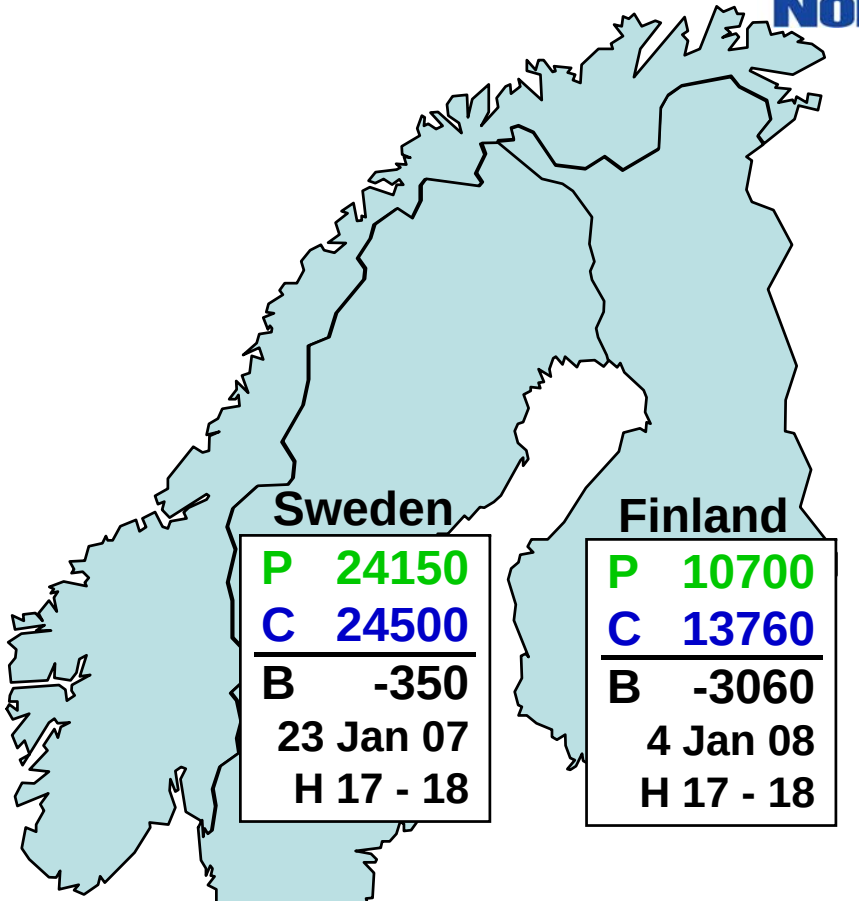
69 000



Appendix 4.3

COUNTRY SPECIFIC PEAK DEMAND 2007/08 [MWh/h]

P - production
C - consumption
B - power balance excluding exchange
export (+) / import (-)
H - hour, CET



Norway

P	22800
C	21600
B	1200
	14 Feb 08
	H 18 - 19

Sweden

P	24150
C	24500
B	-350
	23 Jan 07
	H 17 - 18

Finland

P	10700
C	13760
B	-3060
	4 Jan 08
	H 17 - 18

Denmark - W

P	4000
C	3770
B	230
	17 Dec 07
	H 17 - 18

Denmark - E

P	2420
C	2660
B	-240
	3 Jan 08
	H 17 - 18