

Capacity Market conference in Brussels 28 SEP 2015

EXAMPLE OF A FUNCTIONING PEAK LOAD CAPACITY ARRANGEMENT LINKED TO A DAY AHEAD IMPLICIT AUCTION MARKET

NORD POOL SPOT

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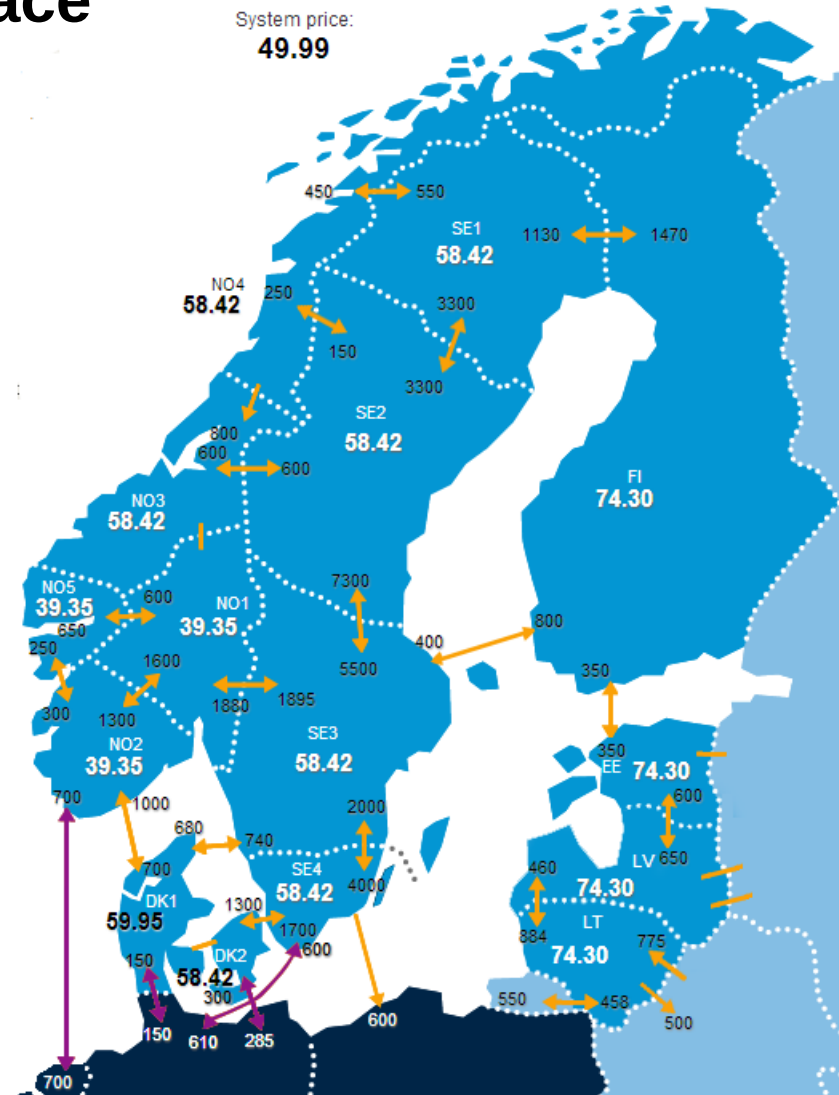
AGENDA

- **Brief info on fundamentals of the market in the example; NPS current DAM in Nordic-Baltic**
- **Brief background facts for Peak Load Capacity (PLC) arrangements applied linked to NPS DAM**
- **Examples of how the PLC has worked in practise**
 - **Also a historic reflection of energy and power load challenges**
- **Opportunities and challenges (to overcome) with such a PLC setup based on Strategic Reserves**

Nord Pool Spot - PX Market Place

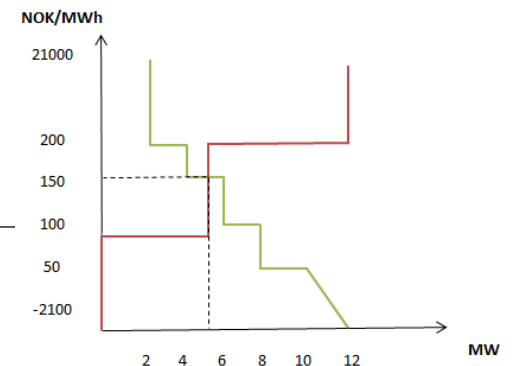
Basic Facts about Day Ahead

- Since a number of years an integrated Nordic-Baltic Day Ahead market (Elspot) is operated by Nord Pool Spot
 - In DA NPS also operate a market in UK, and both it and the Nordic-Baltic DA is part of MRC via the PCR systems
 - In Intra Day (Elbas) also Germany is part of the market run by NPS as well as Nordic-Baltic and separately UK
- Bidding Zones SE1, SE2, NO1, FI, etc.
 - In SWE, NOR and DEN there are multiple BZs
- All transmission capacity is available between the Bidding Zones in DA
- Balance Agreement is required in the respective country where companies are buying/selling in DA/ID markets



How do the various bid types work in practise, also related to the need for flexibility?

- Volume changes in hourly bids give the curve its shape and flexibility
- Block Orders and Flexible Hourly orders are only fixed displacements (shifts) of the curve (just as price independent hourly orders).
- Transmission capacity (ATC) often help since it provides flexibility sharing from and between adjacent Bidding Zones, but when there is a bottleneck the flexibility must also exist locally to reach equilibrium
- Key that participants show available flexibility because otherwise a trustworthy price formation is hard to establish. This is valid in general, thus not only in strained situations! That need also in parts explain why there are many different order types in the market.



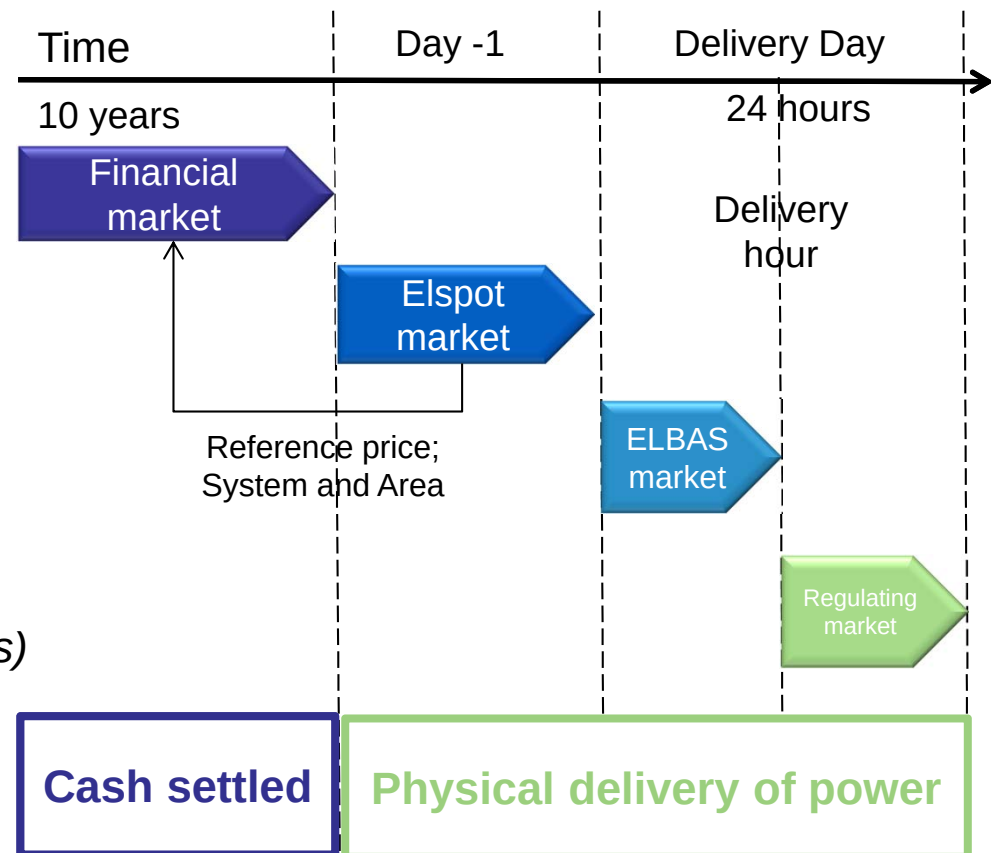
Structure of the related markets – focus Nordic

Financial market (*Nasdaq Comm.*)
Cash settled futures, forwards and options.
Clearing services.

Elspot market (*Nord Pool Spot*)
Day-ahead implicit auction. Equilibrium of
supply and demand set for delivery next day.

Elbas market (*Nord Pool Spot*)
Intraday market with continuous trading up
to one hour before delivery. Max 34 hours
open if next day's trading opens at 2 p.m.

Regulating market – balancing (*TSO's*)
Operated by TSOs where final adjustments
are made to achieve balance between supply
and demand. Price set after delivery by TSO,
participant is price taker.

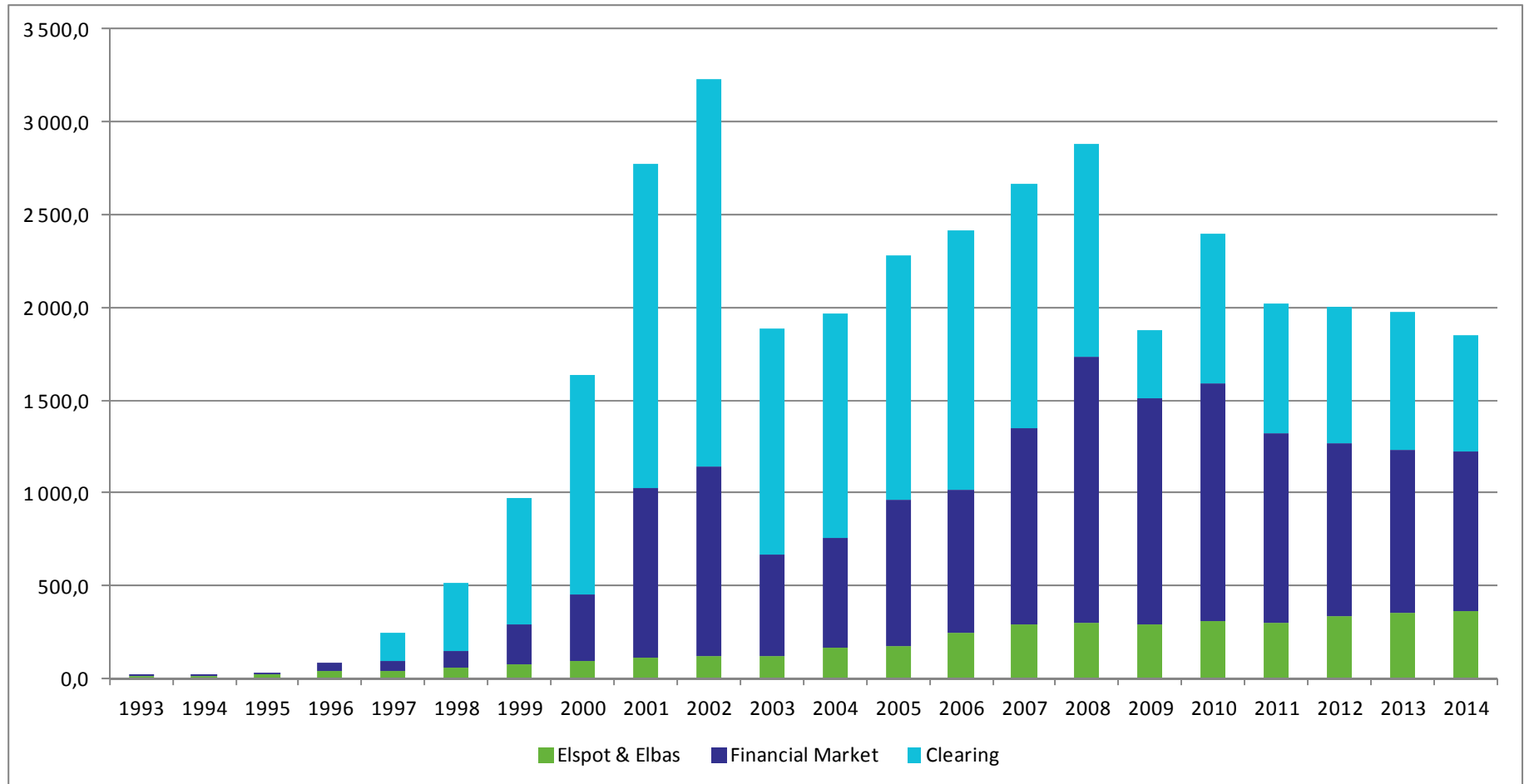


Nord Pool Spot provides among others

- A liquid electricity exchange
 - Day Ahead turnover Nordic-Baltic and UK on average about ~1.5 TWh
- Identical & transparent conditions & rules for all participants
- Central counterparty in all trades
 - Safe market place with guarantee for settlement
- Timely and accurate information to the whole market
 - Publication of fundamental power system data
 - Planned/unplanned outages etc. via Urgent Market Messages (UMM)
 - Data Provider for own data and for TSOs to the ENTSO_E TP
 - Will facilitate REMIT reporting of orders & trades etc. for participants

Turnover all markets 1993-2014 (TWh)

in current Nord Pool Spot physical and NASDAQ financial markets in Nordic-Baltic region

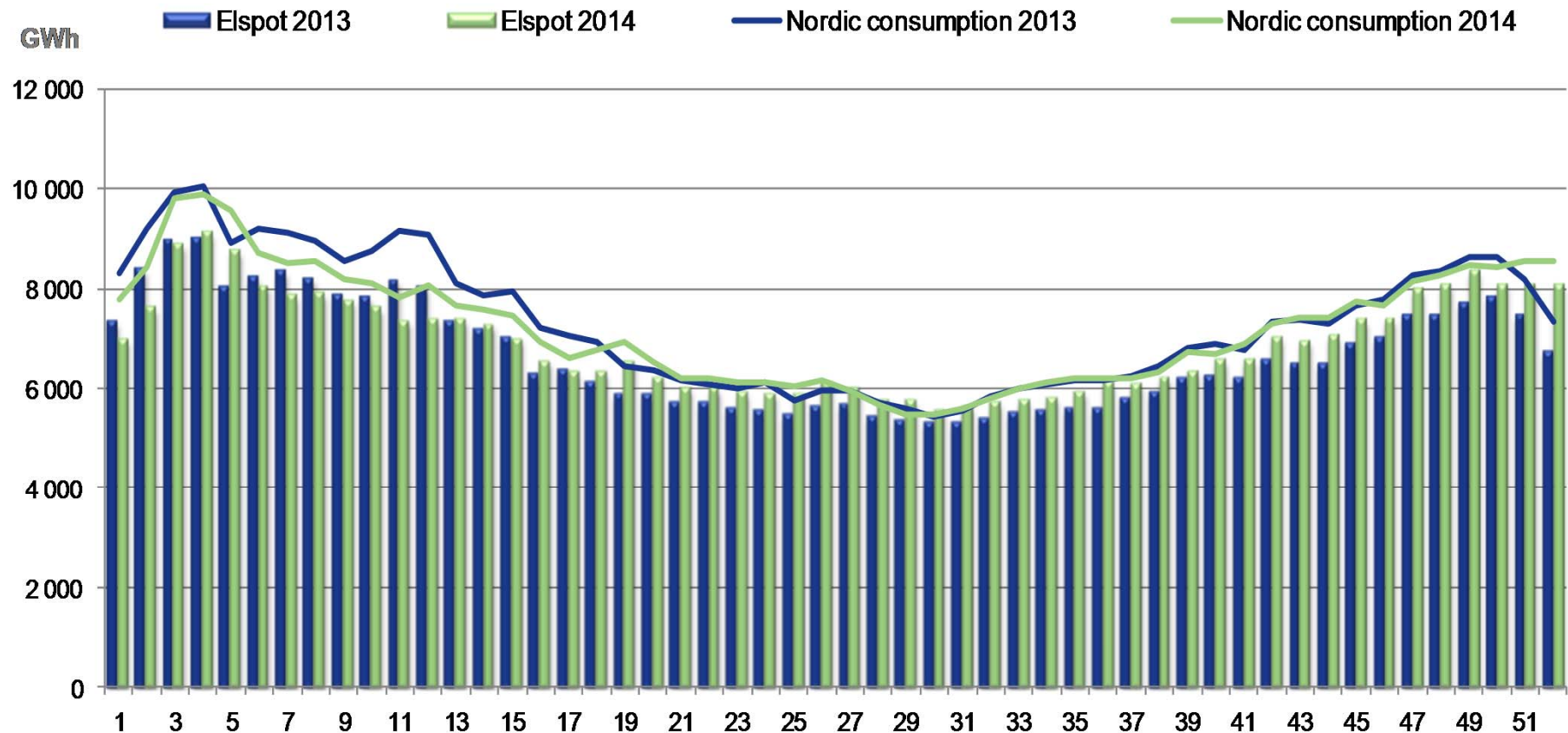


Nord Pool Spot's markets

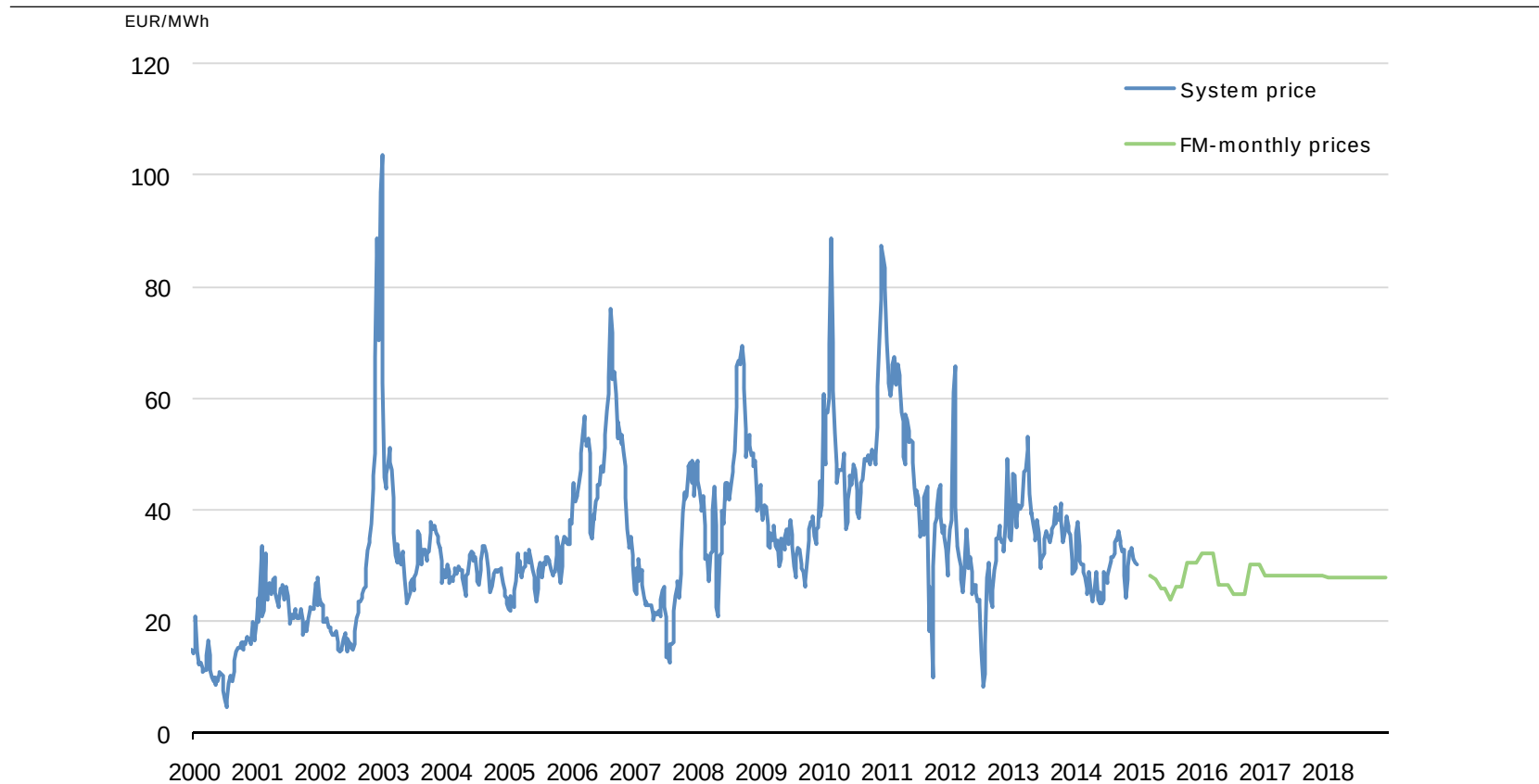
- Elspot Day-ahead auction for the Nordic/Baltic market
 - *Turnover 2013:* 348 TWh (+5 %)
 - *Turnover 2014:* 361 TWh
- Elbas Intraday trade in the Nordic/Baltic/German market
 - *Turnover 2013:* 4.2 TWh (+31 %)
 - *Turnover 2014:* 4.9 TWh
- N2EX UK Day-ahead auction
 - *Turnover 2013:* 139 TWh (+47 %)
 - *Turnover 2014:* 135.5 TWh

Nordic consumption & Day Ahead Elspot volumes

The graph shows that the DA market is very fundamental since its' volume closely follows variations in consumption



Nordic System Prices 2000-2014 at NPS Elspot and 2015-2018 Forwards Prices at Nasdaq by end 2014



PCR (Price Coupling of Regions)

Price Coupling of Regions (PCR); 7 power exchanges cooperates since 2010 in order to achieve a common Day Ahead price calculation covering (eventually) pan-European power market based on:

Common algorithm (Euphemia) used to calculate power prices.

Common system design (PMB) ensuring robust price coupling operations within and between power exchanges and towards TSOs.

Each power exchange responsible for own operations, including market (customer) interfaces and pre-post processes, ex. bidding, result distribution, clearing/settlement.

The project is open for all European PXs based on contracts and different alternatives.



MRC (Multi Regional Coupling)

- Uses PCR algorithm EUPHEMIA

- MRC (Multi Regional Coupling) covers:

Today Nordic-Baltic-CWE-UK-Iberia

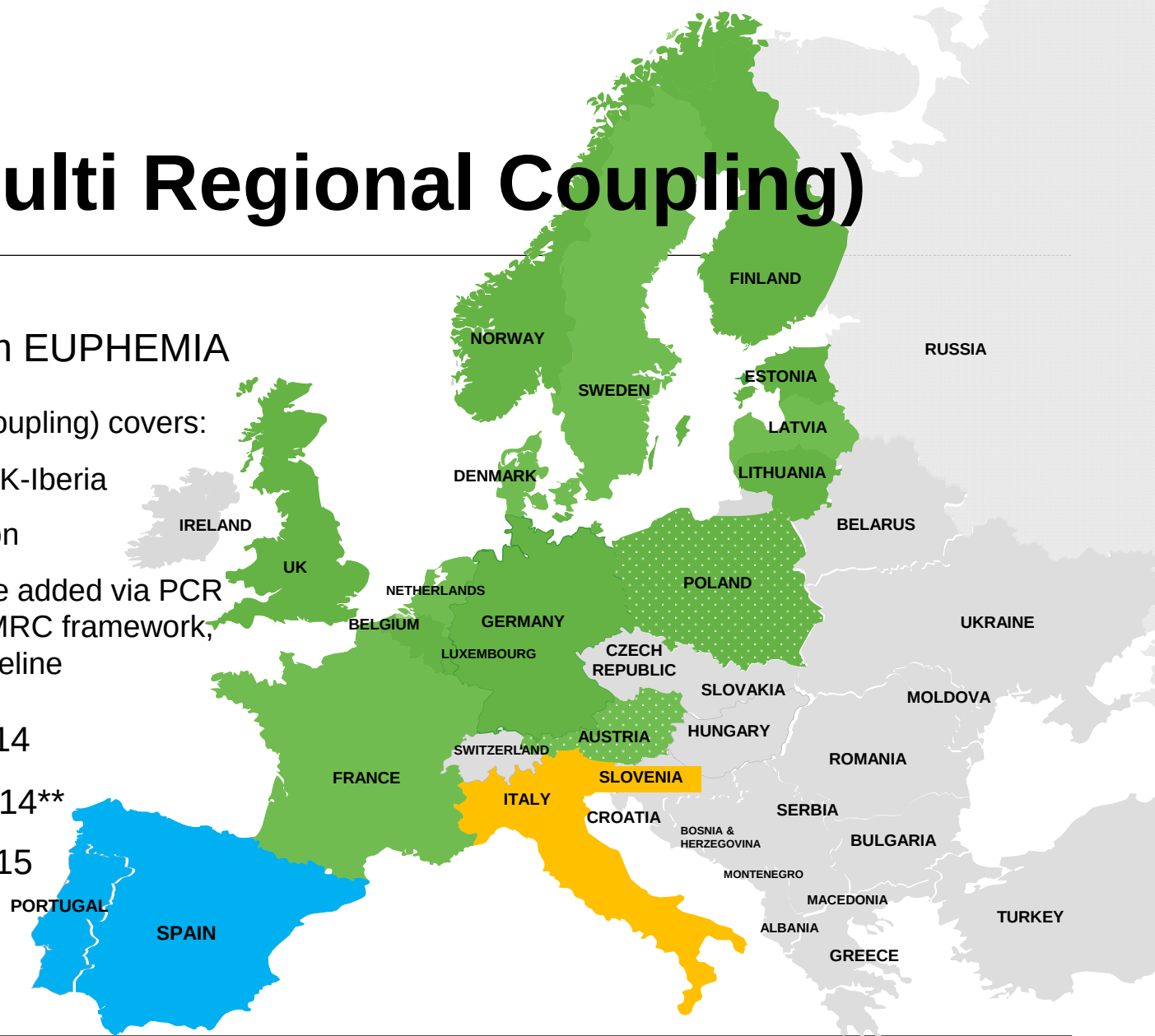
Over 2800 TWh consumption

More regions expected to be added via PCR systems, based largely on MRC framework, and in-line with CACM Guideline

■ In MRC from FEB 2014

■ In MRC from MAY 2014**

■ In MRC from FEB 2015



Peak Load Capacity Reserves in Sweden & Finland

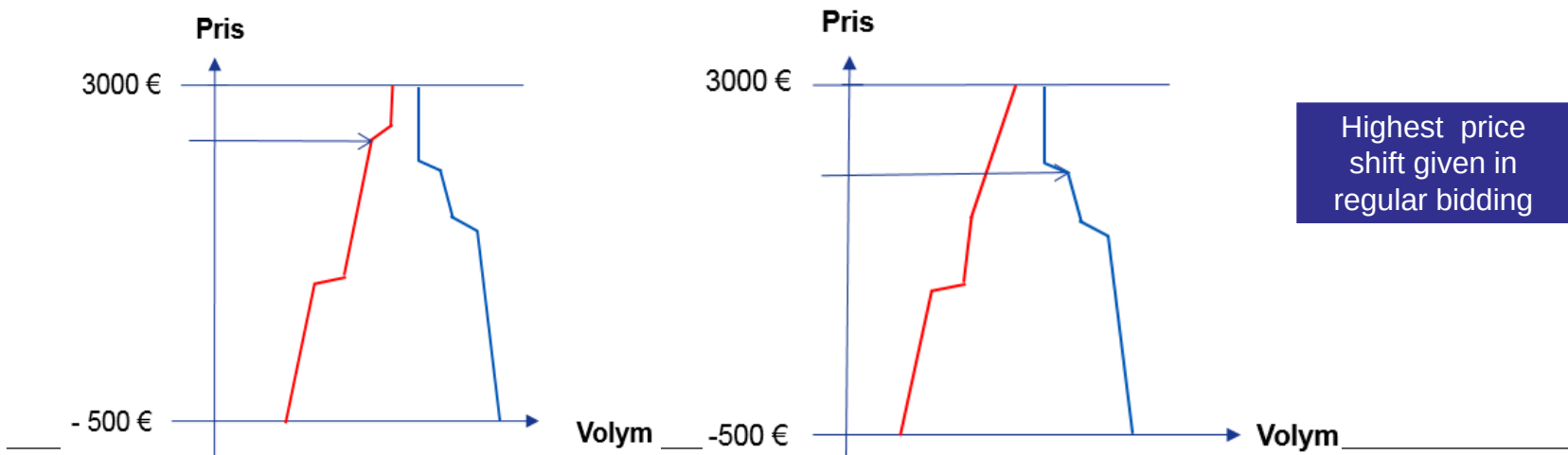
Basic properties of the model for handling PLC in the DA spot market

- **Only activated when DAM do not reach equilibrium even at technical price limit** in any of the Bidding Zones with PLC installed. Then the whole volume that TSOs in SWE/FIN administer is activated as hourly bids for all hours of given delivery day.
- When activated, usage of the PLC reserves is **not** limited to the BZs where the PLC are placed, but can also then on equal premises reduce shortages in adjacent BZs.
- Svenska Kraftnät and Fingrid always keep NPS informed of the volume available as PLC orders in the spot market, and if unavailable also inform whole market via “UMM”
- Consumption reductions that are part of PLC are permitted to be included in the spot market directly by the owner of such plants, i.e before GCT each day
- The price of the production reserve is since about 5 years** decided where the volume change for the highest commercial order for increased sales or decreased buy starts plus +0,1€ (see ex.) in any of the Bidding Zones SE3, SE4 and Finland

Note:** In the early years with PLC in SWE the activation price was instead set related to a multiple of actual production cost and it was published by the TSO. Other alternatives are contemplated for the future, for ex. automatic activation at max technical price limit (today +3000 EUR/MWh).

Peak Load Capacity in SE3, SE4 and FI

- Model for utilization of the Peak Load capacity on the **production side** in the spot market
- SvK and Fingrid before GCT report the **volume** and if applicable a **minimum price** for PLC availability in the Day Ahead spot market
 - The price for activation of the PLC is then decided to be where the volume change begins for the highest priced order (buy or sell) +0,1€ (se picture) in any of the Bidding Zones SE3, SE4 and Finland where the PLC exist



When activated the PLC in given Bidding Zones can also reduce/remove shortage in other BZs – explanation of how that works

- In simple terms, when PLC is activated it enables coverage also for other Bidding Zones then where the PLC resources are (i.e. SE3, SE4 and FI) because the re-calculation including the PLCs do **not** add any restriction on CB flows
- In other words if a shortage (i.e. limit of 3000 EUR/MWh reached and still need for curtailment) has not only been reached in one or all of SE3, SE4 and FI but also for example in DK2, DK1 and NO1 BZs then as long as there is ATC available to/from those BZs the Swedish and Finnish PLCs will also be utilized there without any direct higher prioritization of the Swedish or Finnish balance.

Continued - When activated the PLC in given Bidding Zones can also reduce/remove shortage in other BZs

Simplified illustration number 1 of how sharing of PLC reserves beyond the BZs where the reserves are placed works

- The shortage in a given hour is in total 900 MW with the distribution of 200 MW in SE3, 300 MW in SE4, 150 MW in FIN, 100 MW in DK2, and 150 MW in NO1.
- The total production PLC reserves in SWE and FIN that would be activated in Elspot is 1000 MW
- Since the technical limit (shortage) has been reached in at least 1 of the BZs (actually all 3 in this ex) where the PLC is placed then activation in Elspot occurs based on the last, highest, price shift in a commercial hourly order (buy or sell) in the BZs with PLC
- Let us assume that this highest commercial order was placed from 2400 EUR/MWh, which means that the PLC will be activated from 2400.1 and with full volume provided at 2400.2 EUR/MWh
- As long as there is some BZ to BZ routing of flows possible to all of the BZs with shortage that is above the shortage volume it will lead to a clearance of the market (if all else stays in essence the same***).
- In other words the price in all of those zones would most likely be fairly close to 2400.2 EUR since most of the PLC, but not all of it would be activated to cover the overall (initial) shortage of 900 MW.

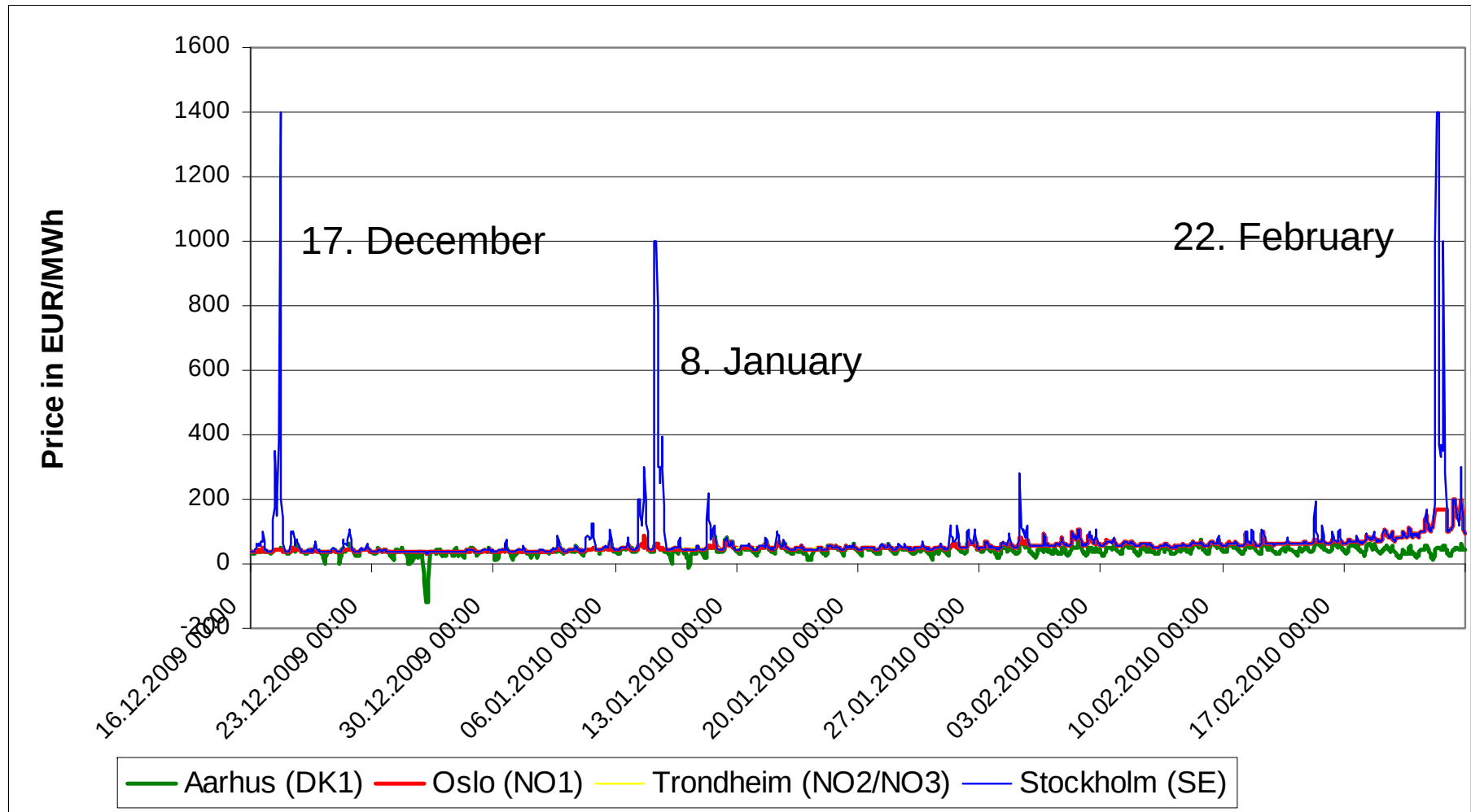
Continued - when activated the PLC in given Bidding Zones can also reduce/remove shortage in other BZs

Simplified illustration number 2 of how sharing of PLC reserves beyond the BZs where the reserves are placed works

- All conditions are identical to in illustration 1, except for that:
 - the total shortage is 1200 MW since the shortage is increased to 450 MW in SE4 and 250 MW in DK2
 - In addition maximum (remaining) import capacity to SE4 is 100 MW while significant capacity remains between SE4 and DK2, and no other (extra) import capacity to DK2
 - The PLC production in SE4 is 400 MW
- In this scenario, if all else essentially stays equal***, this would occur:
 - the FI, SE3 and NO1 BZs would be cleared at 2400.2 EUR/MWh by using 500 MW of the PLC
 - SE4 and DK2 would be a combined short of 200 MW since added import of 100 MW via PLC from SE3 and utilization of the 400 MW PLC in SE4 will not be enough
 - Since there is more remaining Interconnector (IC) capacity SE4-DK2 then there will be a 200 MW combined shortage for SE4 and DK2. Those 2 BZs will get the 3000 EUR/MWh technical limit price and be curtailed on the buying side with a total of 200 MW. That curtailment would be pro-rata distributed among all buying participants in the two BZs
- This case illustrates that since both SE4 and DK2 are short of supply and all IC capacity in to those BZs is utilized while there is much IC capacity left from SE4 to DK2 they can form a common Price Zone and therefore share the curtailment volume pro-rata

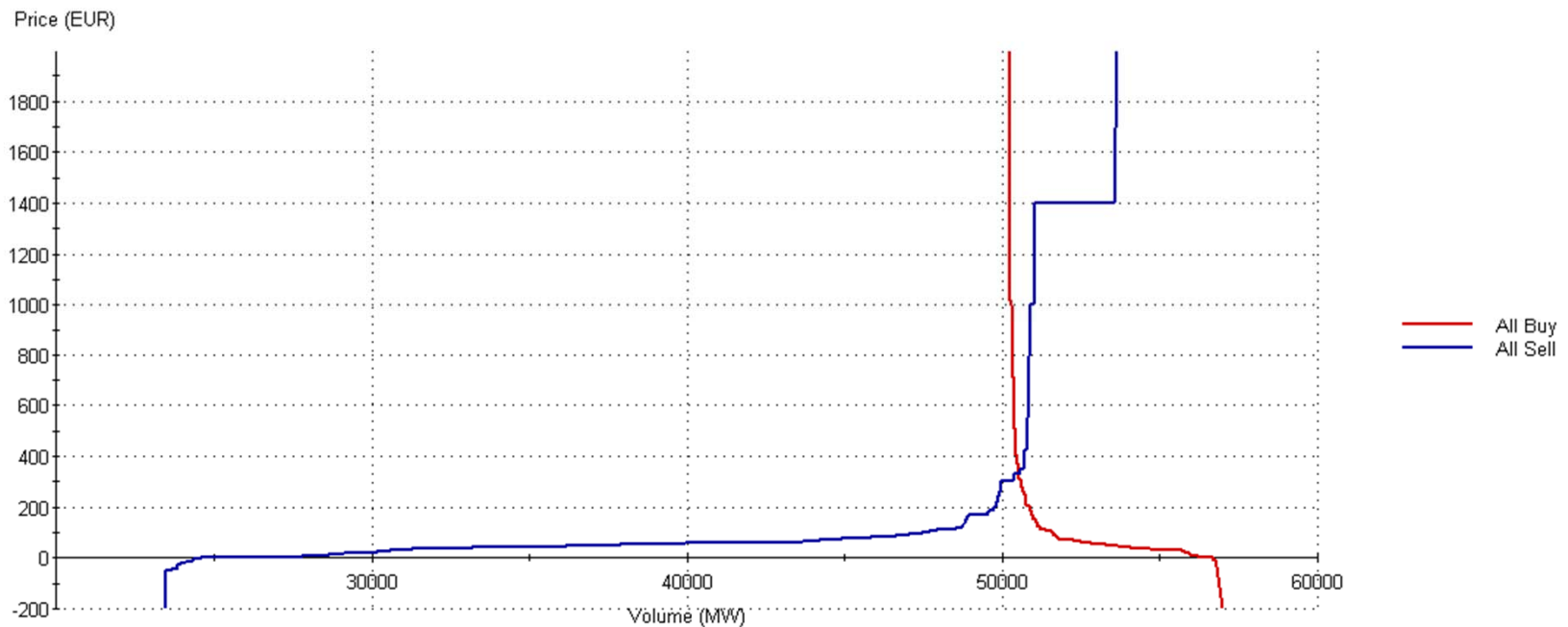
Peak Load Prices and Resources

Ex. via Area Prices 16.12.09 – 23.2.10



System price - 22.2.2010 hour 9

Salescurve including power reserves



UMM – special information

Special information - details given in remarks below

Message Time:	21.02.10 hour 13:06
Decision Time:	21.02.10 hour 12:40
Published:	21.02.10 hour 13:06
Company:	Nord Pool Spot AS
User name:	umm-admin
Affected area(s):	NO3, NO4, DK2, SE, FI

Station: Important message

Event start:	22.02.10 hour 08:00
Event stop:	22.02.10 hour 11:00
Event status:	Open

Remarks/Additional information:

Activation of Power Reserves in Elspot for February 22nd

Nord Pool Spot AS has activated TSO Power Reserves in SE and FI in order to avoid curtailment. The procedure was informed to the market in Exchange Information no. 02/2009.

The table shows by area and by hour the activated amount (in MW).

Area ----- Hour ----- MW activated

FI -----	09 -----	57,5 MW
FI -----	10 -----	57,7 MW
FI -----	11 -----	12,7 MW

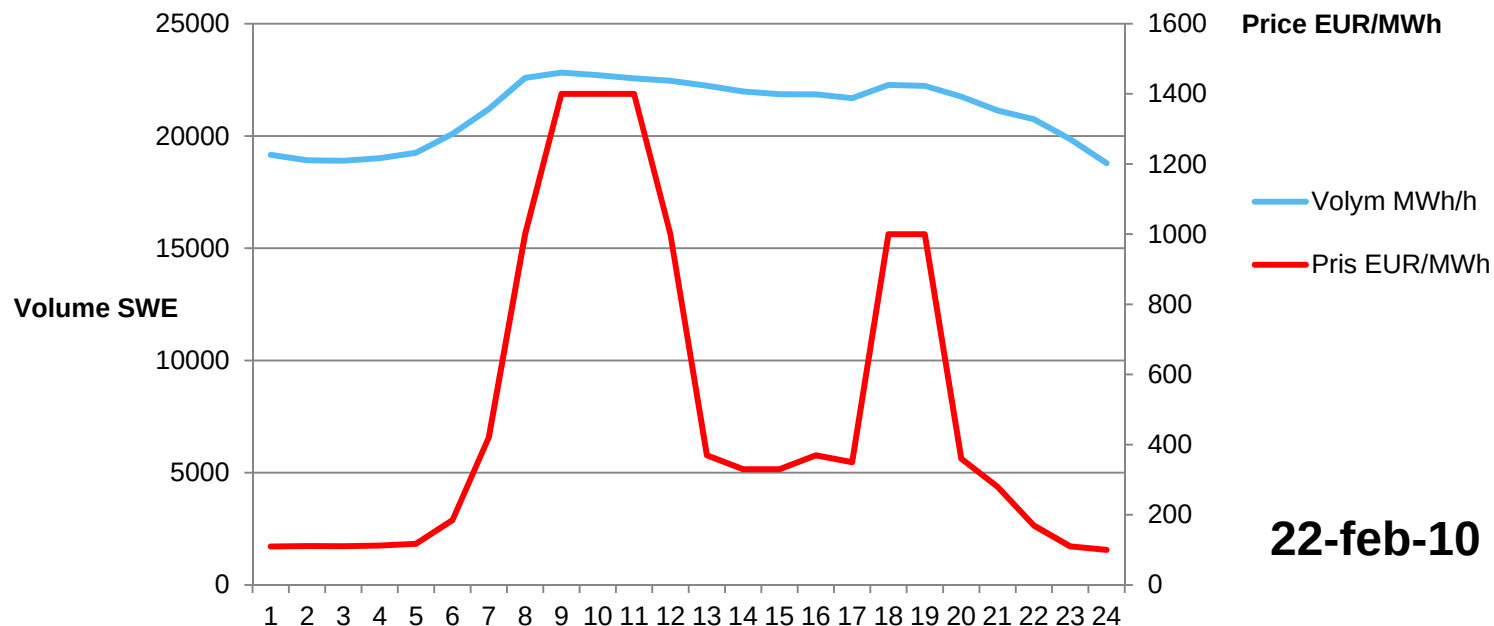
SE -----	09 -----	172,1 MW
SE -----	10 -----	130,0 MW
SE -----	11 -----	28,7 MW

Prices and volumes in spot and RPM (balancing)

When PLC was activated and a small part used to get equilibrium in spot

Clearly indicates that the market reacted to spot price before real time!

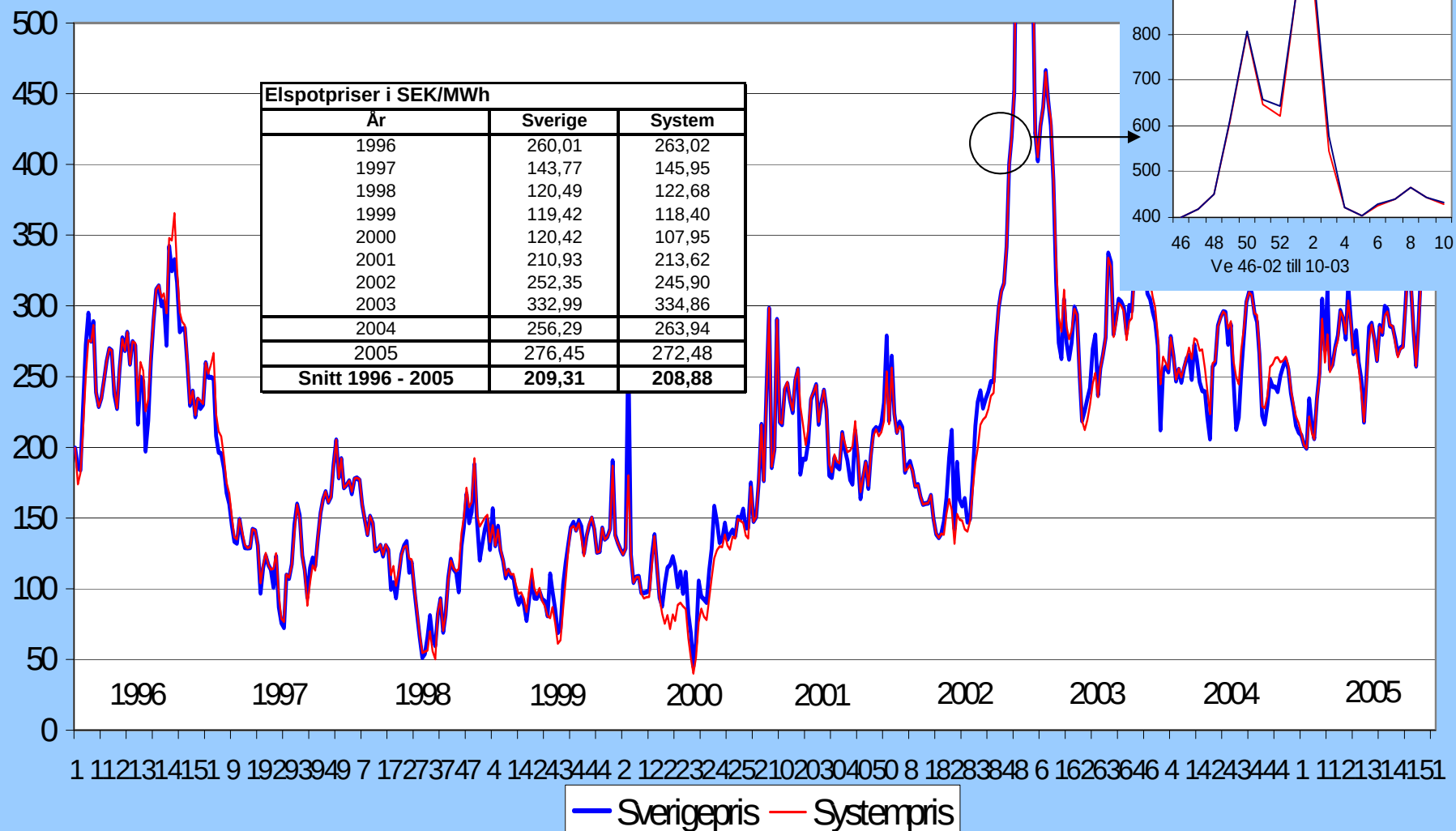
Hour	EUR/MWh	Buy vol (SE)	Nordic Regulating Power volume (MWh)	RPM price SWE EUR/MWh
08-09	1400	22822	-1479	91
09-10	1400	22708	-742	137
10-11	1000	22567	-510	137



Elspot – weekly prices in Sweden and System Price 1996-2005

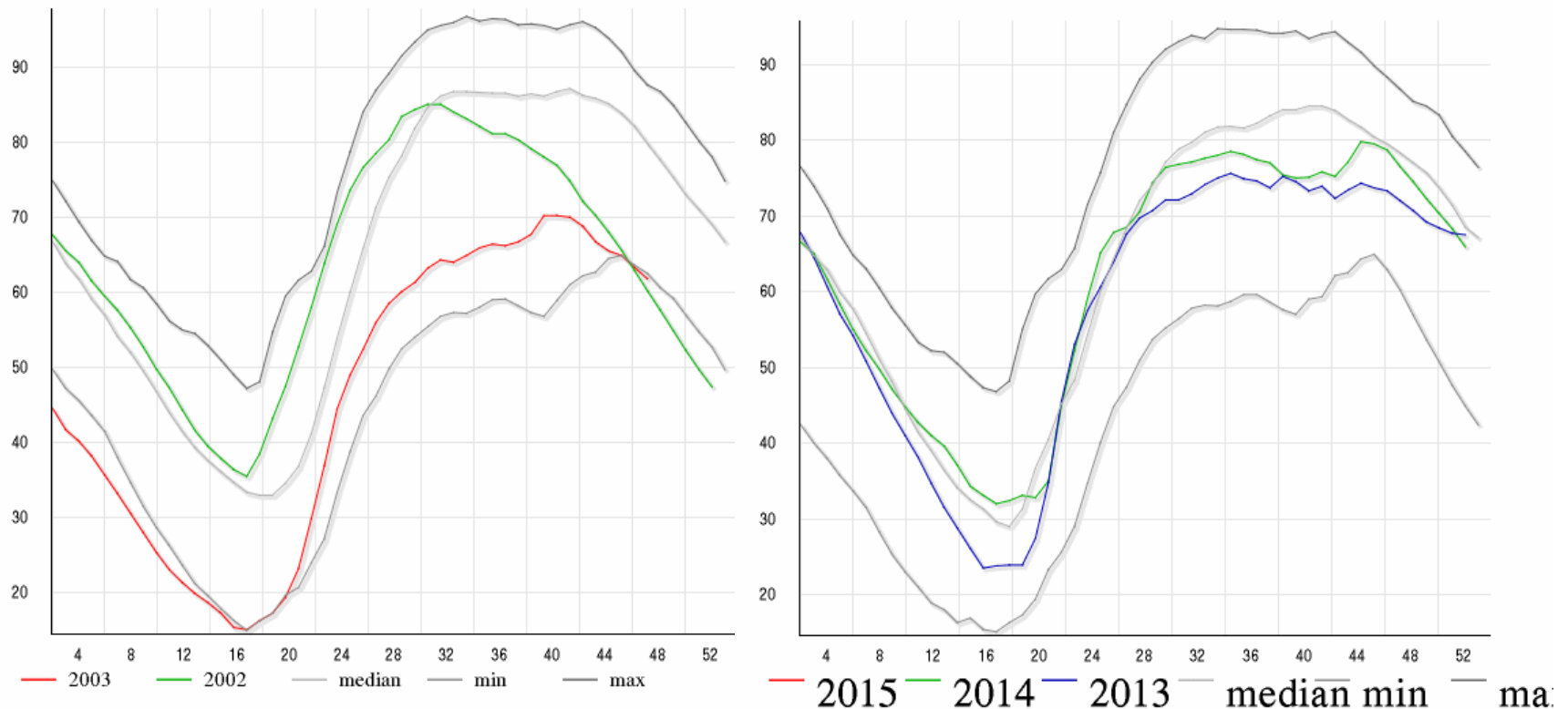
Long periods of strong energy balance and a few severely weak periods, and a few major peak load power problems

SEK/MWh

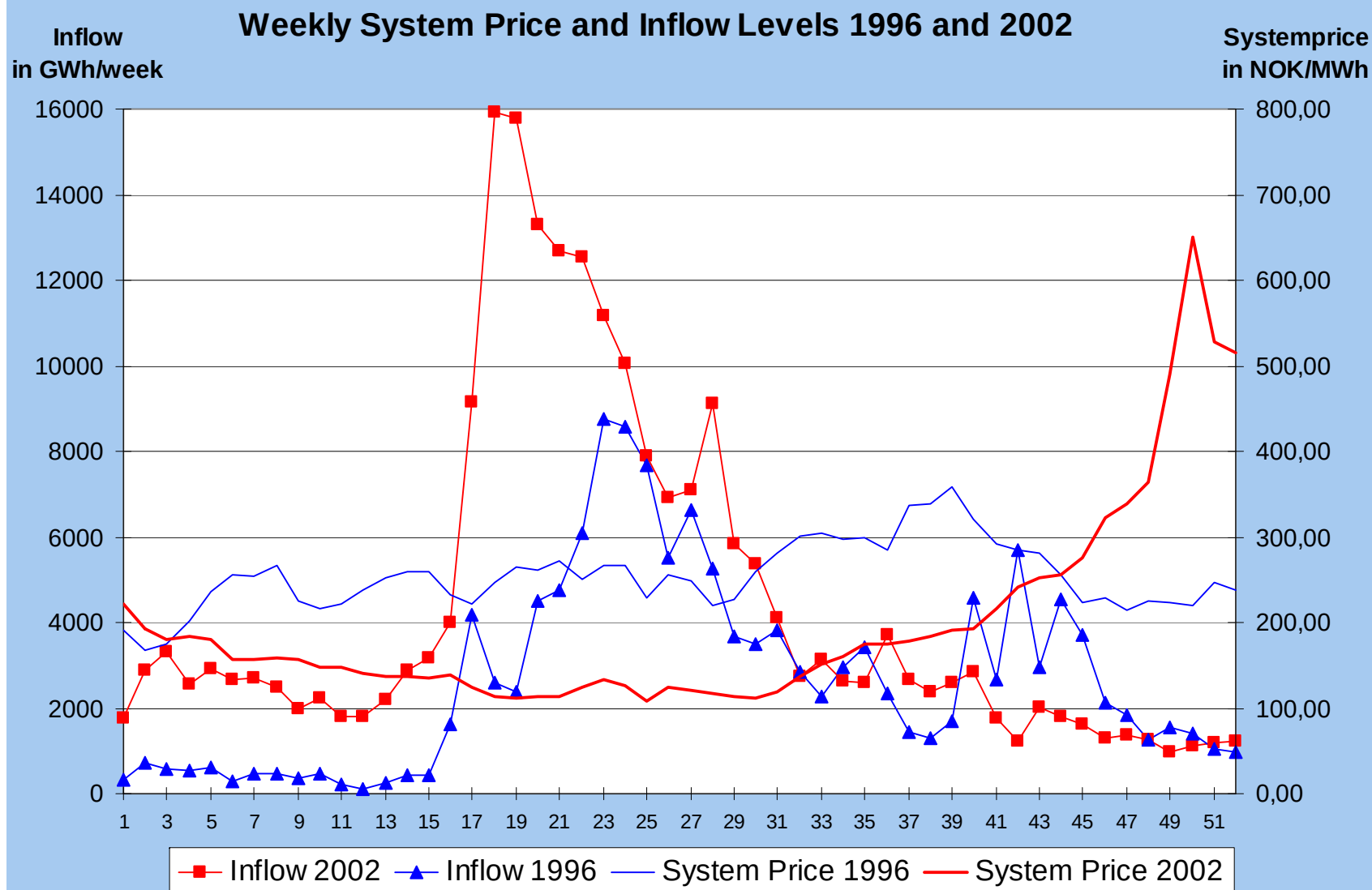


Content in hydro reservoirs in Nordic (NOR+SWE+FIN)

Noted in % of reservoir level (max about 121,4 TWh; inflow serie (left) 1990-2006 and (right) 1990-2012)



To consider: The **total** hydrological balance, ie including snow pack and ground water, is still a considerable factor for the price formation (although not as big now as 10-15 years ago). The reservoir levels is one key part of that total..

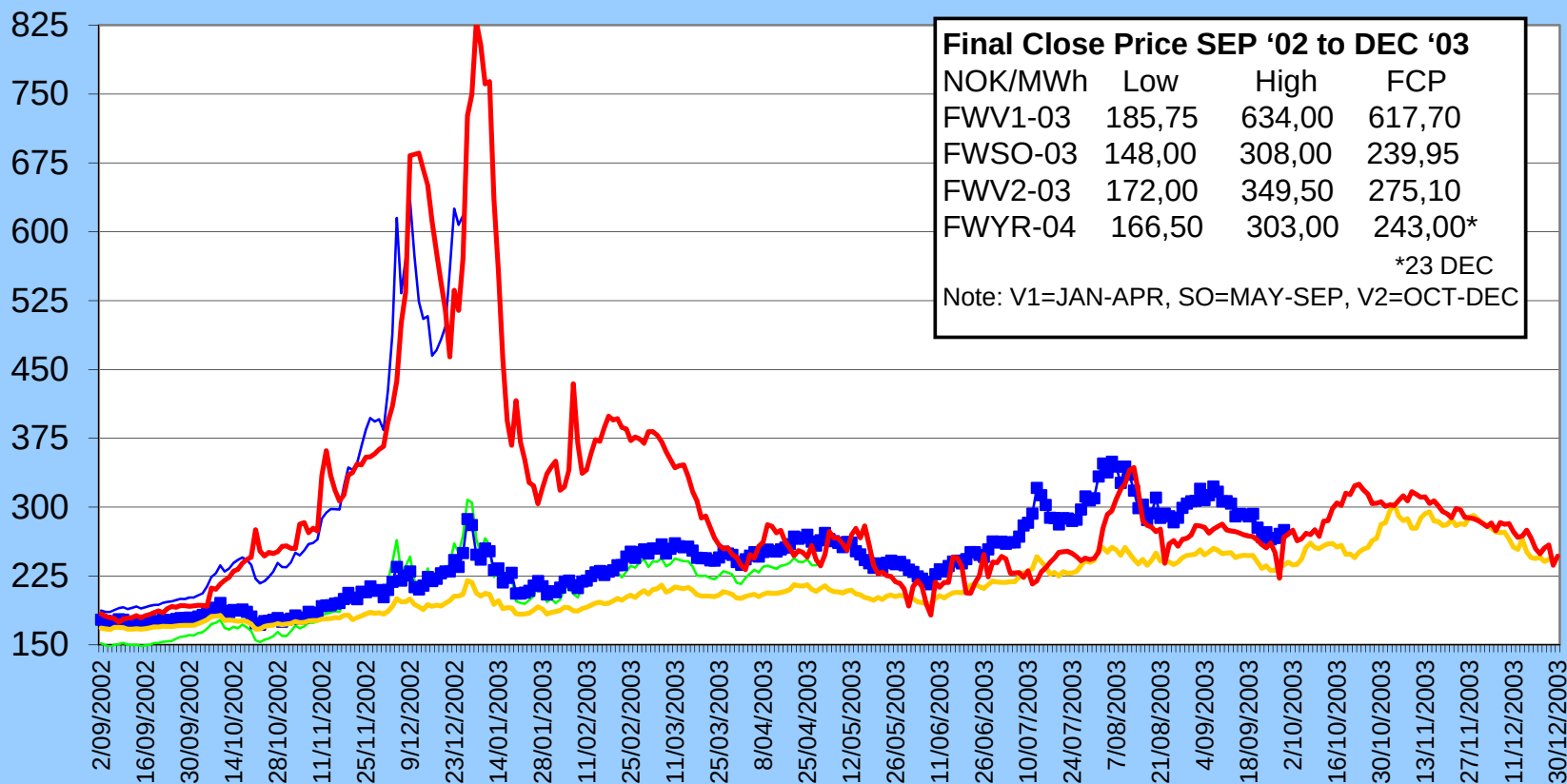


Price development for financial contracts and the underlying System Price from Elspot

Trade period: SEP 2002 - DEC 2003

FWV1-03 FWSO-03
FWV2-03 FWYR-04
Systempris

NOK/MWh



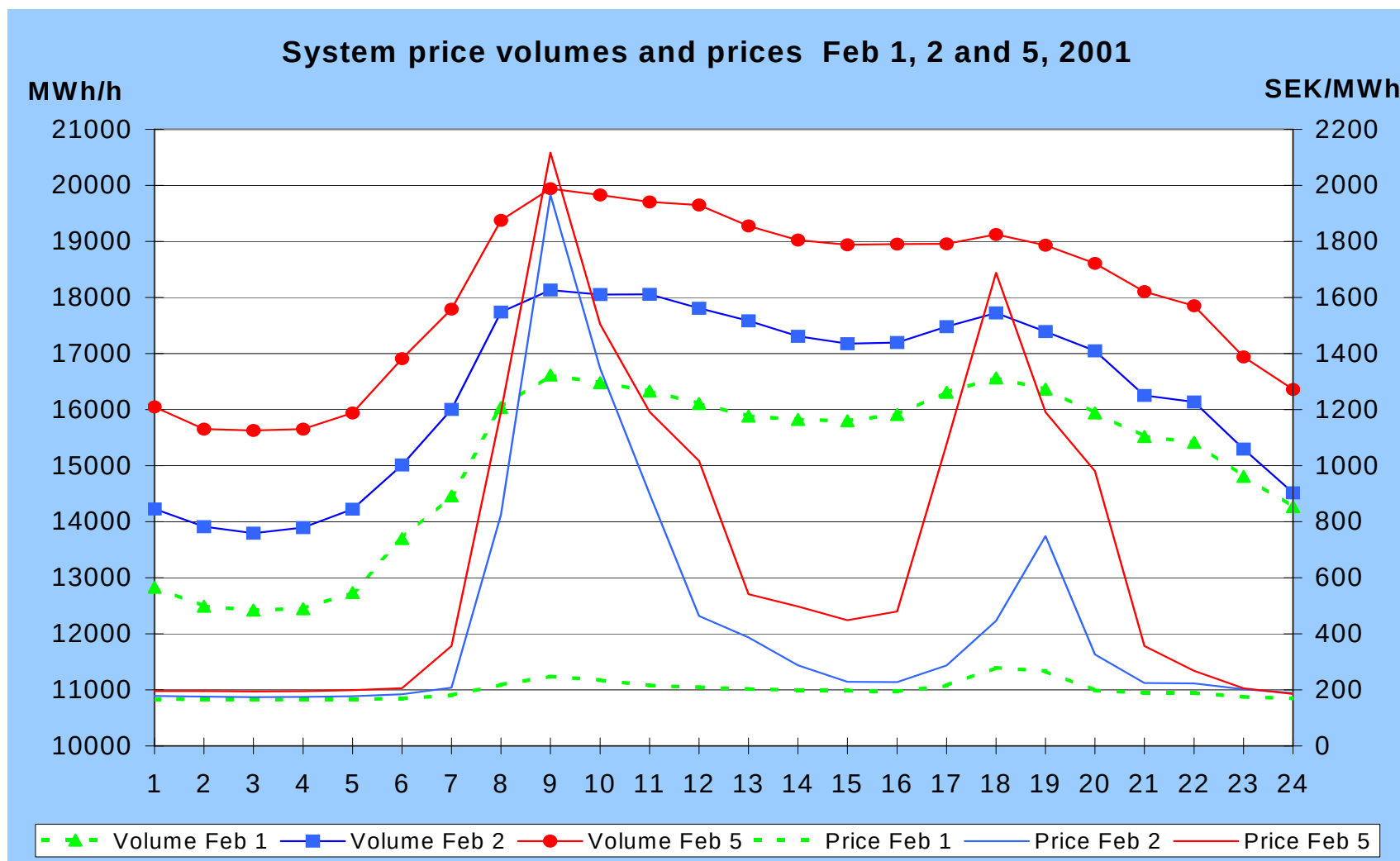
Example of severe peak load capacity issue lasting 4 days in 2001 – results in spot market

Total System price volumes

Feb 5: 433178 MWh

Feb 2: 391972 MWh

Feb 1: 361269 MWh



What do the historic slides with fundamentals actually tell us?

- In the mixed Nordic power system there is a challenge with both energy (MWh) over time and peak load (MW) short term
 - The two problems are to some extent partially negatively correlated
 - The challenge is increased due to that the winter at times is rather cold, and that a sizeable part of heating comes via electricity
 - Also the short term flexible production (hydro) is to a large extent located in sparsely populated areas whereas the heavily populated areas (except Oslo) mainly rely on thermal, including nuclear, and CHP production nearby plus much "import" from hydro rich areas
 - That imbalance gets even more evident when there is a high winter peak load, which gives bottlenecks from the hydro to the thermal based** areas and a need for (MW) imports from the continent and start-up of reserves that mainly are thermal based with significant start-up costs and lead time to start.

Note: **The already significant and growing wind power in particularly Sweden is placed where wind conditions are good, and not necessarily where there is much power demand, and in addition the ability to count on wind power when power is needed in a scarcity situation (winter cold spell) is very limited and usually assumed to be less than 10% of installed capacity.

Strategic Reserve for PLC – some issues to consider to make it effective

- Need to be clear about what the PLC is meant to "handle"
- Key to limit it in size, duration, distribution geographically and type of resources (prod. vs. cons.) to cover only what it is supposed to handle
- If part of the main physical liquidity market, eg. Day Ahead, it needs to be considered how to limit effects on regular orders in short and long term perspective linked to provision of flexibility, competitive prices etc.
- If not part of the Day Ahead Market but instead kept as reserves for real time management by TSOs it needs to be answered why that is better
- Regardless of if in DA or not it is key to recognize that on any given day there is a finite level of resources and they do not become more or easier to use efficiently if kept as last resort rather the via the market
- In other words if used in DA (or not) it is also key to accept that the market in planning stage anyway can end up in a shortage

Cont. "...PLC...issues to consider to make it effective"

- It is key to enable all flexible production & consumption to be placed in first DA, then in ID and finally for usage in the real-time (RPM; balancing) market
- It is key that the price signals set in the DA, ID and RPM are respected, and not afterwards adjusted by political means if deemed politically sensitive
- When PLC or other means to curb extreme situations are part of the DAM it is important to only do it once the technical upper (lower) limit is reached, thus when the market otherwise is in a curtailment situation
 - Therefore it can be harmful for buildup of flexibility to allow measures, such as the 2nd Auctions in CWE region, to be activated far below (today at +500 EUR) the current limit
 - Another implication is that when setting the technical upper/lower price limits it must be understood that those prices can be reached even when the measures are activated
 - Therefore, the limits should preferably be linked to prices where enough VOLL exist to curb demand/consumption according to "expected needs" in extreme PL winter scenarios
 - Also, while markets should be free, the extreme economic effects that would occur if DAM prices in multiple hours were set at the technical limit (and especially if the limit become much higher than today's 3000 EUR/MWh, as some suggest) needs to be considered.
 - As an example, in a PL case **only 1 hour in DA reaching current max price limit across the Nordic region gives a spot cost of 200,000,000 EUR** (vs 2,000,000 EUR "normally").

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THANKS FOR YOUR ATTENTION!

ANY QUESTIONS?

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