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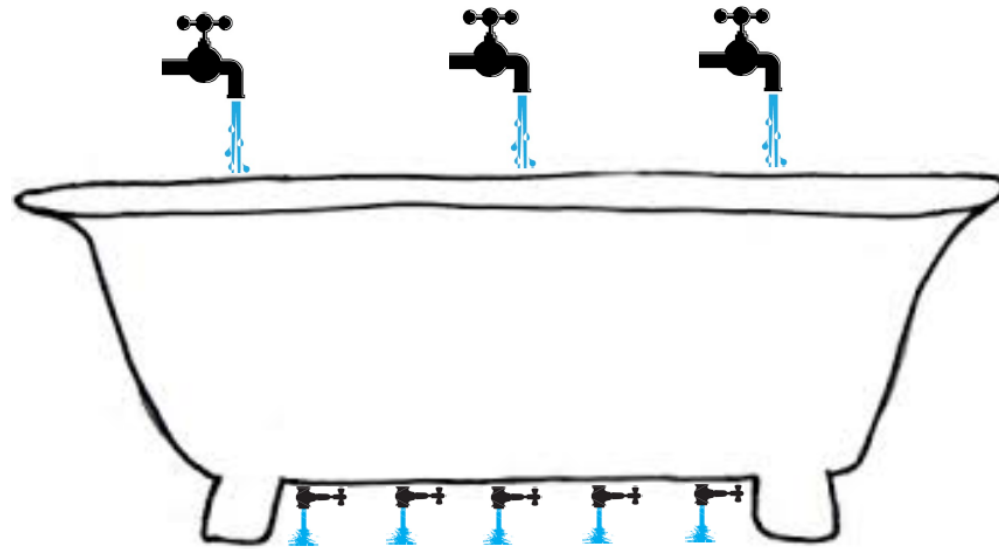
**International Workshop on Electricity Sector Modernization
Brasília, 4-5 September 2019**

Creating the Right Incentives with Regulatory Instruments

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The Electricity System



Roles of Electricity Markets

- Balancing demand and supply
 - wholesale markets
 - balancing markets
- Collecting and distributing payments
 - retail markets
- Handling risk
 - contractual arrangements
 - financial markets

Market-Based vs Synthetic Prices

- Bids and offers summarise agents' relevant information
 - technical and other factual information
 - uncertainties, risks, beliefs and attitudes
- ... while synthetic (such as Brazilian) prices rely mostly on technical input
 - capacities, efficiency, reservoir levels, water flows etc.
 - also, fuel prices, demand forecasts
- Market price formation dampens unsystematic errors
 - averaging through balancing of bids and offers
 - best informed agents at the margin, greater weight in price formation
- ... while computation models are vulnerable to errors
 - especially in new or extreme (out-of-sample) events
- However, potential market imperfections
 - imperfect competition
 - externalities



THE NORWEGIAN ELECTRICITY SYSTEM

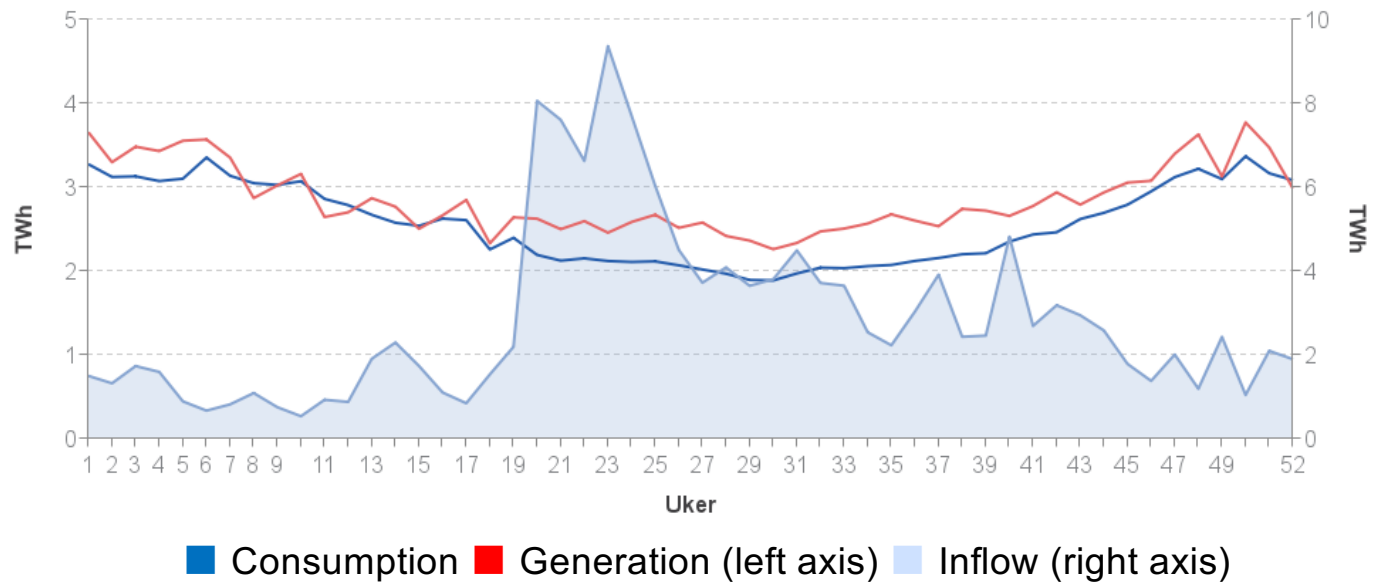
The Main Grid



Source: nve.no

Generation

Installed capacity: 33 200 MW, mean annual output: 139 TWh, energy mix: 96% hydro, storage capacity: 70% of mean annual output



Source: energifaktanorge.no

Market Structure and Ownership

- 180 electricity generators
- 10 largest account for 70% of output
- 90% of capacity owned by local/central government
- State-owned Statkraft operate 35% of capacity
- Strict limits on private ownership of hydro plants
- 130 generators operate networks
- Main grid operated by state-owned Statnett
- Most generators have associated retail businesses

Source: energifaktanorge.no

Regulatory Reforms: 1991 and onwards

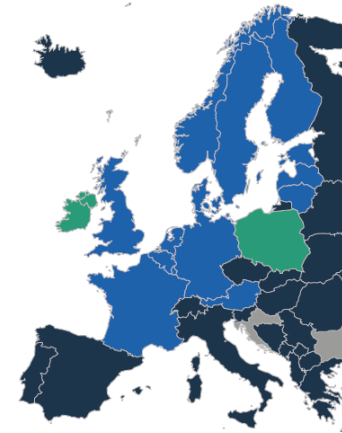
- Unbundling of generation and main grid
 - creation of TSO Statnett
- Opening up power exchange
 - from club of generators to open participation (incl. consumers and traders)
- Removal of monopoly in retail market
 - consumers free to choose supplier
 - no regulation of prices
- Subsequent development of markets
 - often based on initiatives from market participants
 - consultation and consensus

Current Developments

- Growth
 - demand (electrification)
 - supply (subsidised renewables)
- Regional integration
 - new interconnectors to neighbouring countries
- New technology
 - decentralisation of generation
 - new “smart” services and solutions



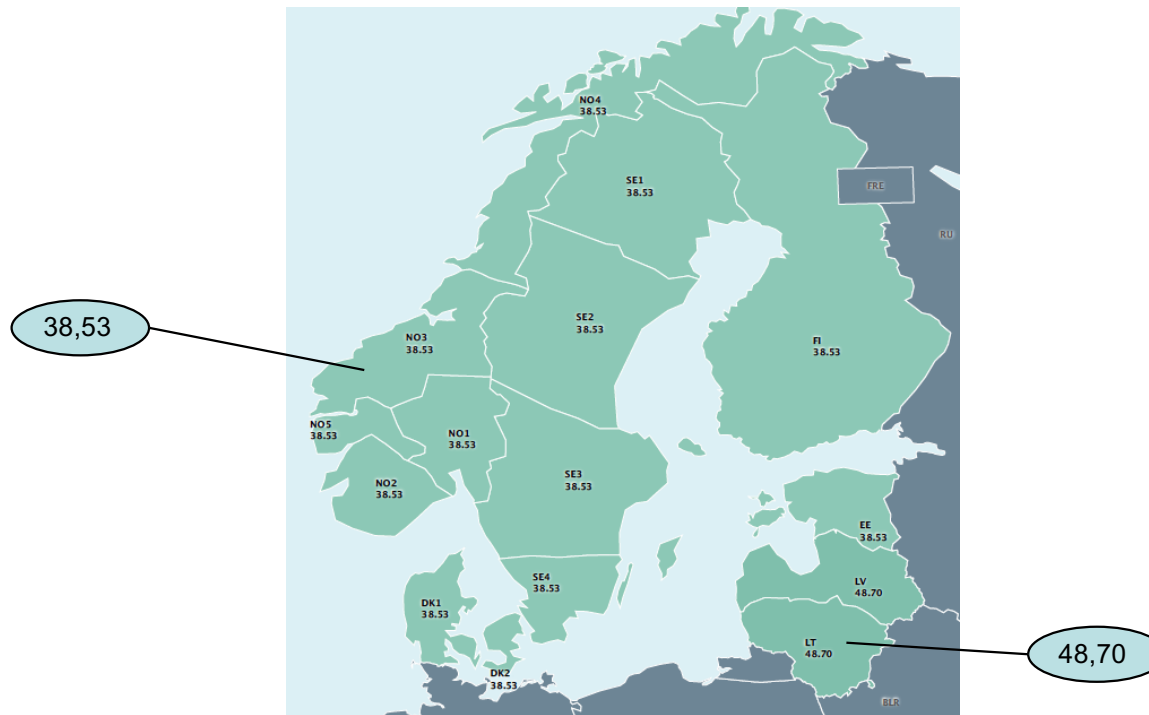
WHOLESALE MARKETS



Nord Pool Spot

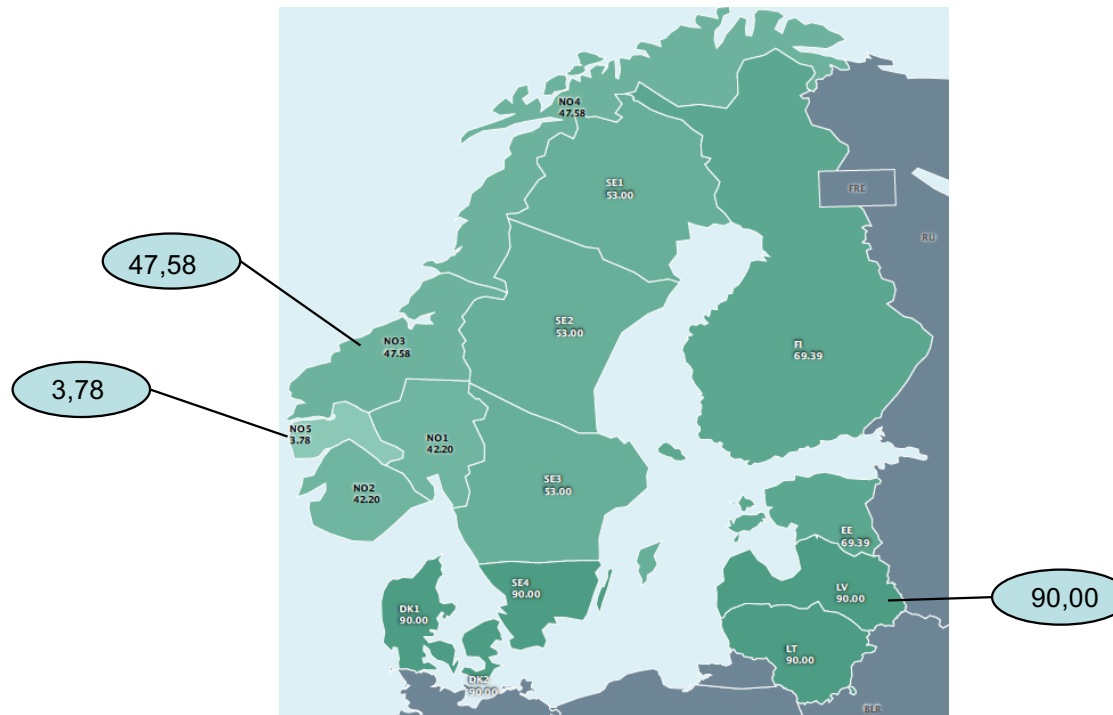
- Day-ahead trade
 - Nordic, Baltic and UK markets
 - hourly (half-hourly in UK)
 - single blocks, block orders, minimum acceptance ratio, linking, flexi orders and exclusive orders
- Intraday trade
 - Nordic, Baltic, German, Luxembourg, French, Dutch, Belgian, Austrian and UK markets
 - 15 minute, 30 minute, hourly and block products
- Market surveillance
 - market manipulation and insider trading
 - promote fair and efficient trade
 - report to national regulatory agencies

Nord Pool Bidding Areas



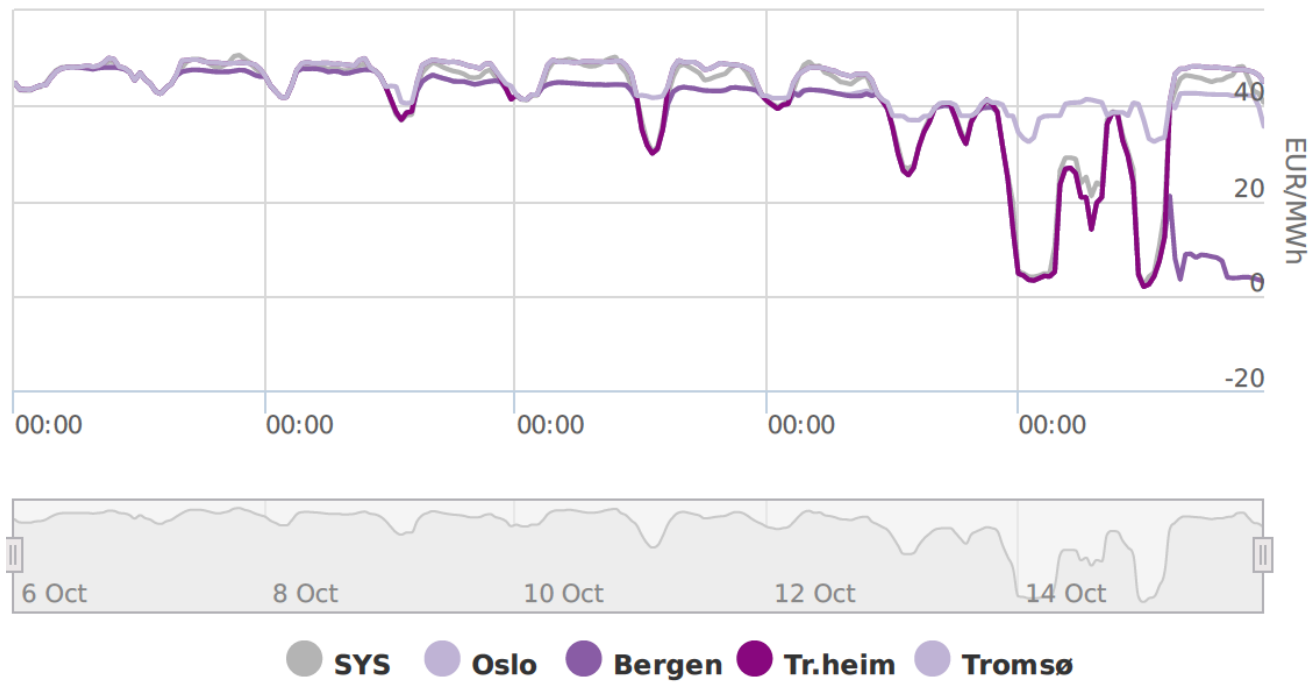
Source: nordpoolgroup.no, October 14, 2018, 18-19

Nord Pool Bidding Areas cont.



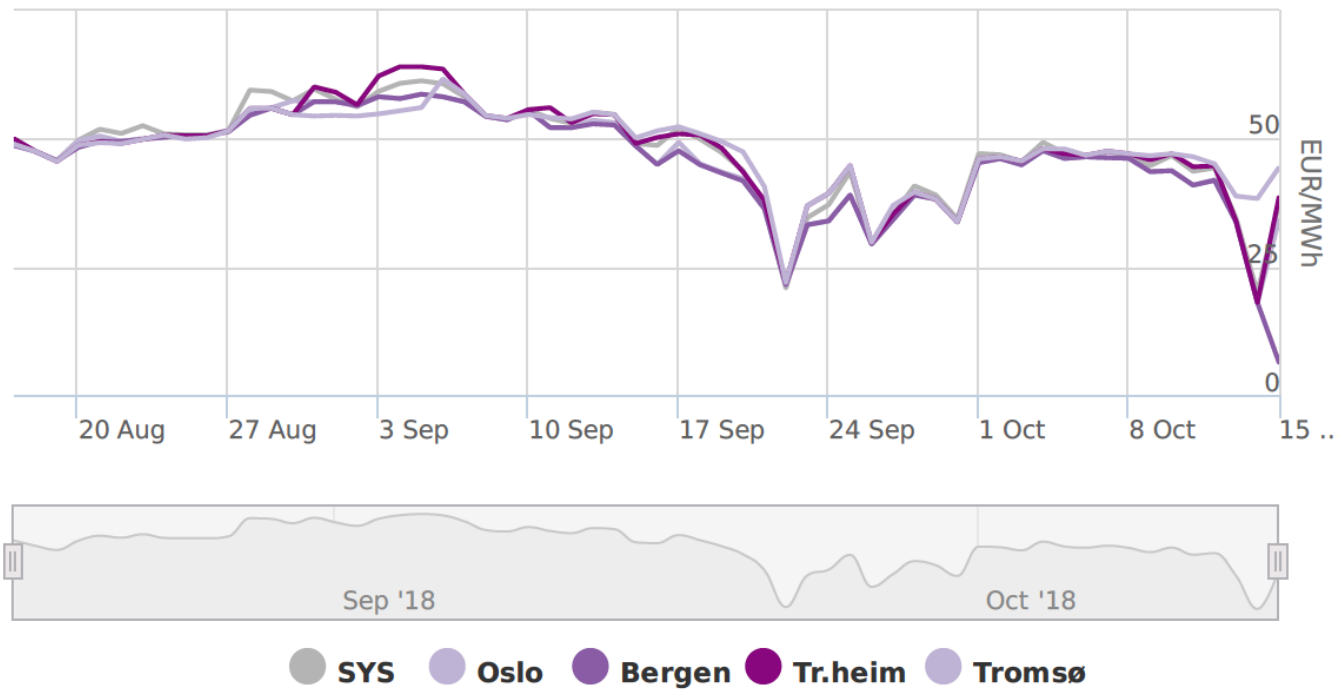
Source: nordpoolgroup.no, October 15, 2018, 18-19

Spot Prices – Hourly



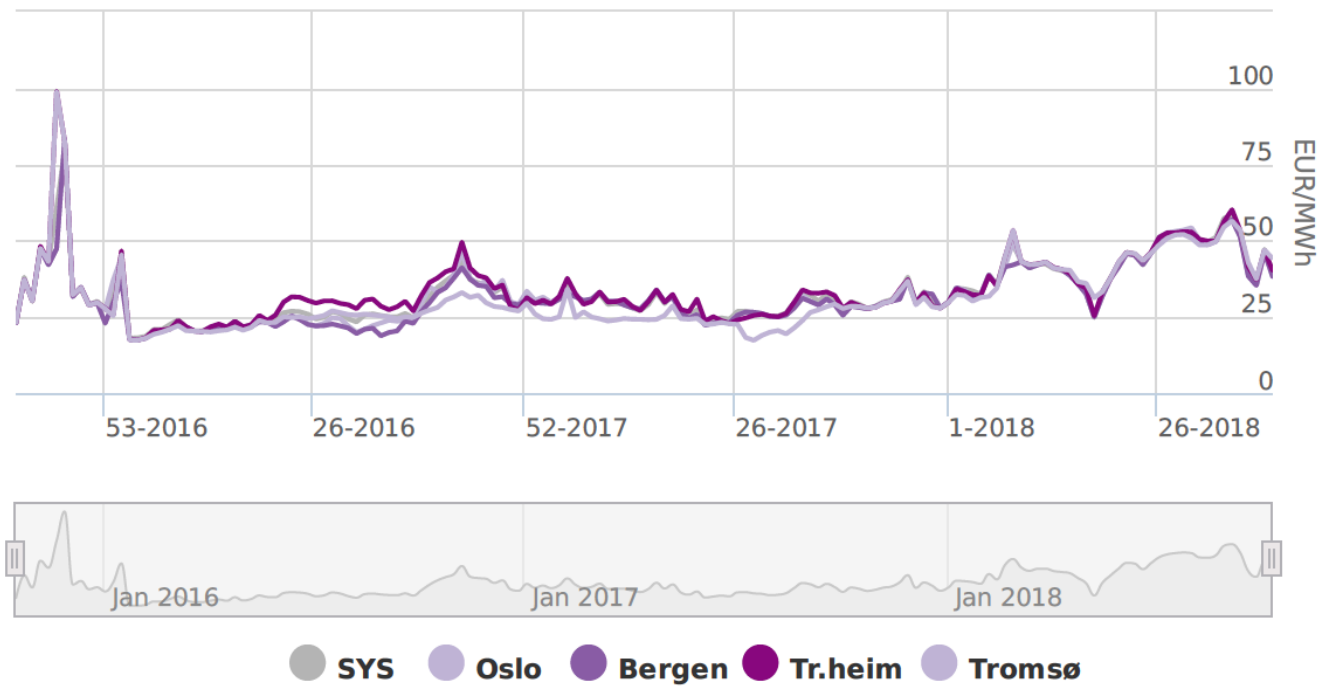
Source: nordpoolgroup.no

Spot Prices – Daily



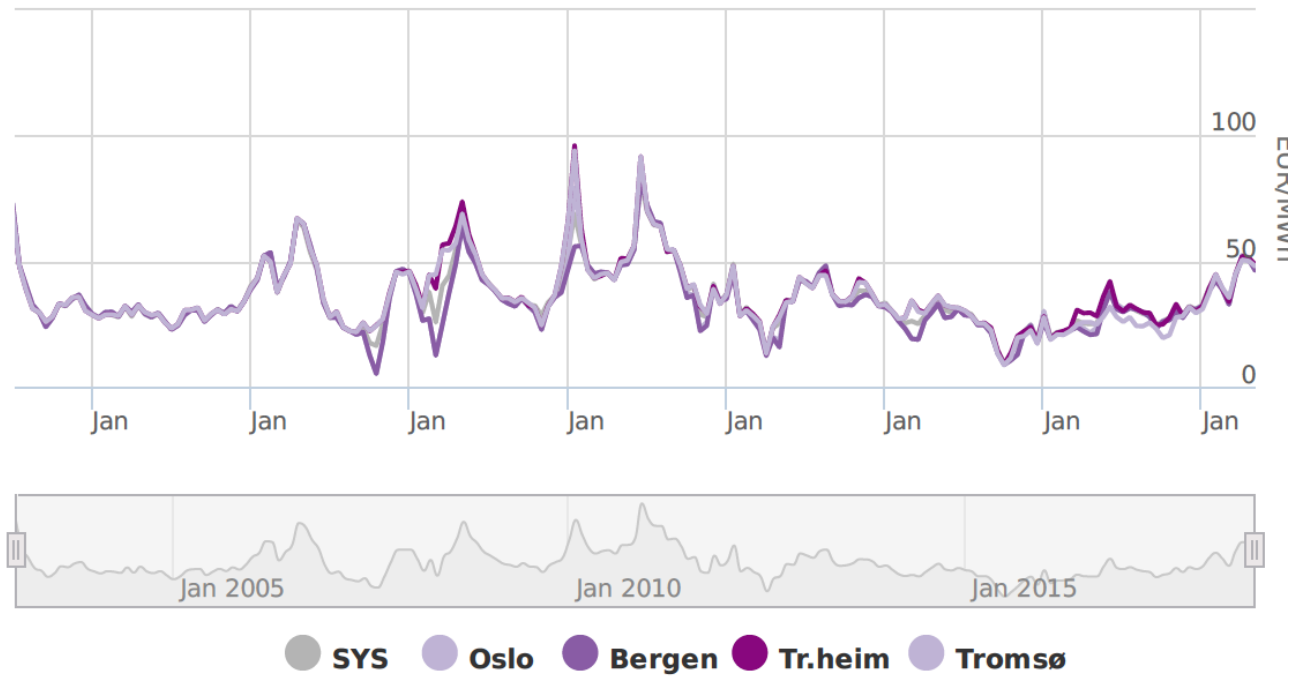
Source: nordpoolgroup.no

Spot Prices – Weekly



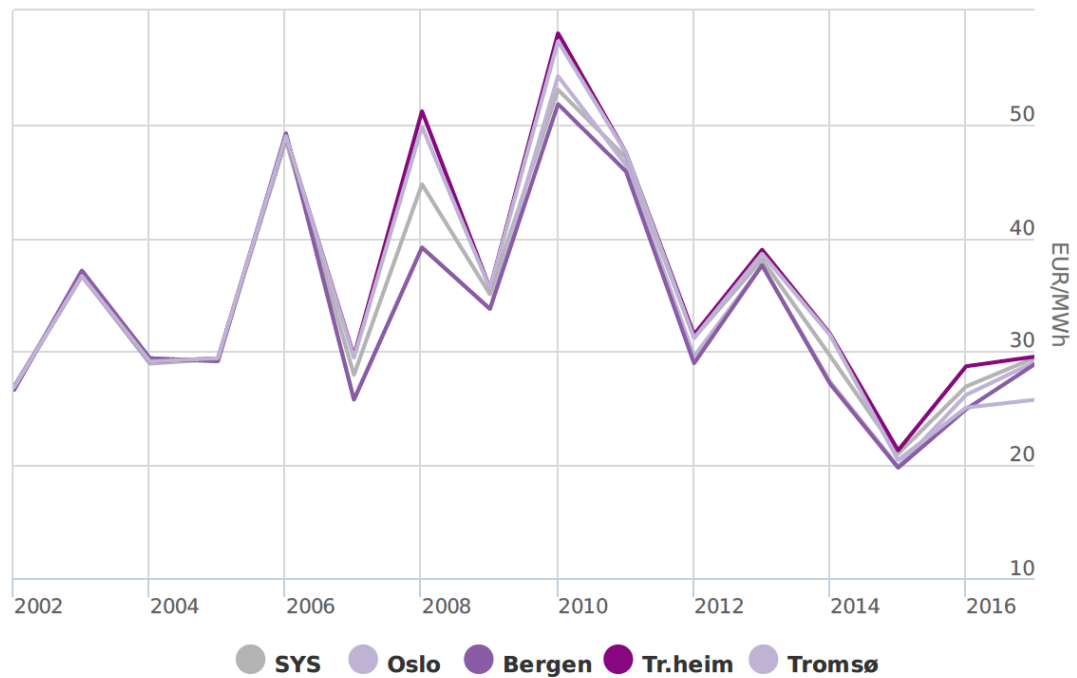
Source: nordpoolgroup.no

Spot Prices – Monthly



Source: nordpoolgroup.no

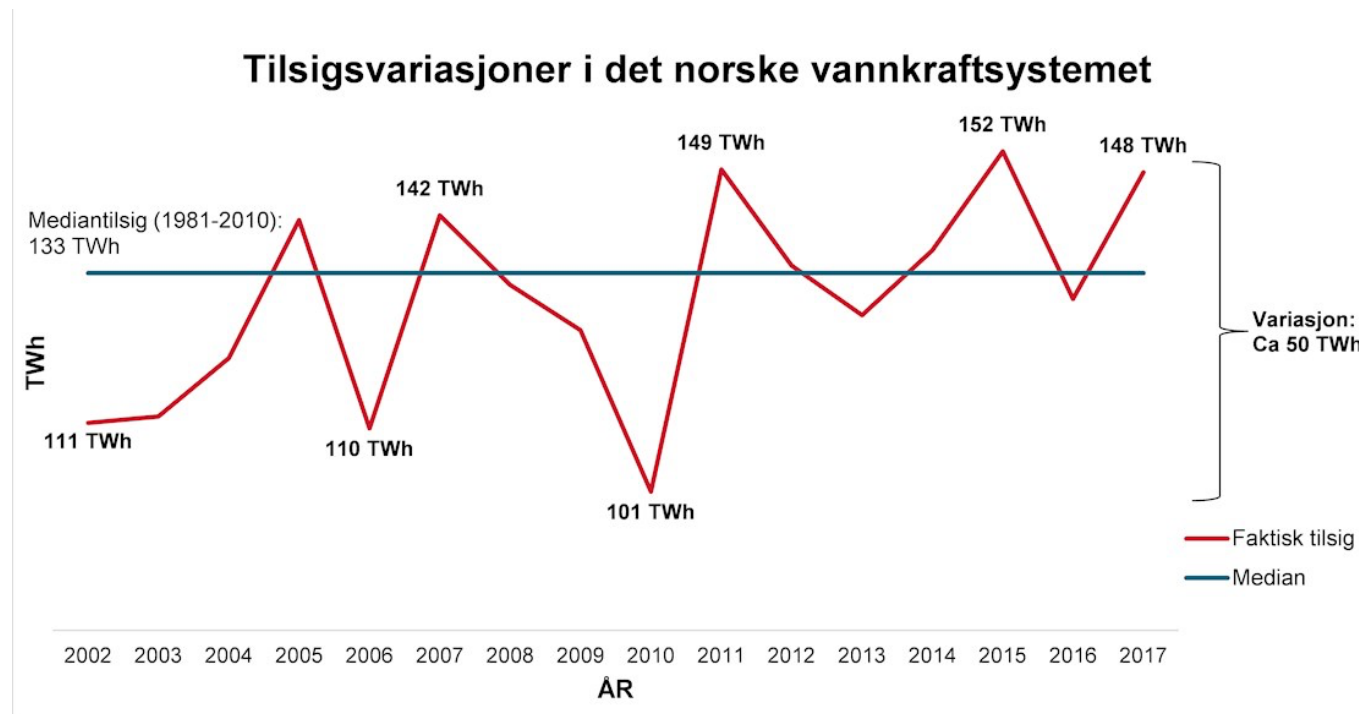
Spot Prices – Yearly



Source: nordpoolgroup.no



Volumes: Annual Inflow



Source: nve.no

4-5 September 2019

von der Fehr: Creating the Right Incentives

Spot-Market Performance

- Spot-price characteristics
 - day-of-week, but no month-of-year effects (Solibakke, 2002)
 - significant seasonal time-dependent jumps (Goto and Karolyi, 2003)
 - more persistent than other European spot prices (Koopman et al., 2007)
 - renewables affect price distribution (Solibakke, 2018a)
 - significant impact of wind forecast movements (Solibakke, 2018b)
- Price-cost margins
 - little evidence of excessive pricing



RISK AND RISK HANDLING

Hedging

- Backward integration
 - consumer-owned generation
 - energy intensive industries
- Forward integration
 - generator-owned retail business
 - relies on fixed-priced retail products
- Long-term contracts
 - bilateral
 - exchanges

Nasdaq OMX


- Products
 - futures (daily mark-to-market)
 - deferred settlement (DS) futures
 - options (yearly, quarterly European, monthly Asian)
- Reference prices
 - Nord Pool system spot prices
 - Nord Pool area and system price differences
- Duration
 - yearly, quarterly, monthly, weekly, daily
 - moving refinement of duration
- Base load
- Clearing
 - collateral, other financial contributions
- Market surveillance



Nasdaq Futures

Updated: 2019-09-03 15:15:23

Market: Electricity Nordic | Types: Year | Product: Futures

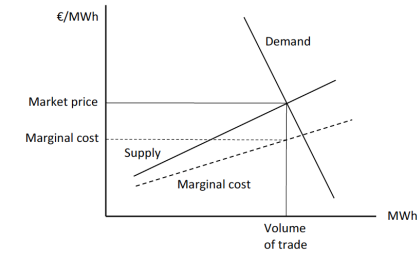
 Export to Excel | Traded

Aggregated volume (GWh): 1272.36 * MW ** HOURS

PRODUCT SERIES	BID	ASK	LAST	+/-	%	HIGH	LOW	ON*	OFF*	VOL*	DAILY FIX	OI	SIZE**	UPD*	MORE...
ENOFUTBLYR-20	33.87	34.00	33.90	-0.05	-0.15	33.95	33.62	26	27.0	53.00	33.95	7041	8784	14:58:50	
ENOFUTBLYR-21	32.80	33.00	32.90	-0.05	-0.15	32.95	32.80	8	5.0	13.00	32.95	3121	8760	14:59:43	
ENOFUTBLYR-22	32.40	32.60	32.35	0.10	0.31	32.35	32.35	3	2.0	5.00	32.25	1152	8760	14:59:42	
ENOFUTBLYR-24	31.80	32.60			0.00				1.0	1.0	32.25	229	8784	14:59:39	
SYHELFUTBLYR-20	6.50	7.25			0.00				31.0	31.0	6.70	899	8784	14:21:51	
SYHELFUTBLYR-21	3.50	4.50			0.00				2.0	2.0	3.88	456	8760	14:21:52	
SYSTOFUTBLYR-21	1.25	1.75			0.00				13.0	13.0	1.25	856	8760	14:21:33	
SYLULFUTBLYR-22	-4.60	-2.60			0.00				5.0	5.0	-3.65	15	8760	13:58:06	
SYLULFUTBLYR-23	-4.60	-2.60			0.00				5.0	5.0	-3.65	5	8760	13:58:06	
SYSUNFUTBLYR-22	-4.60	-2.60			0.00				4.0	4.0	-3.65	36	8760	13:58:11	
SYSUNFUTBLYR-23	-4.60	-2.60			0.00				4.0	4.0	-3.65	17	8760	13:58:11	
SYMALFUTBLYR-21	2.50	3.50			0.00				2.0	2.0	2.90	108	8760	14:43:46	

Financial-Market Performance

- Considerable market risks (prices and volumes)
- Well-developed markets for risk management
- Futures prices
 - strong reaction to hydro inflow, overshoot spot prices (Gjølberg & Johnsen, 2001)
 - future prices tend to exceed spot prices (Botterud et al, 2002)
 - forward curve dynamics depend on hydrology (Audet et al., 2004)
 - area price differentials, risk premia related to maturity (Marckhoff and Wimschulte, 2009)
 - no evidence of time-varying risk premia (Huisman and Kilic, 2012)
- Liquidity
 - limited for area differences and long maturities



MARKET IMPERFECTIONS

Imperfect Competition

- Anticompetitive conduct
 - exercise of market power
 - insider trading
 - market manipulation
- Barriers to competition
 - regulatory (institutional) restrictions
 - network (infrastructure) constraints
 - asymmetric information

Market Power

- Inefficiency may result if individual agents manipulate market outcomes and so distort price signals
 - deviations of prices from underlying costs/valuations
- Market power is more likely to a problem when
 - market is concentrated (i.e. with few sellers and/or buyers)
 - market is segmented (eg. by transmission constraints)
 - capacity utilisation is high
 - entry is difficult
 - a large share of trade is exposed to the relevant price

Long-Term Contracting

- Long-term contracts limit exposure to short-term prices
 - exposure on difference between contracted and actual volumes
- ... and so reduce incentive to distort short-term price
 - gain from trade settled on basis of short-term price only
- Market-power less of a problem in the longer term
 - more elastic supply response (investment, entry)
 - possibility of contracting with new counterparties
- Market power thus likely smaller problem in highly contracted markets
 - voluntary hedging
 - mandated coverage

Regulation and Competition Policy

- Market monitoring
 - structure (barriers to competition)
 - conduct (anticompetitive)
 - performance (excessive price-cost margins)
- In principle easy to characterise, but in practice difficult to ascertain anticompetitive conduct
- More effective to identify barriers to competition and remedies to improve market structure
 - long-term contracting
 - market integration

Externalities

- Inefficiency may result if costs and benefits not fully reflected in prices
- Interdependent hydro producers
 - upstream reservoir management affects downstream flows
 - effects may be both negative and positive
 - single, market-wide price would not internalise such effects
- Possible solutions
 - bilateral or multilateral contracting between affected parties
 - restructuring of ownership
 - joint resource management
 - virtual power plants

Joint Resource Management in Norway

- By law, generators on the same river system must form a water-management association (“brukseierforening”)
- Example: Glommens og Laagens brukseierforening
 - 21 members
 - 50 power stations
 - 27 reservoirs with combined capacity of 3 500 mill. m³
 - annual energy production of 12 TWh (30% from reservoirs)
- Water-management associations
 - produce water-flow prognoses
 - coordinate and approve members’ production plans
 - resolve conflicts, possibly by side payments
 - no explicit internal trading mechanism

Virtual Power Plants

- Pooling of resources
 - all facilities on a given river system (reservoirs, turbines)
 - unified management of operation
- Rights to output
 - according to ownership of underlying resources
- Supply
 - individual participants manage their own output
 - overall output equal to sum of individual supplies
- Examples
 - jointly owned hydro facilities in Norway
 - jointly owned petroleum production facilities

CONCLUSIONS

Conclusions

- Regulation a “guiding hand”
 - promoting well-functioning markets, based on consultation and consensus
- Where implemented sensibly, short-term markets have generally worked well
 - increased efficiency (both short and long term)
- In principle easy to characterise, but in practice difficult to ascertain anti-competitive conduct
 - more effective to identify barriers to competition and reduce those
- Short-term market reforms unlikely to affect security or adequacy of supply, at least if contracting obligations are in place
 - better short-term signals improve long-term contracting and investment decisions

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