National energy strategy for Norway

Einar Hope, Professor
Norwegian School of Economics, Bergen

Workshop Energy for Sustainable Science
Lund, 13 – 14 October, 2011

Outline

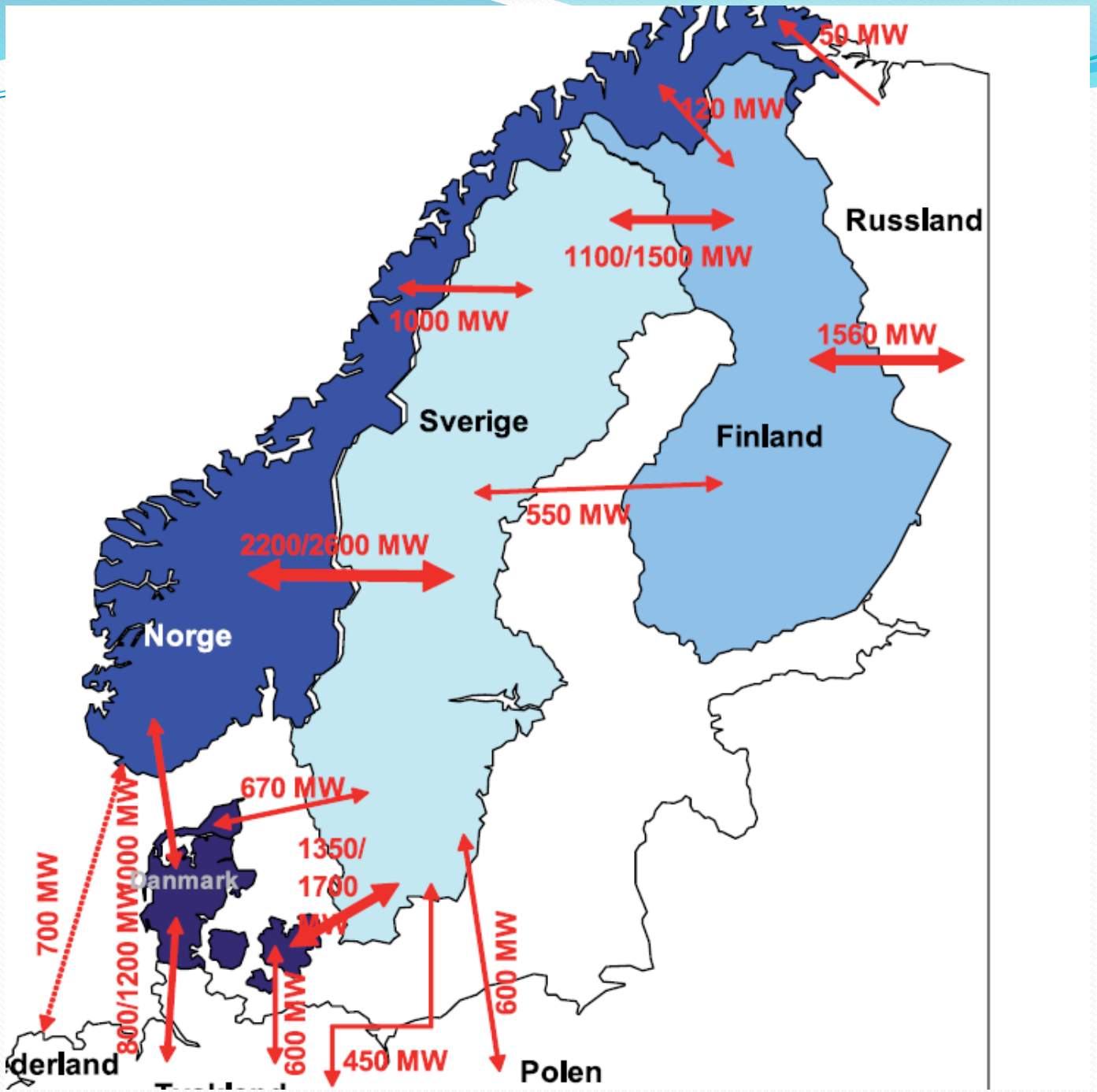
- Briefly about the structure of the Norwegian energy system and energy policy framework
- Norway's market integration with the Nordic countries for power and gas
- Discuss critically three energy strategy issues for Norway:
  - Strategy for renewables (wind and hydro power), and wind and hydro power in combination: Norway as a "battery" for Europe?
  - Strategy for electrification of petroleum installations to reduce GHG emissions
  - Strategy for CCS and increase in Norwegian petroleum resourses and use/export of oil and gas in a climate policy context

Norway's energy system

- Energy production in Norway
  - An almost 100 % hydro power based electricity system, fully integrated with the Nordic power market, and well connected with transmission cables to Germany, the Netherlands and plans for a UK connection. Generally in a net export position. Power intensive industries account for 1/3 of total power production.
  - Major producer of oil and gas, almost all for export. Virtually no domestic natural gas distribution system and market
  - Huge wind power potential onshore and offshore. Very few wind power installations yet. Production properties of wind and hydro power represent a good production mix. Long distances from wind power sources to European power markets

Norway's energy and climate policy framework

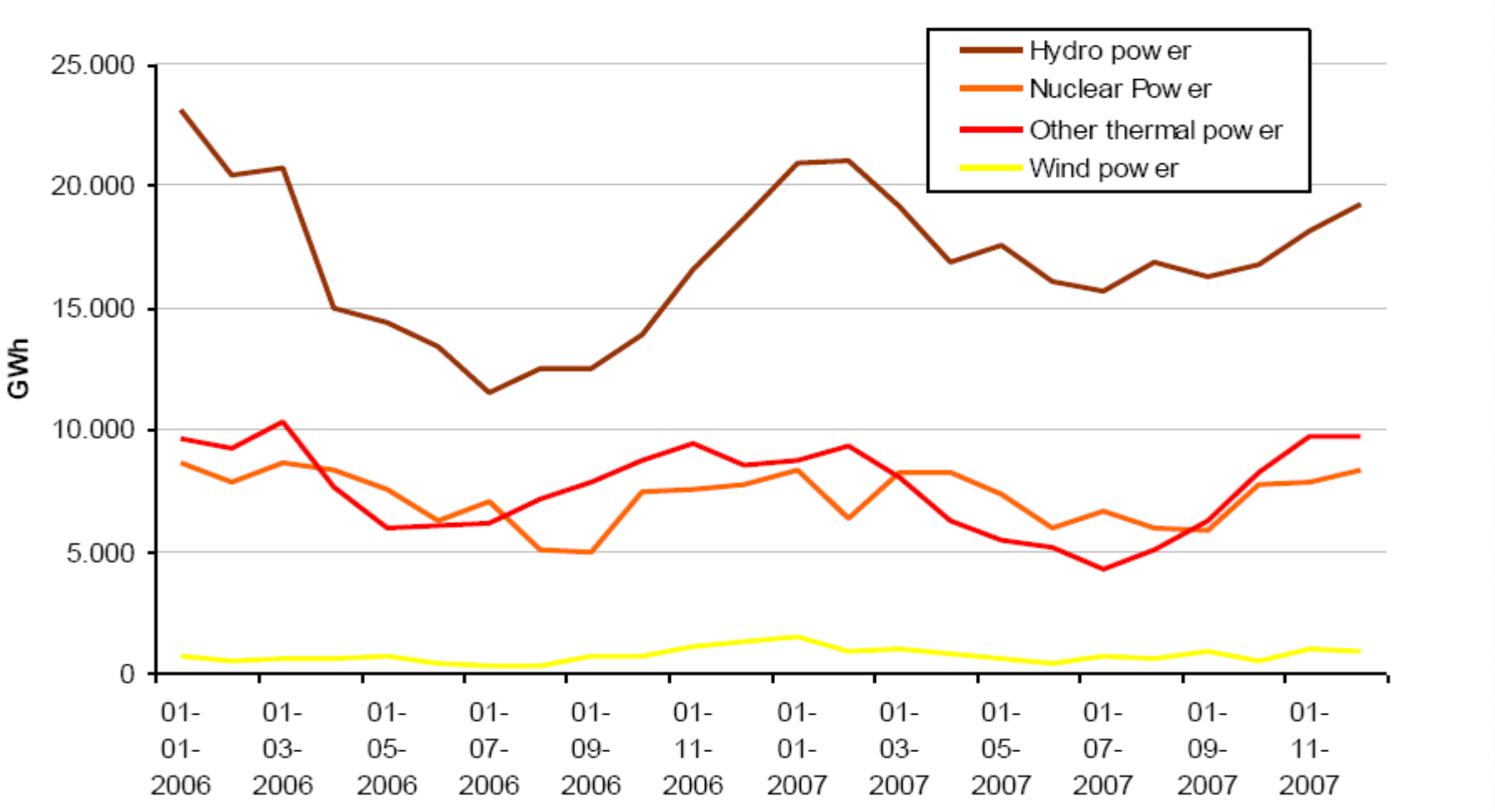
- Climate policy targets (no more than 2 degree C rise in global temperature):
  - Norway will be carbon neutral by 2050; recently given more ambitiously as by 2030
  - Reduce GHG emissions by 30% of its own 1990 emissions by 2020
  - Sectoral targets for petroleum, transport, manufacturing industries, etc
- Renewable energy and efficiency targets:
  - Ca 15 TWh from new renewable energy sources, mostly wind, but some small scale hydro and bioenergy (total power production in a normal year: ca 120 TWh)
  - Ca 15 TWh from energy efficiency savings


50 MW
120 MW
Russland
1100/1500 MW
1000 MW
1560 MW
Sverige
Finland
550 MW
2200/2600 MW
Norge
670 MW
1350/
1700
Danmark
700 MW
800/1200 MW
600 MW
600 MW
450 MW
Polen

Nordic generation capacity (MW) by power source. 2007

	Denmark	Finland	Norway	Sweden	Nordic region
Installed capacity (total)	13 032	16 900	30 313	34 068	94 313
Nuclear power	-	2 651	-	9 074	11 725
Other thermal power	9 899	11 137	890	8 005	29 931
- Condensing power	928	2 988	-	2 298	6 214
- CHP, district heating	7 754	4 051	142	2 883	14 830
- CHP, industry	477	3 293	49	1 224	5 043
- Gas turbines etc.	741	805	699	1 600	3 845
Hydro power	9	3 031	29 043	16 209	48 292
Wind power	3 124	81	380	780	4 365

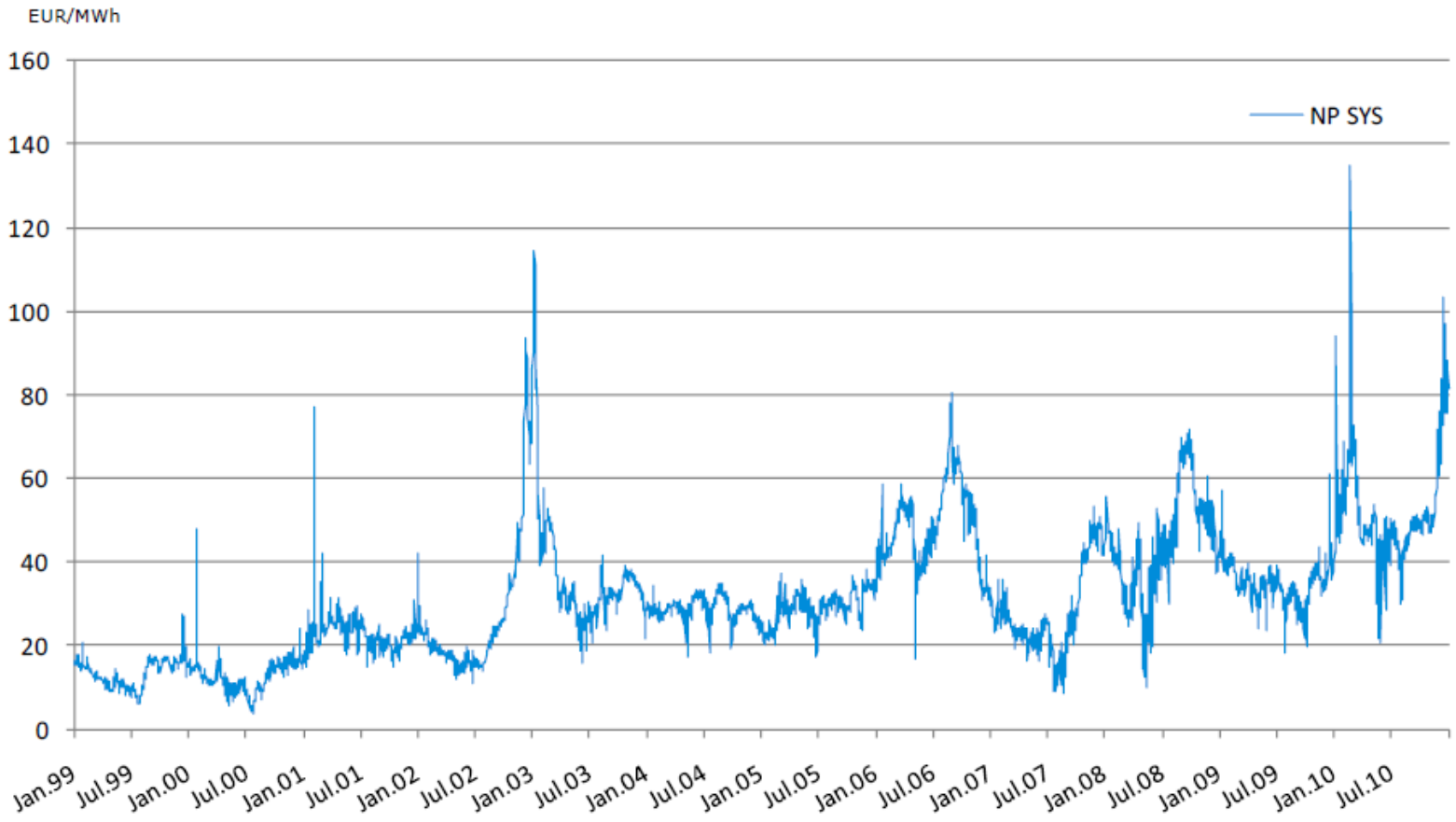
Total power generation in the Nordic region 2006-07



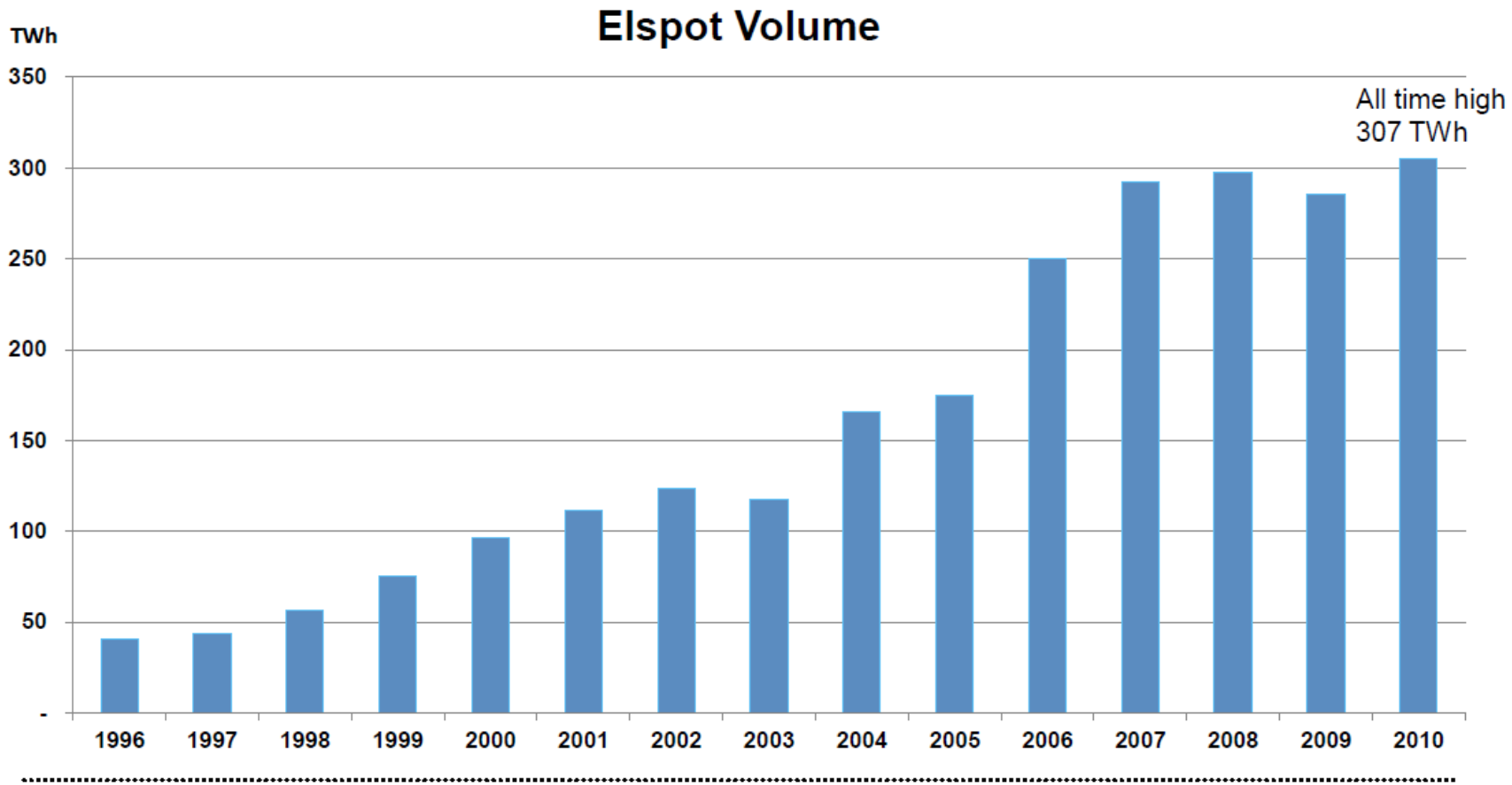
Organisation of the Nordic Power Market

- A common power exchange, NordPool, for the whole market
- Spot market (day-ahead market; system price), balancing markets, financial/derivative markets, clearing functions, network management, etc.
- Also gas market trading and carbon dioxide emission market allowances (EUAs) and carbon contracts (CERs), through the Green Development Mechanism (CDM)
- NordPool is a non-mandatory power exchange pool
- 380 members in 22 countries
- Full market integration of the wholesale market; towards full market integration also of retail markets
- A common Norwegian-Swedish green certificate market established in 2010

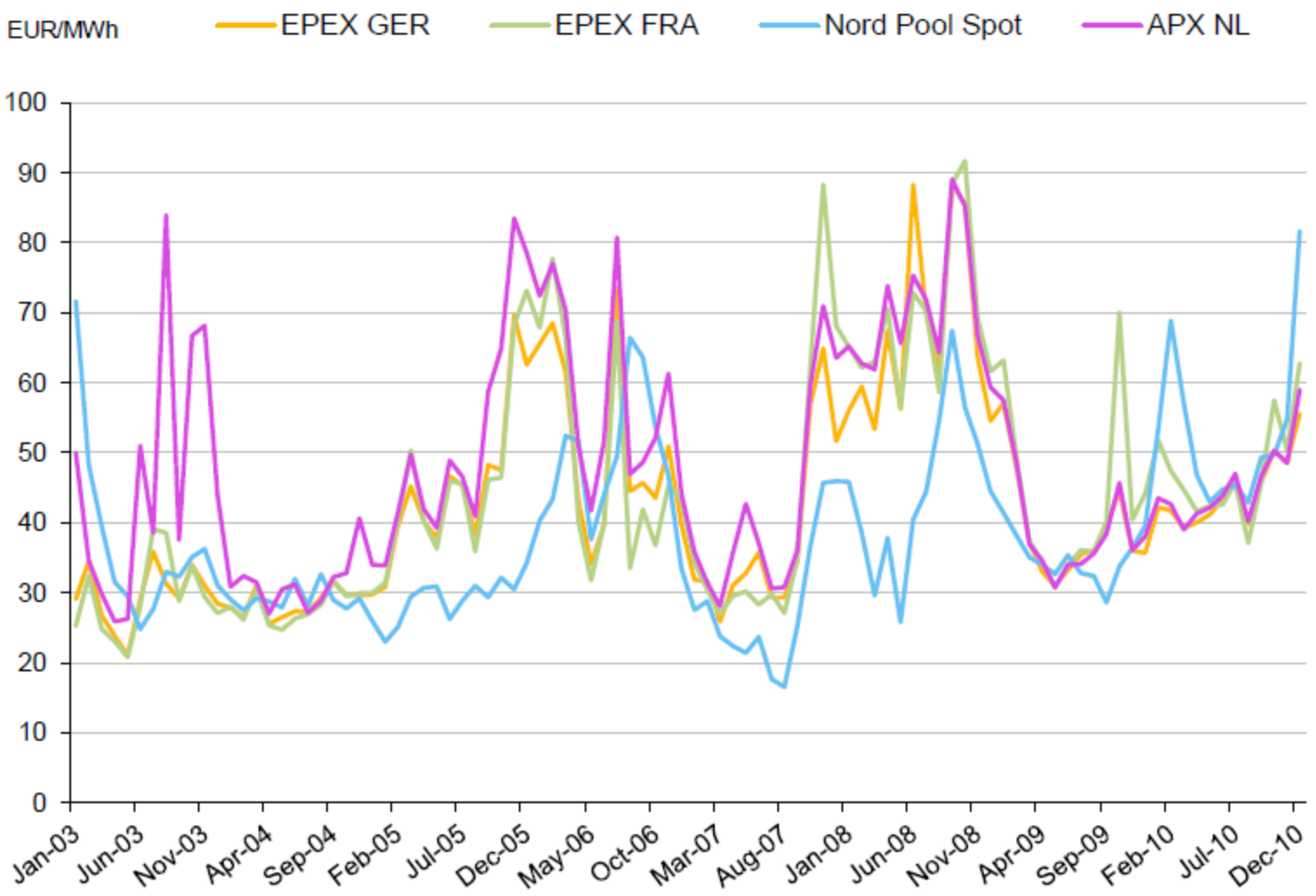
System price
Daily average 1999 - 2010



Volume development 1996 - 2010

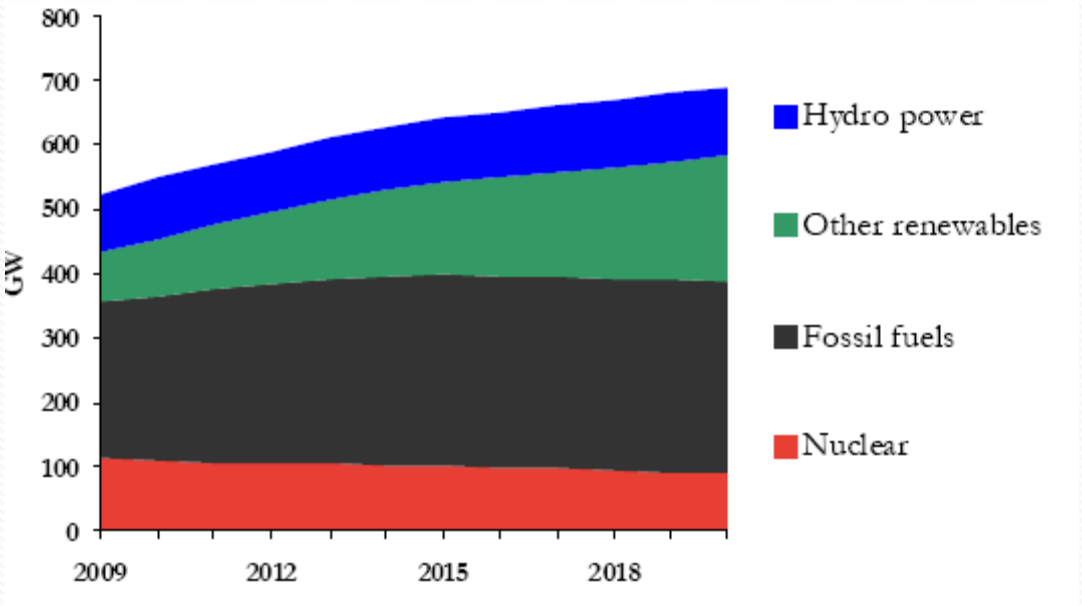


Price comparison for Europe
Monthly spot prices 2003 – 2010



Expected changes in the composition of power production in Europe

(Expected increase in wind power production of 150 %)



Strategic issues wrt wind power and hydro power

- Is the EU renewable policy target wrt to wind overambitious?
  - Profitability of wind power investment and implied subsidies
  - Total cost of wind power investment, including network transmission costs. Implications for grid user prices
  - Suboptimization with regard to location of wind power installations within the EU area in relation to wind resources
  - Policy instruments: feed-in tariffs versus direct subsidies. Priority to wind power in the total power system?
- Intermittency of wind power
  - Back-up facilities and incentives to operate and invest in such facilities in an integrated power system; optimal production mix
  - Incentives to disinvest in polluting power plants
  - Supply of base load, and capacity reserves for security of supply

Wind and hydro power: Production properties

- Intermittency/variability of wind power; over the day (short term) and over the season (year; longer-term): Need for back-up facilities, balancing power
- A hydro system with water storage (reservoiars): Almost instantaneous regulation up and down of production; different from thermal power. Hydro power as back-up in a wind power system
- Thus: wind and hydro power as interesting complements in an optimal design of the composition of the power system; nationally, regionally and internationally

Norway as a "battery" for Europe: Type of products

- "Swing producer" for that part of the variation in wind power production in Europe, which the European power system is unable to accomodate or compensate for effectively
- Regular trade in power through the organized power markets; physical and financial products
- Network products and services; balancing power and ancillary network services to avoid system breakdown (primary, secondary and tertiary reserves)
- Security of supply "products": Access to the Norwegian power system to improve security of supply in the European system, and access for Norway to the thermal power system of Europe to improve security of supply due to variability in hydro power production because of variations in inflow of water (e.g. "dry" year)

Norway as a battery: Some preconditions

- Share of wind power in the total European power system; the larger the share, the larger production variability, generally speaking
- Size of the Norwegian regulating power capacity in relation to Europe's need for balancing power
- Will the current price differences between the Norwegian/Nordic and the European system persist under further market integration?
- Ability to better predict variability in wind power production
- Evening out wind production variability between regions by market and network integration
- Improving the ability of thermal generation to accomodate short term variations in wind power, through technological change

Some preconditions; continued

- Needed investment in new transmission capacity
  - Between Norway/Nordic market and Europe
  - Internally in the European market
- Needed investment in reserve capacity to account for wind power intermittency
- Implications for financing and network pricing/tariffs; e.g. the missing money issue

Potential new international interconnectors

- ambitious plans

HVDC cable to England

SydVästLänken – HVDC link to the Jönköping/ Malmö area

NorNed 2 – 2nd HVDC cable to the Nederland

NORD.LINK/ Norger – HVDC cable to Germany

Skagerrak 4 – 4th HVDC cable to Denmark

Strategy: Electrification of offshore oil and gas installations

- A stated policy of supplying the oil and gas installations on the Norwegian continental shelf with electricity from the onshore power system to reduce GHG emissions to cope with Norwegian emission targets and the Kyoto protocol
- This extra demand puts pressure on the onshore power supply system, both generation and network; need for new capacity investments
- Environmental effects from new high voltage power lines through pristine landscape/nature and new renewable power plants
- Will GHG emissions be reduced? Gas saved from closing down gas turbins on platforms will be exported and burnt e.g. in a gas fired power plant somewhere on the Continent. Who is the marginal supplier in the total system in a given situation?

Electrification; cont.

- How to evaluate GHG emissions against environmental effects e.g. of hydro power or network investment in a cost-benefit investment analysis?
- How to balance GHG emissions as a *global* environmental issue against *local* environmental effects of power investments?
- Cost and risk issues wrt to time and problems of repair in the choice between sea cables and ordinary air power lines
- ”One-eyed” policy targets and instruments; partial versus general equilibrium analysis
- These issue created a heated political and professional debate and led almost to a political crisis in Norway

Strategy for CCS

- Investment of approx. 25 billion NOK (5 billion US$) in a CCS R&D activity and test plant for CCS at the Mongstad petroleum conglomerate site (oil refinery, crude oil terminal, and combined heat and power plant (CPH)), north of Bergen
- Cost increases and delays due to ”unforeseen” events
- Uncertainty with regard to test results and transformation from pilot plant scale to full scale production facility
- Uncertainty with regard to location and form of deposit for storage of emissions

Increased petroleum production and export of oil and gas in a climate policy context

- Increased resource findings and recovery rate for fields in the North Sea and potential in the Barents Sea: What is the optimal production profile over time?
- Substitution for coal and oil with gas in power production etc: What effects on GHG emissions in Europe?
- Effect on gas prices of shale gas; will there be a gas glut in the market?
- Use of gas in Norway to cover demand increases, including from potential new energy intensive industries based on gas, rather than from renewables?

Concluding remarks

- New renewable energy important in an energy-environmental policy and strategic context, but be aware of (total) costs.
- Need for a broader analytical framework for policy planning and for evaluating effects of policy instruments, than typically is applied in energy and environmental (partial) policy analysis
- Uncertainty wrt to effects and outcomes due to the typically long horizon policy perspective needed here
- Avoiding some of the opportunistic behaviour and argumentation from political pressure groups and lobbyists in renewable energy policy formation
- Be aware of unexpected outcomes and effects!