International lessons from power market reforms: The integrated Nordic -Baltic power market and beyond An economic perspective

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Outline

- Background for the Norwegian and Nordic power sector reforms
- Methodological and conceptual issues in market and regulatory reforms of the power sector
- Focus on lessons of the integrated Nordic-Baltic power market reform and ongoing developments towards European market expansion and integration
- Summary of international lessons
- Challenges and unresloved issues

Background for the Norwegian electricity market reform: 1990

- Excess capacity built up over time in the hydro-based power system. Security of supply?
- Is the use of resources in the power sector economic efficient? Ministry of Finance versus the Ministry of Oil and Energy
- The vulnerability of the hydro-based system in relation to variations in generation capacity of the isolated Norwegian system. Changing the composition of the national system, introducing natural gas, or market integration with the Scandinavian countries, or introducing market-based arrangements?
- Liberalization and deregulation of the electricity sector in other other countries.
- Tentative lesson: Excess capacity creates incentives or pressure for competition

The mandate of the research project at SAF/NHH

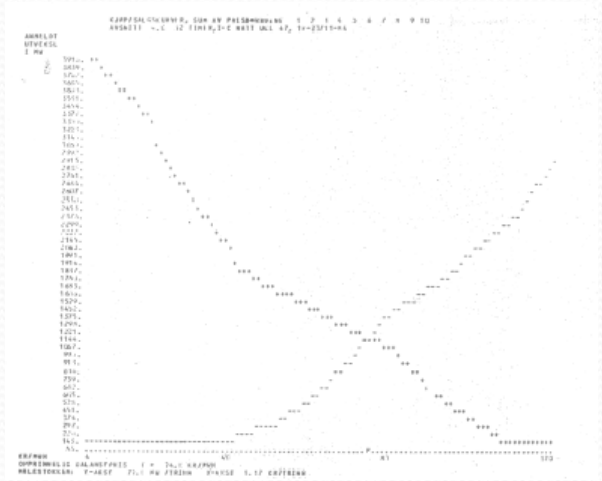
- Research project financed by the Norwegian Minstry of Finance and the Ministry of Oil and Energy. 1988/89
- "…to analyze the possibility for increasing the efficiency of the existing Norwegian electricity system by developing a marked-based power system, with economically rational agents, and public regulation principles and policies adepted to the special technological and economic characteristics and conditions of generation and power trade in a hydro-based system".
- Nine months project time. One main report and nine subreports
- Proposition to Parliament 1989-90. New Energy Act 1990

The structure of the Norwegian power sector prior to the reform

- Close to 100% hydro power generation. Storage of water in a mountain reservoir system. Some flow of river generation
- A decentralized production system; a large number of independent generating companies, connected to an integrated national transmission system. Two transmission connections to Sweden, but otherwise an isolated national power system
- Ca 85 public ownership to generation and network: state, county, intermunicipal and municipal ownership
- Vertical integration between generation, sales and network

Structure, cont

- Long term contracts beween generators and end-users, particularly for power intensive industry companies. («State contracts» with special price and delivery terms).
- Price regulation. «Statkraft price» determined annually by Parliament as part of the budget process for the state-owned company. Reference price for other generators
- Heavily regulated sector politically, and dominated by technological considerations and staffed by engineers. Sector specific regulatory agency
- «Firm power» and «interruptible power» contracts. Share 90/10 percent of total sales. Obligation for producers to deliver power within their concession area. Market for interruptible power between power producers



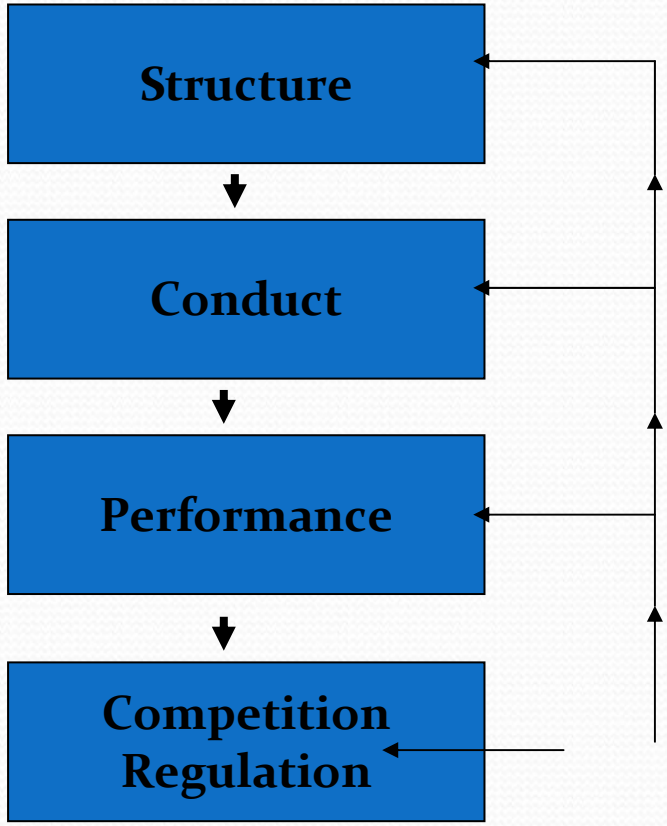
The ”textbook” (market based) model of electricity market reform:

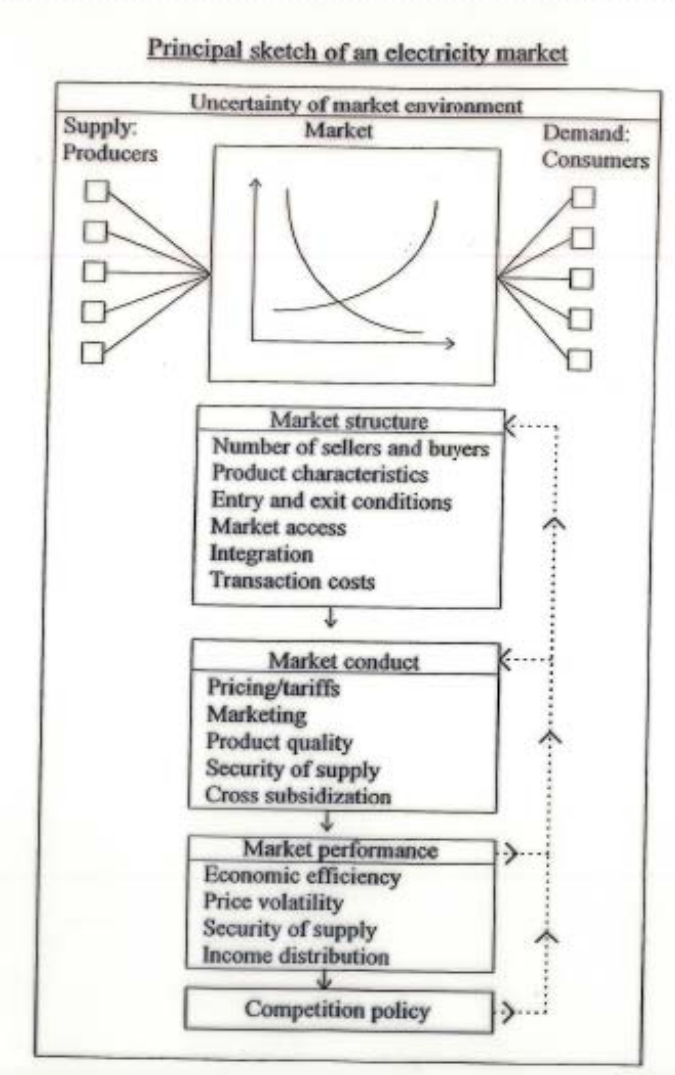
- Restructuring:
  - Vertical unbundling of generation, transmission, distribution and retail supply activities
  - Horizontal splitting of generation and retail supply/trading activities
- Competition and markets
  - Wholesale and retail market design – market based system
  - Allowing entry into generation and retail supply
  - Competition regulation
- Network regulation
  - Establishing an independent network regulator
  - Provision of third-party network access
  - Incentive regulation of transmission and distribution networks
  - Competition versus network regulation and their relationship
- Ownership: privatisation of existing publicly owned companies

Other approaches – other regulatory models

The ”dual” market model with particular reference to developing countries:

- Combining some features of the textbook model with powerful residues of state monopolies, traditionally observed in the electricity industry. Some particular attributes:
  - Incumbent power generation fuel (hydro, oil, coal, etc)
  - National governance (federal, state, degree of centralization)
  - Adequacy of the power sector (e.g. supply needed for economic growth)
  - Reform strategy (e.g. starting with generation or transmission systems)
- Stepwise versus full-fledged market reform implementation
- Full market integration versus regionalization of market approach (Europe?)
- The regulatory problem will be different depending on market design and approach to electricity market reform


Structure
Conduct
Performance
Competition
Regulation


Principal sketch of an electricity market
Uncertainty of market environment
Supply:
Producers
Market
Demand:
Consumers
Market structure
Number of sellers and buyers
Product characteristics
Entry and exit conditions
Market access
Integration
Transaction costs
Market conduct
Pricing/tariffs
Marketing
Product quality
Security of supply
Cross subsidization
Market performance
Economic efficiency
Price volatility
Security of supply
Income distribution
Competition policy

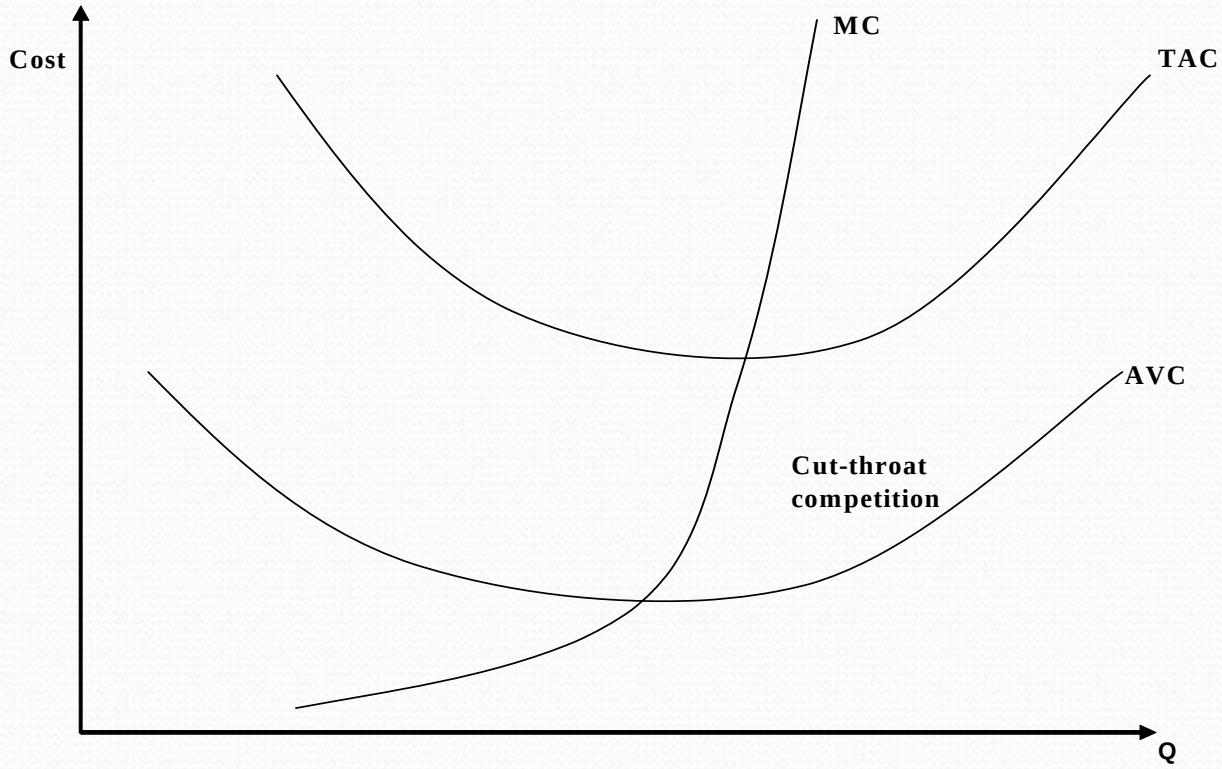


Figure 1: Short run costs

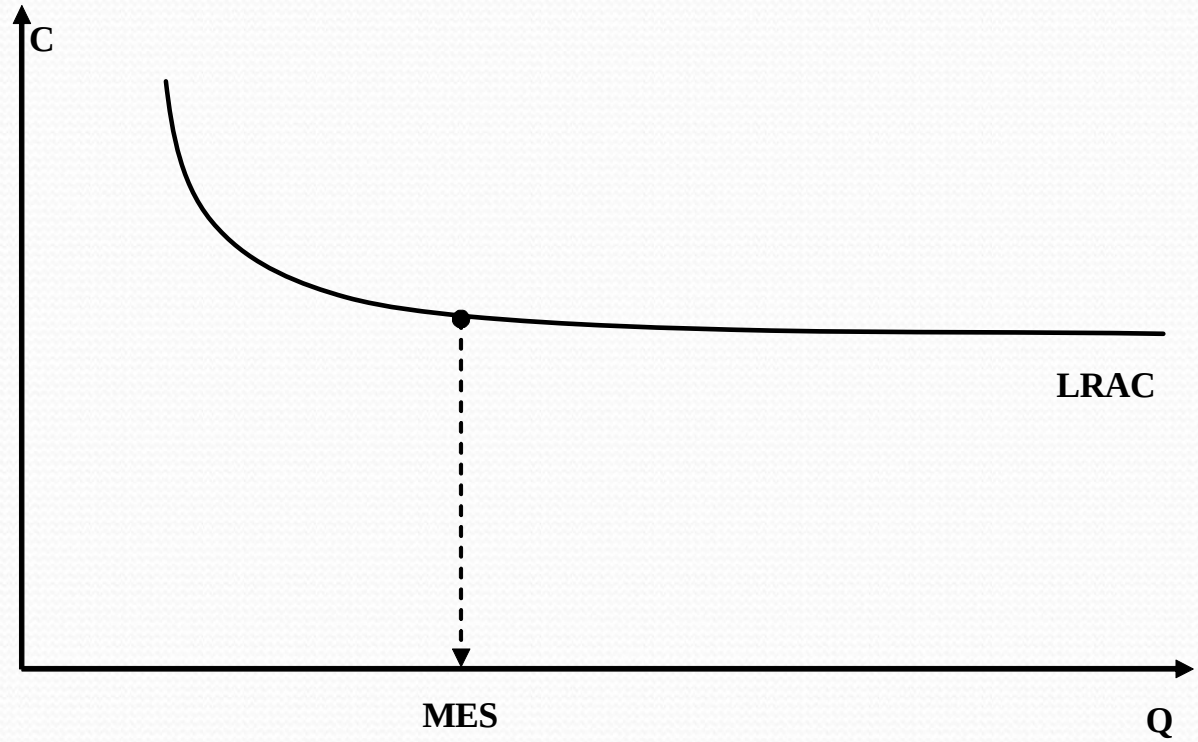


Figure 2: Shape of the long run cost curve. Minimum efficient scale

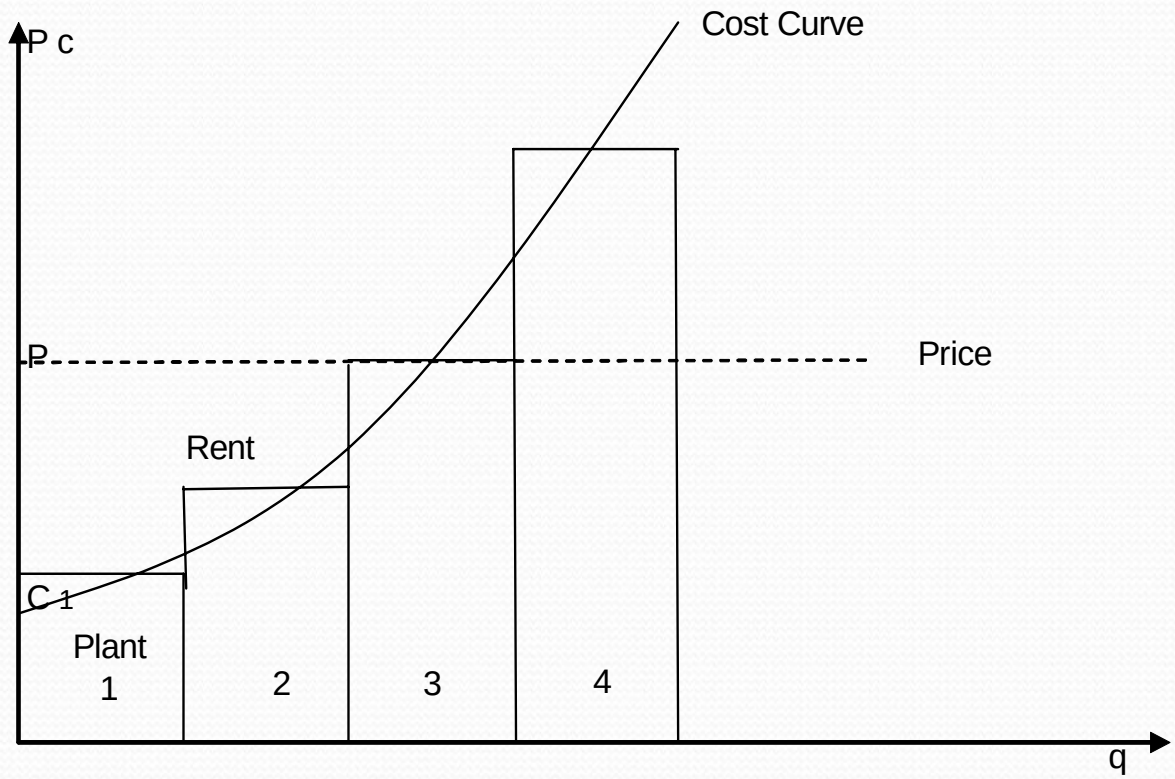


Figure 3: Industry cost (supply) curve. The rent concept

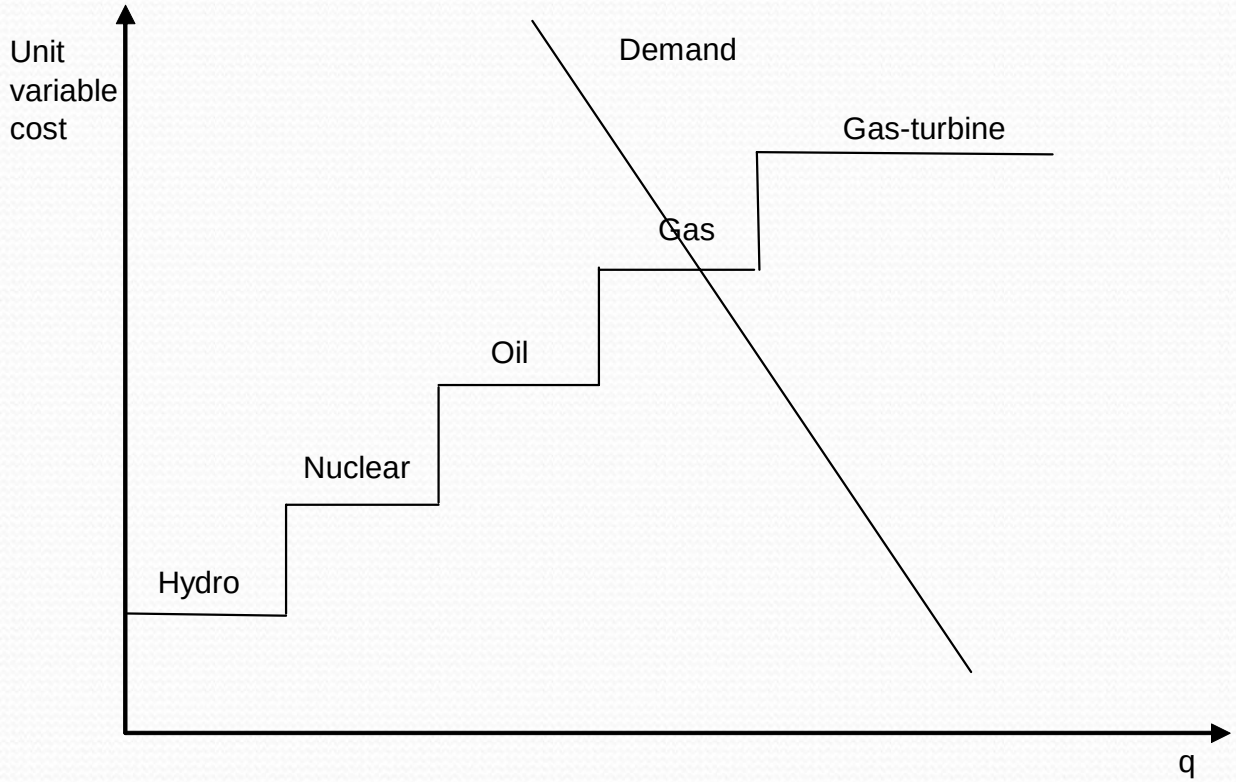


Figure 4: Industry cost curve for energy. Merit order system

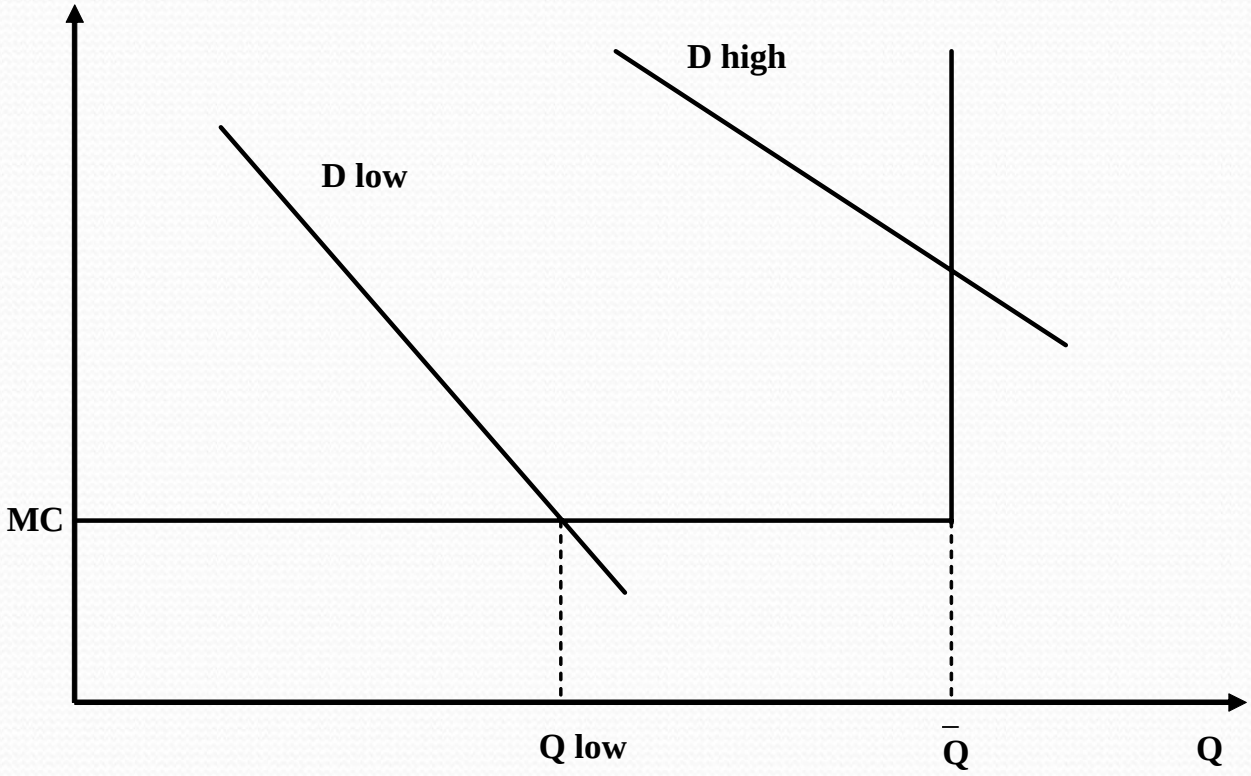
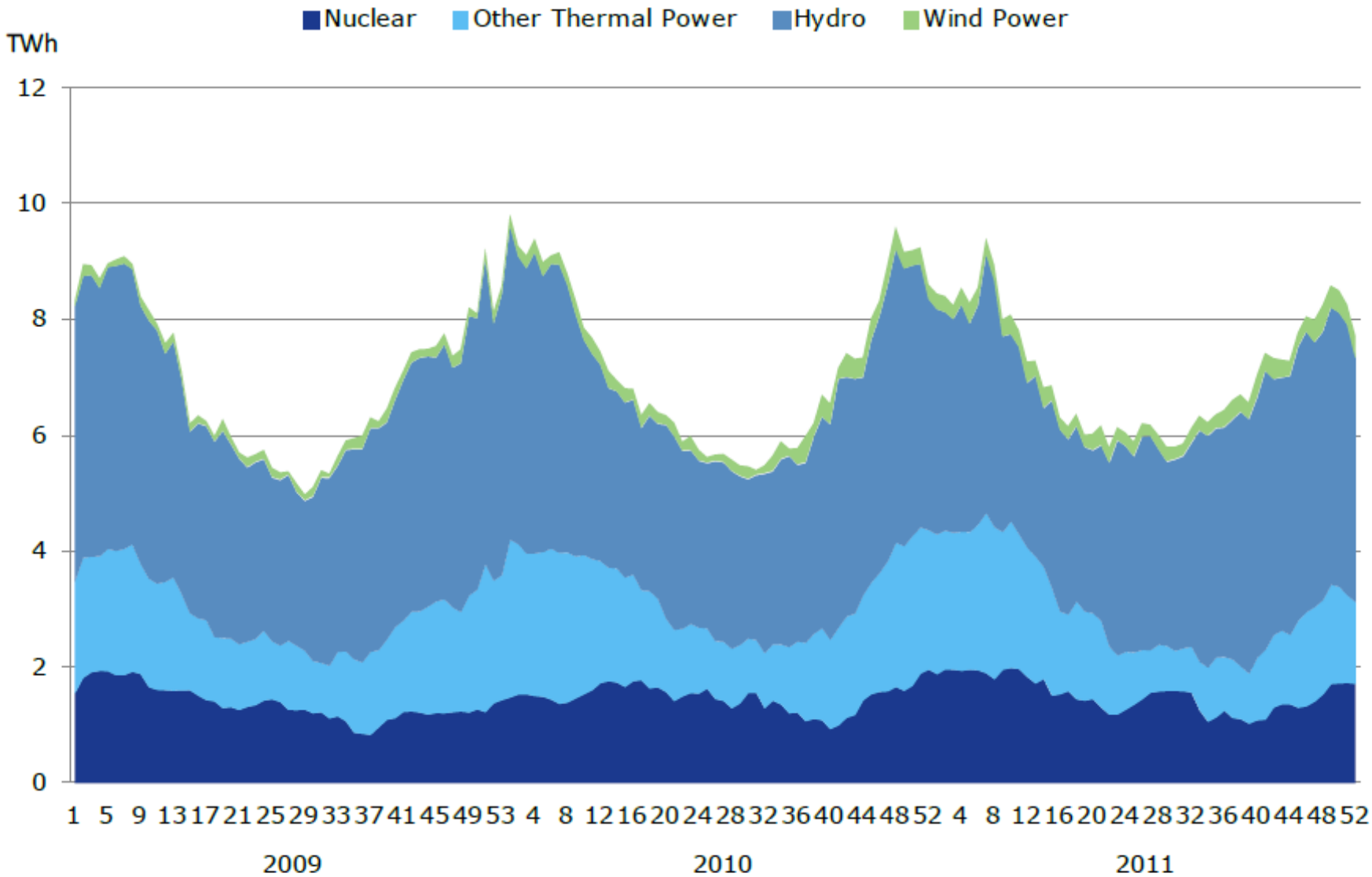
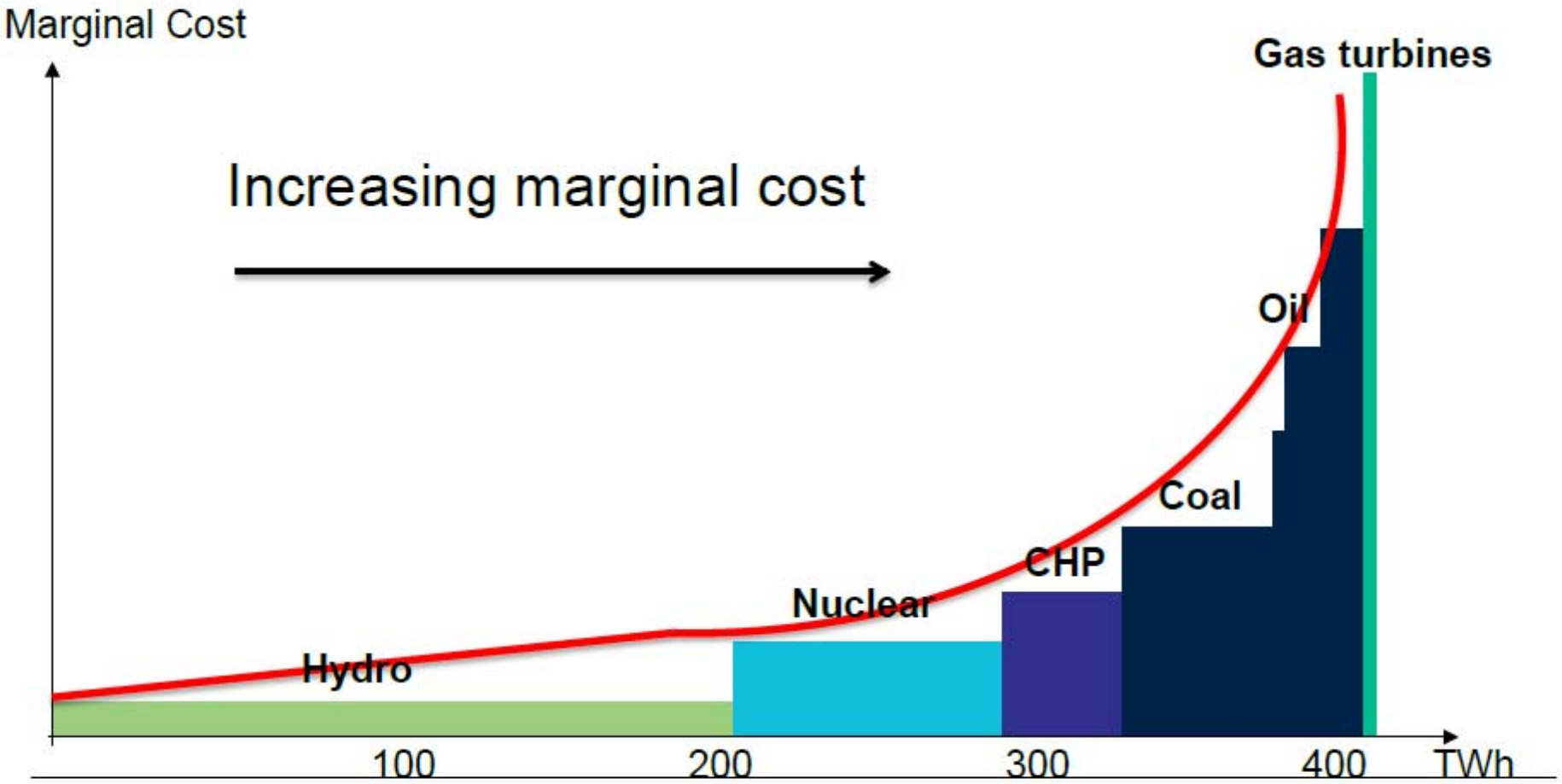


Figure 5: Marginal cost in a hydro power system

ordic production per type



The supply curve in the Nordic



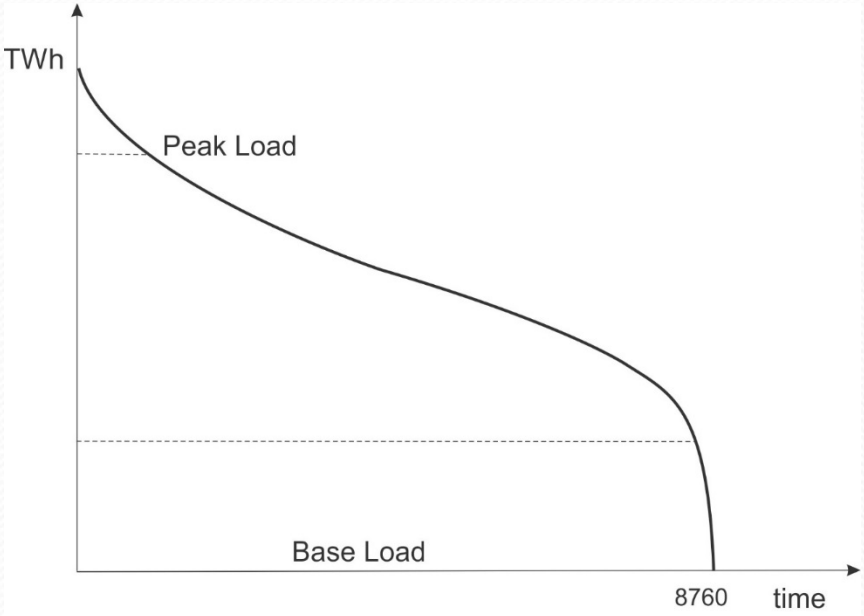


Figure: Load curve for an electricity system

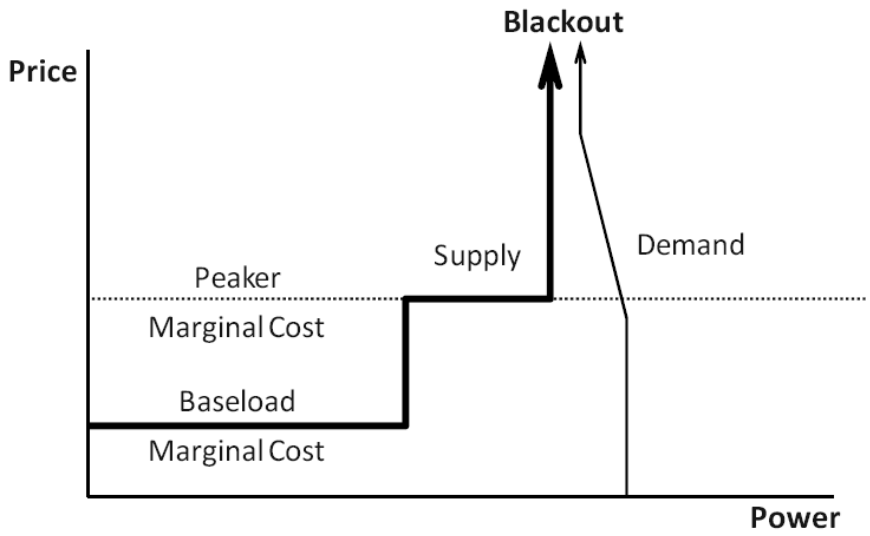


FIGURE 1
Blackouts occur when supply cannot equal demand

Characteristics of electricity markets

- Electricity cannot be stored (hydro), homogeneous commodity
- Instantaneous balancing of supply and demand by system operator
- Very low short run elasticity of demand; also long run; derived demand; price signals with a lag, limited real-time pricing. Also low short run supply elasticity
- Capital intensive, lumpy, irreversible and durable investment; fixed cost, sunk cost. Long lead times
- Capacity constraints in transmission; the network as a ”market”
- Market power issues deriving from characteristics and properties of electricity

What should a market-based system provide?

- The physical delivery of power
- Providing capacity and the handling of capacity constraints in generation and transmission in the short and long runs
- Risk hedging in accordance with the risk preferences of market agents
- Efficient and reliable pricing mechanisms and signals
- Opportunities for parties to trade either through markets or contracts
- Availability of adequate information to all parties
- Efficient timing, size and location of investments: markets for operation of a given power system (short run) versus optimal expansion and composition of the system (long run)

What types of market arrangement are needed?.

- Physical delivery of power – spot market
- Risk hedging facilities – financial markets; derivatives: forward, futures, options, etc
- Capacity and the handling of capacity constraints in generation and transmission – capacity arrangements and markets
- Procurement of ancillary services in the network – ancillary service markets and arrangements
- Instantaneous balancing of supply and demand – system operator (ISO, TSO etc)
- Environmental aspects of energy production and use – environmental markets and instruments: quota markets, green sertificate markets, etc
- Regulatory and policy issues

Economic efficiency and market failure in power markets

- Sources of market failure
  - Public goods (security of supply; resource adequacy, global public goods) (nonrival; nonexclusive)
  - Externalities in production and consumption (e,g. GHG emissions).
  - Market imperfections
    - Economies of scale (natural monopoly, the network)
    - Monopolisation (market concentration; market power)
    - Missing, or imperfectly functioning, markets
    - Competition monopoly regulations; regulatory failure
  - Imperfect information; asymmetric information
  - Uncertainty, e.g. due to long gestation period for investment
- Market failure prevalent in electricity markets

Main elements of the Norwegian power market reform: The "textbook" approach.

- Establishing power markets (spot, financial, regulating/capacity, etc)
- Introducing common carriage in the power grid (third party access)
- Splitting up the integrated power company Statkraft in a generating company (Statkraft) and a transmission company (Statnett)
- Separation of production and trading activities and functions (competitive activities) from network activities and functions (natural monopol activities). Divisionalization
- Preserving ownership; no privatization
- Relationship between competition and regulatory policies

Some important steps and events in the Norwegian and Nordic liberalization and market integration process

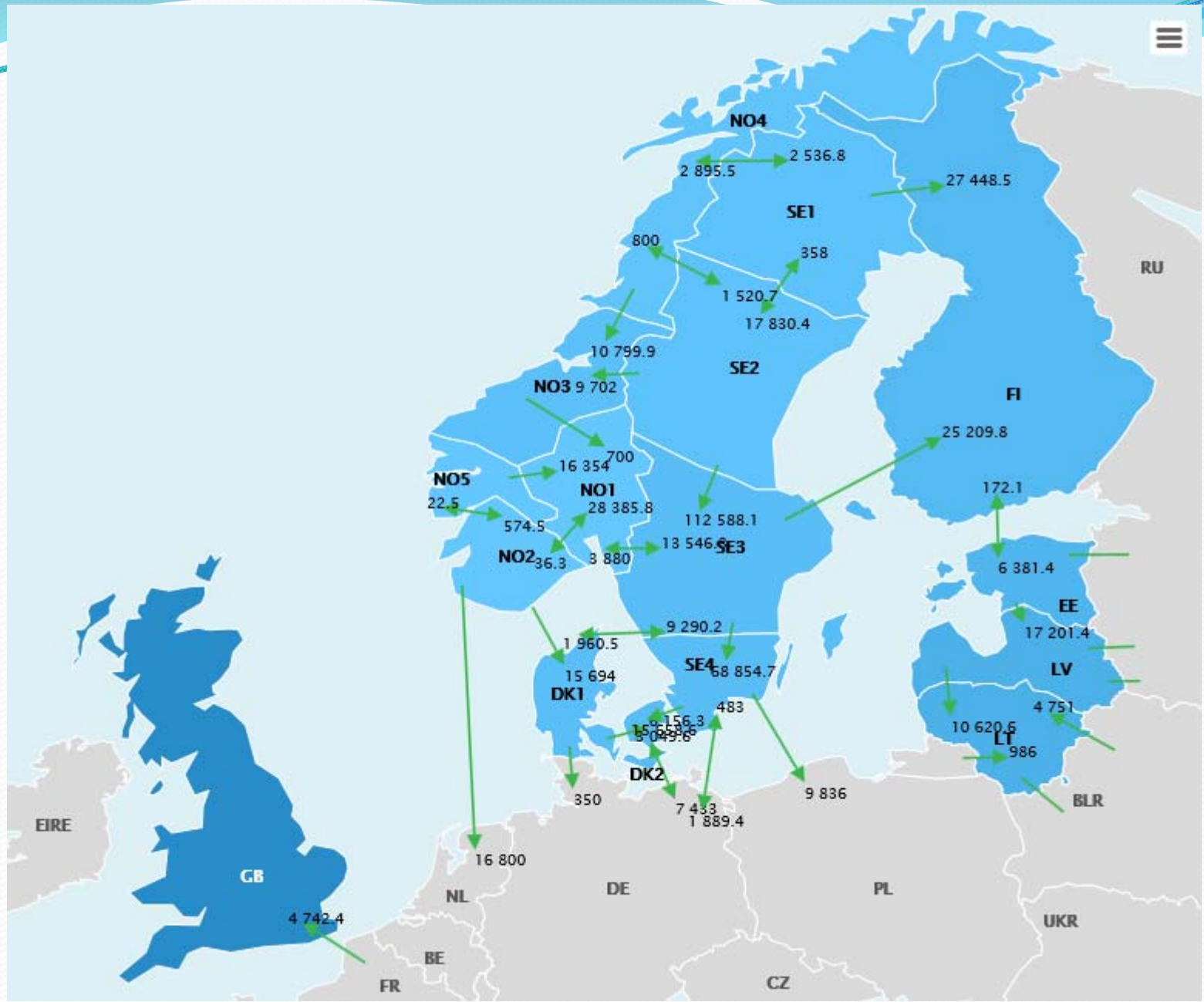
- The Norwegian Energy Act 1990: Economic efficiency throughout the power system (generation, trade, transmission, distribution and end-use.
- 1991:Rate of return regulation of grid entities
- 1992: Statnett Market in operation in Norway, transformed to NordPool in 1996. Regulation market operated by Statnett
- 1994: Financial trade in the weekly market
- 1996: A common Norwegian- Swedish power market
- 1997: New regulatory mechanism for grid units: income frame regulation/revenue-cap regulation
- 1998: Price information system for end consumers by the Norwegian Competition Authority
- 2001-2003: Denmark and Finland integrated into a common Nordic market

Some important events cont

- 1996, 1998 and 2001: European energy market integration. Directives for electricity, natural gas and renewable energy, respectively.
- 2002-03: The Nordic power market put to a test
- 2005-06: EUs Emission Trading System implemented. EUs Green Book for sustainable energy. Security of supply issues
- 2007: New regulatory mechanism for network regulation in Norway
- 2008-09: Futher Nordic market integration; integrating and harmonising the network and network operation. Towards a common system operator. Retail market integration?
- 2013-14 Integration of the Baltic countries (Estonia, Latvia and Lithuania into the Nordic power exchange. (Nor-Balt Pool). Market coupling to other European power exchanges
- 2014-15 Integration of new, renewable energy into the power system
- Market design; security of supply; capacity markets

Organization of the Nordic-Baltic Power Market

- A common power exchange, NordPool Spot, for the spot market. NASDAQ OMX for the financial, derivative markets and clearing functions
- Spot market (day-ahead market; system price, intraday market), 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
- NordPool is a non-mandatory power exchange pool
- Ca. 350 members
- Full market integration of the wholesale market; towards market integration also of retail markets
- A common Norwegian-Swedish elcertificate market effective from 2012.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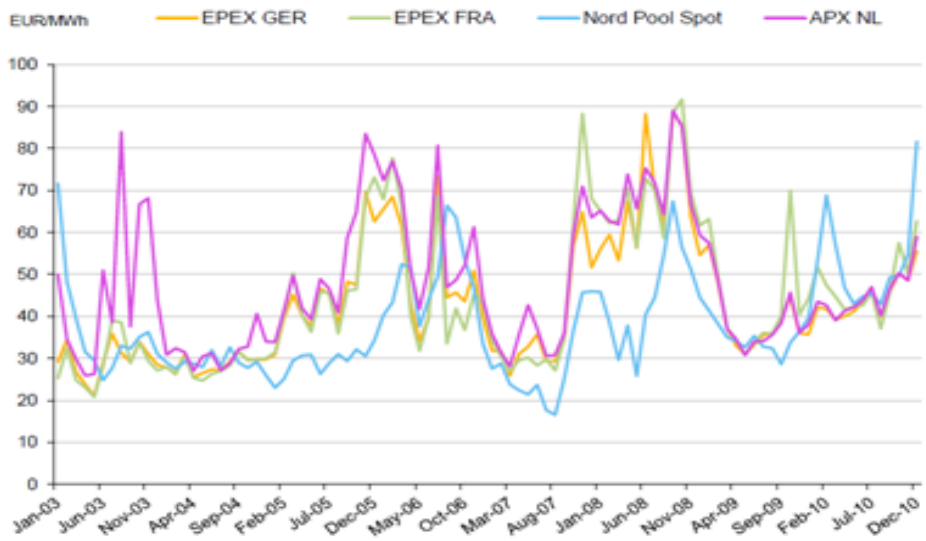
Price comparison for Europe
Monthly spot prices 2003 – 2010



«MER LØNNSOMME INVESTERINGER»

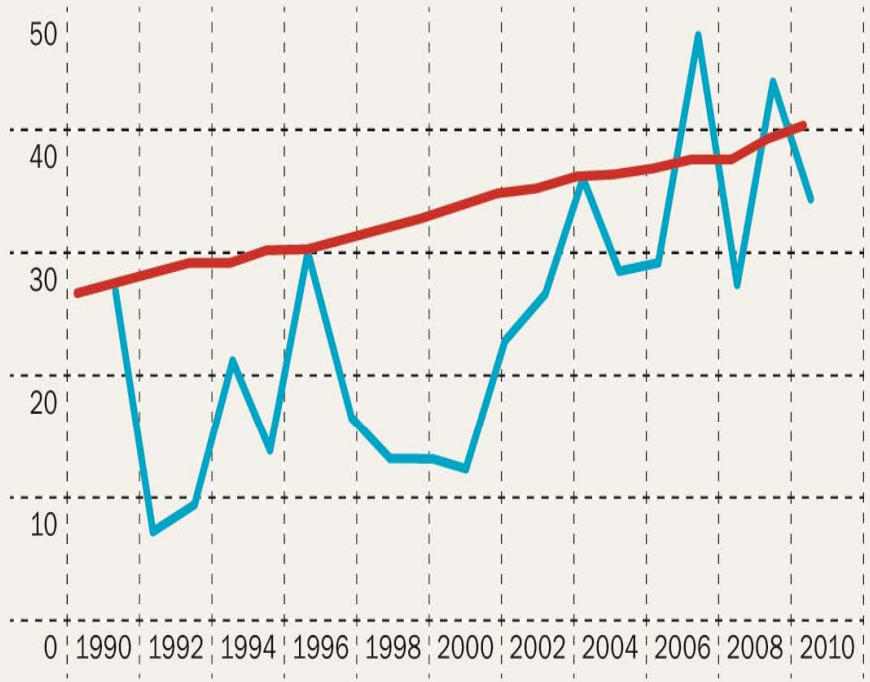
– EN MARKEDSBASERT KRAFTPRIS bidrar også til at vi får de mest lønnsomme investeringene totalt sett, både for produsenten og forbrukeren, sier Tor Arnt Johnsen, seksjonssjef for analyse i Norges vassdrags- og energidirektorat, NVE.

I tillegg til å være et signal om ressursknapphet, peker Johnsen på en av effektene kraftprisene i det finansielle markedet har. Hvis prisen er stabilt høy, vil det være en stimulans til aktører som ønsker å realisere utbyggingsprosjekter. Siden de må selge kraften i et marked med andre tilbydere, vil det først og fremst være konkurransedyktige prosjekter som vinner frem.

– Statkraft og de andre kraftprodusentene er flinke til å se inn i glasskula og gjøre anslag for fremtiden. Det oppstår derfor ikke noe stort etterslep med for høye priser over lang tid, og utilstrekkelige investeringer, sier Johnsen.

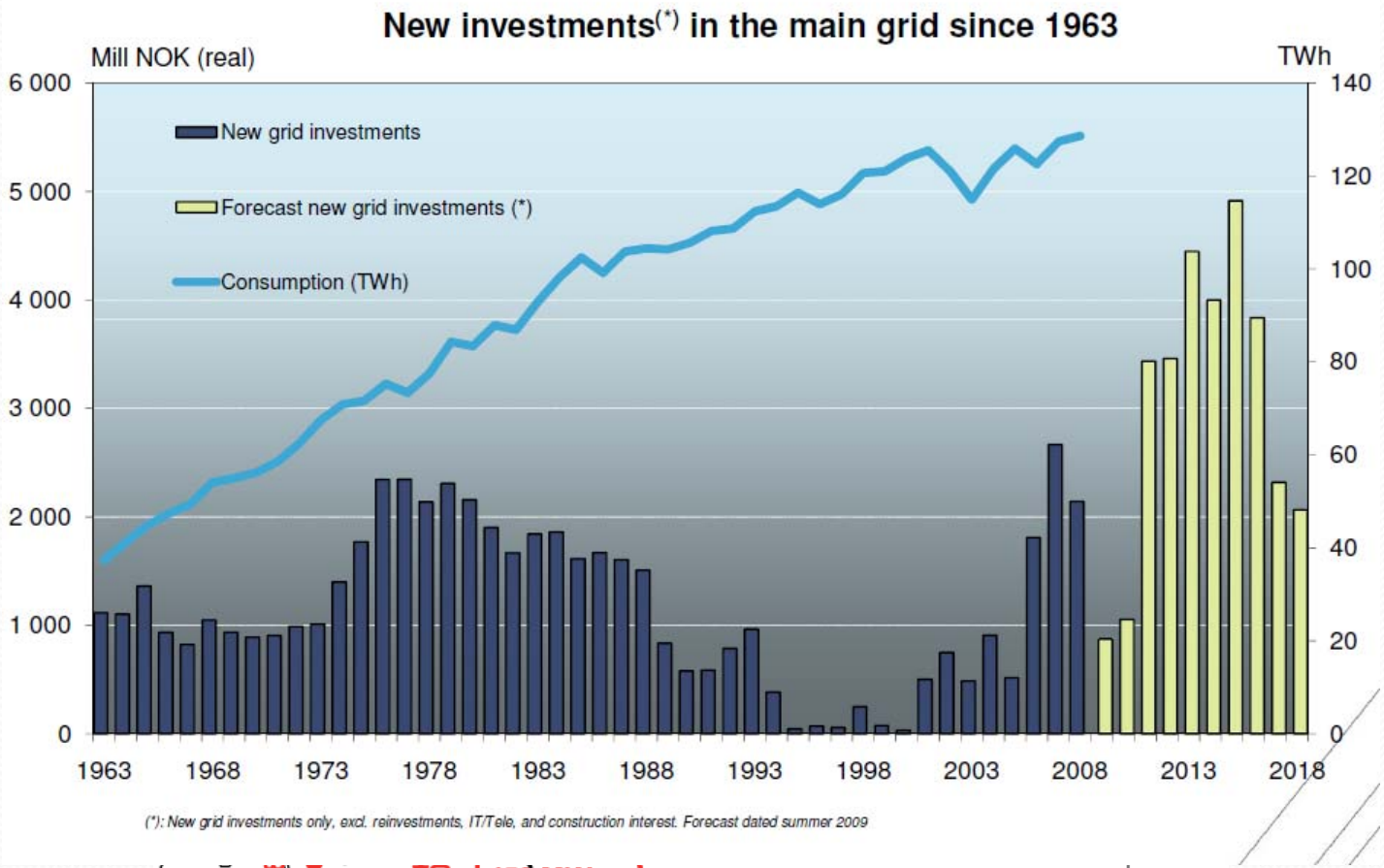
Svingende kraftpriser gjør dessuten at forbrukerne på et tidspunkt vil anse prisnivået som for høyt, og heller investere i alternative energikilder som for eksempel varmepumper.

– Dagens system for kraftpriser er rettferdig og oversiktlig for både produsenter og forbrukere. Begge parter står fritt til å fatte egne avgjørelser, basert på hva de mener vil være mest lønnsomt for dem på sikt, sier Johnsen.



POLITIKERSTYRT PRIS VS. MARKEDSPRIS: Inntil 1991 var kraftprisen i Norge politisk styrt og kalt Statkraftprisen. Den røde linjen viser denne fremskrevet etter utviklingen i konsumprisindeksen. Den blå linjen viser den reelle utviklingen i Systemprisen.

Entering a new phase of major grid investments



derland 60 450 MW Polen

Why has the Nordic power market performed so well ?

- The structure of the market; many players; composition of the production system
- Market design and reform; the ”textbook” model; vertical and horizontal spilt of functions, etc.
- Economic efficiency and a focus on market power issues by competition and regulatory authorities. Strong political support for a market-based power system
- Self regulation, e.g. by stringent market rules by NordPool in terms of controlling for the exercise of market power in the bidding process and for making relevant market information available to all parties
- Voluntary informal commitment to public service by the power industry? Ownership issues; e.g. 85% public ownership of the electricity sector in Norway.

Lessons learnt from the Nordic power market experience?

- Importance of choice of market design model and consistency over time in implementing the market reform
- Enlarging geographically the integrated (inter country) power market to fully tap the potential for economies of scale and economies of scope through the composition of the system wrt to generation technologies. Also wrt to mitigation of the exercise of market power
- Recognising the importance of the transmission network as a facilitating device for market integration and competition
- Designing effective competition and regulatory policies for market monitoring and enforcement
- Strong and robust public support to the market-based system

What went wrong in California?

- Market and regulatory reform in April 1998:
  - Three large investor-owned utilities (IOUs)
  - Vertically integrated into generation, transmission and distribution
  - Retail electricity rates regulated by California Public Utilities Commission (CPUC)
  - Wholesale prices and transmission tariffs regulated by Federal Energy Regulatory Commission (FERC)

California, cont.

- The California reform was built to a large extent on the Norwegian/Nordic model. Exchange of competence/consulting. The reform became a major market and regultory failure from the start
- Main reason for failure: Exercise of market power; withholding of capacity at peak hours. Tacit collusion. Regulatory failure
- The failure of the California power reform cast long shadows over international power sector reforms for a long time, and still is referred to as a warning signal to potential power market reformers

Lessons learnt from international experience of power sector reforms

1. Power sector reforms have significant benefits but also carry the risk of significant political costs if reforms are implemented incompletely or incorrectly; cf. e.g. California
2. The textbook model of sector restructuring, market design and regulatory reform is a sound guide for successful reform, if basic conditions are fulfilled, e.g.
3. Proper national institutions and policies must be observed and in place: a) a competition authority and competition policy for the power markets, b) a regulatory authority and regulatory policy for the networks, and c) financial infrastructure and institutions for the financial markets
4. Similar conditions for intercountry market integration and policy formation, or close institutional cooperation

Lessons, cont.

5. Market power is a significant potential problem in electricity markets, but the cure can be worse than the disease. Try to deal with potential market power structurally *ex ante* rather than *ex post*
6. Creating a well functioning transmission investment framework is important, but continues to be a significant challenge in many countries and across boarder
7. System reliability, ”supply security” and ”resource adequacy” are of great concern for policymakers in almost every country, favouring national solutions.
8. Retail market design and the terms and conditions of default service provided by incumbents have important implications for the success of retail competition programs

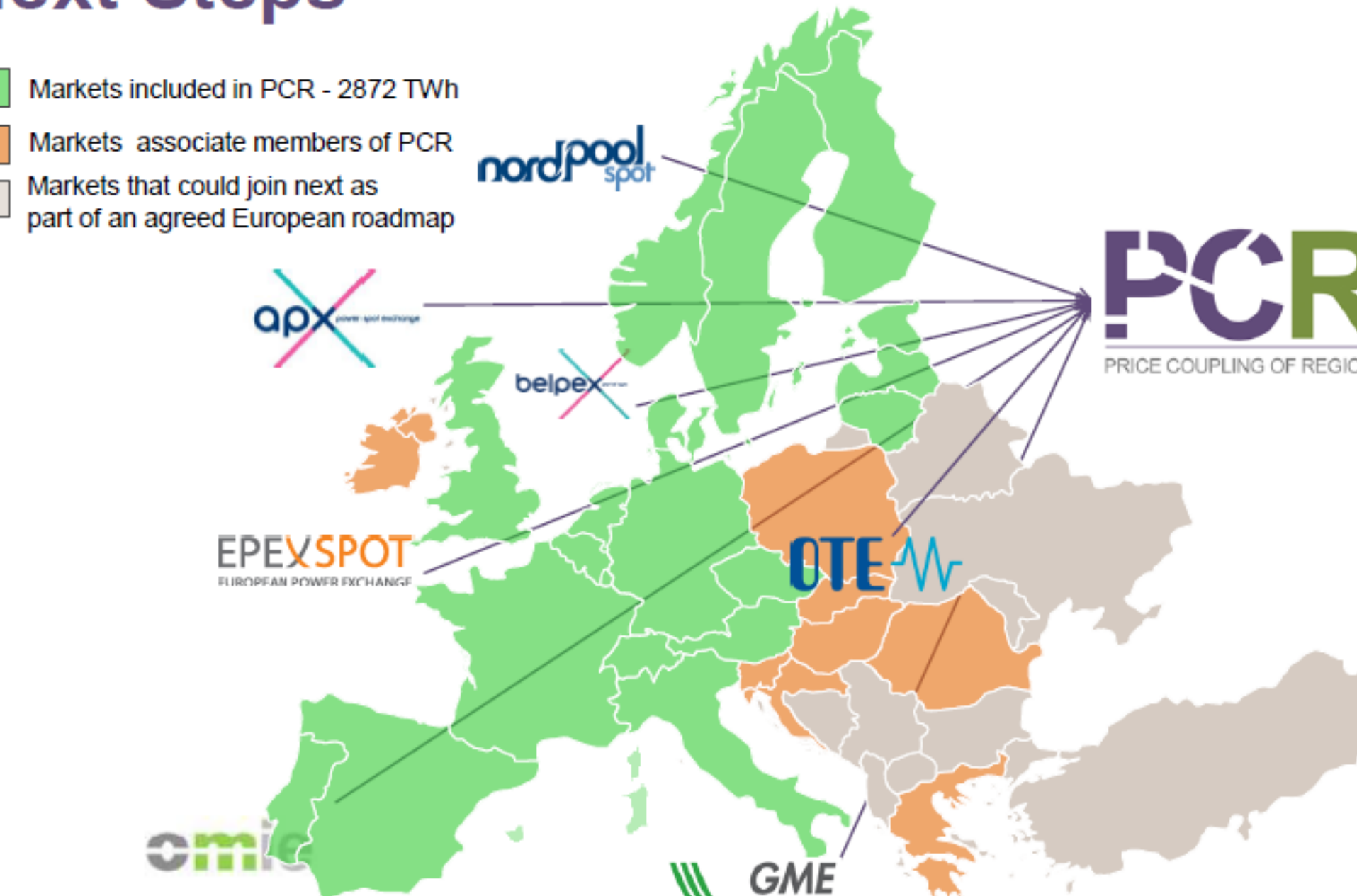
Lessons, cont.

9. Vertical integration between retail supply and generation may be cost efficient but may also create market power problems; therefore a tradeoff to be observed
10. Expanding demand response in spot wholesale power markets needs more attention. Improved response important, especially by introducing real time pricing signals. Modern technology of smart meters and grids may revolutionize retail market design
11. Electricity market reform appears to be a continuous process of improvements, but a process of continuing reform of the reforms has both potential benefits and costs
12. A strong political commitment to reform is important

Some ongoing power market developments

- Market coupling; price coupling of regions (PCR)
- Capacity markets for market balancing and security of supply
- Design and functioning of investment markets for optimal investments in the power system
- European Energy Union initiatives in relation to market integration, etc.
- Integration of renewables into the power market system

owards Single European Market: lext Steps



Concluding remarks – some measures

- Designing efficient markets for optimal investment in production and trade of electricity
- Clarify the relationship between market and network wrt to investment and the market functions of the network
- Clarify conditions and regulatory measures for optimal network investment
- Clarify implications of spacial market integration wrt national solutions and policies, and implementing measures
- Clarify conditions and requirements wrt to Security of supply of energy/electricity

Integration of renewable energy in the power system

- Ambitious policy targets for new, renewable energy in the power generation mix in many countries and the intermittency problems associated with it for an electricity system
- Two issues or implications of intermittency: a) the base load function and b) the energy storage function to supply back-up facilites under intermittency of renewables to secure security of supply.
- Concentrate on the storage function; in particular the storage in hydro reservoirs in a hydro power system and the case of the Norwegian hydro power system an energy «battery» for Europe

Energy storage functions under intermittency

- Storage of water in hydro systems, as an energy «battery». The case of Norway
- Storage og gas in the energy value chain with gas-fired plants as base load coverage reserves.
- Storage of electricity in batteries under technological progress
- Storage of electricity in disributed energy systems and by end-users; smart grid technologies

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 by capacity reserves
- 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). A win-win

Norway as a battery: Some preconditions

- Share of wind and solar power in the total European power system; the larger the share, the larger production variability
- Size of the Norwegian regulating power capacity in relation to Europe's need for balancing power
- Ability to better predict variability in wind and solar power production
- Balancing out wind and solar production variability between regions by market and network integration
- Improving the ability of thermal generation to accomodate short term variations in renewable power, through technological change
- Technology and consumer behaviour changes on the demand side, e.g. smart metering and grid technologies, and their effects on the need for regulating power etc.

Some preconditions; continued

- Needed investment in new transmission capacity
  - Between Norway/Nordic/Baltic market and Europe
  - Internally in the European market
- Needed investment in reserve capacity to account for wind power intermittency. Pumped storage?
- Estimated investment cost of an interconnector between e.g. Norway and Germany: 2 billion US$ + necessary investments at both ends of the interconnector.
- For Europe the estimate is of the order of magnitude of 200 bill. US$ for cross-border investment, and investment for upgrading and expansion of national networks to facilitate market integration
- Implications for financing and network pricing/tariffs;
- Uncertainty wrt to investment in further expansion and upgrading of the hydro power system for capacity reserve purposes, and investment in interconnectors

Potential new international interconnectors

- ambitious plans

HVDC cable to England

NorNed 2 – 2nd HVDC cable to the Nederland

NORD.LINK/ Norger – HVDC cable to Germany

Skagerrak 4 – 4th HVDC cable to Denmark

SydVästLänken – HVDC link to the Jönköping/ Malmö area

Some renewable energy, market integration and policy issues

- The need for coordinated transmission network investment across regions
- The need for harmonising rules and regulations within an integrated power market
- Market arrangements for new renewable energy and the optimal composition of the production mix
- Security of supply issues – national or regional solutions?