Vision for European Electricity Markets in 2030

Final report

   

31/3/2011
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Lappeenranta University of Technology
Faculty of Technology. LUT Energy
Research report 13

Satu Viljainen, Mari Makkonen, Salla Annala, Dmitry Kuleshov

Vision for European Electricity Markets in 2030

Lappeenrannan teknillinen yliopisto
Teknillinen tiedekunta. LUT Energia
PL 20
53851 Lappeenranta

ISBN 978-952-265-073-3
ISBN 978-952-265-074-0 (PDF)
ISSN 1798-1328

Lappeenranta 2011

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Preface

The objective of the research project *Vision for European Electricity Markets in 2030* was to establish a vision of the future electricity market model in Europe. The research focus was mainly on electricity wholesale markets; the drivers of development of the deregulated electricity markets, and the forms of competition under different market settings. Workable competition in electricity wholesale market is also essential in developing competitive electricity retail markets.

The report at hand presents the results of the research project. The research was carried out at Lappeenranta University of Technology (LUT) between March 2010 and April 2011. The research was commissioned by the Finnish Energy Industries (ET), the Finnish Electricity Research Pool, Suomen ElFi Oy, the Finnish Forest Industries Federation, the Federation of Finnish Technology Industries and Nord Pool Spot AS.

The report provides an overview of the theoretical background behind various electricity wholesale market models and their application in Europe, the United States, Russia, Australia and New Zealand. Moreover, the functioning of the retail markets in each of these geographical regions is examined. The report also includes a summary of the workshops organised during the project and the results attained, and presents the Delphi survey carried out in Europe. Description and presentation of the research project *Vision for European Electricity Markets 2030* and its results are at the heart of the report.

Professor Satu Viljainen, Mari Makkonen, M.Sc. (Tech), Salla Annala, M.Sc. (Tech) and Dmitry Kuleshov, M.Sc. (Tech) from Lappeenranta University of Technology participated in the research project.

Special thanks are dedicated to Dr. Hanna Niemelä for revising the language of the report. However, the authors are solely responsible for any remaining errors.

Lappeenranta, March 31, 2011

Satu Viljainen, Mari Makkonen, Salla Annala and Dmitry Kuleshov

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Acronyms

ACER	Agency for Cooperation of Energy Regulators
AEMC	Australian Energy Market Commission
AEMO	Australian Electricity Market Operator
ARR	Auction Revenue Right
ATC	Available Transfer Capacity
ATS	Administrator of Trade System
CfD	Contract for Difference
CRR	Congestion Revenue Right
ENTSO-E	European Network of Transmission System Operators for Electricity
ERCOT	Electricity Reliability Council of Texas
ERGEG	European Regulators Group for Electricity and Gas
EV	Electric vehicle
FGC	Federal Grid Company
FTR	Financial Transmission Right
GDSS	Group Decision Support System
HHI	Herfindal-Hirschmann Index
HVDC	High Voltage Direct Current
ISC	Independent Sale Company
ISO	Independent System Operator
LMP	Locational Marginal Pricing
NEM	National Electricity Market
NordREG	Nordic energy regulators
OJSC	Open joint-stock company
OTC	Over-the-Counter
PJM	Pennsylvania-New Jersey-Maryland
PUC	Public Utilities Commission
RES	Renewable Energy Source
RRN	Regional Reference Node
RSI	Residual Supply Index
RTO	Regional Transmission System Operator
SCADA	Supervisory Control And Data Acquisition
SO	System Operator
SLR	Supplier of last resort
TDU	Transmission and distribution utilities
TGC	Territorial Generating Company
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
WGC	Wholesale Generating Company

Area price	Market area is divided into two or more price areas when there is transmission congestion; area price is calculated for each area.
Host retailer	Offers electricity at regulated terms and conditions.
Locational marginal pricing	Price calculation for each node of the transmission grid based on supply and demand curves in each locations; contains electricity price, losses and congestion cost
Market Coupling	Co-operation of two or more power exchanges to ensure the right power flow between market areas; areas can form single price area or it can be divided few price areas in case of transmission congestion.

Marginal pricing	Directs the merit order of generation; the lowest price generation is brought on line before the highest price generation; marginal price is the intersection of demand and supply curves.
Market Splitting	One power exchange ensures the right cross-border power flow; market area can be divided two or more price areas in the case of transmission congestion.
Pay-as-bid	Each generator is paid according to its bid price and price for all consumption is the weighted average of generation bids; no common market price for all participants.
System price	In Nord Pool Spot, the system price for entire Nordic region is determined by the intersection of the aggregated supply and demand curves.

Extended summary

Electricity markets

Electricity markets comprise the supply and demand of electricity. Electricity supply, in turn, consists of electricity generation, selling, transmission and distribution. The electricity market deregulation has typically meant replacing the inefficient regulation in electricity generation and selling with competition. The electricity transmission and distribution sectors have, on the other hand, typically retained their natural monopoly positions.

In Europe, the development of electricity markets is significantly influenced by the energy and climate policy of the European Union (EU). The main aim has been to open electricity markets for competition and create a common European electricity markets. The corner stones of EU's energy policy are security of supply, competitiveness and sustainability. The climate and energy policies affect the way how electricity is generated and used.

Storing of electricity economically in large quantities is not yet possible. The balance between generation and consumption of power at every instant is a requisite for the system stability. Usually the price of electricity is determined in the day-ahead markets by finding the balance between the supply and demand. *Marginal pricing* is the pricing principle commonly applied in the day-ahead electricity markets. It directs the merit order of generation so that the production with the lowest marginal cost is the first to be brought on line while the production with the highest marginal cost is the last, thereby determining the price for electricity. The price is formed on the basis of the marginal costs of the last production brought on line to satisfy the demand, and it is the same for all forms of production and generators regardless of their bids and also for all consumers. The equilibrium price is found at the intersection of the demand and supply curves. The demand curve indicates the consumers' willingness to pay and the supply curve indicates marginal cost of generation.

Wholesale electricity markets

The market model covers the operation principles of the electricity wholesale market. Two basic market models exist: zonal pricing and nodal pricing. The transmission networks are in an essential role when choosing the market model. In the context of electricity wholesale supply, the statement "the electric power network provides a marketplace for electricity" refers, above all, to the system's capability to respond to the needs of the market. If power can always be transmitted in accordance with market's needs from generation surplus area to deficit area, the transmission system can be considered to constitute a functioning marketplace for electricity trade. On the other hand, if the transmission connections are repeatedly congested and prevent the flow of power in the desired direction in the market area, the need to find tools to control the system congestion starts to dictate the design of the market model. In the first case, applying the zonal pricing market model is possible. In the latter case, the nodal pricing market model is used.

The key difference between the market models lies in the method for calculating the price for electricity. In the zonal pricing model, the electricity transmission system operators responsible for the main transmission grid inform about the transmission capacity available, and the power exchange calculates the price for electricity based on the bids of market parties. In the nodal pricing model, the transmission system operator is responsible both for the operation of the transmission grid and the electricity price calculation. In addition to the energy component, the electricity price includes a transmission congestion fee and losses. In the nodal pricing, a major risk lies in the price differences between nodes caused by transmission congestions; this uncertainty can be hedged against by purchasing certain transmission hedge products, such as Financial Transmission Rights (FTRs).

In Central Europe and the Nordic countries, the zonal pricing model is applied. However, there are some differences between the implementation of the models. In the Nordic countries, market splitting is the used model. In that model, one power exchange (Nord Pool Spot) calculates the system price for entire Nordic region and if there is grid congestion, the market are divided into two or more price areas. Central Europe refers in this context to the CWE (Central West European Region), in which market coupling is used. In that model, two or more power exchanges carry out the price calculation. The wholesale are prices first calculated for each region and then if the available transmission capacity between regions is sufficient the common electricity price is obtained.

In PJM (Pennsylvania-New Jersey-Maryland) and Texas areas in the US, and in Australia, New Zealand and Russia, the market model is the nodal pricing. The electricity price is calculated for each grid node and the price of the node contains energy, losses and congestion fee. Usually one node is a small elementary market with few generators and so there is a chance a market power abuse. That is why the market surveillance is usually tight. In PJM and Russia the offers of generators are supervised strictly and certain offer caps are set. This cuts price spikes, which are necessary part of generators' income formation to guarantee new generation investments. In these areas, the separate capacity markets are created to ensure new capacity investments. Texas, Australia and New Zealand rely on higher price caps and separate capacity markets are not introduced.

Retail electricity markets

Retail markets of electricity are national markets also in those regions where the wholesale trade of electricity crosses the national borders. The decisions on retail markets are also made at the national level, in some countries at the state level.

Co-operation in retail market rulemaking is, however, increasing. In Europe, Citizens' Energy Forum was established in 2008 to enforce consumers' EU-wide rights and to provide them with information about available choices when buying electricity or gas.

The organisation of Nordic energy regulators, NordREG, has since 2005 worked to promote and facilitate "a truly common Nordic retail market with a free choice of supplier". The objective of the work is to minimise regulatory and technical obstacles for the suppliers that wish to operate in various Nordic countries (NordREG 2009).

Many of the most active retail markets of electricity are located in Australia; for example in the State of Victoria the supplier switching rate has been high for many years. In Europe, the switching activity has been high in Great Britain in particular, and in the USA, in Texas (VaasaETT 2010).

In the countries discussed in this report, the retail customers' consumption is not very elastic with respect to wholesale prices. The tariff structures typically applied to retail customers do not encourage wholesale-market-based elasticity, either. Instead, in many countries there are tariff schemes (or pilot schemes) that direct energy use from typical peak hours to other times of the day. The "time of use" pricing is based on a time division that is rougher than the hourly based division of time, and on predefined prices, such as tariffs where the typical hours of peak load are priced higher than for instance night-time consumption.

So far, also in most of the contracts tied to wholesale prices the price has been based on an average price within a certain time interval. The expansion of smart meters will enable more real-time pricing.

Vision for European Electricity Markets in 2030

General goals of the electricity market deregulation are to reduce the government involvement in the electricity supply sector, to introduce competition in electricity generation and selling, and to increase the demand side participation (Littlechild 2006; Harris 2006)

The requirement for free competition to work in electricity markets is the existence of sufficient amount of transmission capacity in the market and the elasticity of demand with respect to price. The latter requirement means that demand side is expected to signal its willingness to pay for electricity in the day-ahead markets, thus playing an essential role in the price formation. If the transmission network constraints hinder the functioning of free competition, coordination for competition is required and the demand side participation may be weaker. For instance, in the day-ahead price formation, the demand may be taken as forecasted, ignoring the demand's willingness to pay. However, it is a characteristic of regulation that it only mimics competition in the absence of the actual forces of competition. Regulation itself is also not without problems since it easily hinders the dynamic development of the markets.

The *Vision for European Electricity Markets 2030* aims at achieving free competition. The vision views competition as a key to efficient operation of the electricity markets that would benefit both the supply side and the demand side, although it is acknowledged that workable competition in electricity markets is not always easily achieved or maintained. For instance, obtaining sufficient transmission capacity and activating the users of electricity are challenging goals in future electricity markets. However, giving up these goals would contradict with the initial objectives of the electricity market deregulation. Also, the heavy-handed regulation that would follow from giving up free competition would threaten the dynamic development of the markets.

The vision enables achieving the EU's goal of internal market in electricity. The vision also honors the objective that there are no structural entry barriers to renewable generation, thus supporting the energy-efficient, low-carbon future of the electricity supply sector.

The vision views electricity networks as enablers. In the wholesale markets, this means that the transmission constraints do not hamper the operation of the markets. In the retail markets, the distribution networks are in a key role in ensuring that there are no technical or structural barriers that would hinder the hourly demand response and the cross-border operation of the electricity retailers.

The realization of the vision depends essentially on two things: the sufficiency of the transmission capacity and the activeness of the demand side. Failing to meet the basic requirements would result in a rather different development of the future electricity market. Next table also presents some of the main characteristics of a so called alternative scenario. The main characteristics of the vision are summarized in the next Table.

Vision for European Electricity Markets in 2030	Alternative scenario
- Large price areas and no structural bottlenecks in the transmission networks within the price areas - Uniform marginal pricing - Demand side plays a key role in limiting the price setting power of the generators - Antitrust policy efficiently applied in assessing mergers and acquisitions to prevent market concentration - No price caps in the day-head market of electricity - Price spikes are possible - Hedging against the price volatility of electric energy - Trading of financial instruments (e.g. futures, forwards, options, CfDs, FTRs) at exchange and bilaterally - 'Energy only' market provides adequate revenues to generators - No separate capacity markets needed - No structural entry barriers for market-based investments and operation of renewable generation - No technical or structural barriers to the cross-border operation of the retailers	- Heavily congested transmission networks and the existence of inter- and intra-regional bottlenecks in the transmission networks - Locational marginal pricing - Demand side participation in price formation is not obligatory - Continuous monitoring of locational market power - Pivotal suppliers' offers to the market are limited through regulation - Regulation of the suppliers' offers reduce price spikes - Hedging against locational price differences with financial transmission rights (FTRs) - FTR auctions organized by the Independent System Operator (ISO) - Feasibility tests to ensure that FTRs do not exceed physical transmission capacities - Revenue adequacy is not guaranteed through the market of electric energy - Capacity markets provide the 'missing money' to the generators - Locational price signals may constitute an entry barrier to renewable generation (but RES support mechanisms may enable entering and staying in the market) - The retail markets are mainly locational because of the locational price risks that the retailers face in the wholesale markets

1. Introduction

This report presents the results of the *Vision for European Electricity Markets 2030* research project. The project was carried out in co-operation with different interest groups of electricity markets. The futurology research methods like scenario working, controlled innovation and Delphi survey were exploited in this project.

In the early stage of the project, the wide interest group workshop was organized. To illustrate optional futures of the electricity markets, the four different scenarios were formed in the workshop. Scenarios were utilized to recognize development paths, which are lead either to free competition or regulated competition. The scenario, in which competition is as free as possible, was chosen for further research. The important justification for choice was the general viewpoint that free competition increases efficiency incentives.

In the second workshop, organized for selected expert group, the controlled innovation method was used. The theme was the competition on electricity markets: which factors affect competition and affecting to which factors competition can be promoted. As a result, a bunch of ideas was collected. These ideas were processed to claims, which are the prerequisites for well-functioning competition on electricity markets. The authenticity and realization of the claims were tested in the Delphi survey, which was directed on the European electricity market experts. The opinions of the respondent, which factors have historically influenced the development of European electricity markets and what kind of the future development is seen, forms one of the main result of the project. The second main result is the *Vision for European Electricity Markets in 2030*, which is formed based on the futurology processes.

The structure of the report is following. Chapter 2 presents the basic fundaments of electricity markets and development paths. Main features of international wholesale electricity markets are introduced in Chapter 3, and in Chapter 4 the operations of electricity retail markets in different countries are illustrated. Chapter 5 introduces the research methods and results. The Vision is illustrated in Chapter 6. Chapter 7 provides the concluding remarks.

2. Electricity markets

Electricity markets comprise the supply and demand of electricity. Electricity supply, in turn, consists of electricity generation, selling, transmission and distribution. The fundamental goals of the electricity market deregulation have been uniform: reducing governments' role in the sector; introducing competition where feasible; and increasing the demand side's participation. The last point has meant, for instance, the free choice of supplier for the electricity users (Harris 2006).

The electricity market deregulation has been characterised by replacing the inefficient regulation in electricity generation and selling with competition. The electricity transmission and distribution sectors, on the other hand, have typically retained their natural monopoly positions. In general, competition is considered to increase efficiency, reduce costs and improve quality (Littlechild 2006).

A focal issue when considering efficient electricity markets is the competitiveness of the market. Internationally, the electricity markets have been opened to competition in particular to guarantee market-based investments in power generation, when the price formation is not regulated.

2.1 Framework for development

The common internal markets for all kinds of commodities have for long been the target of European Union. The development of European electricity markets is significantly influenced by the energy policy of the European Union (EU). The main aim has been to open electricity markets for competition and create a common European electricity markets. The corner stones of EU's energy policy are security of supply, competitiveness and sustainability. The climate and energy policies affect also the way how electricity is generated and used. For instance, the 20-20-20 target have been introduced, which means decreasing greenhouse gases 20 %, increasing energy efficiency 20 % and increasing 20 % the use of renewable energy sources by year 2020.

2.1.1 European Union's energy policy

The EU Directive 2003/54/EY (part of the second legislative energy package) set the guidelines for the gradual liberalisation of the electricity markets within the member states by 1 July 2007. The member states, with some exceptions, mainly managed to open up their markets within the timetable. The Directive 2003/54/EY and the Electricity Regulation 1228/2003 define the objective to establish a common internal market of the EU and to provide guidelines for cross-border electricity trade. The Directive 2009/72/EY, which is part of the third legislative energy package, updates and specifies guidelines related to the establishment of internal electricity markets. The EU has set an objective to establish an internal electricity market through regional markets. The European Council (Energy) specified in February 2011 meeting that a fully functioning, interconnected and integrated internal energy market should be completed in 2014 (European Council 2011).

Nevertheless, there are certain problems related to the integration of regional markets; for instance, transmission bottlenecks between the countries hamper the market integration. The third legislative package concerning the internal energy market contains regulations (Regulation 714/2009) for instance on unbundling the main transmission grid operation and on the transmission system operators' actions to extend the transmission system. For instance, bottleneck income should primarily be used to guarantee the actual availability of the shared capacity or be allocated to network investments that maintain or increase connection capacity (in particular cross-border connections). If the income cannot be efficiently allocated to these targets, it can be used lower the transmission network tariffs, which is the most common way to use those incomes. In addition, the regulation provides guidelines for the establishment of a cooperation organisation between the Agency for Cooperation of Energy Regulators (ACER) and the European Network of Transmission System Operators for Electricity (ENTSO-E).

According to the Regulation 714/2009, framework guidelines for the network code development will be prepared by the new agency ACER, which takes part in elaboration of the codes and investment plans at the European level. Relevant market participants and authorities shall be heard in this process. The ENTSO-E shall adopt and publish an EU-wide, non-binding Ten-Year Network Development Plan (TYNDP), to be updated every two years. Within ENTSO-E, the transmission system operators shall establish a regional investment plan. The third energy package also covers issues such as actions to increase the independence and jurisdiction of national regulatory authorities, transparency rules and regulations concerning retail trade and consumer protection (ERGEG 2010).

European Regulators Group for Electricity and Gas (ERGEG) has published a target model of European electricity market integration. The introduced model comprises seven regional electricity markets in Europe, which is a first step for common European electricity markets. Now, ERGEG has drawn guidelines for the transmission capacity allocations and price zone definitions, and the day ahead, intraday and forward markets. According to ERGEG, the cross-border capacity allocation methods have to be efficient; the suitable methods are flow-based or available transfer capacity allocation (ATC) methods. Price zones are defined so, that there is not significant intra-zonal congestion. Day-ahead calculation algorithms will be harmonized and there should be also efficient forward market for hedging. Also intraday capacity allocation methods should be efficient and harmonized. In spring 2011, the ACER will continue the work of ERGEG (ERGEG 2010).

2.1.2 Power generation and use

In the future, the use of energy will face major changes and the significance of electricity will increase. For instance, electric vehicles (EVs) will increasingly replace traditional internal combustion engine vehicles. The European Union has created a strategy to encourage the development of clean and energy efficient vehicles. According to World Energy Outlook 2009 by the IEA, about one quarter of the new passenger cars sold in the EU will be EVs in 2030, Figure 1 (IEA 2009; European Energy Policy 2010).

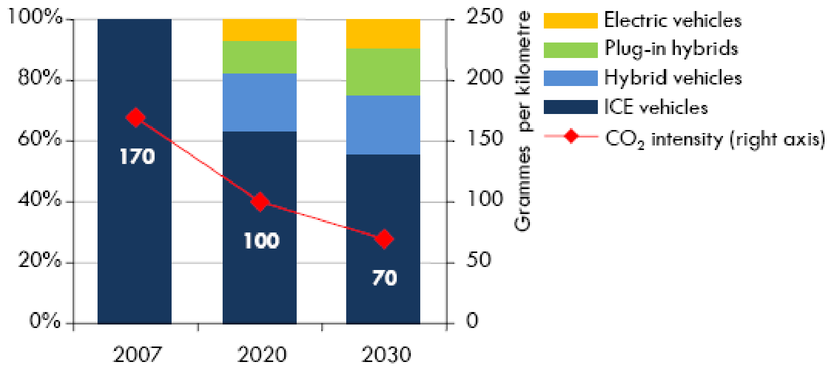

Figure 1 The sales of the passenger cars and average CO_2 emissions in the European Union based on the 450 scenario of the IEA. The 450 scenario aims at restrict global warming to +2 °C (IEA 2009).

Ministry of employment and the economy evaluate that the electricity consumption in Finland is estimated to increase to 115 TWh by 2050 (baseline). On the other hand, according to the vision made by the same ministry, the target is to reduce electricity consumption to 80 TWh by 2050. For example, electricity use in heating, lightning, power tools and domestic appliances can be made more efficient. According to the vision of Finnish Energy Industry ("Turning challenges into opportunities - a carbon neutral vision for electricity and district heat for 2050"), electricity consumption in 2050 is illustrated in Table 1. It shows that electricity consumption may increase even more than in a baseline (TEM 2008; Tynkkynen 2010; ET 2010).

Table 1 Estimation of electricity use in Finland in 2030 and 2050. Reference year is 2007 (ET 2010).

Sector	Electricity use in 2007 (TWh/a)	Electricity use in 2030 (TWh/a)	Electricity use in 2050 (TWh/a)
Households	11	13	13–14
Heating of buildings	12	11	9–11
Cooling of buildings	0,2	1	2
Industry	48	49–56	48 –58
Services & Public	15,5	22	30–40
Transport	0,5	3	8–10
Losses	3	3	4
Total	90	100–111	113–138

According to the objectives set by the EU, the use of renewables should be increased. In "Power Choices Pathways to Carbon-Neutral Electricity in Europe by 2050" report Eurelectric presents a scenario in which RES power generation increases 40 % by year 2050. The total electricity consumption in Europe is seen to be 4800 TWh and 1800 TWh will be produced by renewables, Figure 2 (Eurelectric 2009).

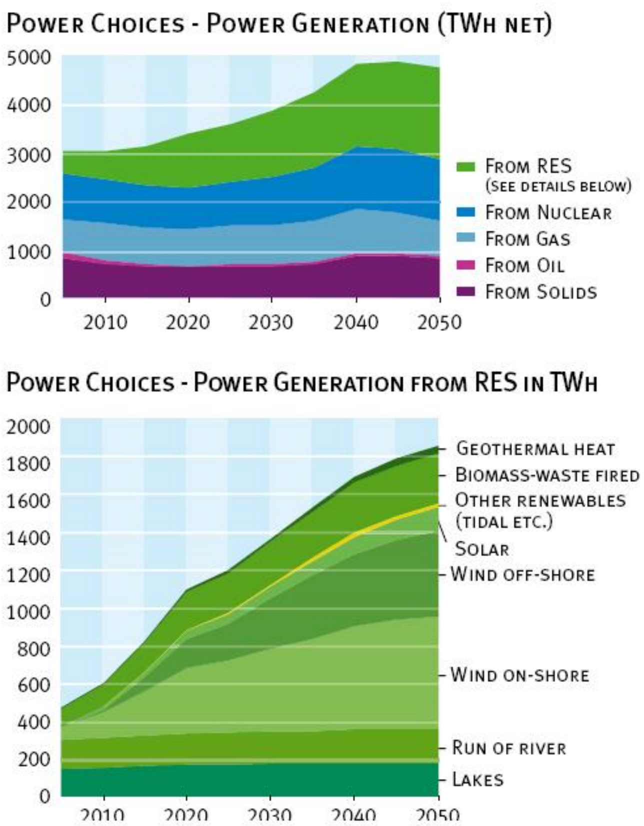

Figure 2 Power generation in Europe 2050 (Eurelectric 2009).

Also in the IEA 's 450 scenario the use of wind, biomass and nuclear power will be increased, Figure 3. The reference scenario is the same as BAU (business as usual), in which the new rationalisation projects to increase e.g. energy efficiency will not be done, so the use and generation of electricity will continue in same baseline (IEA 2009).

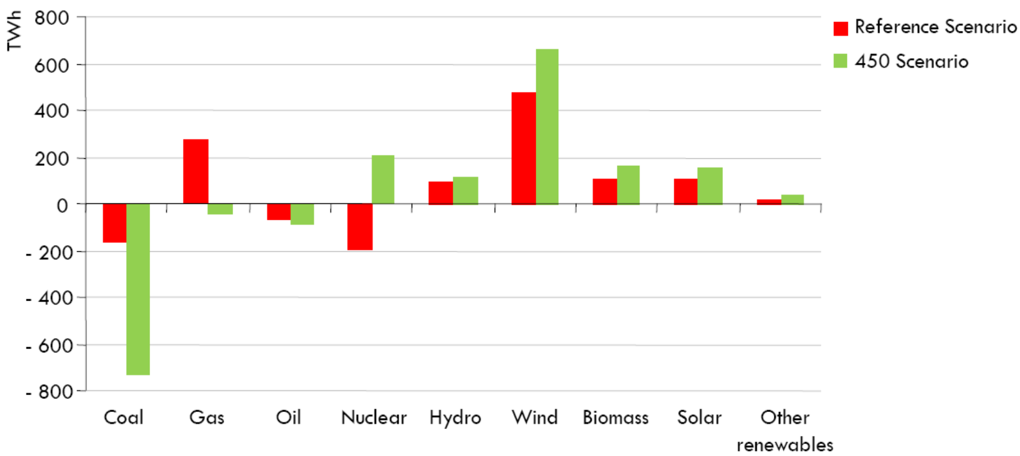

Figure 3 Power generation in the EU according to reference and 450 scenario (IEA 2009).

These scenarios show that a lot of new renewable electricity generation will be built in near future. Moreover, especially the amount of intermittent generation, which is a challenge for electricity markets, will increase significantly and sufficient transmission capacity and reserve power capacity are needed to sustain the security of supply. The forecasted increase in the amount of intermittent generation already in years 2015-2020 is about 9000 MW of wind power and 4000 MW of solar power per year in Central and West European and in the Nordic countries. These investments in intermittent generation call for more transmission capacity rather quickly (National Renewable Energy Action Plans 2010).

2.2 Characteristic of deregulated electricity markets

Storing of electricity economically in large quantities is not yet possible. Electricity markets differ from other commodity markets because consumption and generation must be balanced at every instant. The efficient use of the generation capacity requires sufficient transmission capacity, because the transmission congestion forces the markets to deviate from the optimal dispatching order of the generation.

2.2.1 Pricing of electricity

Market price of electricity is typically formed in the day-head market to balance the generation and consumption during the delivery hours of the following day. The form of trading in day-ahead market is often closed auction. The prices obtained constitute an essential tool to determine the optimal merit order of generation (efficient use of generation capacity). Depending on the market model, the body responsible for price calculation is either the power exchange or the transmission system operator (TSO). However, regardless of the market model, the TSO is, in practice, always the body responsible for keeping balance between generation and consumption of power at every instant, which is a requisite for the system stability.

The electricity market is based on a pricing principle by which the merit order of generation is settled. *Marginal pricing* is the pricing principle commonly applied in the electricity markets. It directs the merit order of generation so that the production with the lowest marginal cost is the first to be brought on line while the production with the highest marginal cost is the last, thereby determining the price for electricity. This results the cost-efficient allocation of production resources. The price is formed on the basis of the marginal costs of the last production brought on line to satisfy the demand, and it is the same for all forms of production and generators regardless of their bids and also for all consumers. In Figure 4, the optimal marginal pricing mechanism is represented.

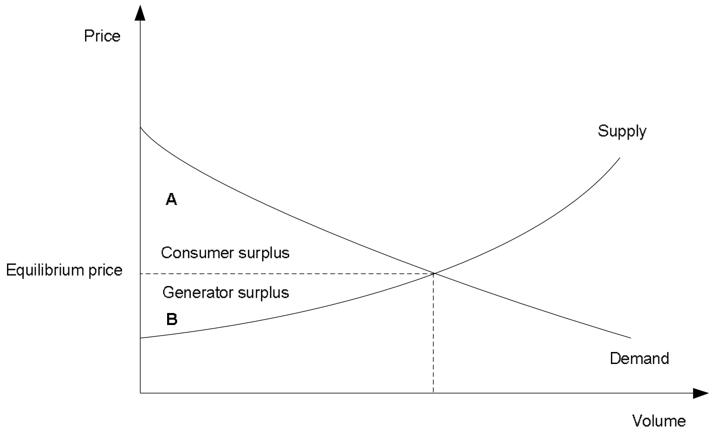

Figure 4 The equilibrium price formation under the marginal pricing principle.

The equilibrium price is found at the intersection of the demand and supply curves. The demand curve indicates the consumers' willingness to pay, and the consumer surplus is the area between the demand curve and the equilibrium price line. The supply curve indicates marginal cost of generation, and the generator surplus is the area between the equilibrium price line and the supply curve. The total social welfare is the sum of consumer and producer surplus (Wangensteen 2006).

An alternative is to determine the merit order by a "pay-as-bid" mechanism, which changes entirely the efficiency of the price formation. In this pricing method, the generators are assumed to bid electricity into the markets based on their marginal costs, according to which the merit order is then determined. Each generator is paid according to its bid price, and thus, no common market price is formed. However, the price for all consumption is the weighted average of generation bids. This principle increases the generators' uncertainty about the determination of the merit order, as it is not possible to predict the bids of other electricity generators, or how the merit order will be determined in each case. To protect themselves against this risk, the generators add a certain risk margin to their bids, which raises the general price level. Another problem of the pay-as-bid pricing is that the generators cease the role of price-takers and start to guess the highest bid and raise their own bids to make sure that they will also be paid the highest price.

2.2.2 Role of transmission system

In the context of electricity wholesale, the statement "the electric power network provides a marketplace for electricity" refers, above all, to the system's capability to respond to the demands of the market. If enough power can always be transmitted from a lower-price area of generation to an area with a higher price, the transmission system can be considered to constitute a functioning marketplace for electricity trade. However, if the transmission connections are repeatedly congested and prevent the flow of power in the desired direction in the market area, the need to find tools to control the system congestion starts to dictate the design of the market model.

In the European electricity markets, the market model applied is the *zonal pricing system*[1], where the target is to determine a single price for the whole market area. When the congestion of the transmission networks prevents the formation of uniform market price, the market contains separate market areas (or zones) that have separate prices. The basic principle is that the congested lines are known and market can be divided into the areas, in which the intra-zonal congestion is rare. In practise, the formation of uncongested price areas have shown complicated problem. The price areas in Europe are typically created so that the borders of price areas coincide with the national borders. In the Nordic countries, smaller price areas inside the countries may also exist.

Internationally, the most widely adopted market model is the one where the calculation of equilibrium prices in the day-ahead trade is included in the optimisation of power system operation. In this *nodal pricing system*, no separate price is determined for power but the equilibrium prices obtained as a result of price calculation reflect the cost of the use of the power system. This model is, for example, used in the parts of the US, Australia, New Zealand and Russia. In the day-ahead auction trade, the generators' bids are made for specific generation plants, and are thus bound to the geographical location of the plant. As a result of price calculation, exact, plant-specific power generation plans are submitted to the generators in return. The nodal pricing system is a tool to manage transmission system congestion, as the transmission capacities in all parts of the system are taken into account from the beginning when optimising the use of the power system.

2.2.3 Market integration

Regardless of the market model, in practice, all open electricity markets share the concern about centralised markets. In the short term, the most efficient approach to the problem is to expand the market area. However, the existing market models diverge on the issue of how the geographical expansion of the market areas influences the actual size of the markets.

The nodal pricing model, which is typical for a congested transmission system, comprises several small submarkets (nodal points). The expansion of the market area does not have an effect on the size of individual submarkets. Ultimately, the market size is determined by the transmission system's capability to respond to the demand for power transmission determined by the markets. If there are numerous bottlenecks in the system, the required power still has to be generated locally, and consequently, also the price is determined locally. Electricity retailers are exposed to local price differences which may affect their willingness to operate across the entire market area.

In the zonal pricing (area price) model, the transmission system plays an equally critical role, as the price differences between areas can be evened up only if the transmission capacity is sufficient to meet the demand for power transmission. If the transmission capacity is not sufficient, separate area prices hold. Area price situations create challenges to the antitrust policies (market monitoring); in the uniform market (comprising all the price areas), the concentration ratios are different from those that would be obtained for the separate price areas. However, the antitrust policies may not be able to identify and react to the dynamic changes in the size of the market. Area

[1] Also referred to as *area price method* in this document

prices are also problematic if there are no liquid financial products that could be used to manage the area price risks. This may, for instance, reduce the electricity retailers' willingness to operate across the borders of the price areas.

2.3 Development patterns of electricity markets

In the course of their short existence, the liberalised electricity markets have faced various crises in different areas. Behind most of these cases, there has been a doubt about an abuse of a dominant position in the market to manipulate the prices. The adverse situation may have developed from excessive centralisation of the market or splitting up of the market into too small submarkets because of insufficient transmission capacity. Tackling the latter problem has proven difficult, as the implementation schedules of transmission network investments typically span several years, and routing of new network connections is often difficult. A critical question in the deregulated electricity markets has proven to be whether timely investments in the transmission networks are made to relieve the congestions. The challenges faced by the deregulated electricity markets and the development pattern of the markets are illustrated Figure 5.

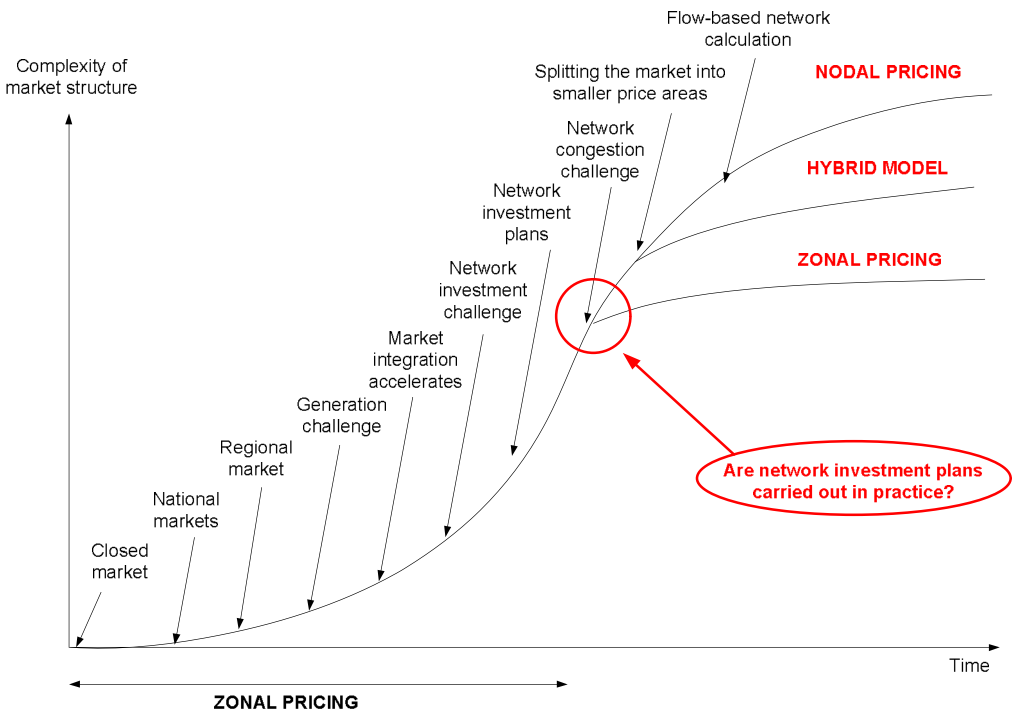

Figure 5 Development patterns of the deregulated electricity markets.

As the electricity market is deregulated, that is, competition in electricity generation and selling, the borders of the market typically coincide with the national (or state) borders. However, in order to promote competition, the deregulated *national markets* often join together to form *regional electricity markets*.

Regional markets are often first characterized with some overcapacity in generation. However, the overcapacity fades away along with the increasing demand. The tightening demand–supply –

situation leads to situation that can be classified as *generation challenge*. Market integration is often viewed as an efficient way to increase competition in the short term because it increases the number of players in the market, and is expected to enable the sharing of resources across a larger geographic area. Hence, the generation challenge typically leads to a situation in which the speed of *market integration accelerates*.

Market integration alone, however, does not guarantee that the benefits of the larger geographic area are realized. Instead, the success of market integration in electricity markets requires sufficient transmission network capacity between the integrated markets. Pursuing the benefits of market integration leads to the emergence of *network investment challenge*. As a result, extensive *network investment plans* that specifically acknowledge the needs of the markets are often drawn. During the planning process, congestion in the networks typically increases, eventually leading to a situation that can be characterized as *network congestion challenge*. Until this point, there exists a universal pattern in the way in which the deregulated electricity markets evolve. However, from this moment on, the development paths of the electricity markets diverge depending on how the transmission network investment plans are carried out. In fact, *carrying out the investment plans* to handle the network congestion challenge seems to be the real challenge in the electricity markets that determines the direction of development in the markets.

Putting the investment plans into practice is a time-consuming process because of the variety of issues affecting the network investment realization. These include, for instance, the land usage question as well as the ability to finance the network investments. Relieving the network congestion by investments enables the continuation of the *zonal pricing* approach. However, if investments are not made, the network congestion gets worse and eventually leads into a situation in which zonal pricing cannot work unless the market is split into *smaller price areas*. The congested lines remain between the newly-formed price areas. Smaller price areas are sometimes enough to handle the network congestion problem. However, if internal congestion is common also within the price areas, re-dispatching is required and opportunities for gaming may emerge. One solution is to optimize dispatching within the area based on supply offers and demand bids at each node of the network. Using the nodal calculation to derive optimal dispatching order, but not to set prices at the nodes characterizes as some kind of *hybrid model* between zonal pricing and nodal pricing.

Large number of price areas may result in inefficient allocation of transmission capacities between the areas. A traditional way to calculate the flows relies on a static ex ante calculation of the available transmission capacities. One suggested improvement is to apply a *flow-based method* to calculate the need of electricity transfers by optimizing the transfers simultaneously with the price calculation. The idea of this approach is close to the idea of the *nodal pricing*, in which the use of the electricity system is optimized by calculating the locational marginal prices at each node of the network. The nodal prices take into account the costs of electric energy, transmission congestion and losses.

3. Market models in electricity wholesale markets

Electricity market model covers the operation principles of the electricity wholesale market. There are two basic market models; zonal pricing and nodal pricing. Which of the models is chosen depends ultimately on the amount of transmission network in the area. The zonal pricing model will be applicable if the transmission networks in the area are sufficient enough, the borders of price area follow the physical limits of the networks, and there are enough competing generators in the area. Congestion inside the price area is allowed only in exceptional circumstances, and there has to be enough generators in the area. Internal congestions cause a need for re-dispatching (rescheduling of generation or counter-trade), and repeated re-dispatching situations may enable the generators to game, which weakens competition in the market.

Nodal pricing model is practically the only choice available, if there is scarcity of transmission capacity, and there are no intentions to invest sufficiently in this capacity. If zonal pricing was selected in a situation like this, the price areas could become very small, or there could be congested lines inside the areas in any case. This would lead to inefficiency in the markets. Figure 6 demonstrates the selection of the market model and factors that change along the market model.

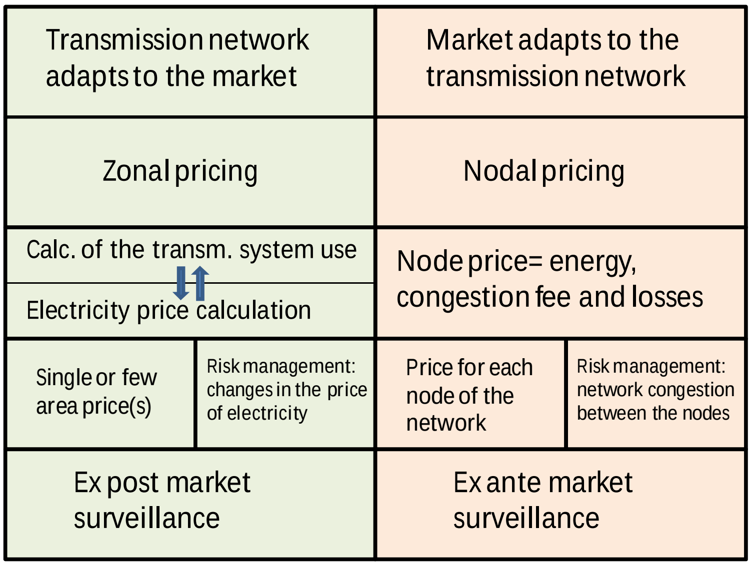

Figure 6 Electricity market models.

The key difference between the market models lies in the method for calculating the price for electricity. In the zonal pricing model, the electricity transmission system operators responsible for the main transmission grid inform about the transmission capacity available, and the power exchange calculates the price for electricity based on the bids of market parties. In the nodal pricing, the transmission system operator is responsible both for the operation of the transmission grid and the electricity price calculation. In addition to the energy component, the electricity price includes a transmission congestion fee and losses. In the nodal pricing, a major risk lies in the price differences between nodes caused by transmission congestions; this uncertainty can be hedged against by purchasing certain transmission hedge products, such as Financial Transmission Rights (FTRs).

A key difference between the market models is the need for market regulation. If the price areas in the zonal pricing model are large enough, the use of market power in the price area does not pose a significant risk. In the zonal pricing model, regulation is carried out ex post; for instance company mergers and acquisitions are monitored or the power exchange may control whether the power generators have informed the market about production failures swiftly enough. In the nodal pricing, the market regulation is carried out ex ante owing to the small size of individual submarkets; the control is also significantly stricter than in the zonal pricing model. In the nodal pricing, the nodes have price caps, which the price may not exceed. Moreover, the bids of individual generation plants are monitored by various tests to prevent the exercise of market power.

The strict price control cuts the price peaks, which, however, are important signals indicating the need for investments in new production capacity. In many nodal markets there are separate quantity-based capacity markets to guarantee new investments in generation capacity. Another alternative is price-based capacity markets, where the generators are paid a lump-sum compensation for the capacity. In the quantity-based markets, the generators and buyers submit their bids to the capacity market similarly as in the spot market; in other words, the generators offer capacity and the buyers estimate their demand for capacity; this determines the price based on which the generators make their investments in capacity. The capacity markets are often compulsory for all market participants. A certain proportion of generators are chosen to meet the firm capacity obligation (peak load and reserve margin) (Creti 2004).

3.1 Nordic countries

In the Nordic countries (here Finland, Sweden, Norway and Denmark), the electricity markets were opened up to competition in the 1990s, and the wholesale markets were fairly soon combined into a single market. The market model to be applied was zonal pricing, and there were ten price areas (spring 2011), one of these being the Estonian price area. The area pricing model was a natural choice as the transmission capacity both between the countries and within them was sufficient for the formation of price areas. The integration of markets was further boosted by the joint activities, originated from the 1960s, through the cooperation organisation Nordel. Within Nordel, the transmission system operators agreed, for instance, upon reinforcements in the transmission grid. In the Nordic countries, electricity consumption was about 400 TWh in 2008, the primary forms of generation by sources of energy being hydro, nuclear, coal, gas and wind (ET 2009; EU Energy 2010).

The common power exchange Nord Pool Spot AS is responsible for the physical spot trading and NASDAQ OMX Commodities Europe (NASDAQ OMX Oslo ASA) for the financial markets. The spot markets comprise the day-ahead Elspot market and the intraday Elbas market. The Elspot market operates as a closed auction, whereas in the Elbas market, contracts may be traded up to one to two hours prior to the physical delivery until a counterpart is found. The Elbas system also automatically controls that the available transmission capacity allows the trade. About 70 % of all electricity trade takes place through spot markets, and the rest by bilateral contracts. In the Nordic day-ahead markets, the average system price in 2010, that is, the unconstrained market price for whole Nordic area, was about 53 €/MWh (Nord Pool Spot 2010).

The products available in the financial markets include forwards, futures, options and CfD products with various maturities to hedge against electricity price fluctuation. The reference price of the derivatives is the system price of Nord Pool Spot AS. The CfD products are used to hedge against price differences between areas. The markets are allowed to operate rather freely, the supervision focusing chiefly on company mergers and acquisitions. The market monitoring is a joint-function of Nord Pool Spot AS and NASDAQ OMX Oslo ASA and, for instance, it includes the monitoring of trading activities on the physical and financial markets. Energy-only market is assumed to ensure adequate revenues for the generators and separate capacity markets are not needed. For the operational security of supply, the Nordic TSOs contract and maintain adequate system reserves needed for frequency regulation and the real-time regulating power market.

At present, there are five price areas in Norway, two in Denmark and one in Finland and Sweden, each. In addition, Estonia joined the Nordic markets in spring 2010, constituting one new price area of its own. In the near future, Latvia and Lithuania are expected to join in the Nordic markets. Sweden will be split into four bidding areas in November 2011. The reason for this division is the congestions inside the country causing problems to the market. Congestions inside bidding and price areas can be cleared through counter-trade (Fingrid 2009; Svenska Kraftnät 2009).

3.2 Central European markets

In Central Europe, electricity markets were gradually opened up to competition mainly in the 2000s, in compliance with the EU legislation. This report concentrates on the electricity markets of France, the Netherlands, Belgium and Germany.

France, Belgium and the Netherlands constituted the 'Trilateral Market Coupling' (TLC) area in 2006. Now the market area with similar coupling process is spread into Germany and it is called as CWE (Central West European) area. The market model applied is zonal pricing with a market coupling mechanism, which means that an area price is calculated for each country, but when the transmission capacity is sufficient, prices form same in each area. In 2008, the average wholesale price of electricity in the CWE area was about 50–70 €/MWh. The electricity consumption was about 495 TWh in France, 120 TWh in the Netherlands and 82 TWh in Belgium in 2009, the most significant forms of production by the sources of energy being nuclear, gas, coal and renewables. Electricity consumption was about 570 TWh in Germany in 2009, the primary forms of generation by the sources of energy being coal, nuclear, renewable, gas and oil (ERGEG 2010; Vattenfall 2008; EU Energy 2010).

The French power exchange Powernext has combined its operations with the German power exchange EEX. The joint company EPEX Spot operates the spot markets of France and Germany, which comprise both day-ahead and intraday markets. The EEX offers financial products for both markets. The power exchanges APX-ENDEX in the Netherlands and Belpex in Belgium are aiming to unify their operations to enhance cooperation. The first joint project was to introduce an intraday market, which operates similarly as in the Nordic countries (EPEX 2011; Belpex 2010).

The target is to intensify cooperation between the Nordic countries and the CWE countries from the current ITVC volume coupling further to full price coupling in 2012 using a single price coupling algorithm. In addition, Germany is already included in the Nord Pool Spot intraday market (Vattenfall 2008; ERGEG 2010).

3.3 Overview of some electricity markets in the USA

Within the North American context, this report focuses on the electricity markets of PJM RTO and Texas Ercot in the USA.

PJM RTO

In 1997, an independent system operator PJM ISO (Independent System Operator) was established by the states Pennsylvania, New Jersey and Maryland, which now formed an integrated wholesale market. In 2002, the ISO became an RTO (Regional Transmission System Operator), when the operations of regional ISOs were unified. In this process, the electricity markets expanded outside these original states, covering now the states of Ohio, Delaware, District of Columbia, Virginia and West Virginia, and partly for instance the states of Indiana and Illinois. First, a zonal pricing model was applied; however, the model proved unsuccessful. For instance, the generators scheduled their generation independently rather than respected transmission constraints. After the first year, nodal pricing was introduced, as it was considered to alleviate the reliability problems caused by the zonal pricing. Electricity consumption in the area of PJM RTO was about 710 TWh in 2009, and the average spot price was 40 €/MWh. The primary forms of generation by sources of energy are coal and gas (Hogan 1999; Maryland 2009; FERC 2010).

There are more than 7000 nodes in the PJM Interconnection. The nodal price includes the cost of energy, congestion fee and losses. The values of the nodes are aggregated into trading hubs. There are 11 hubs, the most important being the Western and Eastern Hub and the PMJ Interface. The hub price is a weighted average of the nodal prices included in the hub, being therefore more stable than the price of a single node. Hub prices are used as a reference for instance in financial markets (PJM 2011).

The PJM spot market is a two-settlement market, including a day-ahead and a real-time market. Bilateral contracts are also allowed, but they have to be approved by the PJM RTO after contracting. The RTO controls that the bilateral contracts do not disturb the reliability of the network. Bids into the day-ahead market are submitted one day prior to the actual delivery. After this, the PJM RTO will perform the optimisation, in other words, the PJM chooses the generation units to be brought on line in the day ahead, and calculates the day-ahead price for electricity. Also the real-time bids are fixed for these units (i.e., they cannot change the bids made in the day-ahead markets). Those companies which are not chosen for generation in the day-ahead market may participate in the new bidding round in the evening prior to the delivery day. These bids are valid also in the real-time markets in the following day, and thus, the bids cannot be altered, because this would create price peaks or an opportunity for the exercise of market power. In the real-time markets, optimisation is performed at five-minute time intervals (PJM 2011).

The PJM's Market Monitor monitors the markets for instance by calculating the Residual Supply Index (RSI), the Herfindahl-Hirschmann Index (HHI) and by making price-cost comparisons. If the market is not found competitive, the generators' bids are limited to cover only the anticipated generation cost with a limited margin. If the market is competitive, the market-based bids of generators are accepted (Market monitoring 2009; Market Power PJM 2007).

The extra costs caused by transmission congestions between nodes can be hedged against by Financial Transmission Rights (FTRs). RTO offers long-term FTRs for auction (for periods ranging from a month to several years), and they can also be sold forward in the aftermarket. The rights are available as options and obligations. The purchaser of the FTR has to determine the time interval for which the FTR is purchased and the direction of the power flow. There are also bilateral aftermarkets for the rights. In the final clearing, it is taken into account whether the initial assumptions were correct. The clearing is made in the day-ahead market against the price difference of the nodal congestion components. The RTO's auction revenues from the FTRs are distributed as Auction Revenue Rights (ARRs) to certain participants, in which case the holder of the ARR has an option either to a financial compensation or a right to exchange the ARR for FTRs (PJM 2011).

In the PJM area there are compulsory capacity markets for both the generators and buyers (Reliability Pricing Model), where long-term (three-year) capacity commitments are being made. The target is to guarantee capacity investments in the future, as the price control in the spot markets prevents sufficient price signals required for new production capacity. The current capacity market model is a result of a long development process. Capacity trading takes place in an auction where the buyers bid for purchasing generation capacity according to the predicted demand curve, and the existing and possible new generators bid for selling capacity. All the generation has to be offered to the market, some special cases excluded (e.g. if the generator is trading outside the PJM), but only the required amount of generation is chosen to meet the capacity obligation. The highest possible peak load and a reserve margin are determined as the capacity obligation. The price determined in the capacity market has to reflect the price level of the zone; in other words, if the required capacity cannot be delivered because of transmission congestions, the zone will be separated into a price zone of its own in the capacity market. The PJM performs monitoring also in the capacity market so that the generators cannot avoid offering their capacity. If the generator does not generate power when its generation is demanded (peak hours), it will not get a compensation in the power and capacity markets regardless of the reason why it did not generate power. Moreover, the PJM monitors the exercise of market power (dominant market position; market power mitigation), because the risk of exercising market power is high. On the other hand, a buyer may reserve a larger capacity than it actually needs. Therefore, offer capping will be introduced in the market, if the market power tests indicate exercise of market power. Common offer caps are determined for the PJM area taking into account for instance investments and return on assets (Market monitoring 2009; Pfeifenberger & al. 2009).

Texas Ercot

The electricity markets of Texas ERCOT (Electric Reliability Council of Texas) covers almost a whole state of Texas. At the present, markets are undergoing significant change from a zonal to a nodal market. In the zonal pricing system, there were no liquid spot markets, and energy was traded between market participants mainly through bilateral contracts. The area of Texas ERCOT was divided into fixed price zones based on the congested transmission lines. The price zones consisted of numerous nodes. The market participants traded between the price zones and were themselves responsible for the congestion costs. Distribution of the transmission capacity between price zones was inefficient, and price signals were too weak to produce favourable and efficient placement of new generation. The main reason for transition to the nodal pricing was the inefficient use of the transmission capacity (Brocato 2004; Hogan 2008; Baldick 2003).

Electricity consumption in the Texas ERCOT markets was about 312 TWh in 2009. The price of electricity in the spot market was 30 €/MWh in 2009. The primary forms of generation by sources of energy were coal and gas (FERC 2010; Texas ERCOT 2010).

In the present nodal pricing model, there are 4000 nodes in the Texas market, and trading takes place in the day-ahead and real-time markets. ERCOT determines the most economic dispatch of individual generation resources every five minutes. There is no separate capacity market, but the price cap for the spot markets is set slightly higher than in other electricity markets in the USA. The price cap is 3000 $/MWh. When the price cap is set high enough, the price peaks should guarantee sufficient investments in generation capacity. In the Texas market, there are Congestion Revenue Rights (CRRs), similar to FTRs, to hedge congestion costs (Texas Nodal Market Implementation 2008; Hogan 2008).

3.4 Australia

The decision to open the Australian electricity market to competition was made in 1991, after which the territories gradually opened up their markets. In this report, the focus is on the National Electricity Market (NEM), which is the wholesale electricity market covering the states and territories of New South Wales, Tasmania, South Australia, Victoria, Australian Capital Territory and Queensland. Within NEM, joint decisions have been made on all issues related to the electricity market, privatisation excluded. Consequently, there are differences between territories concerning for instance the ownership structures of generation plants. For example, the State of Victoria has privatised all the generation that was previously owned by the state, whereas in the State of New South Wales, generation is mostly state owned. Also the ownership structures of transmission networks differ between states; in some states, the transmission networks are owned by the state while in some of the states the network are private owned. The primary forms of generation by sources of energy are coal, gas and hydro. Electricity consumption in Eastern Australian electricity markets was 210 TWh in 2009 and the average price of electricity in the spot market varied between 35 and 50 €/MWh depending on the state. In principle, the electricity markets are integrated, yet owing to long transmission distances and weak connections, the markets are quite separated. Because of the historically independent position of the states and generation capacities of their own, five price zones (nodes) were established (AER 2009, Interviews 2010).

The NEM is an obligatory wholesale pool, where trading of energy takes place. The generators bid for energy a day prior to delivery. The bids are made for five-minute dispatch periods. The generators can also change the bids five minutes before actual delivery. AEMO (Australian Energy

Market Operator) stacks the offer bids of all generators in ascending price order and sets the price for each five-minute dispatch period. The demand is estimated for short, medium and long term by AEMO, and the buyers do not directly bid for purchase in the pool. A wholesale spot price is determined for each half-hour period; it is calculated as an average of the five-minute dispatch prices. A separate spot price is determined for each five regions (nodes), taking into account physical losses and transmission congestions. If there are no transmission congestions between the regions, the spot prices are nearly equal. In practice, the loss component always causes some difference in prices between regions. The nodal calculation process is more simply compared for example to New Zealand markets because the number of the nodes is low. The nodes are always located in the population centre in the region; for instance the pricing node (Regional Reference Node, RRN) of Victoria is in Melbourne and the pricing node of New South Wales is in Sydney. Most of the generation is located close to the consumption; however, those generators that are not located in a consumption centre suffer somewhat from this one-node pricing principle. The consumers pay for the use of electricity according to the spot price for the half-hour period, and the generators are paid for the electricity accordingly. The spot price has to remain between -1000-12500 $/MWh. In principle, there is little price control, and only the spot prices exceeding 5000 $/MWh have to be reported stating the reasons for high prices. The price peaks in the wholesale markets have not been politically influenced so far. There are no separate balancing or regulating power markets, but balance management is carried out by state-owned peak demand plants (Davidson 2010; AER 2009).

Bilateral physical contracts are not allowed, but bilateral financial contracts are actively used for hedging. There are also futures and options available in the power exchange. Introduction of a carbon tax has been debated for long (AER 2009, Interviews 2010; Alert 2010).

From the market perspective, the major problems are the scarce transmission capacity between the states, market rules (especially rebidding) and introduction of renewable energy to the market. In principle, transmission network regulation should guarantee sufficient network investments; however, in the initial stage, there has been no uniform practice for granting licences for network investments, which in practice has blocked many investments. A few years ago, the investment licensing was transferred to the states, which made it easier to obtain investment licences and thereby increased the amount of transmission network investments. The most problematic of the market regulations is the rule concerning generators' opportunity to adjust their bids up to five minutes before physical delivery. Although these changes should be made bona fide, this provides large generators an opportunity to exercise market power, against which there are no tools. High price peaks provide signals for constructing peak power; however, more base load generators would be required to promote competition. There are capacity problems in hot summer days, when all the domestic consumers switch their air conditioning systems on during the afternoon hours. This load cannot be utilised for price elasticity purposes, as the air conditioning load cannot be transferred for instance to the night hours. A new problem emerging the markets is the introduction of distributed renewable energy. Traditionally, generation has been built close to the consumption (mainly coal power), and the transmission networks inside states are weak. Now, the target is to increase the use of wind power; however, the plants would be built to places that have no transmission network yet. The question is who shall pay for the new construction and changes in the transmission network in order to make wind power accessible to the markets (Interviews 2010).

3.5 New Zealand

In New Zealand, there are three large generators Meridian 28 %, Contact Energy 25 % and Genesis 21 % and three smaller generators in the electricity markets. These generators also participate in retail markets, and the three largest wholesale market operators are also the three largest participants in the retail market (vertical integration allowed). Meridian is the largest generator in the South Island while Genesis is the largest in the North Island, which has an impact on the competitiveness of the retail markets as the retailers/generators want to concentrate their operations on their own region due to the lacking opportunities for price hedging. More than half of generation consists of hydro power, but the reserves are small compared with the Nordic countries, for instance. Other forms of generation by sources of energy are gas, coal, geothermal and wind power. The total electricity consumption in New Zealand was 37 TWh in 2008, and the average spot price was approx. 35 €/MWh (EnergyLink 2010).

The transmission networks are owned by Transpower, which is also responsible for new investments. Electricity markets were opened to competition in the 1990s, when the state-owned generation company was split into smaller companies. At present, there are still ownership arrangements taking place; Genesis and Meridian are exchanging part of their power generation ownerships in the South and North Island (EnergyLink 2010).

The market model applied is nodal pricing, and there are 500 nodes, some of which do not participate in the market. There are 250 market-based nodes. The price of each node is based on the price of the last megawatt brought to generation (locational marginal pricing). In addition to demand and supply, physical losses, congestions and the use of the HVDC connection between the islands have an effect of the price. Trading takes place in a compulsory pool, where only generators make bids. Demand is forecast for each half-hour trading period, excluding a few demand-side bids taken into account in the calculation of forecast prices. The half-hour period consists of five-minute dispatch periods; in other words, generation is scheduled for each five-minute period. A day before delivery, half-hour forecast prices are calculated as an average of the five-minute periods. The demand and generation forecasts are adjusted on the day of delivery, and dispatch prices are calculated. The demand (from SCADA) and generation are monitored immediately after the delivery to obtain five-minute indicator prices. The actual price calculation is made afterwards, when actual generation and consumption volumes are checked. When the final prices have been published, they cannot be modified, and all market participants will use these final prices, Figure 7.

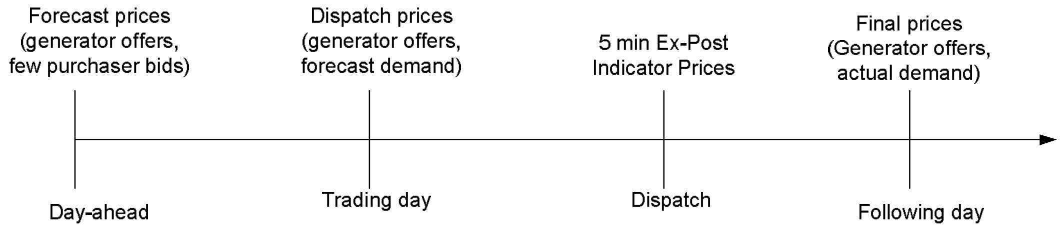

Figure 7 Spot markets in New Zealand (EnergyLink 2010).

In addition to daily price and dispatching calculations, the system operator prepares weekly forecasts for generation and separate winter forecasts (EnergyLink 2010; Interviews 2010).

In addition to trading in the spot market, the generators can make bids for reserve power. The purpose of the reserve is to cover sudden failures in generation units or changes in demand. The generators are allowed to offer only such generation to the reserve markets that can be started up immediately in the occurrence of a failure (the response times further divided into fast, 6 s, and sustained, 60 s) (EnergyLink 2010).

From the market perspective, the HVDC connection between the islands is decisive; if the connection is out of use, the market is split into two. When planning the markets, a zonal pricing model was also considered. However, definition of the price zones was not unambiguous, because there were congestions inside the islands. An alternative considered was a zonal-nodal model, where the generators would have seen the nodal prices and the retailers the zonal prices. The South Island would have consisted of one (or a few) price zone(s), while in the North Island, no price zones could be formed. There are congestions between the nodes; this is called the Spring Washer Effect (SWE). If the SWE had occurred in one price zone, it would have meant congestion inside the price zone, and thus, repeated rescheduling of generation. A compulsory pool has existed since 2004; however, before that also bilateral contracts were allowed (EnergyLink 2010).

In average, every second year in the 2000s, there has been a dry year in New Zealand, and thus, hydro power has been only limitedly available. In such years, the average final price in the spot markets has climbed rather high. As a solution to the problem, price caps have been suggested for dry years. The operation of financial markets has so far been rather limited, but now it is possible to trade financial products both bilaterally and with futures of the power exchange. There are futures available in two nodes. FTRs are not in use at the moment, but the target is to introduce them in the next few years in order for the market participants to be able to hedge against price risks between nodes. In particular, there is a price risk between the nodes of the North and South Islands. CfD contracts are available even at present; however, in the contracts, certain nodes are defined to be used as a reference (which may deviate from the spot contract node). At the moment, the financial markets are very nonliquid, but it is expected that the liquidity will improve along with the upcoming changes in the market. The vertical integration between the generators and retailers is assumed to compensate the need for hedging products (EnergyLink 2010).

There is only little regulation in the market. The generators' offers are not directly monitored, and there are no price caps, but price peaks are allowed. Thus, no separate capacity market is required, as the price peaks guarantee signals for sufficient investments. In case of exceptional market situations, reports will be prepared stating the reasons for high prices. The purpose of the nodal model is to direct the generation to the locations where it is required and where there is transmission network already available. However, some new investments in transmission networks have been made in the past few years (Interviews 2010).

Emissions trading plays no significant role in the markets, although the model is in principle the same as in Europe, that is, the generators are granted emissions rights. The previous allocation of rights was considered not to be impartial, and therefore, rights will be granted again next year (Interviews 2010).

3.6 Russia

The objective of the energy reform in Russia, launched in the late 1990s, was to attract massive investments to the depressed power sector and to establish conditions for the future development of the power industry. The milestones of the reform were recorded in two federal laws issued in spring 2003. After that, Russia adopted a traditional approach of splitting vertically integrated monopolies into specific business-oriented companies. In the generation sector, large Territorial and Wholesale Generating Companies (TGCs and WGCs), the open joint-stock company (OJSC) Rosenergoatom Concern, the JSC Rus Hydro and the JSC Inter RAO were established. The functions of the grid operator were entrusted to the state Federal Grid Company (FGC) comprised of eight regional subsidiaries supervising the national grid. The state-owned holding company MRSK unified eleven interregional subcompanies, each of them being pools of several local companies responsible for running of distribution networks in their regions. The restructuring process was basically completed by 2006 with the allocation of the sale assets of the monopolies to tens of power sale companies. Russia consumes annually about 1023 TWh of electricity. The main generation forms are thermal, hydro and nuclear power (RAO UES 2010; Agency of Balances forecasting 2010; Statistical Yearbook 2009).

The wholesale market model includes regulated contracts, a day-ahead market, a balancing market, markets for derivatives and a market of ancillary services. Further, a market of Financial Transmission Rights (FTR) is on the list of the reform. The commercial operator ATS is in charge for the day-ahead market, and the System Operator (SO) organises balancing trade of energy and also conducts annual competitive selection of generators in the market of ancillary services. The markets for derivatives are supervised by the Moscow Energy Exchange (Exchange). The amounts of energy and capacity under regulated contracts have been gradually decreasing over the last five years. Complete liberalisation of the wholesale market will be reached by 2011 (RAO UES).

The day-ahead market of Russia applies the nodal price formation approach, which reflects the actual situation in the grid. Moreover, the approach matches the constrained transmission capacities and very different costs of generation in the regions of Russia.

In the day-ahead market, the generators first submit to the SO the data about their actual production on the next day and the maximum price of production. Based on this information and its own demand forecasts, the SO defines the feasible modes of the power system, selects the generators to produce and then transfers the data to the ATS, which in turn receives the price offers from the market participants in regard to the planned consumption and generation. The ATS organises a marginal auction of offers and defines the amounts and prices of energy in each of the 8000 nodes of the system. The Federal Antimonopoly Service monitors the day-ahead market for the purpose of market power detection and mitigation. Deviations from the scheduled production and consumption are traded in the balancing market. The SO runs the market by organising competitive auctions of offers of the generators and consumers with regulated load eight times per one trading day. As a result of auctions, the prices and amounts of planned deviations in the nodes are defined. The prices of deviations depend on the reasons that caused these deviations (RAO UES 2010).

Forwards for energy in Russia are purely financial with all the energy under the contracts sold and purchased in the spot market. The energy prices and amounts in contracts are freely set by the counterparties. At present, over-the-counter (OTC) and exchange contracts exist. The reference price under the OTC contract is defined at one of the counterparties' locations, which means that the other party is exposed to a basis risk. The reference price in an exchange contract, instead, is an average price of hundreds of nodes within the given part of the energy system hub. This makes it possible to increase the liquidity of the forwards but does not eliminate the basis risk to the counterparties. The market for energy futures was opened in June 2010 by the Exchange. The contracts are monthly based peak load contracts, the time slot of trading being two and half months. Each contract defines the due date and the standard energy delivery rate of 100 kW per hour. The underlying assets in the contracts are monthly average hub prices. The futures are traded until the last day of the delivery period, and the final settlement takes place on the due date. Entering the futures contract requires a performance bond, which is 4–15% of the contract settlement price.

The capacity market was organised in Russia with the primary aim of covering the fixed costs of generators and encouraging investments in new capacities. The generators make their offers to the market, and the buyers have an obligation to purchase the amount of capacity that corresponds to their peak consumption. The SO runs the market, organising auctions of the generators' offers and selecting capacities for the period of four years. The price cap applied during the auction for 2011 is approximately 3000 €/MW per month. Capacity forward agreements can be concluded before the auction to hedge against capacity price changes, and after the auction, to mitigate credit risks (RAO UES 2010).

New nuclear and hydro power plants of the JSC Rus Hydro are included in the government long-term contracts of future capacity supply. Also, new heat generation can optionally enter into similar agreements called Capacity Delivery Agreements. In fact, they represent long-term loans taken by the government from private generators for the construction of new power plants. The maturity of the loan is set to 15 years, and the interest rate on invested capital is 14–15%. Annuity payments to generators are collected from the market end-users in the form of capacity payments. The average contract prices of 12000–25000 €/MWh per month for different types of power plants meet the reimbursement of 71–95% of invested capital and operational costs. Compensation is provided only for the first ten years, with the assumption that the rest of investments are recovered from the energy market. The total amount of capacity 30.5 GW put under contract will presumably cover most of the capacity deficit in the upcoming years.

4. Electricity retail markets

Retail markets of electricity are national markets also in those regions where the wholesale trade of electricity crosses the national borders. The decisions on retail markets are also made at the national level, in some countries at the state level.

Co-operation in retail market rulemaking is, however, increasing. In Europe, Citizens' Energy Forum was established in 2008 to enforce consumers' EU-wide rights and to provide them with information about available choices when buying electricity or gas. The forum prepares recommendations that aim to improve the implementation and enforcement of energy consumers' rights and functioning of electricity and gas markets (European Commission 2008).

Many of the most active retail markets of electricity are located in Australia; for example in the State of Victoria the supplier switching rate has been high for many years. In Europe, the switching activity has been high in Great Britain in particular, and in the USA, in Texas (VaasaETT 2010).

In the countries discussed in this report, the retail customers' consumption is not very elastic with respect to wholesale prices. The tariff structures typically applied to retail customers do not encourage wholesale-market-based elasticity, either. Instead, in many countries there are tariff schemes (or pilot schemes) that direct energy use from typical peak hours to other times of the day. The "time of use" pricing is based on a time division that is rougher than the hourly based division of time, and on predefined prices, such as tariffs where the typical hours of peak load are priced higher than for instance night-time consumption.

So far, also in most of the contracts tied to wholesale prices the price has been based on an average price within a certain time interval. The expansion of smart meters will enable more real-time pricing.

4.1 Nordic countries

Finland, Sweden and Norway opened the markets to competition in the late 1990s, and Denmark in 2003. Despite the common wholesale market, the retail markets have remained national, although the target is to establish a common Nordic retail market.

Market participants and division of tasks

In the Nordic countries, a retail market model is applied, where both the supplier and the network company are under contract to the customer and may both separately bill the customer. In practice, a customer who has not switched the supplier has only one contract, and receives only one bill. After supplier switching, the customer has separate contracts with the supplier and the network company, and the supplier and the network company both separately bill the customer.

In the Nordic countries, the number of market participants in the retail market is relatively high compared with many other countries. The number of distribution companies varies from 80 to 170 between countries. Also the number of suppliers varies between countries. The number of suppliers is largest in Sweden (more than 100) and in Norway (about 100); however, all suppliers do not offer electricity to the whole country (ERGEG 2010).

Pricing and contracts

In the Nordic countries, the retail prices of electricity are regulated only in Denmark (ERGEG 2010). Those customers who have not switched supplier typically purchase electricity with contracts that are valid until further notice, and the supplier may change the contract price within the time limits set for notification of a price change. When a customer invites tenders from suppliers, (s)he may also choose between a spot- or fixed-price contract, the duration of which is also determined in the contract. Spot-price contracts are typically based on the monthly average of the Nord Pool area price, but also a moving average is possible. Spot-price contracts are popular especially in Norway and Sweden (ERGEG 2010).

Energy meters

Energy metering is the responsibility of the network company in all the Nordic countries. In Sweden, since summer 2009, the network companies have been obliged to read the energy meters for domestic customers once a month (ERGEG 2010). In practice, the reform has been carried out by providing the customers with remotely read meters. However, the metering data do not have to be recorded every hour. The regulator has suggested hourly metering for customers that consume more than 8000 kWh a year (EI 2010). In Finland, the energy meters have to be replaced with hourly meters by Dec. 31, 2013. The metering devices shall be remotely read, and they shall be able to receive load control commands (Government Decree on settlement and metering of electricity deliveries 66/2009).

Common Nordic retail market

The organisation of Nordic energy regulators, NordREG, has since 2005 worked to promote and facilitate "a truly common Nordic retail market with a free choice of supplier". The objective of the work is to minimise regulatory and technical obstacles for the suppliers that wish to operate in various Nordic countries (NordREG 2009). In October 2010, the Nordic energy ministers gave their support for the implementation plan for a common retail market prepared by NordREG. The ongoing and future work to enable the common market include for example defining the contractual arrangements between DSOs, suppliers and customers, defining the billing regime, specification of future common Nordic business processes and creating a harmonised Nordic balance settlement (NordREG 2010). The framework for the common Nordic retail market should be in place in 2015. However, for example creating the necessary data systems may take longer.

4.2 Central Europe

Germany and Great Britain opened the retail markets to competition in the late 1990s. In Belgium and France instead, the customers were allowed to switch suppliers as late as 2007, which was the deadline for opening up of the retail markets in the EU. The years of liberalisation of the retail market in the above-mentioned countries are listed in Table 2.

Table 2 Liberalisation of the retail market in Central Europe (VaasaETT 2010).

Country	Time of the full retail contestability
Great Britain	1998
Germany	1998
Netherlands	2004
Belgium	2004 (Flanders), 2007 (Wallonia, Brussels)
France	2007

Market participants and division of tasks

In most of the Central European countries, the customer typically has a contract only with the supplier, who also charges the customer for network services. The number of suppliers and network companies varies between countries. In Germany there are more than 1000 suppliers, more than 20 of which sell electricity for 90 % of the network areas. In Great Britain, the retail market is dominated by six large vertically integrated suppliers, the total market share of which is above 99 % of the households (calculated by the number of customers) (ERGEG 2010).

Pricing

In Belgium, Great Britain and Germany, retail prices for electricity are not regulated. In the Netherlands, the suppliers have to submit their tariff proposals to the regulator, who assesses the reasonableness of pricing. The regulator has an opportunity to force the supplier to reduce the tariffs. In France, the Ministry of Energy and Economy determines the retail prices based on the regulator's recommendations (ERGEG 2010).

Meters

In Central Europe (Great Britain excluded, where the supplier is responsible for metering), the network companies are typically in charge of energy metering. In Great Britain, the target is to replace the energy meters with smart meters by the end of 2020 (ERGEG 2010). In France, 95 % of the energy meters shall be smart ones by the end of 2016, and from 2012 onwards all new meters have to be smart ones (Smart Grid News 2010). In the Netherlands, a bill to provide all customers with smart meters was rejected in 2009, and at present, the replacement of energy meters is based on voluntariness (Esma 2010).

4.3 USA

In the USA, decisions on electricity retail markets are typically made at the state level. In several states, the customers were first allowed to switch supplier in the late 1990s or early 2000s; however, in many states, the retail market remains closed (EIA 2010).

For instance green electricity, month to month rates, and fixed or indexed rates are available to domestic customers. In Texas, the number of suppliers is higher than in most states, and also the switching activity has been higher. Hence, Texas has been considered to be the most successful retail market in North America (DEFG 2010; PUCT 2011).

Investments in smart grids are a part of the American Recovery and Reinforcement Act signed by president Obama in February 2009. The $4 billion allocated on smart grid investments will be used on for example the installation of 18 million smart meters which should allow homeowners to monitor their energy use by the month, week or even hour and on 877 sensors on the electric transmission system to improve reliability and security (White House 2009).

Pennsylvania

In the state of Pennsylvania, all customers have been allowed to switch supplier from Jan 1, 2000 onwards. The last price caps for retail customers were lifted at the beginning of 2011 (EIA 2010).

In Pennsylvania, each distribution company has to provide a plan for meter replacement in the coming 15 years. New meters have to be capable of bidirectional communication. The meters have to record consumption at least at an hour level, and submit data to the customer on the consumption and price of energy (PUC 2010).

New Jersey

In New Jersey, the retail market was completely opened up to competition in the autumn 1999 (EIA 2010). Price caps were lifted in summer 2003 (Pfeifenberger & al. 2005).

In New Jersey, no decision has been made at the state level on installing smart meters. However, in the Energy Master Plan published in 2008, smart meters and demand elasticity are considered as tools to reduce the peak load (New Jersey 2008).

Maryland

In Maryland, the retail market was opened in the early 2000s (Maryland Public Service Commission 2008). In the early years of the competitive market, retail prices were regulated, and regulation was continued longer than was initially planned; however, price caps have now mainly been lifted.

Texas

The retail market was opened to competition on Jan 1, 2002. The price regulation, applied in the initial stage of the opening process, terminated at the beginning of 2007. The start of the opening process was postponed in the areas outside Texas ERCOT. In June 2010, in the areas open to competition, more than 52 % of the customers purchased their electricity from other than the incumbent supplier. Of these customers, 84 % were households. The number of suppliers has increased in the past few years; in September 2010, there were 38 suppliers offering products throughout the competitive area of the state (PUCT 2011).

The Texas legislation encourages the adoption of smart meters. The three largest transmission and distribution utilities (TDUs) have received the Public Utility Commission approval of the plans for the deployment of smart meters, and the installation of meters has already begun. By the end of November 2010, 2.5 million smart meters had been installed (PUCT 2011).

4.4 Australia

In Australia, the jurisdiction concerning the opening of the electricity retail markets to competition takes place at the state and territory level. The schedule of the opening of the retail markets (retail contestability) is given in Table 3 below.

Table 3 Opening of the electricity retail markets to competition in Australia (AER 2009).

Region	Time of the full retail contestability
New South Wales	1/2002
Victoria	1/2002
South Australia	1/2003
Australian Capital Territory	7/2003
Queensland	7/2007

In Tasmania, there is no decision on the full retail contestability so far. Some non-residential customers are already allowed to switch the supplier, while residential customers do not have this opportunity yet. The National Energy Retailer Law to harmonise the regulations between the jurisdictions is under process in the Parliament. Nevertheless, owing to the different conditions between the jurisdictions, many jurisdictions want to stick to their own regulations (AER 2009; Interviews 2010).

Market participation and division of tasks

The numbers of retail suppliers in different states and territories in April 2009 are listed in Table 4.

Table 4 Numbers of retailers in different jurisdictions (AER 2009).

Region	Number of suppliers (retail licence holders) for residential and small non-residential customers 4/2009
New South Wales	9/26
Victoria	14/29
South Australia	11/16
Australian Capital Territory	2/15
Queensland	10/24

There are 16 distribution network companies responsible for the electricity delivery; 13 of these operating in the National Electricity Market (NEM). In Australia, a retail customer has a contract with the supplier only, and the supplier includes the network charge in the customer's bill. The distribution company is responsible for the metering (AER 2009).

Pricing and contracts

Typically, a 'host retailer' shall offer electricity at regulated terms and conditions. The host retailer contracts shall meet the minimum requirements set for the service, and also the price can be monitored. In summer 2009, the State of Victoria excluded, all the jurisdictions applied a price cap regime. The Australian Energy Market Commission (AEMC) assesses the need for retail price caps for instance based on the ability of suppliers to enter the market, exercise of market choice by customers and products and services available. The actual decision on the lifting of retail price caps, however, is made at the territorial level. The Victorian Government removed price caps at the beginning of 2009 (AER 2009).

According to the AEMC, retail price caps could soon be removed in some other jurisdictions as well. For instance in Queensland, the retail market has been significantly activated in 2010 (Interviews 2010).

In addition to open-ended contracts, contracts are also commonly offered for a specified period (fixed term). Duel fuel products that bundle electricity and gas service are also popular. In addition to gas, also telephone subscriptions or insurance contracts can be bundled together with the electricity contract. Moreover, a contribution to a charity or a sports club can be included in the electricity product. There are also green power contracts available, the proportion of green electricity varying between 10 and 100 % (Interviews 2010).

Meters

Decisions on electricity meters are made at the jurisdiction level. The state of Victoria has launched a project to replace all meters with smart ones. However, the high costs of the project have been criticised, and moreover, the end-customer prices are expected to increase due to meter replacements (the distribution company's charges are included in the supplier's bill). In New South Wales, the target is to replace all meters by smart ones by 2017 (AER 2009; Interviews 2010).

Demand elasticity and load control

In practice, so far, only the aluminium industry has been elastic with respect to price. The present tariff structures do not direct the temporal distribution of power consumption, either. However, there have been pilot projects investigating the remote control of air conditioning and pool pumps, and pricing models that encourage transferring consumption from the peak hours (AER 2009; Interviews 2010).

Market activity

The State of Victoria was the first to open the retail market to competition in Australia. Victoria was also the first state to lift retail price caps when the competition was found effective enough. The key explanation to the retail market activity in Victoria is that the state privatised the energy sector as a whole. In other jurisdictions where privatisation has not taken place, there have been signs that the jurisdiction is protecting the interests of the suppliers of the home jurisdiction. From the perspective of new suppliers, this, of course, does not look very tempting. In Victoria, the customers have been able to get more savings than in New South Wales, where the supplier margins have been smaller. Especially in the initial stage, the customers could end up switching the supplier even though the new supplier offered the same price as the previous one; an impulse for the supplier switching could be a bonus, such as a free magazine subscription, or the customer's dissatisfaction with the previous supplier. Moreover, the Victorian energy regulator actively encouraged the customers to switch suppliers; for instance, an energy ombudsman was established, and it is well known in the jurisdiction (Interviews 2010).

4.5 New Zealand

In New Zealand, the electricity retail markets were opened to competition in the 1990s. In practice, obstacles to supplier switching were removed in 1999, when the consumption profiles based on statistical data were introduced into billing (Evans & Meade 2005).

Market participants and division of tasks

In New Zealand, there are 18 electricity retail suppliers, most of which are owned by the five largest generators. The small number of independent suppliers is chiefly explained by the high fluctuation of spot prices and inadequate hedging options. Retail suppliers and generators are not allowed to make bilateral contracts, but the suppliers have to buy all the electricity from the spot markets. In areas where the locational price risk is especially high, the number of suppliers is smaller than in larger population centres. The margins in the retail market are also typically higher in the south, which may partly be due to the higher risk. On the other hand, all small local companies do not necessarily aim at making high profits, and thus the prices can be lower in certain areas also without competition (Electricity Authority 2010; Interviews 2010).

The ownership of network companies and retail suppliers has to be unbundled. The ownership unbundling was not required in the initial stage of the market opening; however, it was made obligatory when the vertically integrated supply/distribution companies were suspected to back up their retail activities by network charges. However, there are plans to allow retail trade by distribution companies again (Interviews 2010).

A typical retail customer has a contract only with the supplier, and the customer is charged by the supplier. The network service charges are also included in the electricity supplier's bill. The supplier is also responsible for metering. The electricity delivery is provided by 28 local distribution companies (Electricity Authority 2010; Interviews 2010).

Pricing and contracts

The retail prices reflect the spot price level of the nodes. Therefore, the retail prices are higher in the northern parts of the North Island, where the price level of the wholesale market is typically higher than in the South Island. The retail prices are not regulated. However, the suppliers have to offer the domestic customers a tariff where the fixed charge is at maximum 30 cents a day. The tariff is intended for customers that consume less than 8000–9000 kWh a year (Interviews 2010; Powerswitch 2010).

Typically, the contracts offered are open-ended contracts (fixed price, variable volume). There are also contracts tied to the spot price and fixed price, fixed term contracts, but these contract types are not as frequently used as open-ended contracts. Dual fuel contracts for gas and electricity are commonly offered to customers connected to the gas network, and the dual fuel customers typically choose a dual fuel supplier even when switching the supplier. In addition to gas, also telephone or internet subscriptions or water supply contracts can be bundled together with the electricity contract. There are environmentally friendly products available, as well as products with a contribution to a charity or a sports club (Interviews 2010).

Network service charges

The transmission network operator Transpower publishes its network service charges for distribution network companies once a year, after which the network companies make the decisions on their prices. Also the distribution network companies may change their prices only once a year. There are no standards of practice or guidelines on how the distribution network companies should notify the suppliers of changes (Interviews 2010).

Information exchange

All the electricity consumption sites are entered into a single register, maintained by Jade Software. Also the information exchange related to supplier switching takes place through the register, and the distribution companies have to notify the register of issues concerning network service charges. The register is used by electricity suppliers, distribution companies and metering services providers. A right to use the register has to be applied from the Electricity Authority (Interviews 2010).

Meters

Small customers are not required to have energy meters that would register the temporal distribution of consumption. At present, replacing the old meters with smart ones is voluntary. However, the regulator is of the opinion that certain technical characteristics, such as the data transfer format, should be regulated (Electricity Commission 2009).

Demand elasticity and load control

The load control of small customers is mainly limited to water heating, where the same technology has been in use for decades. In typical water heaters there is a relay, to which the distribution company can send a control signal. The water heater can be switched off for a certain time, and typically, the customer does not even notice the switching off. The motives for the control are mainly network based. The customer benefits from the control by a lower network charge; however, the actual savings of the customer depend also on the supplier (Interviews 2010).

In dry years, a voluntary power savings campaign can be launched, in which a domestic customer can participate for instance by replacing electric heating with some other heating system, assuming that there are dual/multiple heating options available in the household. So far, a customer that has been charged on a typical tariff (fixed price, variable volume) has not received any compensation for participating in the campaign. The Electricity Authority (before Nov 1, 2010 the Electricity Commission) is preparing a compensation scheme for fixed price, variable volume customers. The compensation scheme would also reduce the suppliers' incentives to use the power savings campaign within their risk management strategies against high spot prices (Electricity Commission 2010; Interviews 2010).

4.6 Russia

Electricity supply to retail customers is provided by suppliers of last resort (SLR) and independent sale companies (ISC). SLRs operate within certain territories only, whereas ISCs can supply end-users in different areas of the market. Generally, SLRs supply small and medium end-users, charging them with the average monthly prices of procurements in the wholesale market plus a regulated mark-up of 2–3%. They are also responsible for power supply to residential customers at regulated tariffs set by local authorities. ISCs, instead, basically provide supply for large consumers equipped with hourly consumption metering devices.

Escape of small and medium end-users from their SLRs is rare due to the lack of technical solutions to start the switching procedure. SLRs continue to supply an absolute majority of the retail end-users.

Local and municipal distribution network companies manage distribution networks in their regions and provide the network connection of the end-users. Local authorities define the Regulatory Asset Base tariffs of the distribution services for three or five years ahead. The distribution fee is identical for the end-users supplied at the same voltage level regardless of their location.

5. Scanning for the future – Case: European electricity markets

In the project *Vision for European Electricity Markets 2030*, the target was to create a vision for European electricity markets in year 2030. To form the vision, the prospects of the electricity markets were scanned in different interest group meetings and workshops. The utilised working methods were scenario work, an innovation session using electronic GDSS (Group Decision Support System) and Delphi survey.

5.1 Scenarios of electricity markets in 2030

In the beginning of project, a two stage scenario process was carried out. The first part consisted of a scenario workshop, which was organised for a number of Finnish electricity market specialists, many of whom also had wide experience of working in international context. The second part consisted of the testing of the scenarios for credibility, desirability and probability. The testing was carried out as an electronic survey. The result of the scenario process was four different scenarios of the development of electricity markets.

5.1.1 Forming the scenarios

In the first stage of the scenario process, a one-day meeting session was arranged for a group of experts in the electricity markets. The target was to recognise and identify factors that direct the development of the electricity markets, and to assess their significance in the market model applied in the market. It was assumed that the key factors affecting the operation of the market are the way in which a balance between generation and consumption is found and what are the opportunities to promote competitiveness by extending the market. As a result of the scenario work, four different scenarios of the future electricity markets were produced. A summary of the scenarios is presented in Figure 8. The detailed descriptions of the scenarios are provided in Appendix 1.

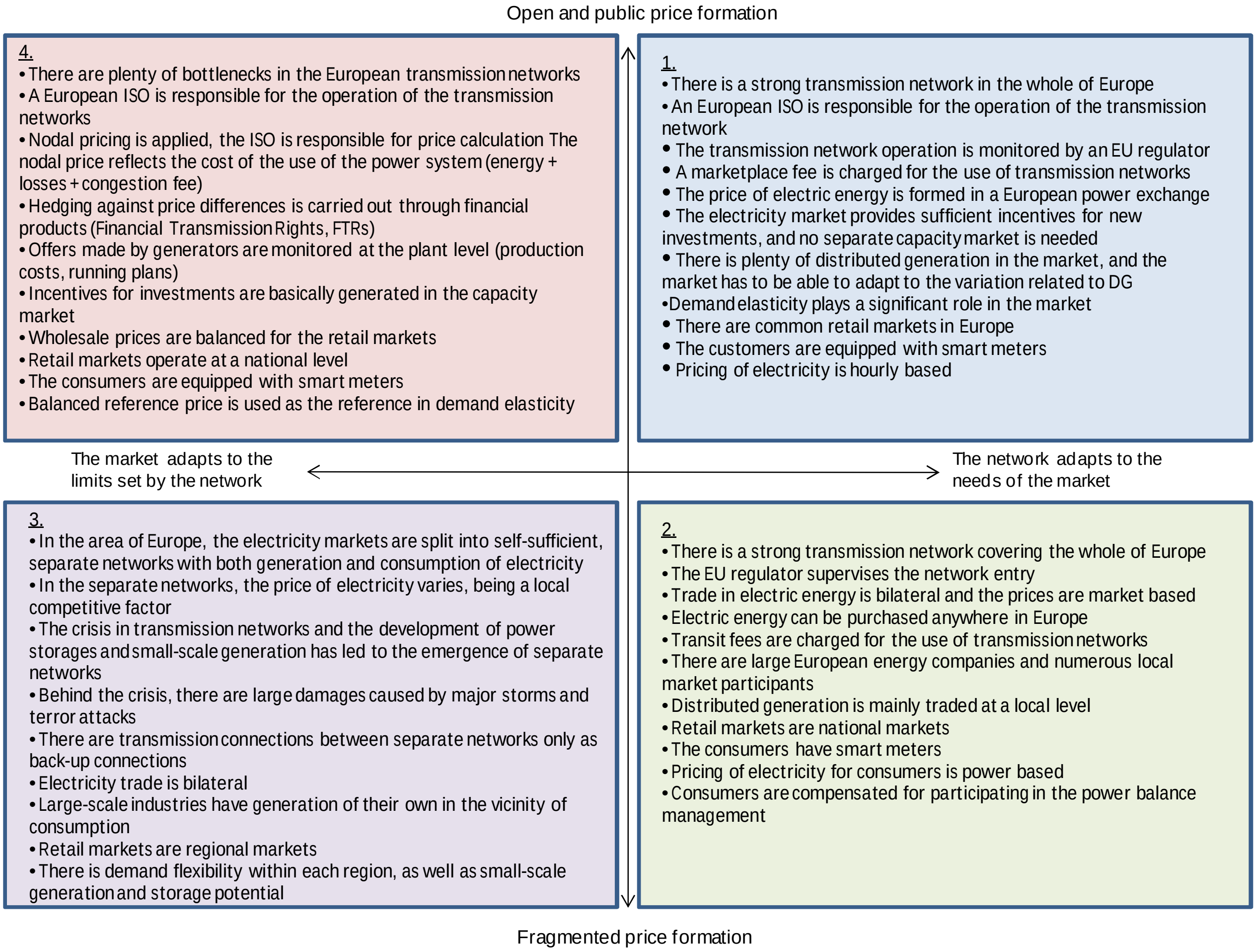

Figure 8 Graphic presentation of the scenarios.

In the vertical scenario axis, one extreme is the situation where public, open price formation plays a key role in the balancing of generation and consumption. In the other extreme, the trading is based on bilateral contracts only. Consequently, there is no centralised price formation in the market, and the market participants have no public information available about the system state (power balance).

In the horizontal scenario axis, one extreme is the situation in which the transmission network is, at all times, capable of transmitting power from generation to consumption according to the demand. At the other extreme, the transmission network does not enable free power flow, the market have to adapt to the network constraints. In the latter case, the actual market size may be significantly smaller than what the geographical size would suggest.

5.1.2 Scenario survey

In the second stage of the scenario process, the credibility, desirability and probability of the scenarios were assessed by a questionnaire survey among experts in the field. In addition to the evaluation of the scenarios, the experts were asked to assess the significance of the factors affecting the development of the electricity markets and the probability of realisation of these factors.

The survey was carried out using an electric questionnaire, which was sent to 43 persons. The response rate was 65 % (28 respondents). The respondents represented the following stakeholders: energy companies (12); electricity end-users (4); and researchers, authorities and others (12). The responses were given and analysed anonymously. Summary of the results is in the Appendix 2. Figure 9 presents the proportions of the respondents in each scenario. All the scenarios were considered possible.

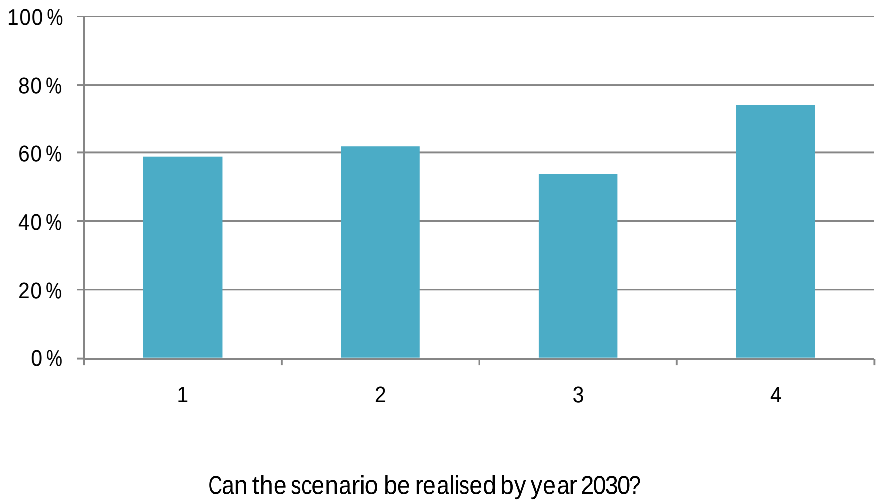

Figure 9 Realisation of the scenario by 2030.

Uniform and binding rules for the development of transmission networks were seen as the most focal factor affecting the future of electricity markets. Inability to solve the problems concerning the transmission congestion is a threat for common European electricity markets. Harmonizing the trading practices and the price calculation algorithms were also considered challenging but the solutions were believed to be found.

The overall results of the scenario survey are on the Appendix 2.

5.2 GDSS-innovation

The results of scenario process were used as source information for controlled electronic innovation session carried out in Lappeenranta University of Lappeenranta in GDSS-laboratory (Group Decision Support System). A selected group of Finnish electricity market specialists with in-depth knowledge about Nordic and European electricity markets took part in the innovation session. The key target was to identify tools and actions to promote competition in the electricity market and to assess the effects of these actions and the time required. The participants were strongly involved in the development of the Nordic and European electricity markets. The main result of the workshop was the extensive list of factors affecting competition in the electricity markets.

The innovation session proceeded as follows. First, there was a brainstorming session where the participants listed factors affecting competition in the market. Total number of ideas was 144. Second, the ideas were discussed and grouped into categories. The grouping was decided by the participants and the categories were concluded to be the following: market regulation, market information, demand elasticity, transmission network investments, energy policy, obstacles to market entry, market access and threats posed by competition. Finally, there was a vote on the significance of the ideas for competition.

The ideas generated in the GDSS-innovation provided a starting point for an international Delphi survey that aimed to selected group of European electricity market specialists. The objective of the survey was to assess the effects of various factors on competition in electricity markets.

5.3 Delphi survey

In the Delphi method, the objectives are to forecast the future development, to determine the desirable development trends and to find out how the future development can be influenced. In the research project *Vision for European Electricity Market in 2030*, the Delphi method was exploited to find out the factors affecting competition and implementation of competition in the European electricity markets. Respondents of the survey presented European electricity market professionals.

The Delphi survey was conducted in two rounds. On the first round, 15 different European countries was mentioned as working country of respondents. The respond rates of the questionnaires were 51.7 % (the 1st round) and 86.7 % (the 2nd round). Results for all questions are in the Appendix 3.

Delphi survey, Round 1

The main result of the first round was the outlook of the essential elements influencing competition and future development of the European electricity markets. The questions on the first round were concerning transmission networks, electricity trade, antitrust policy, generation investments and demand flexibility. The respondents assessed these themes on historical and future viewpoints and as well as significance to the functioning of competition and likelihood.

On historical viewpoint, the one of the most critical issues was that "lengthy permitting procedures related to building of transmission lines result in significant delays in putting the investments plans into practice". Also, it was considered important that "transmission capacity is allocated in a market-based method". The importance of both claims was also seen to increase in future. Close co-operation of power exchanges, harmonized algorithms for day-ahead calculation and harmonized intraday principles were seen very significant to the functioning of competition. It was also seen that these issues are likely to come true.

Delphi survey, Round 2

The results of the first round were exploited on the second round. The goal of the second round was to find out the possibilities of influencing some factors that play a role in creating competitive environment in electricity markets. The questionnaire was sent to the persons who answered to the first round.

In the first round, the transmission networks had been concluded critical for developing the common European electricity markets. On the second round of the Delphi survey, the respondents suggested the ways to promote intra- and inter-regional transmission network investments. The suggested methods included, for example: regulatory co-operation and legislation, separation of transmission ownership and operation, terminating the bottleneck revenues, merchant lines, stronger role of ACER, easier permitting procedures, and TSOs' obligation to pay for the congestion.

According to the respondents of the second Delphi round, deeper cooperation in developing the European transmission networks could be achieved, if, for example, regulatory processes will be harmonized, system operations will be centralized to one System Operator or the permitting procedures for new transmission lines will be faster.

Small price areas were generally viewed as a problem for the competition. Especially, low market liquidity, market power abuse and investment risks were seen problematic. On the other hand, some respondents saw that small price areas could also effectively signal about the correct locations for the investments.

The respondents saw that there could be one power exchange in year 2030, Figure 10. However, the respondents also commented that a couple of exchanges with close co-operation might be an alternative outcome.

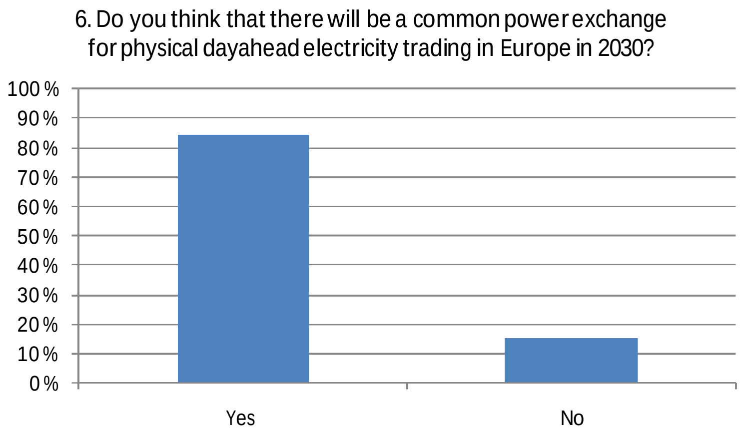

Figure 10 Delphi survey, power exchange.

When asked about the need for separate capacity markets, the respondents viewed that the energy-only markets would be likely to guarantee adequate revenues to electricity generators, Figure 11.

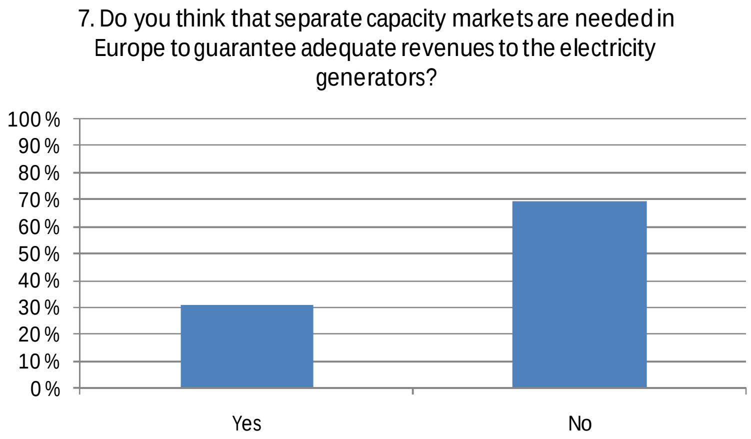

Figure 11 Delphi survey, capacity markets.

Storing electricity economically in large quantities might be the wild card in the electricity markets. The impacts to the markets could be, for instance: reduced volatility of electricity prices and the easier penetration of RES.

6. Vision for European Electricity Markets in 2030

The goals of the electricity market deregulation are often generic: to reduce the government involvement in the electricity supply sector, to introduce competition in electricity generation and selling, and to increase the demand side participation. However, the resulting deregulated electricity markets diverge with respect to the level of coordination in the markets, as illustrated in the Figure 12.

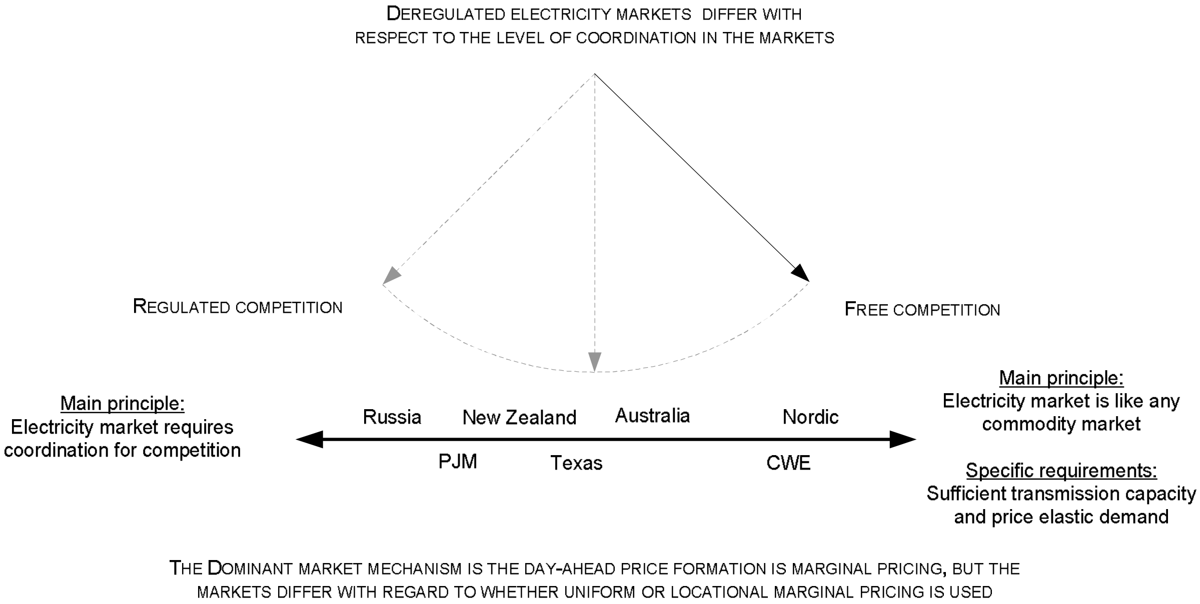

Figure 12 Divergence of electricity markets with respect to the level of coordination in the markets.

According to the free competition school of thought, the main principle is that the electricity markets are like any other commodity markets. In the regulated competition school of thought, in contrast, the main principle is that the electricity markets require coordination for competition.

The specific requirements for free competition to work in electricity markets are the existence of sufficient amount of transmission capacity in the market and the elasticity of demand with respect to price. The latter requirement means that the demand side is expected to signal its willingness to pay for electricity in the day-ahead markets, thus playing an essential role in the price formation. Under regulated competition, on the other hand, the demand side participation can be rather weak. For instance, in the day-ahead price formation, the demand may be taken as forecasted, ignoring the demand's willingness to pay. Regulated competition is often the only solution if the transmission networks do not enable free competition. However, it is a characteristic of regulation that it only mimics competition in the absence of the actual forces of competition. Regulation itself is also not without problems since it easily hinders the dynamic development of the markets.

6.1 Forming the vision

The *Vision for European Electricity Markets in 2030* is constructed following the logics of free competition school of thought. The vision views workable competition as a key to efficient operation of the electricity markets that would benefit both the supply side and the demand side, although it is acknowledged that workable competition in electricity markets is not always easily achieved or maintained. For instance, obtaining sufficient transmission capacity and activating the demand side are extremely challenging goals in future electricity markets. However, giving up these goals would contradict with the initial objectives of the electricity market deregulation and the heavy-handed regulation that would follow from giving up free competition would threaten the dynamic development of the markets.

In addition to striving for workable competition, the vision enables achieving the EU's goal of internal market in electricity. The vision also honors the objective that there are no structural entry barriers to renewable generation, thus supporting the energy-efficient, low-carbon future of the electricity supply sector.

The vision views electricity networks as enablers. In the wholesale markets, this means that the transmission constraints do not hamper the operation of the markets. In the retail markets, the distribution networks play a key role in ensuring that there are no technical or structural barriers that would hinder the cross-border operation of the electricity retailers.

The main characteristics of the vision are summarized in Table 5. The realization of the vision depends essentially on two things: the sufficiency of the transmission capacity and the activeness of the demand side. Table 5 also illustrates an alternative scenario for the development of the European electricity markets, which may occur if the basic requirements of the vision are not achieved.

Table 5 Characteristics of the Vision for European Electricity Markets in 2030 and the alternative scenario.

Vision for European Electricity Markets in 2030	Alternative scenario
- Large price areas and no structural bottlenecks in the transmission networks within the price areas - Uniform marginal pricing - Demand side plays a key role in limiting the price setting power of the generators - Antitrust policy efficiently applied in assessing mergers and acquisitions to prevent market concentration - No price caps in the day-head market of electricity - Price spikes are possible - Hedging against the price volatility of electric energy - Trading of financial instruments (e.g. futures, forwards, options, CfDs, FTRs) at exchange and bilaterally - 'Energy only' market provides adequate revenues to generators - No separate capacity markets needed - No structural entry barriers for market-based investments and operation of renewable generation - No technical or structural barriers to the cross-border operation of the retailers	- Heavily congested transmission networks and the existence of inter- and intra-regional bottlenecks in the transmission networks - Locational marginal pricing - Demand side participation in price formation is not obligatory - Continuous monitoring of locational market power - Pivotal suppliers' offers to the market are limited through regulation - Regulation of the suppliers' offers reduce price spikes - Hedging against locational price differences with financial transmission rights (FTRs) - FTR auctions organized by the Independent System Operator (ISO) - Feasibility tests to ensure that FTRs do not exceed physical transmission capacities - Revenue adequacy is not guaranteed through the market of electric energy - Capacity markets provide the 'missing money' to the generators - Locational price signals may constitute an entry barrier to renewable generation (but RES support mechanisms may enable entering and staying in the market) - The retail markets are mainly locational because of the locational price risks that the retailers face in the wholesale markets

The limitation of both the vision and the alternative scenario is that they assume the primary market mechanism to be the price formation of electricity in the day-head market applying marginal pricing. However, should an event or phenomena occur that would destroy this market mechanism, the markets would end up in a completely unknown situation. Such a wild card could be, for example, that the enormous penetration of intermittent generation would prevent the formation of the day-ahead prices because of the limited day-ahead supply forecasts. In other words, a lot of supply capacity would be missing from the day-ahead price formation, and the intersection of the supply and demand curves could not necessarily be determined. The lack of day-ahead market prices, in turn, would enforce notable changes in the structure of the markets because many of the operations in today's markets (and in the vision and the alternative scenario also) rely on having such price references.

6.2 Description

In the *Vision for European Electricity Markets in 2030*, the electricity market area covers the present European Union. An adequate transmission network in the electricity market area enables the equalization of the electricity price. There are few large price areas in Europe which enable competition on the electricity markets. The planning and implementation of transmission network investments play a key role in this process. Here, the starting point is the interest of the whole market area, then proceeding to land-specific plans. All TSOs are obliged to carry out investments, and the costs of those investments that benefit the entire market are allocated to the TSOs in proportion to their benefits. The regulatory models by which the operation of national TSOs is monitored are compatible with each other and the models guide to eliminate transmission bottlenecks. The efficient allocation and use of the existing transmission network capacity is ensured by implicit mechanisms both in the day-ahead and intraday trade.

In the electricity wholesale market, the price is formed freely without any price caps or price floors. The main pricing principle is the marginal pricing, which defines the merit order of generation from the lowest to the highest marginal cost of generation. In Europe, there is a single power exchange or a few power exchanges operating in close cooperation with each other, and applying a "single price coupling" mechanism in price calculation in the day-ahead market. Also the operation principles of the intraday market are harmonised. The relevant market information is available to all market participants, and credible communication of information is provided.

The price of electric energy provides a sufficient signal for new investments in generation, and no separate capacity markets or charges are required. The market entry and exit of generation are market-based. The market actors have equal access to relevant generation technologies. Permitting procedures for new generation are harmonised in Europe. Also, the intermittent generation participates in the markets in a market-based manner. There is a clear-cut global system for limiting CO_2 emissions. The electric power network provides opportunities rather than restricts the placement of new generation. There is enough balancing and reserve power capacity in the market area, and free price formation provides sufficient incentives also to remain in the market.

A common large wholesale market area also promotes the development of common retail markets. There is a harmonised retail market model in the EU, which includes for instance the customer interface processes, the principle of the data transfer and sharing mechanism and other operating principles. This enables supranational retail markets with a large number of suppliers. The price signals in the wholesale market are transmitted to the retail market, and the retail prices are not subsidised. There is a wide selection of retail products, and also the supplier can be chosen freely. The distribution networks enable competition in the retail market.

All the electricity end-users are involved in demand elasticity. Participation to the markets is fostered by providing consumers with relevant information regarding to the opportunities and sufficient level of consumer protection. Energy storages are widely adopted for instance in the form of EV batteries. Some of the households have own small-scale generation, and excess power is sold in the market in a market-based manner.

6.3 Discussion

The vision can occur if there are sufficient transmission networks and price elastic demand. The vision requires close co-operation between national/regional TSOs, and also between the TSOs and the exchanges. Sophisticated regulation is needed to guarantee new intra- and inter-regional transmission investments, and the allocation of transmission capacity is market based. The price calculation algorithms applied are preferably the same in the whole market area. Full implementation of the smart grids increases the demand side participation possibilities. The vision enables the achievement of the internal electricity market, and allows for the participation of renewable energy in electricity markets without structural entry barriers. In the Table 6, the requirements of the vision are illustrated.

Table 6 Activities and actions.

Activities	Actions
Transmission networks Ø Sufficient transmission capacity to cover large price areas in Europe Ø Market based transmission capacity allocation	ü Implementation of TYNDP, taking into account the needs of the European electricity markets ü Incentives for TSOs to reduce bottlenecks and invest in new intra- and inter- regional transmission capacity ü Easier permitting procedures for new transmission investments
Renewable energy generation Ø Reduction of CO_2 emissions	ü Sufficient transmission networks allow the entry of renewable energy generation ü RES support mechanisms do not disturb the markets
Power Exchange Ø One or few power exchange(s) in Europe	ü Single price coupling ü EU-wide shared order book and capacity management module in intraday trading
Demand side participation Ø Price elastic demand	ü Smart grid possibilities ü Storing of electricity ü Trust in the market

Inability to development the transmission networks according to needs of the markets would hinder the possibilities to achieve the vision. For instance, if the electricity markets in Europe have to be divided into smaller price areas, the possibilities of market power abuse will increase in certain areas. If price caps are implemented to limit the market power abuse, it leads to the situation in which generators are not able to earn sufficient revenues from the energy markets. The 'missing money' of the generators has to be covered with the separate capacity payments. In other words, the short term variable costs are covered the revenues from energy markets and long-term fixed costs are mainly covered with capacity payments.

7. Conclusions

The electricity markets are in the middle of the change. The European Union requires common electricity markets in Europe as a part of the single market project, increase of energy efficiency and reduction of CO_2 emissions in electricity generation and use. Also, the use of electricity will increase in the future for example in transport sector because of CO_2 limitations. The electric vehicles can be seen also as energy stores and large amount of these kinds of storages will also affect functioning of the market. Renewable electricity generation, in turn, is often intermittent (e.g. wind and sun) and the availability of the primary energy source determines the location of generation. This is a challenge to the transmission networks. It is also a challenge to the market model; the enormous share of intermittent generation may hamper the price formation in the day-ahead markets.

The *Vision for European Electricity Markets in 2030* is illustrated in this report. First, the theoretical background of electricity markets is introduced and an international overview of the electricity wholesale and retail markets is presented. The report demonstrates the typical development patterns of the electricity markets and discusses the drivers of the deregulated electricity markets. The report also presents various ways of implementing competition in electricity markets. The studied markets included: the Nordic countries and the CWE area in Europe, the PJM and Texas markets in the US, Australia, New Zealand and Russia.

During the research, information about the future development of the electricity markets was gathered through a variety of workshops and surveys targeted to the electricity market specialists. The information was utilised in forming the vision for the European electricity market in 2030.

The *Vision for European Electricity Markets in 2030* has been constructed so that it takes into account the requirements of common European electricity market, increasing RES generation and support of energy efficiency. The common European wholesale markets will also promote the European retail markets. In the vision, competition is seen as a key to efficient operation of the electricity markets that benefits both the supply and demand side. Sufficient transmission capacity and price elastic demand are of crucial importance. Sufficient transmission capacity guarantees large price areas in Europe which is important for competition, and the active demand side is essential for the functioning of the marginal pricing. Development of smart grids increases the possibilities of demand side participation, especially in the retail markets.

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Grant Read, University of Canterbury, Christchurch
Bart van Campen & Stephen Poletti, University of Auckland, Auckland

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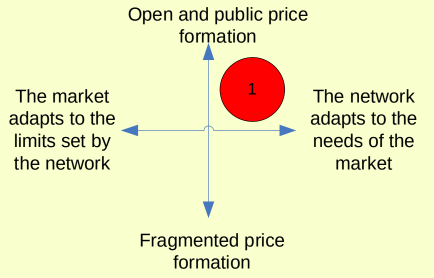
Appendix 1:

Detailed descriptions of the scenarios

The scenarios generated in the workshop of *Vision for European Electricity Markets in 2030*, supplemented by the project researchers, are described in detail below.

Scenario I "Victory march of market powers"

The boundary conditions of the scenario are: "The network adapts to the needs of the market" and "Open and public price formation." Figure A1-1 provides a summary of the scenario.



1. Victory march of market powers
- There is a strong transmission network in the whole of Europe
- An European ISO is responsible for the operation of the transmission network
- The transmission network operation is monitored by an EU regulator
- A marketplace fee is charged for the use of transmission networks
- The price of electric energy is formed in a European power exchange
- The electricity market provides sufficient incentives for new investments, and no separate capacity market is needed
- There is plenty of distributed generation in the market, and the market has to be able to adapt to the variation related to DG
- Demand elasticity plays a significant role in the market
- There are common retail markets in Europe
- The customers are equipped with smart meters
- Pricing of electricity is hourly based

Figure A1-1 "Victory march of market powers".

The long-lasting problem related to the inadequate transmission capacity in Europe was solved in the 2020s by constructing a SUPERGRID to cover the whole of Europe; this way, the development path of the internal market has finally been followed to the end. The ownership of the transmission networks is distributed among different companies. The transmission network companies together own the SUPERGRID; however, an independent, non-profit EU-ISO is in charge of the network operation. The EUR-ISO was founded as a successor to the European Network of Transmission System Operators for Electricity, which had started its operation a couple of decades earlier. Network investments are decided upon at a national level. The costs of investments benefiting the whole market are allocated to transmission network companies based on the calculations made by the EUR-ISO. The EUR-ISO is responsible for the long-term planning of investments required for the development of the electricity markets, and negotiates about the implementation of the investments with the owners. If the parties do not reach an agreement, the dispute will be brought before EUREG, the highest regulatory authority in the European electricity market. EUREG is a strong player in the European electricity market sector. The jurisdiction of EUREG crosses the national borders, and is primarily associated with the regulation of the operation and development of electricity transmission networks. The jurisdiction of national energy market authorities includes consumer affairs related to electricity retail markets.

For the electricity wholesale there is a common European physical market, the power exchange EUROPEX. The power exchange applies marginal pricing, and as a result of trading, a common European reference price is formed for electric energy. Participation in the power exchange is voluntary; nevertheless, cross-border trade is possible only in the power exchange. About ten large generators are responsible for the majority of supply in the power exchange. As a result of various support measures, there is plenty of renewable power generation around Europe, and by a common power exchange, this generation is efficiently brought to the market. In Europe, there are also aggregators, which operate by collecting distributed generation into their portfolios and offering it in the power exchange. Distributed generation is traded also outside the power exchange. As the energy subsidies have been removed, renewables are competing on equal terms with the other fuels, and they have to win out in the market-based competition. The competition authorities monitor the preconditions and realisation of competition in the electricity wholesale.

The random variation related to renewable generation has created a need for active demand elasticity, the implementation of which is technically easy, as there has been a regulation in Europe already for years according to which the customer loads have to be controllable. Demand elasticity, for its part, has calmed down the sometimes heated debate on the excessive concentration of electricity markets, as it has almost completely removed price peaks.

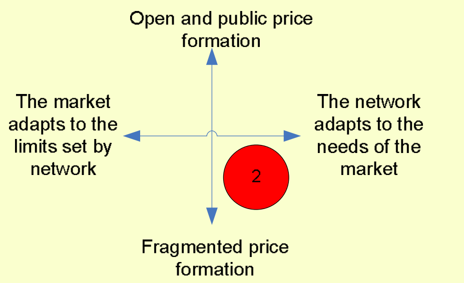
The electricity price development is expected to provide strong enough signals for new market-based investments, and incentives for new generation plants are not given in separate capacity markets. However, there is no definite evidence of the strength of the regulatory signals, as the investment phase started in the 2010s is characterized by a significant proportion of subsidy-based investments. In particular, only little back-up power is brought to the market; however, flexible demand alleviates the problem.

In the electricity retail market, the first steps in the common European market are being taken. All the customers are subject to hourly based metering, and the metering data are recorded into national databases, which have been implemented in compliance with common standards. The interfaces of the metering database are standardised, and the market participants are able to retrieve data directly from the database. The determination of obligation to deliver has been abolished. However, distribution network companies are obliged to take care of “vulnerable customers” and those customers who are not able to get offers from competitive markets. The reference price used in these contracts is the EUROPEX balance price. The distribution companies have an obligation to buy excess electricity produced in distributed generation, should there be no other buyer available in the market. The diverse obligations of the distribution companies are explained by the fact that the authorities have good opportunities to supervise licensed distribution network operators. The pursuit of the activity of electricity sale instead does not require a licence, and the European consumers can buy electricity from any country they please. Possible disputes are brought to the European Consumer Centre, which if required, consults the authorities in the consumer's and seller's home countries.

Smart meters and hourly based pricing eventually enable demand elasticity with respect to price also in the retail market. The demand elasticity is typically carried out by switching off the customer's controllable load when a predetermined price limit is exceeded, or by shifting heating to the cheapest hours (without separate price limits). The consumers benefit financially from demand elasticity. Some of the customers also regulate their consumption themselves based on price information. A controllable load consists typically of heating/cooling load; however, also charging of EVs is gaining significance. The market penetration of EVs brings considerable elasticity potential also for those customers who have typically not had such potential before. In the areas of small distribution network companies, demand elasticity is managed by separate service providers.

Scenario II "Traders paradise"

The boundary conditions of the scenario are: " The network adapts to the needs of the market" and "Fragmented price formation." Figure A1-2 provides a summary of the scenario.



2. Traders' paradise

- There is a strong transmission network covering the whole of Europe
- The EU regulator supervises the network entry
- Trade in electric energy is bilateral and the prices are market based
- Electric energy can be purchased anywhere in Europe
- Transit fees are charged for the use of transmission networks
- There are large European energy companies and numerous local market participants
- Distributed generation is mainly traded at a local level
- Retail markets are national markets
- The consumers have smart meters
- Pricing of electricity for consumers is power based
- Consumers are compensated for participating in the power balance management

Figure A1-2 "Traders' paradise".

For historical reasons, there is a strong electricity transmission network in Europe, which in practice does not limit transmission of electricity across and between different regions in Europe. Transmission network operators are national actors, which, however, participate in international cooperation in the transmission network development across national borders. In order to establish internal markets for electricity, substantial sums of money were invested in the development of transmission networks in different parts of Europe in the 2010s. At the same time, also a common physical market was being developed for electric energy. Nevertheless, mutual understanding on which of the existing power exchanges would be responsible for the price calculation in the integrated market was not found. As a solution, it was suggested that a completely new European power exchange should be established; this idea, however, was not supported. Consequently, a common physical market was finally created by maintaining the existing regional power exchanges and establishing a separate organisation to optimise the power transmission between the regions. However, optimisation of the transmission volumes proved extremely difficult because of multiple transmission connections between the unified regions. The cross-border connections (lines) were constantly underutilised, which attracted severe criticism. Problems in centralised price calculation caused delays in the operation of regional power exchanges. Constant problems were not in favour of the liquidity of regional power exchanges, which was at a low level already. Eventually, in order to put the transmission connections into efficient use, bilateral trade was permitted on all cross-border transmission connections in Europe. This was the final nail into the coffin of centralised price calculation. Simultaneously, also the desire to develop a common marketplace for physical electricity trade faded out and bilateral trading became the common practice in the field.

Bilateral trade is permitted in the whole of Europe. The price of electricity is formed under market conditions (based on offers). The price for transmission is determined based on the geographical distance between the buyer and the seller (transit fees for the use of different networks). The largest participants in the electricity market are profoundly international actors, the domestic market of which encompasses the entire Europe. There is also room for local actors in the market; distributed generation being a typical example of these. Also industry has plenty of local, own generation.

Plenty of distributed generation has been built around Europe, as connection to the network is inexpensive and easy. There are also aggregators in the market that manage the trade in distributed generation in different areas. The reasonableness of transmission charges is guaranteed by regulation, which is implemented by an energy regulator operating in the whole of Europe.

The electricity retail markets in Europe are national markets. The contracts are typically made on a long-term basis. As there is no public hourly reference price, dynamics in pricing is generated by power tariffs. All customers are equipped with hourly read energy meters, which can also be controlled. The consumers may also participate in the power balance management by agreeing to load control when required by the system. The consumers are compensated for participation in the system regulation.

Scenario III ”Heyday of localisation”

The boundary conditions of the scenario are: ”The market adapts to the limits set by the network” and ”Fragmented price formation.” Figure A1-3 provides a summary of the scenario.

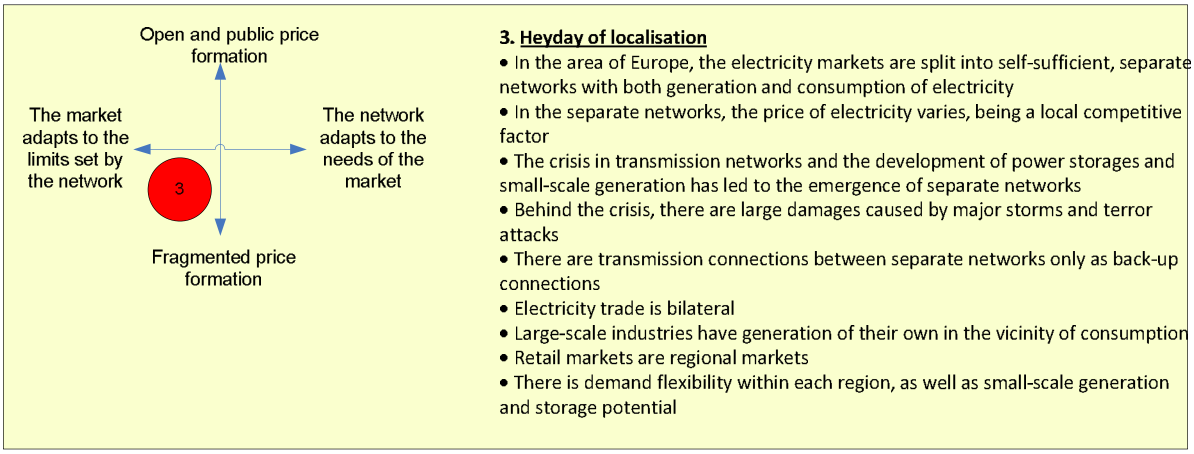


Figure A1-3 "Heyday of localisation".

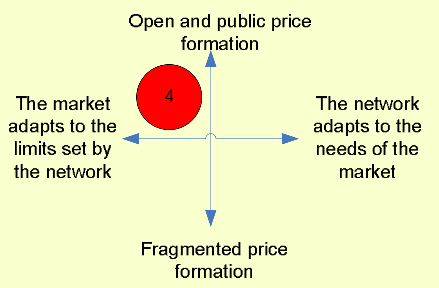
The market is split into local, self-sufficient separate networks with both generation and consumption of electricity. The large-scale problems in the European transmission networks, caused by large storms and other exceptional weather phenomena (e.g. snow loads) and terror attacks on power systems have led to the development of separate networks. The crisis in the European transmission networks showed the vulnerability of a centralised power system. Along with the development of power storages and distributed, small-scale generation, expensive network investments were no longer considered absolutely necessary for the availability of power, but local, separate networks were introduced in many areas.

The transmission connections between the regions are used only as back-up connections, and no actual trade across the regions takes place. If there is trade between the regions, a fixed reservation for the transmission connection is required, and there is no aftermarket available. Trade inside the region is bilateral. Large-scale industry has generation of its own close to the consumption, as there may be situations where there is not enough generation for the needs of the large-scale industry. In the regions with separate networks, the price of electricity may be a competitive factor to attract new enterprises and consumers to the area.

Retail markets operate regionally so that there is one or a few retailer(s) with an obligation to supply in the network area. Small-scale generation plants are allowed to connect to the network. Within the region, demand elasticity takes place with respect to price. In some regions, the power storage potential is already in use for instance in the form of batteries of EVs.

Scenario IV "Regulated competition"

The boundary conditions of the scenario are: "The market adapts to the limits set by the network" and "Open and public price formation." Figure A1-4 provides a summary of the scenario.



4. Regulated competition

- There are plenty of bottlenecks in the European transmission networks
- A European ISO is responsible for the operation of the transmission networks
- Nodal pricing is applied, the ISO is responsible for price calculation
- The nodal price reflects the cost of the use of the power system (energy + losses + congestion fee)
- Hedging against price differences is carried out through financial products (Financial Transmission Rights, FTRs)
- Offers made by generators are monitored at the plant level (production costs, running plans)
- Incentives for investments are basically generated in the capacity market
- Wholesale prices are balanced for the retail markets
- Retail markets operate at a national level
- The consumers are equipped with smart meters
- Balanced reference price is used as the reference in demand elasticity

Figure A1-4 "Regulated competition".

The objectives set for the reinforcements of the transmission network in Europe were not met as there was simply not enough room for new transmission lines. Hence, in the 2020s, the European Network of Transmission System Operators for Electricity was charged also with the operation of the transmission networks in the whole of Europe, and the organisation became a non-profit EUR-ISO. The EUR-ISO is in charge of the transmission system management and calculation of the price of electricity. Price calculation is based on the power flow calculation; in other words, a nodal pricing method is applied. The ownership of the transmission networks is distributed. Long-term investment plans are made by the EUR-ISO. The owners of the transmission networks are responsible for the implementation of investments.

Electricity retail markets are organised by the EUR-ISO, and additionally, there is plenty of bilateral trade between nodes. Bilateral trades between nodes have always to be notified to the EUR-ISO, which controls their compatibility with the plans for generation and network use. Trading through the EUR-ISO takes place in the day-ahead and balance market. The price for electricity is calculated for the nodes with generation or consumption in the network. The price is formed as a sum of the cost of energy, physical losses and congestion fees. There are about 15 000 nodes in Europe. Some of the transmission connections are highly congested, and thus, the costs caused by congestions are managed by FTRs. Financial Transmission Rights are bought and sold in auctions for varying periods (quarter-year, half-year, year). Although FTRs are financial products, also physical transmission constraints are taken into account in the assignment of FTRs.

Market regulation plays a significant role in this scenario, as there is a high risk of the exercise of market power. A separate organisation EUREG is responsible for market regulation. Market regulation is performed on an *ex ante* basis, where the bids of each generation plant are directly monitored and limited if abuse of market power is detected. As a result, some price peaks that would provide essential signals for the new generation investments are cut off, and separate capacity markets are required. Hence, a retailer may acquire capacity rights, and the generator has an obligation to cover the rights.

Retail markets are national markets. Nodal prices in the wholesale markets are balanced for the retail markets so that the consumers would not be in an unequal position because of nodal prices. By balancing the wholesale market price, a common reference price is formed, where all changes in the wholesale prices are not fully taken into account. The consumers have smart meters, and they are ready for demand elasticity, as it may be compensated in money. Demand elasticity is carried out for instance by switching off a controllable load when the balanced wholesale price exceeds a certain predetermined price level.

Small-scale generation may enter the market if the network allows it, and the distribution network company is obliged to buy the small-scale generation unless there is no other market for the power.

Appendix 2:

The aim of the survey was to determine those scenarios that could be used as a basis for the electricity market vision. The objectives of the survey were

- to assess the consistency and realisation of the scenario by 2030.
- to select the most likely, most desirable and the worst-case scenario.
- to assess the probability and significance of the factors affecting the development of the electricity markets.

Consistency and realisation of the scenarios

The respondents were asked to assess the consistency of the scenarios. Most of the respondents considered all the scenarios to be consistent.

In addition to consistency, the respondents assessed the probability of the realisation of the scenarios by 2030.

Some of the respondents did not believe in the realisation of the scenarios, at least not by 2030. In the case of the scenarios ”Victory march of market powers (1)” and ”Traders’ paradise (2)”, the lack of network investments was considered the most serious obstacle to the scenario. If investments are not made even at present, how could a strong transmission network covering the whole of Europe be accomplished by 2030?

In the scenario ”Traders’ paradise (2)”, the use of transit fees was considered an inefficient solution. As the power exchanges already operate across national borders, it was considered incredible that this development trend would end completely.

The third scenario ”Heyday of localisation (3)” was considered the most unlikely alternative, as it was against the current development trend. A crisis in transmission networks was not considered likely; nevertheless, construction of transmission networks may simply become too expensive and the licensing processes too complicated to allow an increase in the transmission network volume. Moreover, the citizens may oppose the construction of new transmission networks. The significance of local activities may be emphasised if plenty of distributed generation is connected to the network, and the generators want to sell the power directly to their neighbours or members of their own community.

In the fourth scenario ”Regulated competition (4)”, it was considered incredible by some of the respondents that bottlenecks in the European transmission network could not be removed completely or at least to a large degree by 2030. Changing over to the nodal pricing would be against the idea of the internal EU market, and it would also be disadvantageous to the operation and transparency of the wholesale markets.

Table 7 summarises the respondents’ comments on each scenario.

Table A2-1 Summary of the respondents' comments.

1 Victory march of market powers	• Scarcity of transmission network investments; not enough investments even at present – how can sufficient investments be guaranteed to establish a Supergrid by 2030 • Establishing a Supergrid may prove impossible; area prices required
2 Traders' paradise	• Scarcity of transmission network investments is a problem even at present • Transit fees are an inefficient solution • The unification process of the power exchanges is not likely to stop • The requirements for more efficient markets would result in the re-establishment of power exchanges, should the situation of bilateral contracts prevail
3 Heyday of localisation	• A remote alternative, as it deviates considerably from the current trend • A transmission network crisis is unlikely, yet the network construction may become too expensive and the licensing process too complicated to allow new investments • If this scenario came true, so many other undesirable things would also have happened that the development of the electricity markets would be only a minor problem • The significance of local activities may be emphasised if plenty of distributed generation is brought to the network, and the generators want to sell the power to their neighbours or their own community • Energy storages and demand elasticity may reduce the need for transmission networks; on the other hand, variable generation requires a strong and extensive network, in which case the fragmented markets would reduce the efficiency • Storage and small-scale generation methods will not develop enough by 2030
4 Regulated competition	• It is incredible that the bottleneck problems in Europe will not be solved by 2030 • EUR-ISO, in which pricing and investment decisions are made separately, is an unlikely alternative • Changing over to nodal pricing would mean shifting away from the idea of an internal EU market • Nodal pricing hampers the operation and transparency of the wholesale markets

Comparison of scenarios

The respondents were also asked to choose the most likely, desirable and the worst-case scenario. All the scenarios got some answers to the question of the most likely scenario; Figure A2-1. However, the scenario "Victory march of market powers" received the largest number, 50 %, of all answers. The scenario "Heyday of localisation" was considered the least likely scenario.

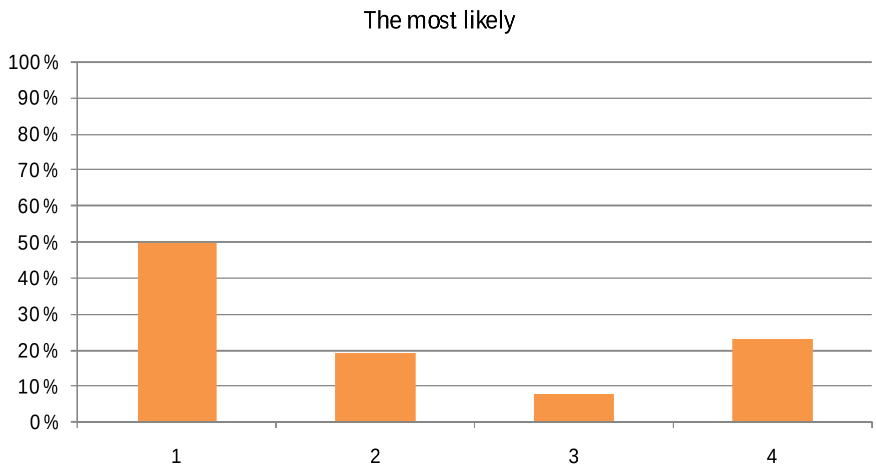


Figure A2-1 The most likely scenario.

The scenario ”Victory march of market powers” was clearly the most desirable alternative, and the other scenarios got only a few hits, Figure A2-1. The scenario ”Victory march of market powers” was closest to the present market development in the Nordic countries, which partly explains its desirability among the respondents.

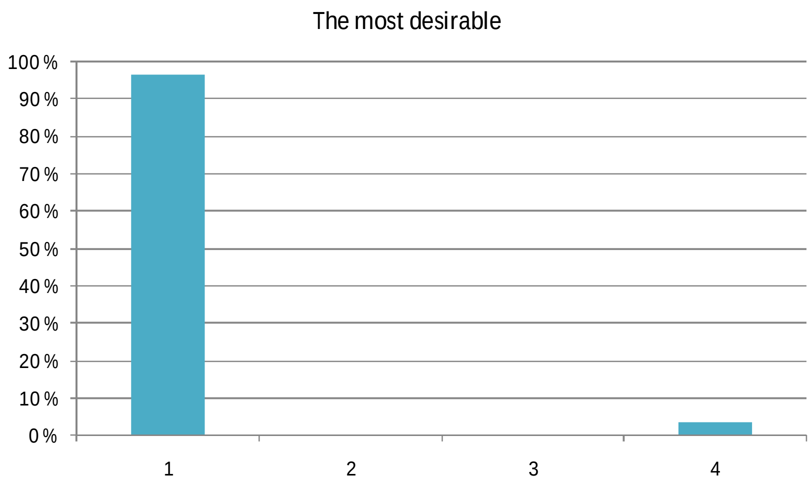


Figure A2-2 The most desirable scenario.

Both the scenarios ”Heyday of localisation” and ”Regulated competition” were considered the worst alternatives, Figure A2-3. Also the scenario ”Traders' paradise” was considered the worst alternative by some respondents.

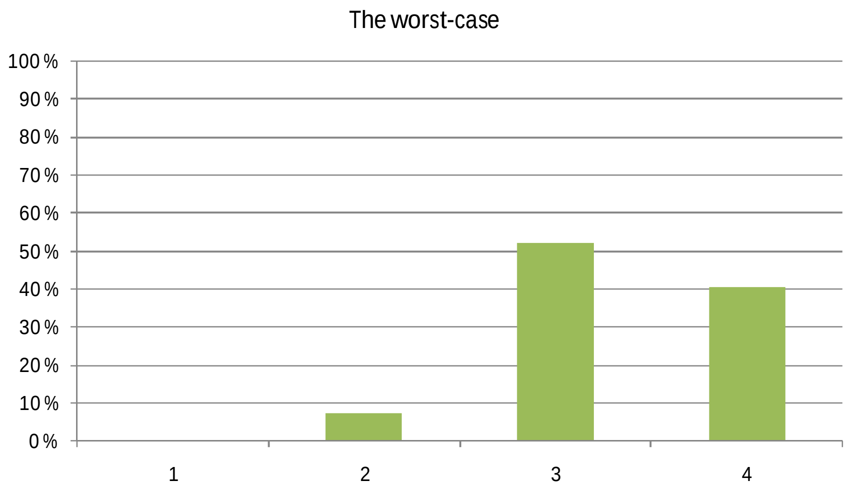
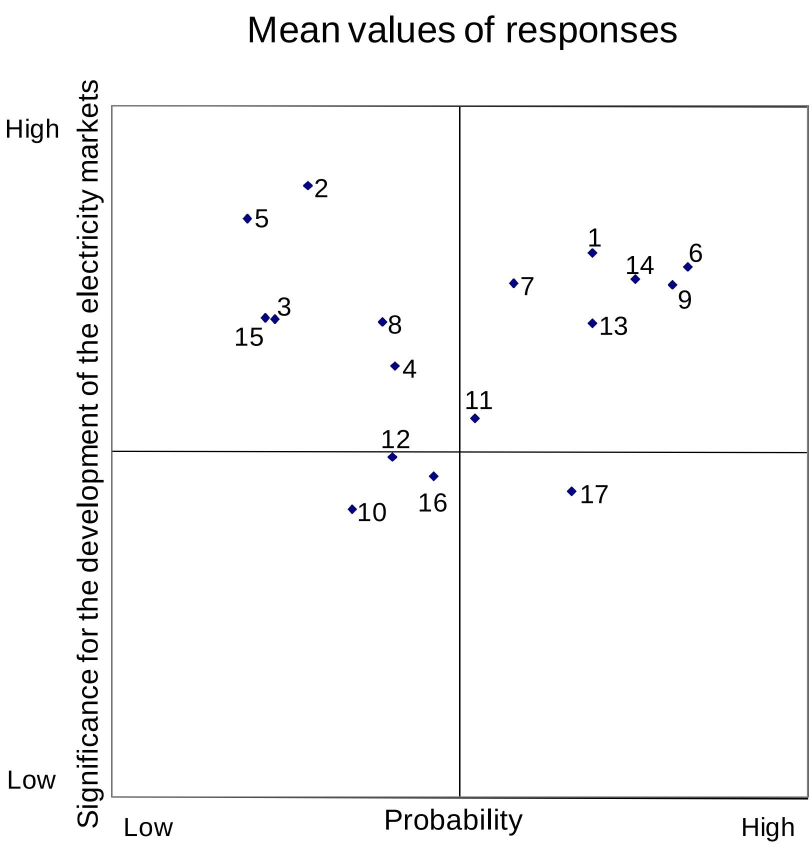


Figure A2-3 The worst-case scenario.

Factors directing the development of the electricity markets

The last task in the questionnaire was to assess the validity and significance of various statements for the development of the electricity markets, and whether these statements could become reality by 2030. The statements to be assessed and their position in the fourfold table is presented in Figure A2-4.



1. Bottlenecks in the transmission network prevent the formation of a uniform market area.
2. Confidence in the stock market price collapses.
3. The consumers are nearly self-sufficient in energy.
4. Nearly all the consumers have an energy storage of their own (e.g. an electric vehicle)
5. The collapse of the centralised system will lead to the formation of separate, independent networks.
6. There is plenty of variable generation.
7. A European power exchange is established.
8. A common European transmission network operator is established.
9. Supranational regulation at the EU level increases.
10. Electricity trade is concentrated mainly among other than energy companies.
11. Electricity generation is concentrated mainly among large European companies.
12. The market shares vary rapidly in electricity sales.
13. The consumers adopt the price of electricity as a factor guiding their electricity use.
14. The tightening environmental requirements hinder the construction of new power plants and transmission lines.
15. New innovations lead to shrinking costs in electricity generation.
16. The proportion of energy expenses of the income available increases substantially.
17. The social structure becomes tighter.

Figure A2-4 Statements to be assessed and their average position.

An increase in the variable generation is considered very likely, and its significance high. It was also considered very likely and highly significant that the volume of variable generation will increase. Similarly, the collapse of confidence in the stock market price was found very significant for the development of the electricity markets; however, this alternative was not considered very likely. Also the effects of the collapse of the centralised system and the formation of separate, independent networks would be significant for the market, yet this scenario was considered unlikely.

The expansion of the end-users' own energy storages was not considered very likely. This, however, does not mean that such storages could not become more popular later in the future; in the survey, the respondents were asked to assess the realisation of the statements by 2030 only.

In the following, the answers to certain statements are analysed in more detail. Here, we have selected statements that are essential for the realisation of different scenarios. As to some of the statements, we can clearly see that the respondents consider the development trend as an already existing one, as the most hits are found in the categories of high probability and high significance. On the other hand, some statements are considered unlikely, but highly significant. Statements of this kind have to be observed with care; although not being expected to become reality, they would have a significant impact on the market model if they came true. In some cases there is high variation in the answers, indicating plenty of uncertainty in these statements.

Answers to the statement "Bottlenecks in the transmission network prevent the formation of a uniform market area" and "A common European power exchange is established" are illustrated in Figure A2-5.

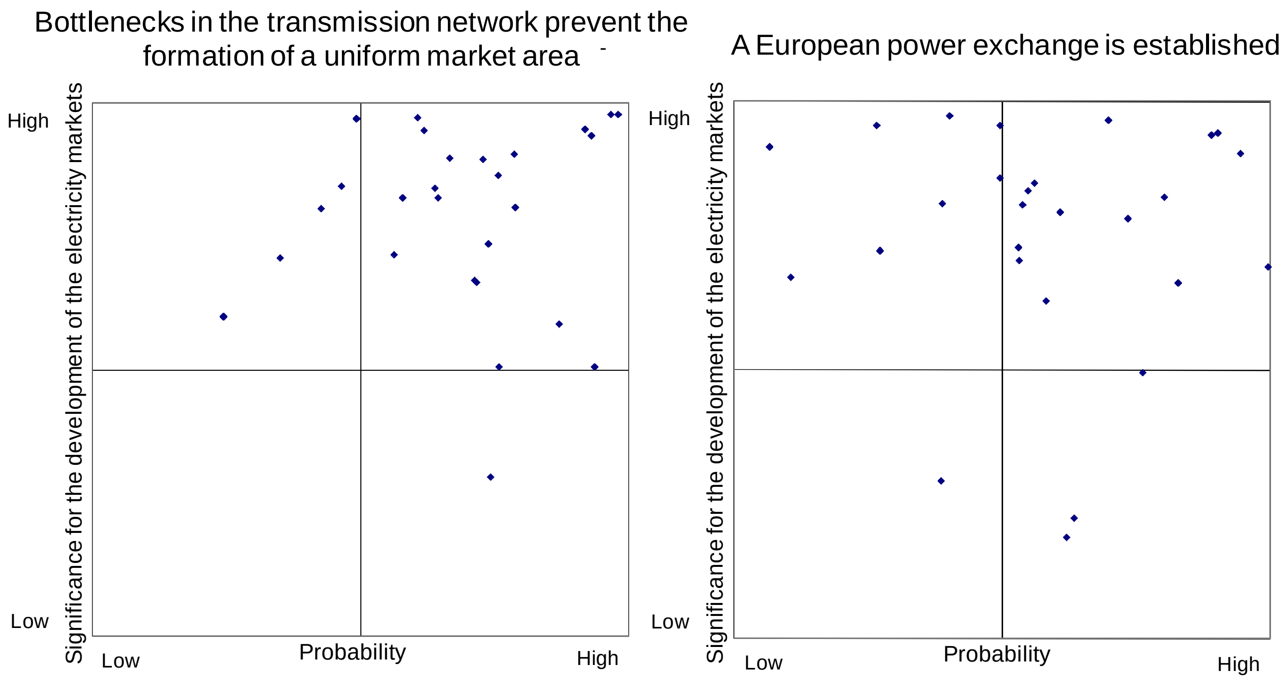


Figure A2-5 Answers to the statements " Bottlenecks in the transmission network prevent the formation of a uniform market area" and "A common European power exchange is established."

In Figure A2-5, the statement "Bottlenecks in the transmission network prevent the formation of a uniform market area" is of particular significance for the realisation of the scenario "Victory march of market powers". Most of the respondents considered this scenario both desirable and the most likely one, yet many found it also likely and significant that the bottlenecks in transmission networks prevent the formation of a uniform market area. Also the statement "A common European power exchange is established" was significant for the first scenario. However, there is more divergence in the answers to this statement, and thus, part of the respondents do not consider a European power exchange very likely, even though a common power exchange may, to some extent, promote the establishment of a common market area.

Figure A2-6 presents the answers to the statements "The collapse of the centralised system will lead to formation of separate, independent networks" and "There is plenty of variable generation."

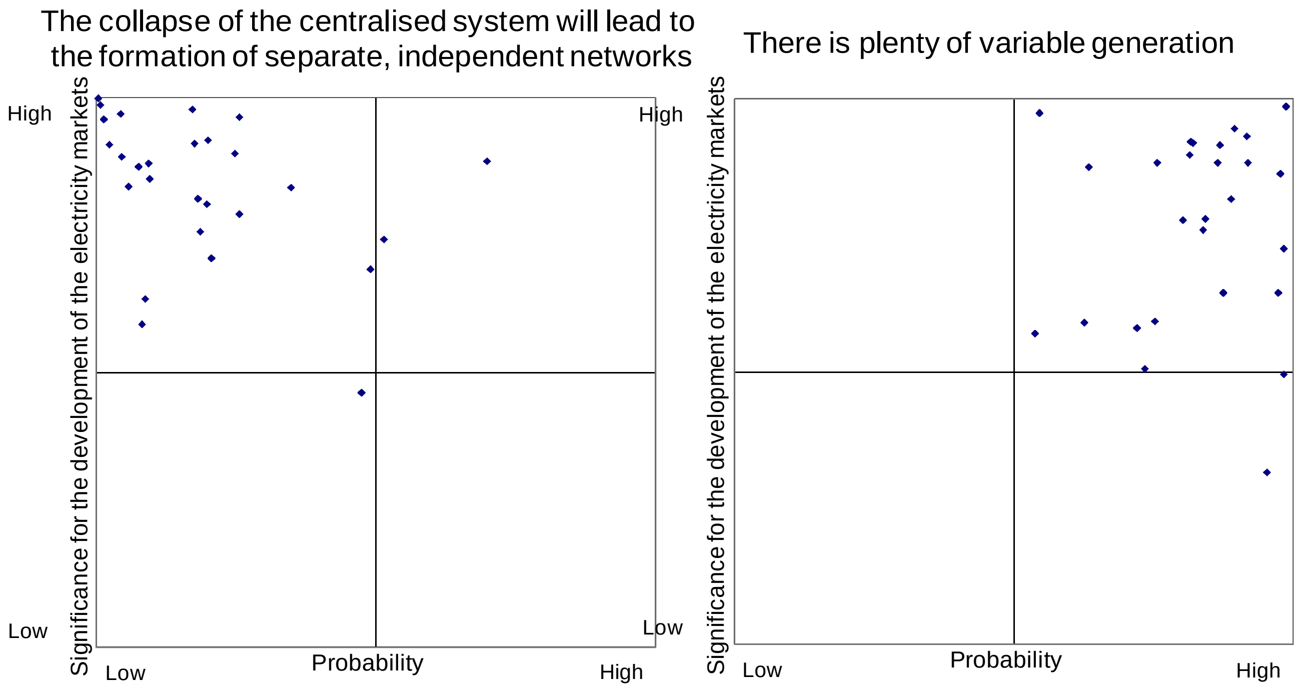


Figure A2-6 Answers to the statement "The collapse of the centralised system will lead to formation of separate, independent networks" and “There is plenty of variable generation.”

The statements in Figure A2-6 are both considered very significant to the development of the electricity markets. According to the respondents, an increase in variable generation is very likely. Considerations on the variable generation are highly topical also in the public debate at the moment. The collapse of the centralised system was not considered likely; however, should something like this happen, it would lead to the scenario ”Heyday of localisation”, which essentially diverges from the current development trend.

The answers to the statement ”A common European transmission network operator is established” are illustrated in Figure A2-7.

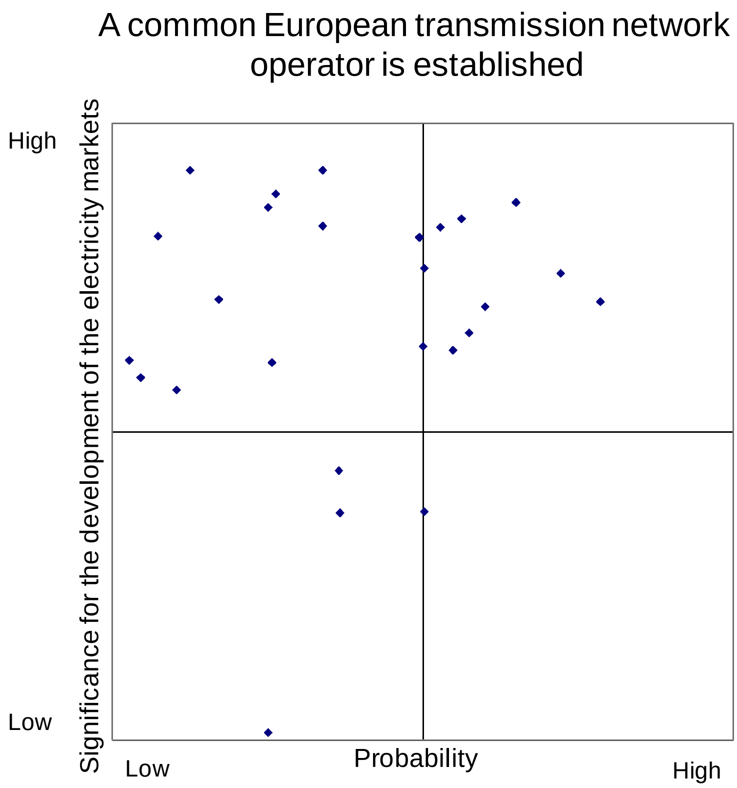


Figure A2-7 Answers to the statement "A common European transmission network operator is established."

The establishment of a common European transmission network operator was considered significant for the development of the electricity markets. However, the probability of the establishment of a common transmission network operator is lower than that of the common European power exchange. The operation of transmission networks is expected to remain national more probably than the operation of power exchanges. In the power exchanges, the cooperation has maybe been more evident so far.

Appendix 3:

Delphi survey, Round 1

On the first round of Delphi enquiry, the respondents were asked to consider historical and future significance to competition on electricity markets or significance to the functioning of the competition or likelihood of the occurrence. The results of Delphi survey round 1 are presented in the tables. First there are the specific question and the grading system for each question type, and after that the average answers for each claim are shown. The response rate of the questionnaire was 51.7 % and the respondents represented different countries of Europe.

1.1 Please assess the historical and future significance of the following claims to the functioning of competition in the European electricity markets.

Table A3-1 Delphi survey, historical and future significance.

Electricity transmission network as a market place, historical significance	Electricity transmission network as a market place, future significance to competition
1 = very important	1 = greatly increasing in importance
2 = important	2 = increasing in importance
3 = marginally important	3 = remaining the same importance
4 = unimportant	4 = decreasing in importance
5 = not a factor	5 = no longer a factor

Historical	Future	Claim
1,967	2,033	Bottlenecks in the electricity transmission network prevent the formation of a single uniform market area.
2,893	2,321	Transmission congestion leads to re scheduling of generation after day-ahead trading.
2,464	2,25	There is no compelling obligation to use congestions rents to remove transmission bottlenecks.
1,963	1,815	Transmission capacity is allocated in a market-based method.
2,207	3,69	Electricity generation and transmission are vertically integrated.
2,433	3,467	Market actors do not have equal access to networks.
1,833	1,767	Lengthy permitting procedures related to building of transmission lines result in significant delays in putting the investment plans into practice.
2,233	2,2	The permitting procedures related to building of transmission lines involve several different permitting authorities (e.g. land-use and environmental planning authorities and other regional or local authorities).
2,586	2,586	Economic regulation does not sufficiently reward investments in transmission networks.

1.2 Please assess the significance of the following claims to the functioning of competition in the European electricity markets, and the likelihood of occurrence of the claims.

Table A3-2 Delphi survey, significance and likelihood.

Electricity transmission network as a market place, significance to the functioning competition	Electricity transmission network as a market place, likelihood of occurrence
1 = very important	1 = almost certain
2 = important	2 = likely
3 = marginally important	3 = even or 50/50 chance
4 = unimportant	4 = unlikely
5 = not a factor	5 = almost impossible

Significance	Likelihood	Claim
1,467	2,933	Electricity transmission networks in Europe are planned according to the needs of the European electricity market as a whole.
2,833	3,2	Network reinforcement costs caused by a new connection are primarily charged to the new generation connected to the network.
2,6	3,133	Network charges can be used as an instrument for directing generation according to network congestion.
1,9	3,267	The common European energy regulator (such as the Agency for the Cooperation of Energy Regulators, ACER) has competence to enforce transmission network operators to invest in removing critical network bottlenecks.
3,133	3,067	Transmission lines are increasingly being owned by private investors.
2,433	3,8	There is an independent European electricity transmission network operator.

2.1 Please assess the historical and future significance of the following claims to the functioning of competition in the European electricity markets.

Table A3-3 Delphi survey, historical and future significance.

Electricity trade, historical significance	Electricity trade, future significance to competition
1 = very important	1 = greatly increasing in importance
2 = important	2 = increasing in importance
3 = marginally important	3 = remaining the same importance
4 = unimportant	4 = decreasing in importance
5 = not a factor	5 = no longer a factor

Historical	Future	Claim
2,033	3,633	Most of physical electricity trading takes place by bilateral contracts.
2,741	2,714	It is difficult to define price zones that have no internal network congestions.
2,75	2,5	Intra-zonal network congestions create pressure to introduce smaller and smaller price zones.
2,103	2,867	Defining the borders of prize zones is a politically sensitive issue.

2,276	3,071	The principles of intraday trading of electricity vary from one country to another.
2,172	3,1	The lack of transparency in the price formation of electricity in the day-ahead markets erodes confidence in the functioning of electricity markets.
2,133	3,233	Market actors do not have equal access to relevant market information.
3	3,6	The non-transparent operation of the power exchange reduces its liquidity.
2,867	3,633	Gas and electricity companies are vertically integrated.

2.2 Please assess the significance of the following claims to the functioning of competition in the European electricity markets, and the likelihood of occurrence of the claims.

Table A3-4 Delphi survey, significance and likelihood.

Electricity trade, significance to the functioning of competition	Electricity trade, likelihood of occurrence
1 = very important	1 = almost certain
2 = important	2 = likely
3 = marginally important	3 = even or 50/50 chance
4 = unimportant	4 = unlikely
5 = not a factor	5 = almost impossible

Significance	Likelihood	Claim
2,133	2,6	The internal electricity markets of the EU encompass all the current Member States.
1,867	2,345	The power exchanges in the EU closely cooperate with each other.
1,733	2,233	The power exchanges in the EU apply a harmonized algorithm to the calculation of the day-ahead market prices of electricity in their own areas of responsibility.
1,8	2,533	Harmonized principles are applied to the intraday trading of electricity in the EU.
1,867	1,7	The pricing mechanism in the day-ahead electricity trading is marginal pricing.

3. Please assess the significance of the following claims to the functioning of competition in the European electricity markets, and the likelihood of occurrence of the claims

Table A3-5 Delphi survey, significance and likelihood

Antitrust policy, significance to the functioning of competition	Antitrust policy, likelihood of occurrence
1 = very important	1 = almost certain
2 = important	2 = likely
3 = marginally important	3 = even or 50/50 chance
4 = unimportant	4 = unlikely
5 = not a factor	5 = almost impossible

Significance	Likelihood	Claim
1,8	2,333	Antitrust policies applied to the electricity markets in the EU are found effective by the market participants.
1,9	2,7	Antitrust policies applied to the electricity markets in the EU anticipate and respond to the special situations of the markets (e.g. tight demand –supply situations, splitting of the market into price zones).
1,6	2,567	Harmonized antitrust policies are applied to the electricity markets in the EU.

4. Please assess the significance of the following claims to the functioning of competition in the European electricity markets, and the likelihood of occurrence of the claims

Table A3-6 Delphi survey, significance and likelihood.

Incentives for generation investments, significance to the functioning of competition	Incentives for generation investments, likelihood of occurrence
1 = very important	1 = almost certain
2 = important	2 = likely
3 = marginally important	3 = even or 50/50 chance
4 = unimportant	4 = unlikely
5 = not a factor	5 = almost impossible

Significance	Likelihood	Claim
1,793	2,655	The wholesale price of electric energy is not subject to capping (excluding the technical price caps applied by power exchanges to the price calculation algorithms).
2,679	3,143	Electricity generators' offers are subject to offer caps.
3,276	2,964	Part of the investment incentives for electricity generation are created in a separate capacity market for electricity.
2,286	2,929	All market actors have equal access to relevant generation facilities.
1,536	2,571	Intermittent generation participates in the electricity markets in a market-based manner.
3,621	3,138	Adequate revenues are guaranteed for base load generation through specific capacity payments.
2	3,433	The renewable energy support schemes in the EU are harmonized.

5. Please assess the significance of the following claims to the functioning of competition in the European electricity markets, and the likelihood of occurrence of the claims.

Table A3-7 Delphi survey, significance and likelihood.

Demand flexibility, significance to the functioning of competition	Demand flexibility, likelihood of occurrence
1 = very important	1 = almost certain
2 = important	2 = likely
3 = marginally important	3 = even or 50/50 chance
4 = unimportant	4 = unlikely
5 = not a factor	5 = almost impossible

Significance	Likelihood	Claim
2,267	2,8	The loads of small consumers can be controlled according to electricity price signals to increase the demand elasticity in the electricity markets.
2,533	3,133	Storing electricity in large quantities is economically profitable.
3,2	2,867	Households also act as electricity sellers in relation to their own small scale electricity generation.
2,6	3,1	Households increasingly use spot price based contracts.

Delphi survey, Round 2

The questions of the second round of the Delphi enquiry were based on the answers of the first round. The goal of the second round was to find out the possibilities of influencing some factors that play a role in creating competitive environment in electricity markets. The questionnaire was sent to the persons who answered to the first round. The results of the survey are presented below. The response rate of the second round was 86.7 %. Remark: Only parts of the written answers are shown.

1. Do you agree with the claim that the transmission companies have no necessary incentives to build new cross-border lines because they would then lose their congestion revenues?

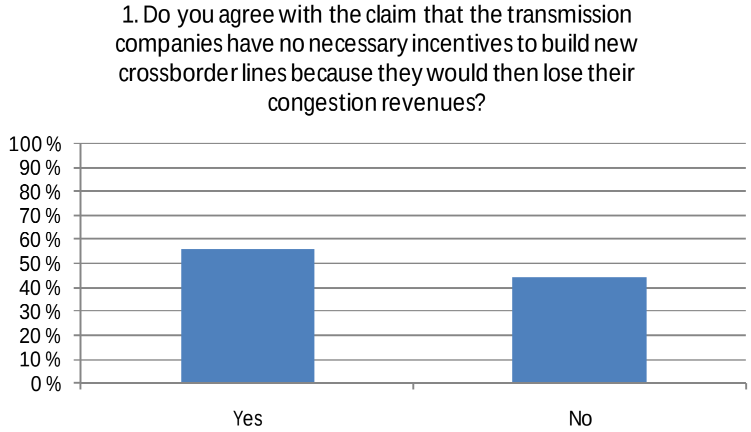


Figure A3-1 Incentives for transmission investments.

2. What do you think would be the most effective ways to promote investments in intra- and inter-regional transmission capacities (in both long term and short term)?

Summary of the answers:

- ü Separate transmission ownership from system operation
- ü More regulatory cooperation and harmonization, legislation
- ü To terminate the bottleneck revenues
- ü Allow more merchant lines
- ü ACER needs to drive the process and make sure that investments happen
- ü TSOs should be allowed to earn reasonable return on investments
- ü EU directive on simplification of national licensing etc. procedures
- ü Making it more difficult to use the option of using congestion revenue for general tariff reduction
- ü Part of the incomes will go to EU which will deliver it further to support function of the markets
- ü Common European planning of transmission investment
- ü Bottleneck income could only be used to increase transmission capacity either by investing into transmission infrastructure or by relieving bottlenecks through countertrading
- ü Make TSOs pay for the congestion by either re-dispatching or by buying back capacity from the market
- ü Clear rules that congestions shall be handled where they occur; if counter trading/re-dispatch it shall apply also cross border

3. How do you think a deeper cooperation in developing the European transmission networks could be achieved?

Summary of the answers:

- ü TYNDP defined in Regulation is a framework for cooperation if properly implemented
- ü Separation of transmission ownership from system operation
- ü By bringing system operation and system development on a European (or regional as a first step) level
- ü Faster permitting procedures and more merchant lines
- ü This should happen with the establishment of ACER and ENTSOE
- ü Merging of TSOs, pressure from Governments for deeper cooperation, closer cooperation by regulators
- ü Concentration of system operation in ISOs across borders
- ü Cross-border capacity calculation/allocation without borders
- ü Single EU wide TSO common codes
- ü Development of an European Masterplan as long term target model (30 yrs) and as orientation for the ENTSOE TYNDP and the National Plans.
- ü With market-based congestion rents, more cooperation will not be necessary
- ü There are bodies and networks, so the cooperation framework should exist
- ü More political will from Member States

4. Do you think a single European price area (covering the most of the EU) is a relevant goal?

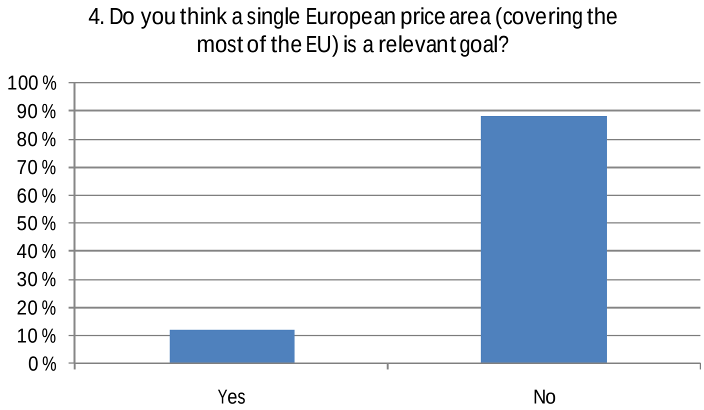


Figure A3-2 European price area.

5. What kind of problems (if any) would smaller than national price areas constitute?

Summary of the answers:

- If these bidding areas are defined according to physical limits in the network the problems of large countertrading/re-dispatching will be avoided.
- Within a small area competition may decrease but market power (and its abuse) is more visible compared to larger bidding areas.
- Most important problem is lower liquidity and competition level; problems for retailers
- Low liquidity of financial markets may rise hedging costs
- No real problems but there may be an issue for retailers that need to hedge themselves
- Payments for renewables, should areas with more renewables pay more of the subsidies as prices might be lower in these areas?
- Would be good to support larger that national "price areas"
- Price areas have to be defined by technical congestions (and not by national borders).
- Introducing small bidding areas should be coupled with the obligation to develop the network during a certain time horizon to reduce bottlenecks and to achieve bigger bidding areas.
- Locational pricing, promotes investments more effectively at the "correct" locations (both generation and transmission)
- Political problems if using locational marginal pricing: until the investments take place, which will bring prices to the same level in all regions (at least in theory), someone will have to explain to consumers why they will have more expensive electricity than their neighbors.
- Accepting smaller price areas would mean accepting transmission bottlenecks.

6. Do you think that there will be a common power exchange for physical day-ahead electricity trading in Europe in 2030?

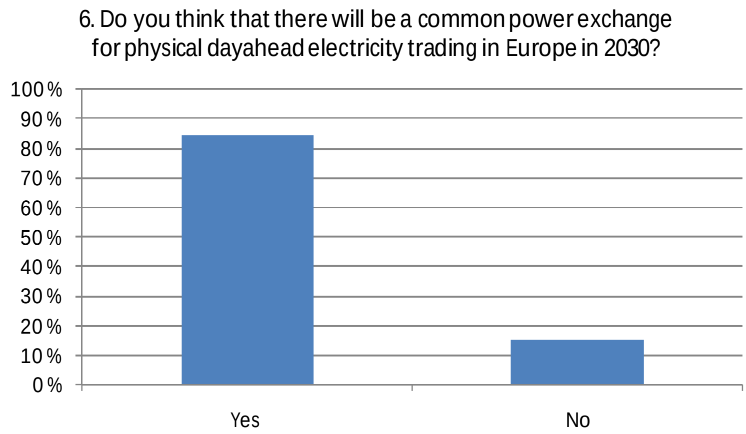


Figure A3-3 Power exchange.

7. Do you think that separate capacity markets are needed in Europe to guarantee adequate revenues to the electricity generators?

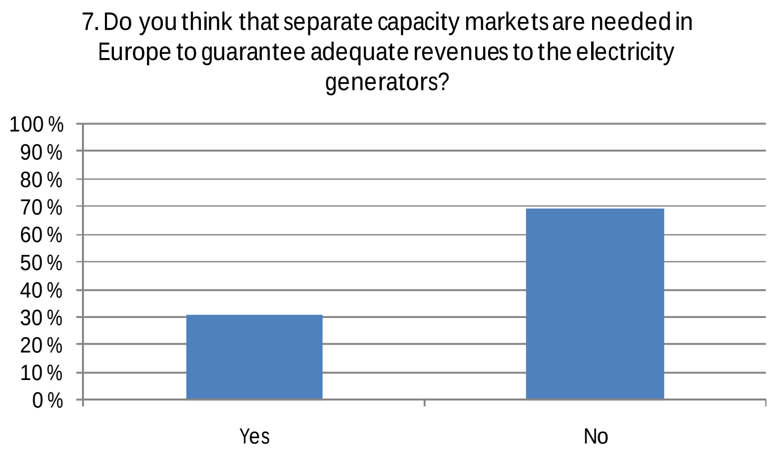


Figure A3-4 Capacity markets.

8. Can you suggest any measures that could be taken to avoid the need for capacity markets?

Summary of the answers:

- ü Current market pricing mechanism is not transparent and leads to wrong price signals.
- ü Remove distortions in wholesale markets (price caps), develop liquid and integrated gas markets, increase electricity interconnections and market integration
- ü Support schemes for renewables
- ü Price spikes should be accepted
- ü R&D support for storage solutions
- ü Competition authorities should follow market more tightly
- ü Shorter licensing time for new cables and power plants

- ü For reserve power a capacity market is probably necessary as already exists in many countries.
- ü Ten next decade or two, the main problem will be surplus, not deficit. A general capacity market would exacerbate that problem. What is needed is balancing, not capacity.
- ü DSM and demand participation in the market should be promoted and peak prices should be visible to customers (not necessarily compulsory to apply spot-based tariffs but also more sophisticated tariffs should be available)
- ü You have to trust the market and don't interfere as interfering will give uncertainty for investments
- ü Separation of Remuneration of Fixed Costs and Variable Costs are usual for several services (rent a car...) why should it not be part of products and contracts at the electricity supply business?
- ü One can avoid capacity markets only if the relevant energy price is increased. This is thought though politically unacceptable.
- ü Integrated intraday and balancing markets
- ü Not disturbing the market by too much regulation

9. Do you think that there will also be a common electricity retail market in Europe in 2030 (covering the most of EU) where the regulatory and technical obstacles for the suppliers willing to operate in various countries are minimized?

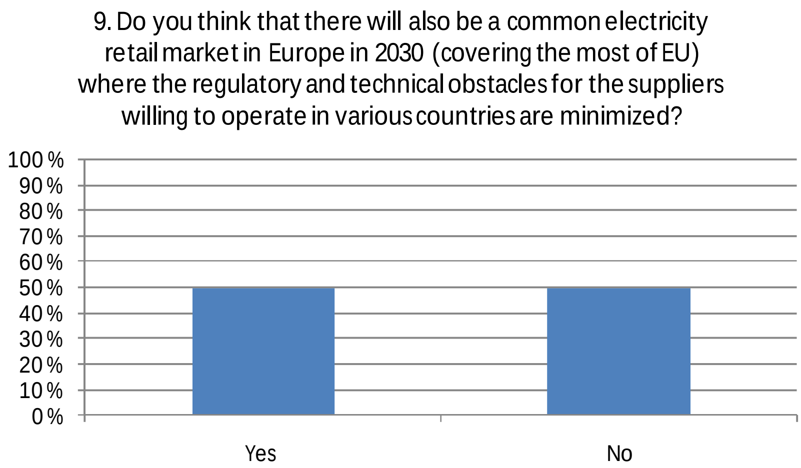


Figure A3-5 Retail markets.

10. If it was possible to store electricity economically in large quantities, how do you think it would change the operation of the electricity market as we know it today?

Summary of the answers:

- ü Clearly, volatility would be reduced. Cost reduction would depend on where these storages would be built and its costs.
- ü Market moves to the direction of other commodity markets, but also in these markets there are sometimes volatility in prices and lack of substance.
- ü It would not change the operation, it would change the generation mix and there could be more penetration of RES
- ü Not a big changes, because the cause to store is that at the same time there will be more uncontrolled production (wind, solar etc). Although, peak / off-peak price spread would narrow.

- ü No different from a huge hydro based system
- ü It would make it possible to operate the market as we know it today. Otherwise, there might be a need for capacity markets
- ü It would significantly reduce market volatility, risk, and enable introduction of increasing volumes of renewable power
- ü Some problems would be solved, but others would continue to require our attention (as for the natural gas market), such as dominance by historical incumbents, lack of unbundling, insufficient market integration (market coupling)
- ü It will influence the operation of the energy system to be must easier to balance supply and demand
- ü Storing of electricity way of another will be "a must" to cope with wind power in the future

11. Please comment the questions and/or the questionnaire. If you are commenting a specific question, please, also indicate the number of the question that you are referring to.

Summary of the answers:

- ü If there would be only one price in Europe then our grids are too strong and customers have to pay for that.
- ü It might not be relevant to have one PX in Europe, rather than PXs working as one.
- ü Building transmission capacity is the weakest link in the system
- ü It is an exaggeration to say that there are no incentives, as TSO is not allowed to keep the money in any case, but it may be more popular to lower tariffs than use the income for other accepted purposes.
- ü Permitting and zoning policies may be very difficult for grid expansion.
- ü The increase in intermittent power will rather increase than decrease regional price differences
- ü There may be several power exchanges in Europe, but they should be using one algorithm for price formation and all interconnectors should be operated on a market basis
- ü Need for a capacity market is dependent on both market and support mechanism design. Designing a good capacity payment mechanism is also very difficult as customers basically do not need any capacity, they want energy
- ü Why avoid capacity markets?