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LEARNINGS FROM NORD POOL REGION: Power Market Development

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FOREWORD

The USAID/India "South Asia Regional Initiative for Energy Integration" (SARI/EI) program, implemented by "Integrated Research & Action for Development" (IRADe), promotes regional energy integration including through Cross-Border Electricity Trade (CBET). The program focuses on three key outcomes; i) including harmonization of policy, regulatory and legal frameworks; ii) advancement of transmission systems interconnections; and iii) establishment of a South Asia Regional Electricity Market.

Three inter-governmental Task Forces have been constituted under the program with representations form each of the South Asian governments. The primary mandate of each of the Task Forces is to prepare the roadmap for promoting Cross-border electricity trade in the region. The Task Forces are supported by the SARI/EI Secretariat by providing timely analysis to provide as well as orientation visits to identify international best practices for regional power markets.

The SARI/EI program organized a study visit to Nord Pool in October 2015 Task Force members with an exposure to the ways that market operates in Nord Pool and how different stakeholders (market operators in Norway and system operators in Denmark) have gone about integrating the different transmission grids and operating a regional market. Studying the successes and challenges of the Nord Pool region will provide valuable lessons for the Task Force members as they prepare the roadmap for South Asia.

This report, "Learnings from the Nord Pool Region: Power Market Development," is an excellent compilation of the experiences from the Nord Pool study tour. The report details the evolution of Nord Pool regional power pool including best practices. It covers issues such as transmission pricing mechanisms, transmission planning, settling the imbalance, energy accounting and scheduling, regional grid codes, and higher penetration of renewable energy. We are hopeful that this report will be useful for all energy stakeholders in the region, especially those working on cross-border electricity trade as the best practices presented in the report can be considered for the market development in South Asia after assessing its suitability.

I would like to take this opportunity to commend the Nord Pool Consulting and Energinet for organizing an excellent study tour and providing their inputs for this report. I would also like to thank SARI/EI project secretariat team, managed by IRADe, for compiling this report. I hope the report is useful and is actively used to inform policy decisions by the South Asian Country Governments.

Thank you,

Michael Satin
Regional Energy Director
Clean Energy & Environment Office

Acknowledgements

The preparation of the report, “Learnings from Nord Pool Region: Power Market Development” held under the SARI/EI programme would not have been possible without the time and support of various individuals and organizations.

We would like to express our sincere thanks to Mr. Colin Dreizin, Director, Clean Energy and Environment Office, USAID/India and Ms. Monali Zeya Hazra, Regional Energy Manager and Clean Energy Specialist, USAID/India for their valuable inputs and suggestions.

We sincerely thank Dr. Jyoti Parikh, Executive Director, IRADe and Mr. V. K. Kharbanda, Project Director, SARI/EI for their valuable suggestions and direction and Ms. Reshmi Vasudevan, Project Coordinator for organizing the study tour to Nord Pool.

We also thank Mr. Haakon Reiersen Leknes, Consultant and Mr. Hans-Arild Bredesen, CEO, Nord Pool Consulting for their support and help in formulizing and conducting the programme successfully and providing an opportunity to visit and understand the regional power market. Our sincere regards also due to Mr. Peter Jørgensen, Vice President, Energinet, Denmark, and his team for all their efforts in making this study tour successful.

We acknowledge and express our appreciation for all those individuals whose names are not penned here but offered invaluable time and generous support throughout this exercise. We hope this document will serve as a valuable resource for promoting Cross-Border Power Trade in South Asia.

Preface

The South Asian regional energy cooperation not only provides energy security but also provides impetus for transforming economies in these countries. The dominance of certain fuel types – coal in India, gas in Bangladesh, petroleum in Pakistan, hydro power in Bhutan and Nepal – leads to over-dependence on these resources at a country level and leaves them vulnerable to supply side risks. Despite of having huge hydro potential of 350 GW, only 13-15% of hydro potential has been tapped so far and few countries bound to rely on imported fuel in the absence of integrated regional market.

South Asian region can learn a lot from other regional power markets to develop sustainable and mature power markets through sharing of available natural resources. A study tour delegation of SA countries policy makers, power system administrators, power market experts went Nord Pool region to understand the first regional power pool/power exchange market evolution, operation and design.

Nord Pool has played an important role in setting up of various other National/International Power Exchanges such as the Leipzig power exchange (LPX) in Germany, France's Powernext Exchange, Japanese Power Exchange, developing the power market in SAPP (involving 12 countries), Romanian power market etc. Nord Pool is one of the regional power pool having mature regional electricity market and facilitate around 88% of the total Nordic electricity consumption through Nord Pool spot market.

We are happy to present our findings based on Nord Pool study tour detailed discussion among SA countries representatives, USAID representatives, SARI/EI technical team and International experts. It is a major milestone for SARI/EI. The successful event had painstaking efforts behind it, for shaping the sessions, getting appropriate speakers, bringing on the representatives from country governments and site visits.

I hope this report will initiate the thought provoking discussions among sector key stakeholders in South Asia for assessing the international best practices in the context of South Asia. The lessons learnt from Nord Pool a can benefit other stakeholder's who could not go at the time. The session summary of this report is based on a detailed review and discussion with the Nord Pool that would be beneficial for South Asian region.

Jyoti K. Parikh

Jyoti Parikh
Executive Director

List of Abbreviations

ACER	Agency for the Cooperation of Energy Regulators
CACM	Capacity Allocation and Congestion Management for Electricity
CBET	Cross Border Electricity Trade
CEER	Council of European Energy Regulators
CHP	Combined Heat and Power
ENTSO-E	European Network of Transmission System Operators for Electricity
ESMAP	Energy Sector Management Assistance Program
IRADe	Integrated Research and Action for Development
NC FCA	Network Code on Forward Capacity Allocation
NGDP	Nordic Grid Development Plan
PCR	Price Coupling of Region
SARI/EI	South Asia Regional Initiative for Energy Integration
NordREG	Nordic Energy Regulators
TSO	Transmission System Operator
TYNDP	Ten Year Network Development Plan
USAID	United States Agency for International Development

Introduction

The South Asian (SA) region comprises of eight (8) nations namely, Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. It constitutes only 4% of the world's total surface area but with nearly 23% of the world's population. The region has witnessed immense economic growth over the last decade of approximately 5% to 6% per annum. Even though the energy demand in the region is rising fuelled by the economic growth, there is huge variation in energy resource endowments and consumption pattern within the region. The region is characterized with skewed distribution of available energy resources both within a country and across the region.

This would potentially benefit the SAR member countries if the electric grids and markets can function more closely with each other. It is also important to provide incentives for efficient use of resources for power generation while minimizing the associated environmental impact. Responding effectively to these challenges requires concerted efforts from all the regional countries in South Asia.

In the SA context, the risks associated with cross-border electricity project would be greatly minimized if policy alignment of participating nations, harmonization of operating systems and procedures for CBET and standard set of commercial terms and conditions were developed. Key issues that need to be addressed or considered before developing a large regional power market are transmission pricing methodology, deviation settlement mechanism, scheduling and dispatch procedures, coordination planning and operating procedure. The necessary regulatory and institutional mechanisms also have to develop adequately. All these necessary changes will play an important role in the establishment of a regional power market in the SA region including a power exchange.

SARI/EI has constituted three task forces comprising of representatives from the governments of different South Asian Country (SAC) to address the above mentioned issues of harmonization/coordination of laws, policies and regulations; advancement of physical transmission interconnections, and formation of South Asian Market for Electricity (SAME).

As the process of regional energy cooperation is taking shape in South Asia, the representatives from different South Asian governments and task force members need to be familiar with the best practices in other regional power markets to understand the evolutionary process of regional power market creation and learn the design and operations of the other regional power markets. Visiting the Nord Pool power market also helped the participants to understand the transition from bilateral to multilateral trading and trading through the regional power exchange.

This study tour provided learnings related to bilateral and multilateral and long- and short-term trades. Similarly, a power exchange is an essential part of the CBET in

the SA region and this aspect needs to be adequately covered. Moreover, power exchange formulation is one of the major components of the power market formulation. Another important aspect to be considered is the evolution of the integrated regional grid and the planning and technical issues related to the same.

As per the Annual Work Plan of 2014–15, IRADe organized a study tour to a regional power market to explore and understand aspects that dwell upon the process of evolution, technical/ operational, institutional and commercial aspects of regional power markets.

Objectives of SARI/EI Study Tour to Nord Pool, 2015

The objective of this study tour was to give an insight to the members of the establishment, evolution, and growth of the regional power market so that the members can suitably apply the learnings to the growing Cross Border Market in the SA region.

In particular, the following aspects were covered:

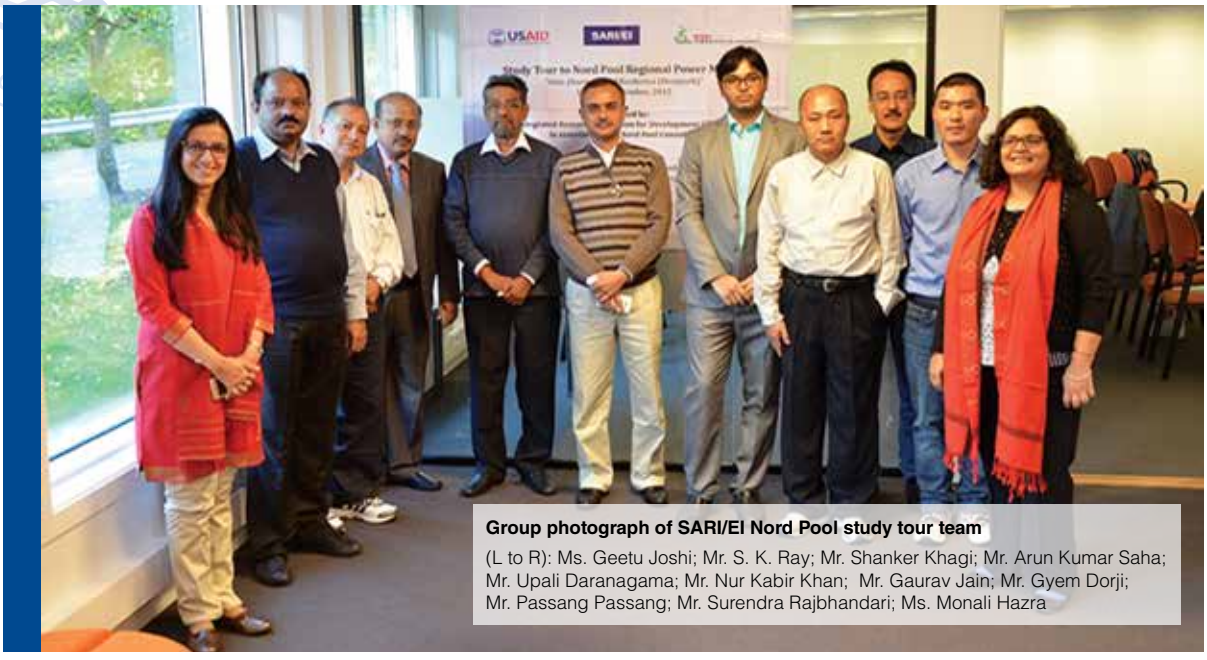
- Evolutionary process of the regional power market and introduction of various products in the market
- Market development strategy, challenges and constraints faced during the implementation stage of regional power market including the regional power exchange
- To understand the role of participating country governments, utilities, regulators, system operators etc. played in the establishment of Nord Pool Regional Power Market
- Planning and coordination among dispatch centres, regulatory bodies and generation and transmission utilities
- Technical and operational issues faced during the development of the regional power market and how these were addressed
- Introduction to regional power exchange and market products such as Day Ahead Market, Intra-Day Market, etc.
- Power pricing methodology/price discovery mechanisms prevailing in the regional power market
- To understand the commercial aspects of power transmission such as transmission pricing, loss allocation, treatment of unscheduled deviation etc.
- To understand the planning and technical aspect of power transmission such as development of inter-country coordination procedures, transmission planning at national and regional levels, outage planning, reactive power management, etc.
- Site visits to Nord Pool Spot Trading Desk, Energinet–the Danish transmission system operator (TSO) etc.

Highlights - Key Lessons Learnt

- Strong political mandate is necessary: It gave a clear road map both at Nordic and European levels which translated into conducive legal, regulatory and policy framework for CBET and creation of the electricity market.
- Maturity of short-term power market is attainable: The total volume traded at Nord Pool Spot in 2013 was about 88% of the total Nordic electricity consumption. By taking necessary measures, short-term power market (power exchange) trade could achieve high maturity level as well.
- High renewable energy integration feasible: By making a regional market, countries are gearing towards ambitious plans for renewable energy integration such as Denmark achieving 50% of its electricity requirement from wind energy by 2020. The energy security from integrating energy resources in the regional basket and the wider geographical area provides an opportunity for reducing and managing the intermittency of renewable energy.
- Regional planning for transmission infrastructure is required: The present Nordic Grid Development Plan (NGDP), 2014, is based on ENTSO-E's joint regional planning. The ENTSO-E approach to developing its Ten Year Network Development Plan (TYNDP) is an example of a coherent and integrated framework for integration of larger geographical areas and countries into a common market structure and centralized transmission system planning platform, which is continuously revised.
- Operation and management of transmission infrastructure:
  - In a price-coupled market, the exchange on interconnectors may change on hourly basis depending on specific system characteristics. Intermittent RES generation may be a driver for changing exchange patterns.

Group Photograph of SARI/EI Nord Pool team

(L to R): Mr. Nur Kabir Khan; Mr. Arun Kumar Saha; Mr. S. K. Ray; Ms. Geetu Joshi; Ms. Monali Hazra; Mr. Upali Daranagama; Mr. Gyem Dorji; Mr. Gaurav Jain; Mr. Passang Passang; Mr. Shanker Khagi; Mr. Surendra Rajbhandari; Mr. Haakon Reiersen Leknes



Group photograph of SARI/EI Nord Pool study tour team

(L to R): Ms. Geetu Joshi; Mr. S. K. Ray; Mr. Shanker Khagi; Mr. Arun Kumar Saha; Mr. Upali Daranagama; Mr. Nur Kabir Khan; Mr. Gaurav Jain; Mr. Gyem Dorji; Mr. Passang Passang; Mr. Surendra Rajbhandari; Ms. Monali Hazra

  - The load on interconnectors is optimized as an integrated part of the market-based clearing process.
  - Decision on transmission development is taken on basis of socio-economic cost benefit analyses. Investment costs are paid for over the transmission tariff.
  - Denmark uses a competitive tendering process for establishing offshore wind power farms. Cheapest bid is selected. Investment costs are socialized over the public service obligation (PSO) tariff.

- Regulatory affairs coordination: Each country has its own country regulator, and for regional-level cooperation there is NordREG, a forum of regulator of participating countries. Further, European electricity trade cooperation is being done by the Agency for Cooperation of Energy Regulations (ACER) and Council of European Energy Regulators (CEER). All entities coexist with harmony and attain their goals by taking coordinated steps. The Nordic electricity market is increasingly connected to the continental markets.
- Regional grid code is desirable: To achieve coherent and coordinated Nordic operation and planning between the companies responsible for operating the transmission systems, a regional grid code is critical. It established the best possible conditions for development of a functioning and effectively integrated Nordic power market.
- Regional or cross-border link losses apportioned: Countries follow different methodology for "loss pricing": Norway uses differentiated tariff based on marginal loss rates at each connection point, while Denmark follows differentiated postage stamp only to consumers. Losses on interconnectors are covered by the TSOs often shared equally. Each TSO recovers losses according to the approved regime in the respective country.
- Scheduling and dispatch coordination: For common day-ahead, intraday and regulation markets, gate closure timing is aligned in Nordic countries.

Learnings from Nord Pool Power Market

Introduction to Nordic Power Market

Mr. Haakon Reiersen Leknes
Senior Consultant, Norway

The total installed capacity of the Nordic System in 2014 was about 98,400 MW with a peak load of 67,300 MW. Most of the generation in the region is from hydropower (53%) with significant contributions from nuclear power plants (23%), fossil (23%), wind energy (6%) and biomass (6%).

Topics Covered

- Nordic power market installed capacity
- Energy mix of Nordic countries
- Driving force for integration of Nordic countries
- Import and export of last 10 years in the Nordic power market
- Process of evolution of regional power market in Nord Pool region
- Timeline and evolution of regional power market

The driving forces for developing a Nordic electricity market were the complementarities in resources of Nordic countries. Norway and Sweden produce much of their electricity from hydropower while Finland and Denmark highly rely on thermal power systems. This resulted in increased economic efficiency, higher security of supply and improved environmental performance of the Nordic power system.

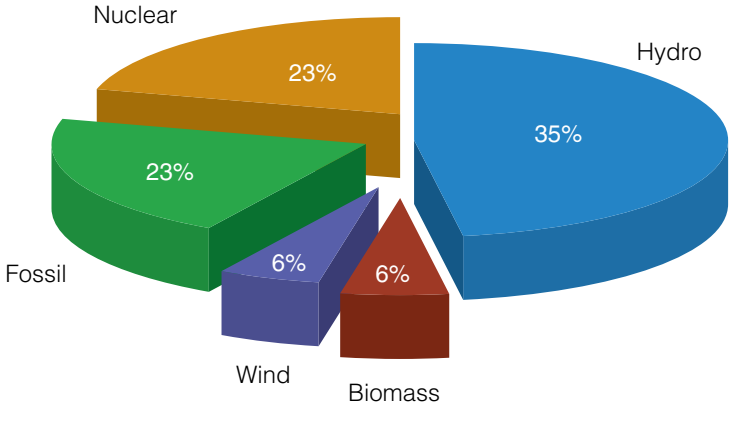


Figure 1: Nordic region fuel mix (NordREG, 2014)

Table 1: Country-wise fuel mix of Nordic Region (NordREG, 2014)

Source	Denmark	Finland	Norway	Sweden	Nordic Region
Nuclear power	-	2,752	-	9,531	12,283
Hydro power	9	3,125	30,900	16,150	50,184
Wind power	4,809	288	811	3,745	9,653
Sun power	563	-	N/A	43	606
Other Thermal power	6,989	11,135	1,040	8,079	27,243
Condensing Power	-	2,465	-	1,375	3,840
CHP, district heating	1,929	4,375	-	3,631	9,935
CHP, industry	562	3,180	-	1,498	5,240
Gas turbine	-	1,115	-	1,575	2,690
Installed capacity	14,861	17,300	32,879	38,273	103,313

Source: Swedenergy, NEV, DERA, EMI

Further, the market unification is optimizing the use of Swedish and Norwegian hydropower resulting in lower electricity prices (average prices) and reduced carbon emissions in the Nordic region as a whole, while security of supply increased in dry years through integration of thermal capacity in Denmark and Finland.

Finland's net import of 12.2 TWh of electricity from Sweden was the highest in 2013. The highest combined flows between two countries were those between Norway and Sweden that reached 14 TWh.

In the same year, electricity flow from Denmark to Norway and Sweden was 7.9 TWh. Power exchange or trade between the countries is shown in Figure 2.

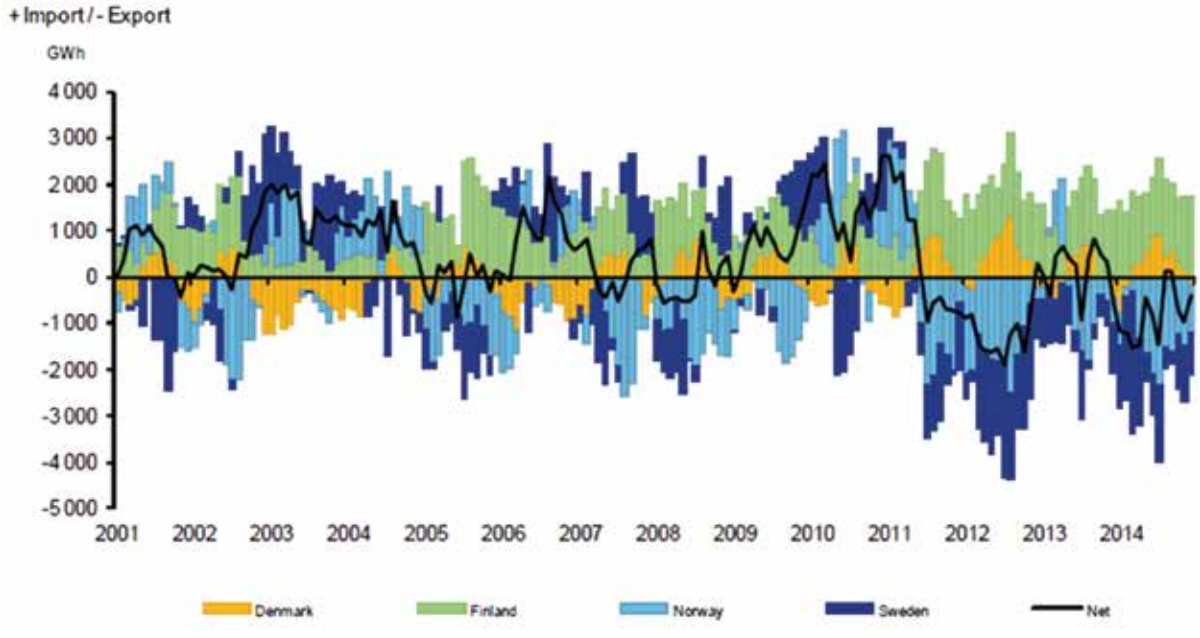


Figure 2: Nordic region power trade (Leknes, 2015)

Process of evolution of regional power market in Nord Pool region

Nordic countries have a well-established tradition of cooperation and trade between their national electricity systems. Cooperation was formalized in 1963 with the establishment of Nordel.[1] This resulted in increased collaboration on technical issues and trade culminating in the establishment of a common Nordic electricity market.

In comparison with the times of monopoly and central planning, the price formation in the electricity market today is based on decentralized decision making by mutually independent companies. The balancing of demand and supply is planned by a number of balance responsible parties on a commercial basis. Every consumer and every producer in the market must either be balance responsible, or have a valid contract with a balance responsible party. The system operator takes over the physical balance responsibility in actual operation. By 1995, the Nordic Ministers of Energy issued the Louisiana Declaration stating that a pan-Nordic electricity market would be economically and environmentally beneficial for all countries and should be created as soon as possible.

The common Nordic market developed in phases. In 1996, the common exchange Nord Pool was established for Norway and Sweden. Finland joined it in 1998 and Denmark in 2000. Thereby the spot market (day ahead) covered the entire Nordic area. Today, all consumers can select their retailer, and all retailers and generators have access to the market. The details of evolution are provided in Table 2. The development and integration of the Nordic electricity markets has resulted in the removal of barriers to cross-border trade, the introduction of common grid codes, common

Table 2: Evolution of regional power market (Leknes, 2015)

Timeline	Regional Market
1991–1995	Norwegian power market deregulated
1993	Nord Pool Spot established as 'Statnett Marked'
1995–	Nordic energy ministers formed a committee to investigate the establishment of a common Nordic electricity market. Committee provides favourable report.
1996	Rebranded to Nord Pool when Sweden joins
1998	Finland joins Nord Pool
1999	Elbas becomes the first intraday market
2000	The Nordic market fully integrated as Denmark joins
2001	Independent Market Surveillance is established
2002	Nord Pool Spot established as a separate company
2005	The Kontek bidding area in Germany opens
2008	Financial market sold to NASDAQ OMX Commodities
2009	Market coupling of 11 European countries launched through European Market Coupling Company (EMCC)
2010	N2EX launched by Nord Pool Spot and NASDAQ OMX Nord Pool Spot opens bidding area in Estonia
2012	Nord Pool Spot opens bidding area in Lithuania
2013	Nord Pool Spot opens bidding area in Latvia thus including all the Baltic countries

[1] Nordel was founded in 1963 and was a body for cooperation between the TSOs, whose objective was to create preconditions for further development of an effective and harmonized Nordic electricity market. On 1 July, 2009 Nordel was wound up. All operational tasks were transferred to ENTSO-E.

handling of reserves, common planning of interconnectors, congestion management, harmonized balance settlement and common goals for retail markets.

The common Nordic electricity market is now being integrated with adjacent regional markets with the ultimate goal of a pan-European electricity market. Nordic cooperation remains an important driver for further market improvement and continues to provide inspiration for developments in the EU market design. The Nordic electricity market is increasingly connected to the continental markets. Nordic electricity market is working towards better integration through cooperation with the EU Commission, ACER, CEER and system operators (ENTSO-E). They are working towards developing day-ahead market coupling across Europe. There are different types of market coupling models in the EU member states and Norway where a common feature is the implicit nature of transmission capacity allocation in energy markets. In practice, this means that market participants do not actually receive cross-border transmission capacity allocations separately, but instead offer energy bids in their areas for production or consumption and transmission capacity allocation is also confirmed if their bids are confirmed.

The Nordic market has adopted a model known as Market Splitting or zonal pricing. The model was first applied in Norway and Sweden in 1996: Finland and Denmark joined in 1998 and 2000, respectively. The Nordic Regulators have actively taken part in writing the Framework Guidelines and in drafting the Opinions of ACER on proposed Network Codes.

Role of the Market Institutions

Regional and national market structure overview

Topics Covered

- Regulatory structure at regional level
- Transmission system related activity at regional level
- Long-term coordinated plan at regional level
- Regional power trade and exchange in Nordic power market

The Nordic regional electricity market is now moving towards an integrated European market.

One regulator per country: Each county has its own regulator as listed below and NordREG for regional level cooperation, while ACER does the pan European level cooperation.

- Danish Energy Regulatory Authority (DERA) – Denmark
- Energy Market Authority (Energiamarkkinavirasto) – Finland
- Norwegian Water Resources and Energy Directorate (NVE) – Norway
- Energy Markets Inspectorate supervise the Swedish electricity – Sweden

NordREG is a cooperative body between the Nordic energy regulatory authorities, which was formed from the traditional close cooperation on energy between the Nordic countries. The Nordic Council of Ministers[2] already supports the plans for realizing a common Nordic energy market not only in the wholesale market, but also in the retail market. Their mission is to actively promote legal and institutional framework and conditions necessary for developing the Nordic and European electricity markets.

ACER coordinates regulation by the European regulators, monitors regional collaboration between TSOs in the electricity and gas sectors and monitors the single European markets for

[2] The Nordic Council of Ministers is the official inter-governmental body for cooperation in the Nordic Region. Representatives of the Nordic governments meet at the Council of Ministers to draft Nordic conventions, etc.

gas and electricity. ACER was given its legal capacity from 3 March 2011. CEER, a not-for-profit association, the national regulators, cooperate and exchange best practice. A key objective of the CEER is to facilitate the creation of a single, competitive, efficient and sustainable EU internal energy market that works in public interest.

One system operator per country: The Nordic TSOs at country level are Statnett SF (Norway), Svenska Kraftnät (Sweden), Fingrid (Finland) and Energinet.dk (Denmark).

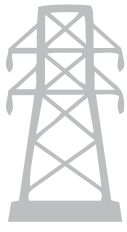
At the regional level, earlier Nordel was in charge to ensure efficient utilization of the Nordic electricity generation and transmission systems. It acted as an advisory and recommendatory body for cooperation between the Nordic system operators, and a forum for market participants and the system operators. Later, in 2009 all operational tasks were transferred to ENTSO-E to promote the integration of EU's internal market and to create security of supply and market rules pertaining to transmission grids. It works in cooperation with the Commission of the EU, national authorities and electricity market parties.

The TSO in each Nordic country has the responsibility[3] of transmission of electricity for the nation and to ensure that production and consumption is in balance at all times. They have several tasks, *inter alia*, contributing to a high security of supply for end-users, while making sure that physical limits of the transmission grid are not violated. A TSO must always act in a neutral and non-discriminative manner towards various market participants.

Long-term coordinated plan: The Nordic TSOs have a long tradition of cooperating in grid and market development to secure the supply of electricity to consumers, based on a regional perspective. The Nordic Grid Development Plan 2014 (NGDP14) follows the lines of the Nordic Grid Development Plan 2012 in being an extract from the ENTSO-E Regional plans from the North Sea and the Baltic Sea. This NGDP-2014 assesses the market of 2030 and feasibility of possible interconnections and other grid development project.

Power Trade: Nord Pool Spot AS is owned by the Nordic TSOs, Statnett SF, Svenska Kraftnät, Fingrid Oyj, Energinet.dk and the Baltic TSOs Elering, Litgrid and Augstsprieguma tikls (AST). The total volume traded at Nord Pool Spot in 2013 was about 88% of the total Nordic electricity consumption. The total volume traded at Nord Pool Spot in 2013 was 348.9 TWh. Within the Nord Pool Spot exchange, all the transmission capacity on the external transmission lines is handled by Nord Pool Spot through implicit auction during price calculation. Two Nordic commercial players situated in different bidding areas cannot trade electricity with each other. This is because Nord Pool Spot handles all the trading capacity on the cross-border links, on behalf of the Nordic TSOs. Financial electricity market is used for trade between Nordic players in different bidding areas. Two players can trade the power on Nord Pool Spot or with a player situated in their own bidding area (i.e. the power is traded locally). In addition, the two players will settle in accordance with the financial contract.

Regional power exchange: The core responsibilities of the Power Exchange are providing a price reference to the power market, operating a spot market, and organizing a market for financial products (products like forward, futures and option contracts). The power exchange acts as a neutral and reliable power-contract counterparty to market participants. It uses the spot market's price mechanisms to alleviate grid congestion (capacity bottlenecks) through optimal use of available capacity. To this end, the Nord Pool Spot operates the leading markets to buy and sell power in Europe.



[3] The TSOs keep the system in balance at all times, uphold the correct voltage level, maintain security of supply, coordinate among neighbouring countries and coordinate maintenance.

A Market Participants View

Mr. Sletten Torbjørn
Statkraft, Norway

Statkraft is a Norwegian state-owned electricity company headquartered in Oslo, Norway. With a total energy production of 56 TWh in 2014, the Statkraft Group is the third largest energy producer in the Nordic region, as well as the largest energy producer based on renewable energy sources in Europe, consisting of 40% of the production in Norway. It is one of the main traders within the European power market. Norway has abundant hydropower with more than 95% of installed capacity. Being cyclical in nature, hydropower availability is very less in dry season.

Topics Covered

- Statkraft overview
- EMPS - Power Market simulator methodology
- Statkraft production planning
- Crucial factors for strategic decision making

Being a generator and trader, Statkraft does price projection using their production planning model for power scheduling for various power plants. Data on transmission lines, hydrology, flexible demand and plant availability, and maintenance planning are fed into the model. For achieving accuracy, the model is calibrated 2–5 times every hour. Price projections for the next five years on 73 alternative inflow scenarios are provided by the model. Based on model output decisions regarding power generation and trade are taken on short, medium and long term.

Production Planning in Statkfraft is bsed on modelling fundamentals

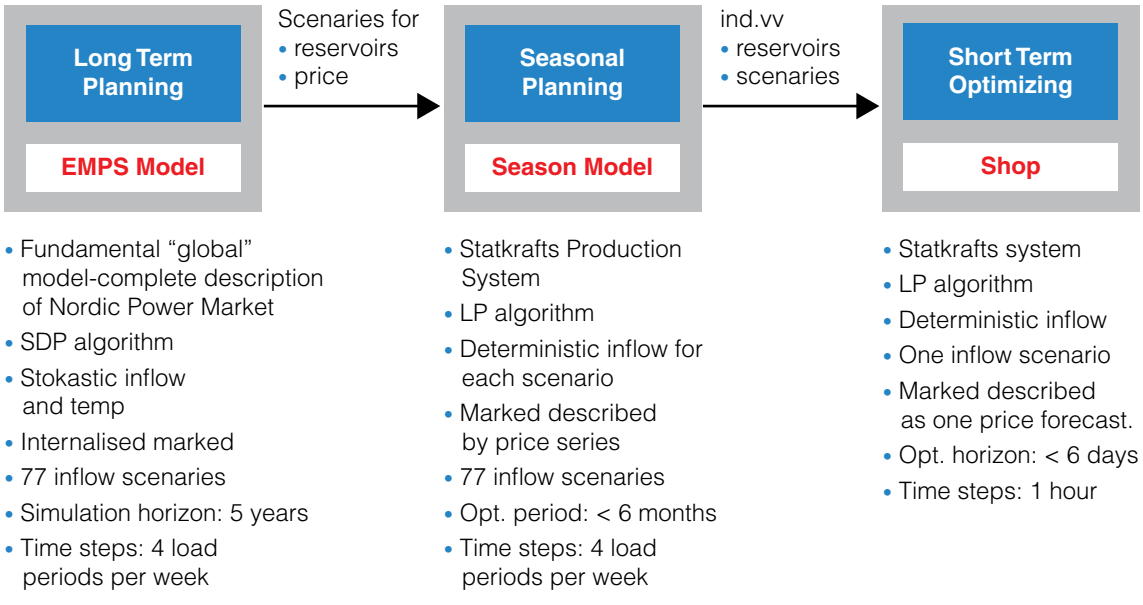


Figure 3: Modelling fundamentals of Statkraft (Torbjørn, 2015)

Power Exchange Overview

Power exchanges offer a fair, transparent and neutral platform resulting in the discovery of efficient price of electricity. The prices have not only brought up the "time of delivery" aspect (peak, day and night hours) but also the "locational" component of electricity.

Topics Covered

- Introduction to power exchange
- Market products such as day-ahead market, intraday market, ancillary/reserves
- Regional market integration
- Price discovery and market coupling

The temporal nature of pricing and the seasonality of the supply and demand dynamics are also covered. The prices have been able to identify congestion, its severity and its trajectory, which has resulted in identification of the need to augment, strengthen and upgrade the transmission network in the country. The primary role of a power market is to establish balance between supply and demand based on an economic merit order and taking transmission constraint into account.

This is the foundation of the "Energy only" market concept

- Both the buyer and seller are settled by the balance price in the intersection between demand and supply: the point of equilibrium
- The price formation process increases social economical walfare
- The demand side pays less than the bidding price and the seller will get paid more than the asking price.

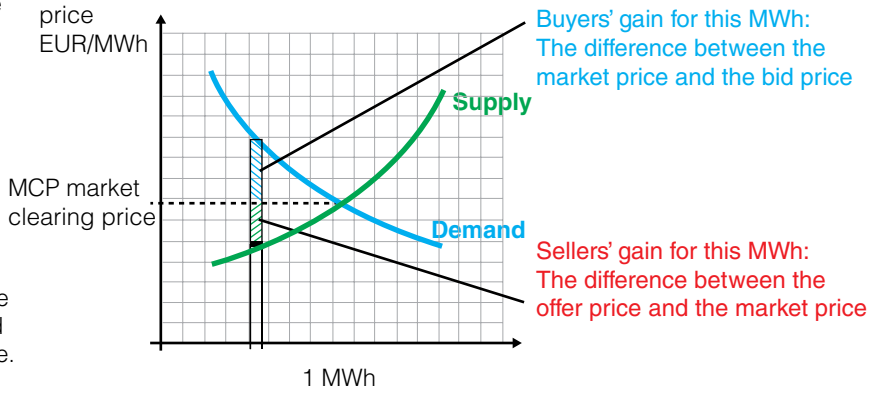


Figure 4: Market socioeconomic welfare aspects (Leknes, 2015)

Nord Pool Spot operates the following leading markets for buying and selling power in Europe:

- Elspot day-ahead market in the Nordic and Baltic regions
- Elbas intraday markets in the Nordic and Baltic regions
- N2EX market in the UK

The day-ahead and intraday markets supplement each other, with the intraday market acting as a balancing market. The intraday market is continuous, and power trading takes place until 30 minutes before the power is delivered whereas the day-ahead market is run the day before the date of actual power transfer. Elbas, cross-border intraday market has been operational from 1999. The TSO market is basically a real-time balancing market with two balancing tools: the balancing market and the ancillary services market.

All the products are physical contracts. In the day-ahead market, the balance is achieved between generation and demand, which is further tuned in the intraday market. The balancing power market (BPR) is useful in achieving hourly balance and the ancillary market is for frequency control.

The EU Target Model for energy trading is based on one common algorithm in the day-ahead timeframe (gate closure at 1200 for the next day's 24 hours) and one shared order book in the

intraday timeframe. The progress for this is based on cooperation between eight of the power market operators in Europe. The first stage of this went live in February 2014 through Price Coupling of Regions (PCRs). This process is expected to ultimately lead to a Single European Market.

- 154 members in 14 countries
- 75% of all trades are cross border
- 1/3 traded last hour before delivery
- 4.9 TWh in 2014, YTD 30% increase

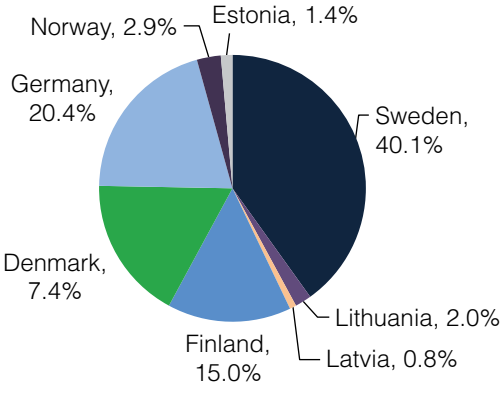


Figure 5: Elbas: Cross-Border Intraday Market (Leknes, 2015)

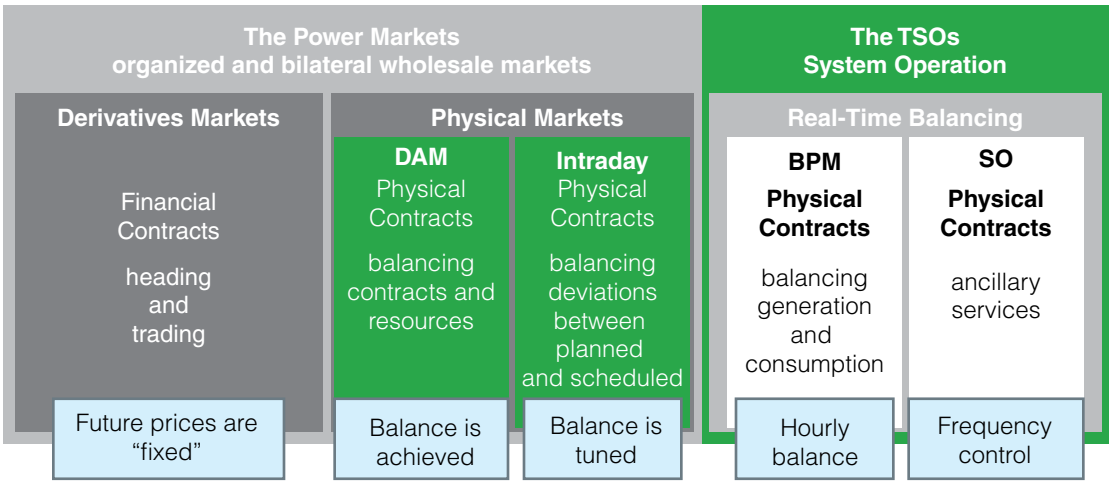


Figure 6: Role of Market (Leknes, 2015)

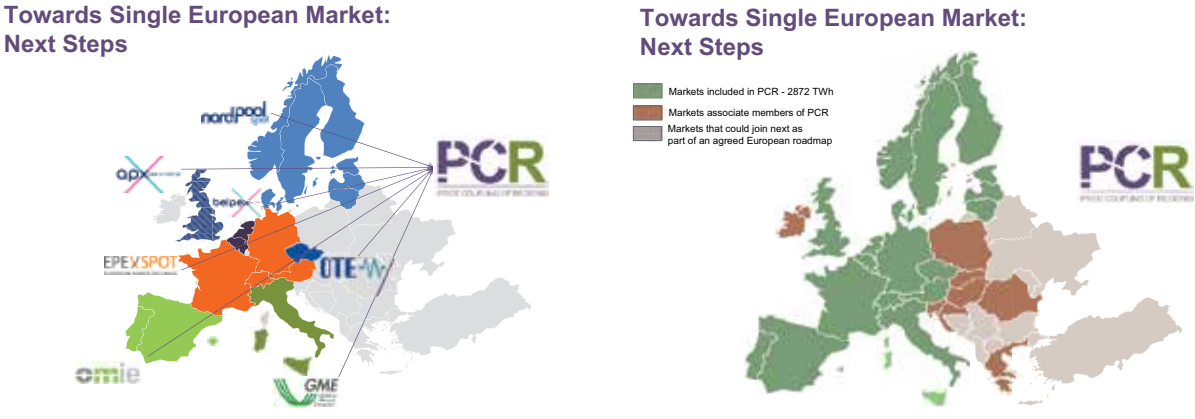


Figure 7: Towards Single European Market (Leknes, 2015)

Market Coupling and Cross-Border Electricity Trade

Market coupling is a method for integrating markets which allows two or more wholesale electricity market areas (normally corresponding to a national territory) to be merged into a single market area, as long as there is sufficient transmission capacity available between those markets.

Topics Covered

- Explicit and implicit auction
- Tools for balancing power market
- Price and volume coupling

- **Explicit Auction:** The transmission capacity is auctioned separately and energy is traded separately. The energy trades are dictated by the results of the transmission capacity auction.
- **Implicit Auction:** The energy and the associated transmission capacity is traded together. This improves liquidity and electricity flows from low-price areas to high-price areas.

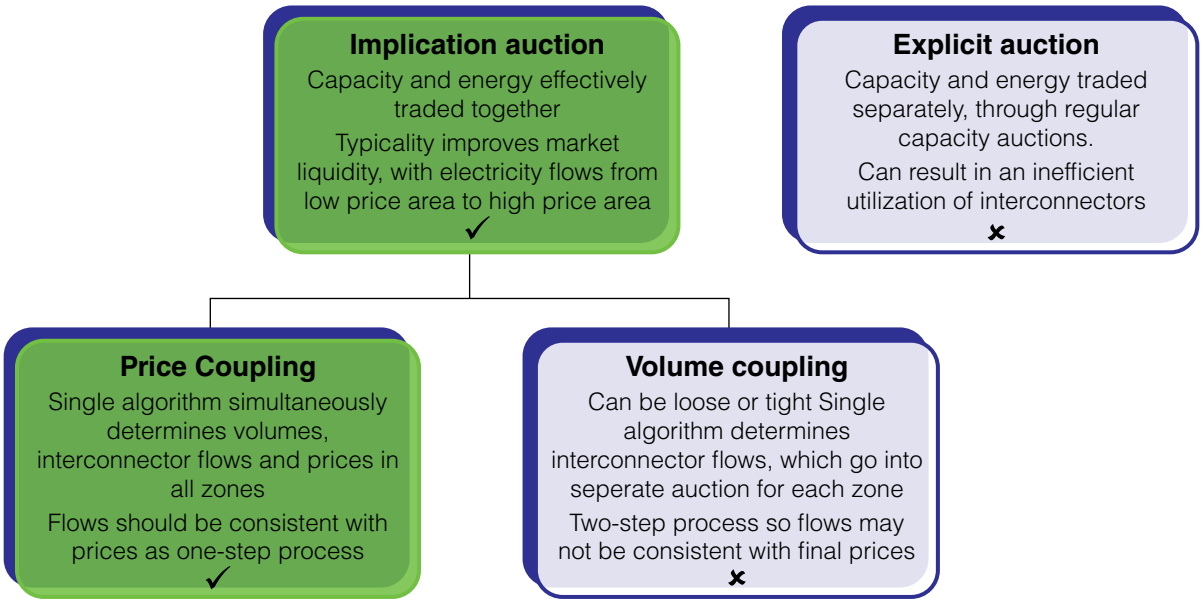


Figure 8: Market coupling

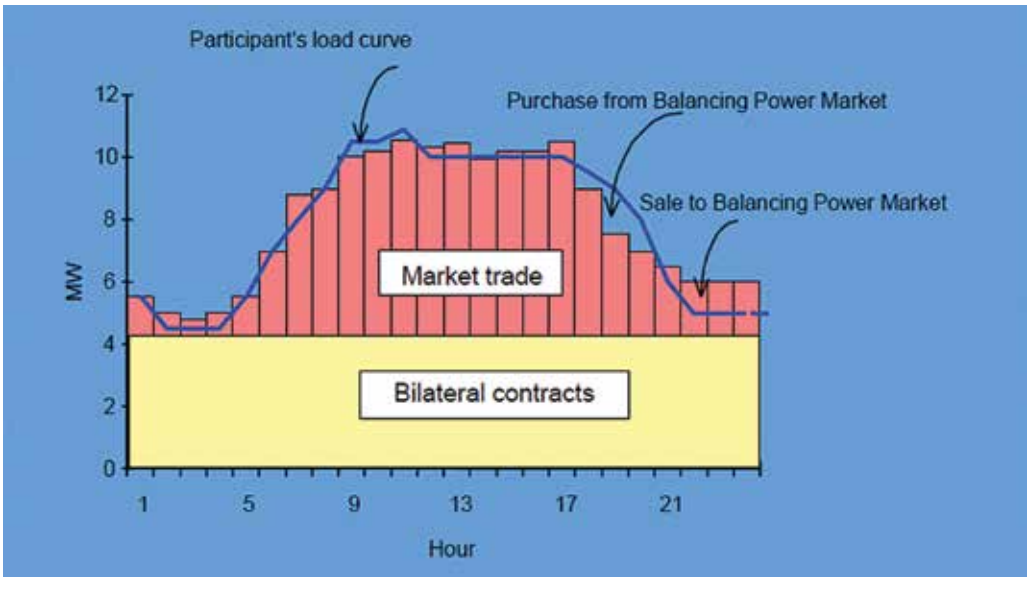


Figure 9: Settlement for one participant-example

In volume coupling, a single algorithm determines interconnector flows, which go into separate auction for each zone. This leads to a two-step process, so flows may not be consistent with final prices. In case of price coupling, a single algorithm simultaneously determines volumes, interconnector flows and prices in all zones. The concept of area price calculations using market splitting was explained.

There are four tools for power market balancing:

- Day-ahead market
- Intraday market which gives an opportunity for adjustments of positions 1–2 hours ahead of delivery
- BPM which operates with a notice time of 15 minutes
- Primary and secondary reserves/Ancillary services: 1–2 minutes to seconds (mille) to respond

Market participants balance their contracts and resources through the day-ahead and intraday markets. TSOs perform a load forecast and a load flow analysis for the control areas. They invite bids for the BPM. These bids are executable within 15 minutes after the TSO gives notice to the bidder. These bids are capacity bids and the minimum bid quantum is 25 MW. The TSO sorts the bids for the BPM in a merit order and clears internal congestions by using BPM bids.

The TSOs have to maintain instantaneous balance between production and consumption at all times. This is specially challenging for the Nordic TSOs as there is a sizable amount of renewable generation especially wind power. This is achieved through the Ancillary Services Market, which is the market for purchase of primary, secondary and tertiary reserves. This market varies from country to country to some extent. For example, in Norway, their primary reserve is bought at uniform pricing, whereas in Sweden procurement is pay-as-bid. Similarly, Statkraft has a 5-year contract with Statnett to deliver 60 MW of secondary reserve to HVDC connection between Norway and Denmark. Settlement for each market participant is based on the result of all the above market products and mechanisms.

Tasks and Systems Used on the Trading Desk

Ms. Ellen Charlotte
Business Developer
Innovation and Market Design
Nord Pool Consulting, Norway

Electricity markets are volatile, offering both challenges and opportunities. To survive in this exciting and competitive environment an effective trading and risk management strategy is essential. The key to successful trading will be having access to real-time information about a wide range of factors including power prices, prices of other key commodities like

Topics Covered

- Trading desk functionality visit
- Importance and utility of trading desk
- Key issue needs to be addressed

gas, coal and oil, understanding speculative activity, global, regional and local events and demand and supply dynamics. Thus, the key issues that should be addressed before one can start trading are listed below:

- Figuring out what the legal and financial obligations are for dealing with the relevant TSO(s).
- For the post-trade activities, a risk management team, an accounting system, bank arrangements, a trading and risk management system either in Excel form or an off-the-shelf product like Open Link, Allegro, Sungard, etc., and a function to oversee the whole chain of activities after the trade is done need to be in place.
- Addressing everything before executing the first trades: access to information sources like Thomson Reuters, Argus, Platt's, analytics and a model to estimate potential future gains and losses is necessary.
- Taking care of the most important issue: the counterparties. This could either be a central market entity (like Nord Pool, EPEX Spot, etc.) or OTC partners. Alternatively, you can seek the help of brokers for this. The main risk faced with counterparties will be the credit risk: do they have a good credit standing and are you willing to trade with them, and if yes under what conditions?
- In order to trade with counterparties in the wholesale power market, we have to sign and agree to a so-called master agreement with each potential counterparty. The master agreement is the legal document that sets out the terms of the agreement with regard to financially settling the contract and physically delivering the power. Without a signed master agreement, other parties will most likely not be willing to trade.

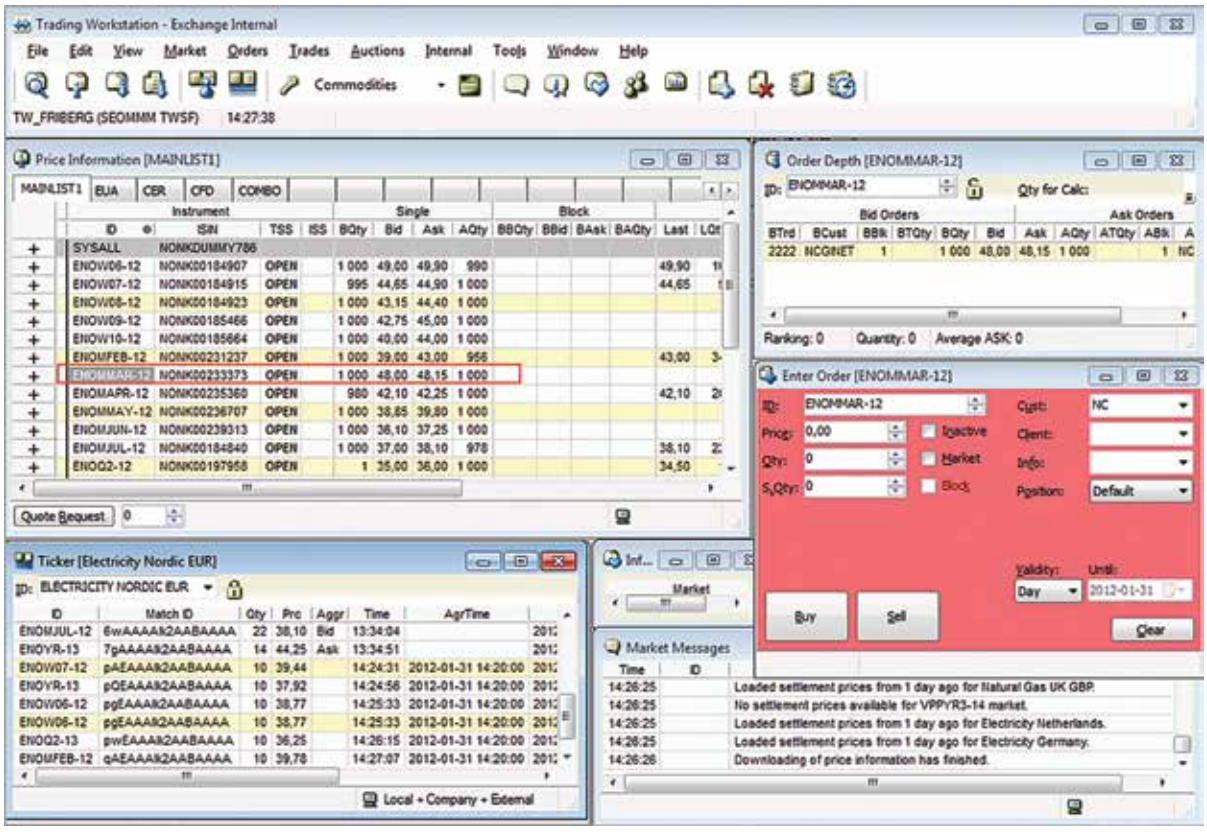


Figure 10: Trading workstation

Commodity Market and Financial Market including Future Market

Mr. Knut Rabbe
Head of Commodity Sales, Europe, NASDAQ

Topics Covered

- Overview of the financial and commodity market in the Nord Pool
- Key elements required for a well-functioning future market
- Operation of the financial power derivative market

In the financial and commodity market in the Nord Pool, Nasdaq Commodities was operational by 2009 and in 2010 Nord Pool Spot and Nasdaq Commodities launched the UK N2EX power market. Subsequently commodities transferred the N2EX clearing and IT solutions to NORD Pool Spot ASA. As on date, there are about 400 members in the Nasdaq Commodities market.

Commodities and financial markets provide clients with risk and capital solutions across physical and financial markets. This diverse platform has evolved and provides financing, financial hedging, physical execution and access to market pricing for clients exposed to commodities and financial markets.

The key elements required for a well-functioning market in general and for a futures market in particular are as follows:

- Liquidity: An illiquid market will distort prices. In this case, the Day-Ahead Spot Market system price is defined as the reference price.
- Transparency – Bids/Offer: Spread and volumes are visible to all counterparts. An Urgent Market Message (UMM) system has been installed to ensure adequate and timely communication.
- Market surveillance: To supervise and check transactions to prevent insider trading and also to check regulatory compliance
- Equality and secure counterpart are other key elements necessary in the market.

Principles of operation of the financial power derivative market: The contracts to buy/sell power are traded on the exchange but financial delivery happens in the future. The delivery period may be as long as 10 years. It is noteworthy that there is no provision for physical delivery. The financial market is useful in mitigating or optimizing risk. It provides an opportunity to have a separate financial hedge of the price risk. A trader can take a long or a short position in a financial market. The settlement can take place in time during the delivery period at the option of the position holder.

Product specifications for the trading of power derivatives: The minimum volume is 1 MW and the currency is EUR for the entire region except for UK power where GBP is used. The tick size (minimum incremental rate) is 0.01 EUR/MWHr and 0.01 GBP/ MWHr, respectively. All contracts are traded and settled irrespective of transmission capacity.

Collateral management is the function responsible for reducing credit risk in unsecured financial transactions. Collateral is the security provided against the possibility of payment default by

the opposing party (or parties) in a trade. The margin for initial, variation and base collateral requirements are to be maintained by the participants. There is also a default fund to protect the counterparty from any default by the position holder for both long and short terms.

The eligible collaterals include the following:

- Cash, where the participants deposit cash/securities to NASDAQ OMX accounts
- Securities like shares and bonds
- European Union Allowances
- Bank Guarantees are acceptable as collateral only for margin requirements.

Power derivate products are the future product in the power market of the South Asian countries.

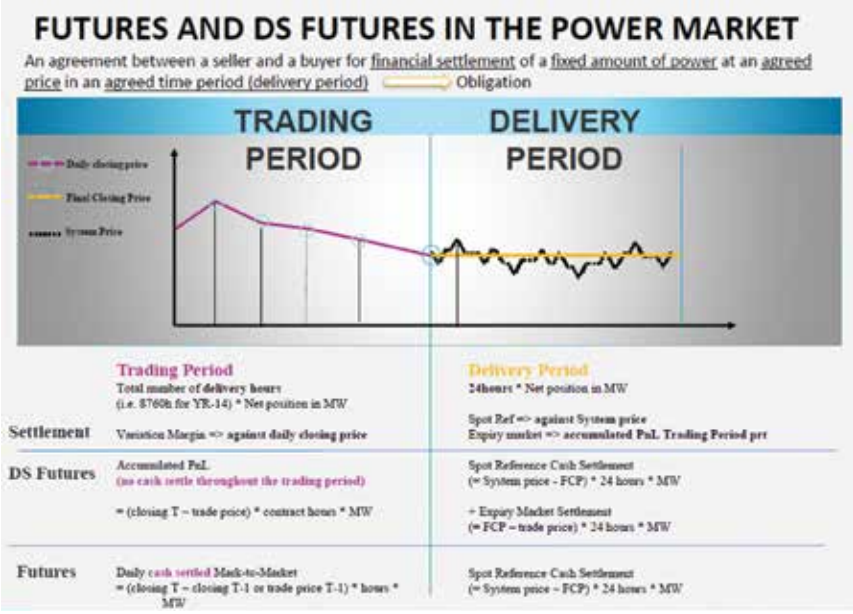


Figure 11: Power Derivatives: Future and DS Future (Rabbe, 2015)

Commercial Aspects of Power Transmission

Mr. Peter Jørgensen
Vice President
Energinet, Denmark

Ms. Christina Plum
Economist
Energinet, Denmark

Transmission Pricing and Congestion Management

Topics Covered

- Introduction of transmission pricing and principle
- Components of transmission pricing and methodology
- Congestion management
- Imbalance management process
- Scheduling and dispatch

The pricing system for the access to the grid is more or less similar among the Scandinavian countries, each using a point-of-connection tariff to compute the access charges. These charges are more or less intended to recover the costs for managing the transmission network and are controlled by country-specific regulatory offices. They should be based on objective calculations, so that users can estimate their transmission costs.

The basic principle of the point-of-connection tariff is that payment in one point, the point of connection, gives access to the whole network system, and thus the whole electricity market place. This means that consumers or producers connected to a local network pay network fees only to the owner of that network. This payment allows them to trade electricity with any other player within the entire national network system. Similarly, the local network owner will pay network fees to the appropriate regional network owner, which will pay fees to Svenska Kraftnät for use of the national transmission network. That is more or less the same logic as the postage stamp principle, which consists of applying the same charge for each consumer or producer according to the level (national, regional and local) of his/her connection point.

Table 3: Transmission Pricing Mechanism in Nordic Region

	Norway	Sweden	West Denmark	East Denmark	Finland
Access fee	Point-of-connection tariff	Point-of-connection tariff	Point-of-connection tariff	Point-of-connection tariff	Point-of-connection tariff
Loss pricing	Differentiated tariff based on marginal loss rates at each connection point	Differentiated tariff based on marginal loss rates at each connection point	Postage stamp only to consumers	Postage stamp only to consumers	Differentiated postage stamp for the customers, uniform postage stamp for the generator
Congestion pricing	Market splitting (sometimes counter trade)	Counter trade	Counter trade	Counter trade	Counter trade

*Differentiated postage-stamp means that the tariff changes according to the time period of the transmission.

Congestion Management: Structural congestions are removed or reduced by grid investments whenever socioeconomically viable, otherwise market splitting is applied. Temporary congestions shall be handled by counter trade (redispatching). The income from congestion management is used for investments in transmission.

Old Congestion Management: Sweden and Norway have different philosophies of congestion management. The existing system permits these philosophies to coexist without conflict. Norway seeks to effectively prevent congestion by using the spot market settlement process. When congestion is predicted, the system operator declares that the system is split into price areas at predicted congestion bottlenecks. Spot market bidders must submit separate bids for each price area in which they have generation or load. If no congestion occurs during market settlement, the market will settle at one price, which will be the same as if no price areas existed. If congestion does occur, price areas are separately settled at prices that satisfy transmission constraints. Areas with excess generation will have lower prices, and areas with excess load will have higher prices.

Sweden's philosophy is that the transmission system should not affect the market solution. Consequently, Sweden is always a one-price area. However, Sweden varies the capacity charge portion of its point tariff based on geography. Power flow in Sweden is always from north to south, so generation is charged more, and load less, in the northern part of the country. This affects generation costs, and thus the bids made to the market, deterring some congestion. Congestion in post-market schedules or appearing in real time is corrected by purchase of generation raise and lower energy blocks from the system operator regulating markets. This is known as buyback.

In Denmark, congestions between the two price areas DK West and DK East is handled via market splitting. Internally in the two areas, congestions are handled via counter trade.

Imbalance Management: In the Nordic Balance Settlement model, the settlement of BRPs' imbalances is based on a harmonized Nordic model implemented in all Nordic countries in

2009. There are two imbalances calculated and settled in the model: production imbalance and consumption imbalance. Production imbalance volume is calculated as the deviation between metered productions, planned production and imbalance adjustment. Consumption imbalance is calculated as the deviation between metered consumption, planned production, trades and imbalance adjustment.

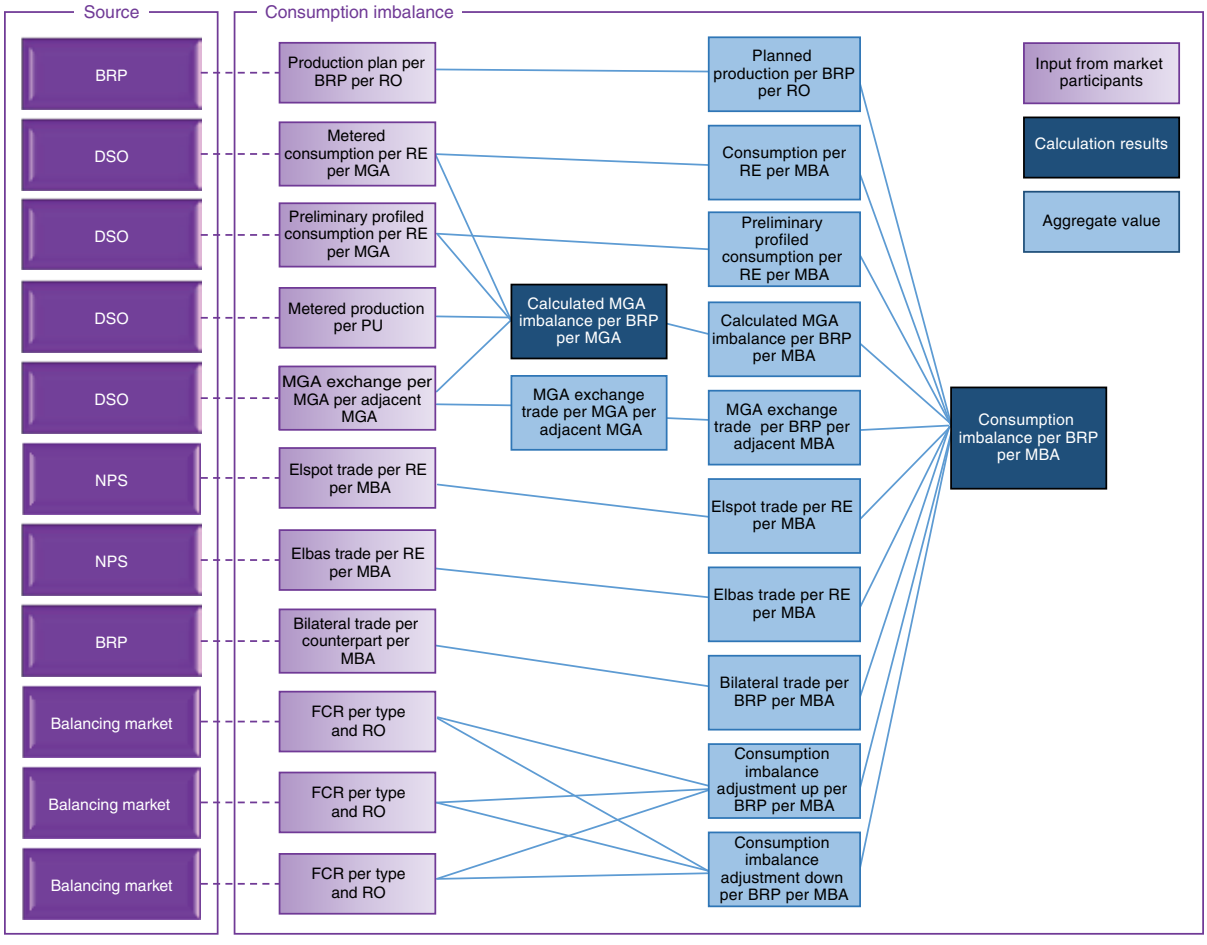


Figure 12: Consumption imbalance settlement (Handbook, 2015)

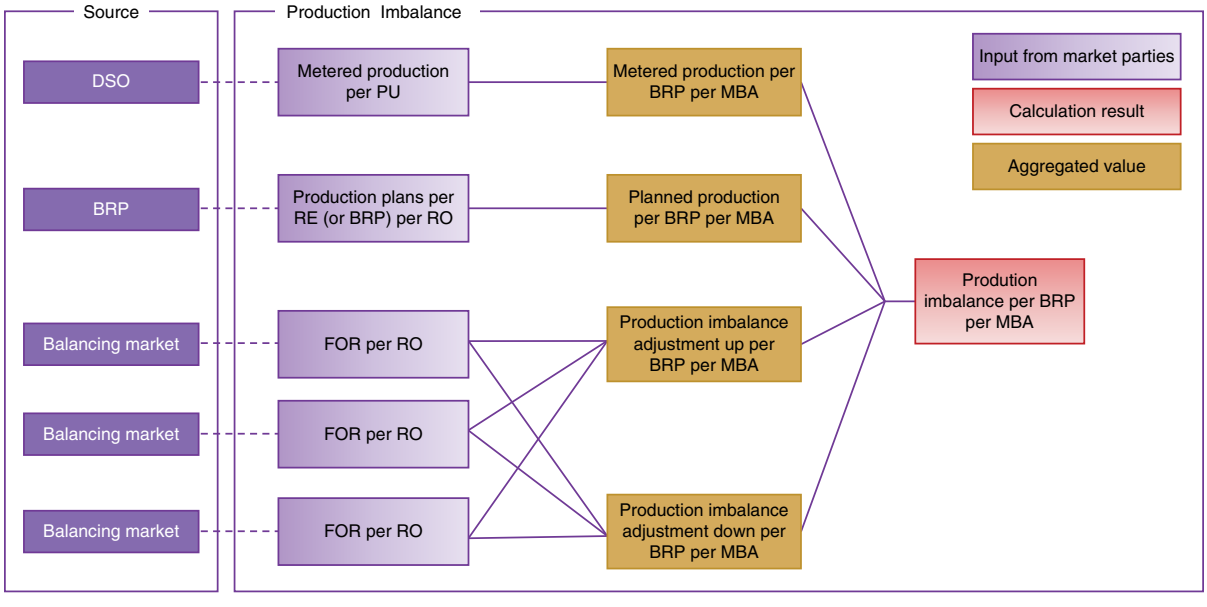


Figure 13: Calculation of production imbalance settlement (Handbook, 2015)

Nordic Imbalance Settlement Handbook Instructions and Rules for Market Participants was published in 2015 to provide an overview to the Nordic Imbalance Settlement Model from the market participant's perspective.

Scheduling and Dispatch

The total volume traded at Nord Pool Spot in 2013 was about 88% of the total Nordic electricity consumption. Generation and transmission scheduling in Nordic region primarily takes place in the price coupled integrated Nordic day-ahead market. Figure 16 gives an overview of actions and processes in the different markets: day-ahead, intraday and regulating power markets, how they are interlinked with the reserve markets (capacity reserve for regulating power market and primary reserve market) and form the basis for the TSO's daily operation and control.

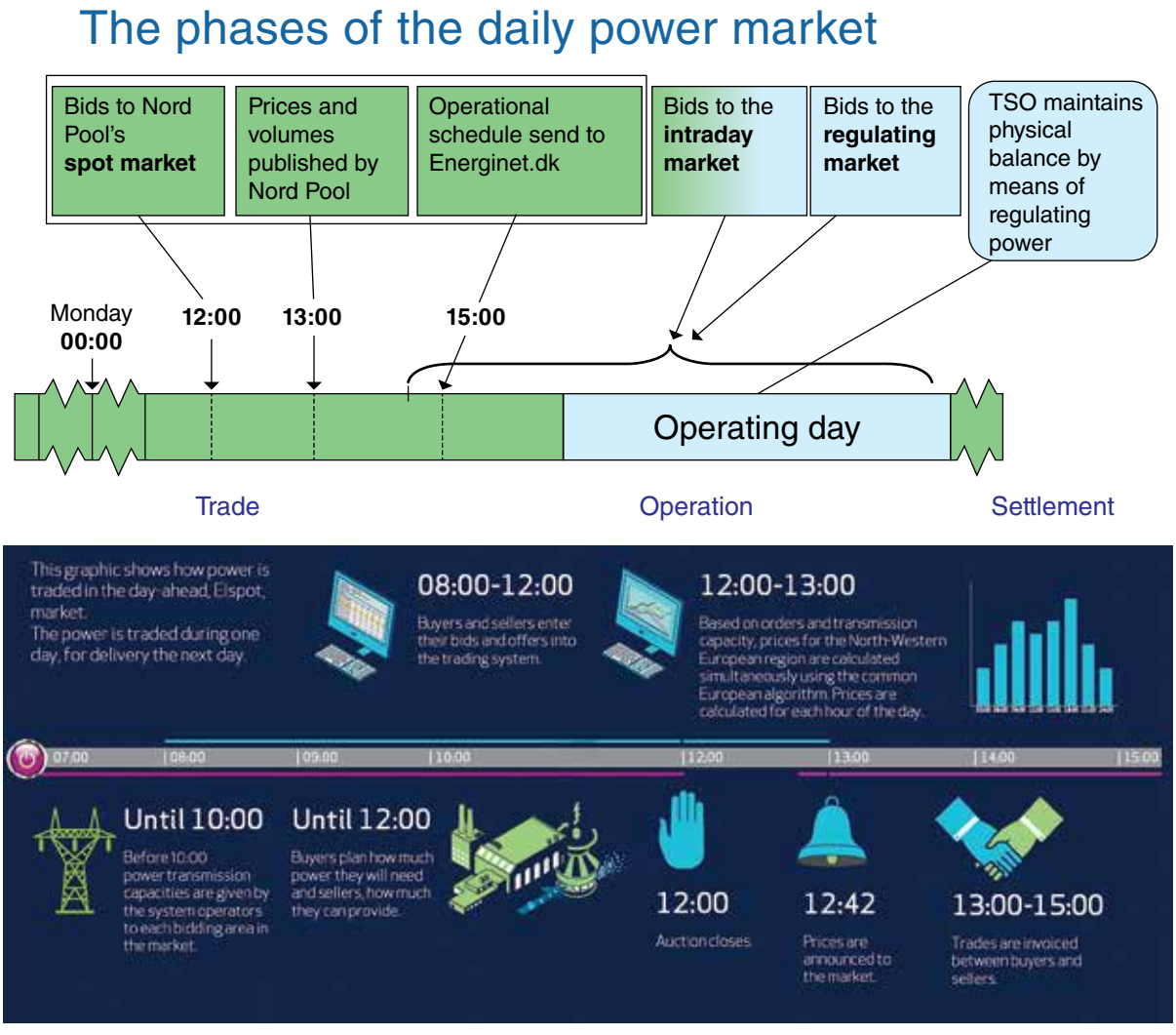


Figure 14: Daily Power Market Scheduling and Dispatch Timeline (Leknes, 2015)

Each day before 12 AM, the market actors in the whole of Nordic countries give in their bids to the market operator for generation and demand.

Planning and Operational Aspects of CBET – TSOs

Antje Orths
Senior Engineer, Electricity Market
Energinet, Denmark

The Nordic TSOs have a long history of successful cooperation within grid development. Three common Nordic grid master plans have been developed in the last 10 years in the context of Nordel, the previous cooperative organization for the Nordic TSOs. The present plan follows along the lines of the Nordic Grid Development Plan 2012 based on the ENTSO-E joint regional planning.

The Nordic cooperation on grid development now takes place within the wider regional context provided by the regional groups North Sea and Baltic Sea of ENTSO-E, the European organization for TSOs, in addition to bilateral cooperation when required.

Topics Covered

- Nordic cooperation for transmission planning
- Cost benefit analysis
- Nordic Grid Development Plan 2014
- Operational collaboration between Nordic countries
- Development of a common Nordic Balance Settlement

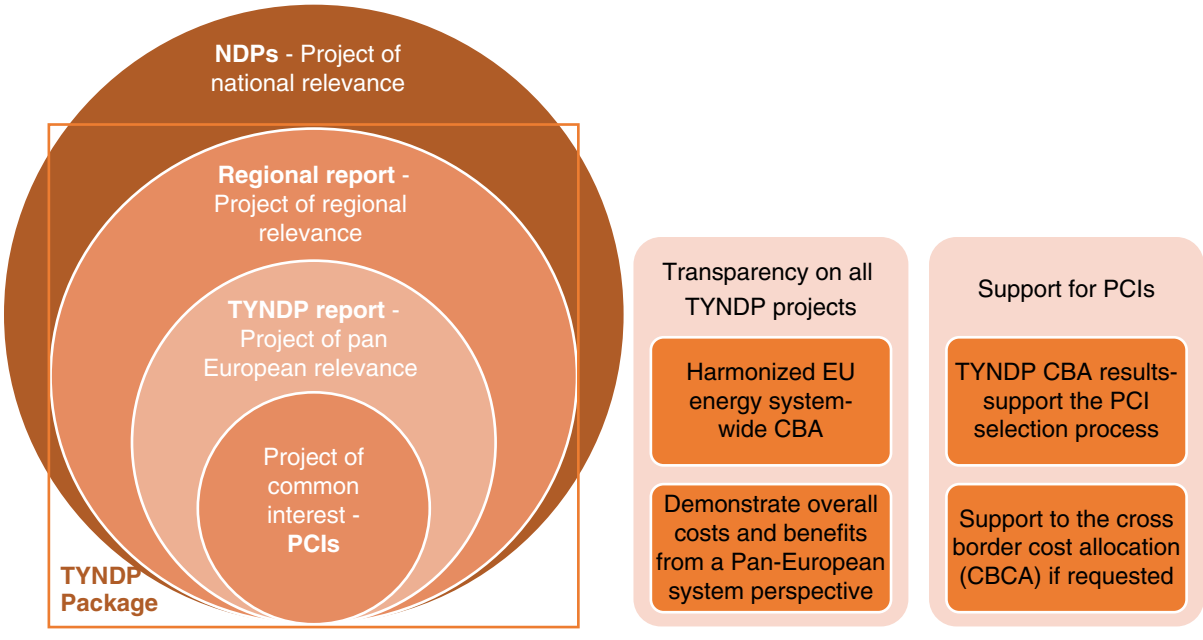


Figure 15: TYNDP Package (Orths, 2015)

The Nordic Grid Development Plan 2014 is prepared as a response to the request from the Nordic Council of Ministers dated 28 October 2013. The plan is prepared by Energinet.dk, Fingrid, Statnett and Svenska Kraftnät, and the Icelandic TSO Landsnet has provided input regarding the Icelandic grid. The plan presents Nordic grid investment candidates and their evaluation with a time horizon up to 2030.

The Nordic TSOs have a long tradition of cooperating in grid and market development in order to secure the supply of electricity to the consumers, based on a regional perspective. This tradition continues to this day in the ENTSO-E particularly, as well as in specific joint studies where two or more TSOs participate and in business case studies where interconnector projects are matured and decided.

The plan is founded on the analysis and studies done commonly in the two regional groups where an even larger area has been the focus of the study, according to the regions defined within ENTSO-E. Common market and grid analyses were performed and based on a number of scenarios and sensitivities. As such, this plan contains no new information compared to the ENTSO-E TYNDP 2014 package. The results are shown for the Nordic area especially in Figure 17.

Cost Benefits Analysis

- General Assessment Method
- How to ensure that benefits outweigh costs?
- Glance at single Indicators
- Handling of uncertainties

	Project assessment									
Criteria	Grid Transfer Capacity Increase	Socio-economic Welfare	RES integration	Improved security of supply	Losses variation	CO_2mitigation	Technical resilience	Flexibility	Social and environmental	Project cost
	MW	M€/year	MWh/year	MWh/year	M€	Mt				M€
Project A	1000	150	500			0,5	+++	++		650
Project B	500	30		3000	20		++			25
Project C	800	225	3000		10	1	++	+++		150

Figure 16: Cost Benefit Analysis (CBA) for deciding the transmission connectivity requirement (Orths, 2015)

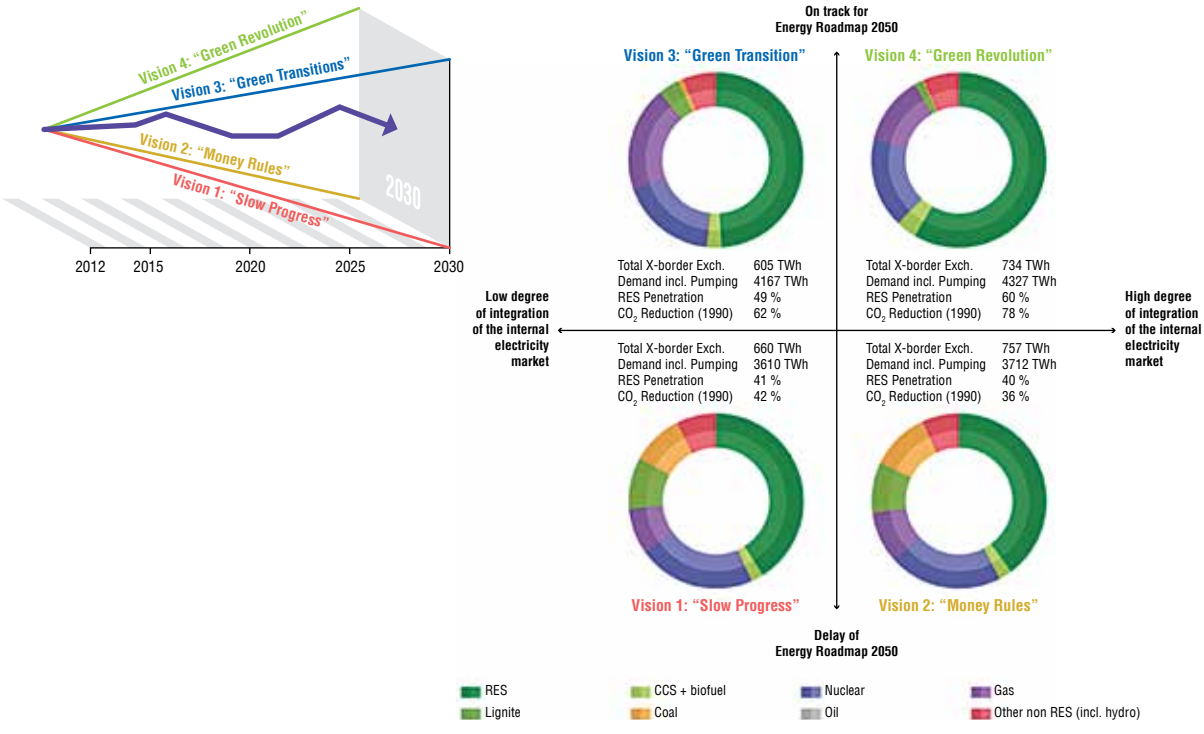


Figure 17: TYNDP-2014 explores four different vision of development until 2030 (Orths, 2015 & TYNDP-2014)

Operational Collaboration

System Operation Agreement: 'Regarding operation of the interconnected Nordic power system' Prepared by ENTSOE - The subsystems of Norway, Sweden, Finland and Eastern Denmark are synchronously interconnected, forming the so-called synchronous system. Effective collaboration between these will provide the technical prerequisites for trading in power on an open electricity market. The agreement regulates the operational collaboration between the parties. Several of the agreement's provisions are based on recommendations issued by Nordel.

The objective of the agreement is to make use of the advantages arising from the interconnected operation of the Nordic power system. The parties shall thus jointly uphold the interconnected operation of the Nordic power system on a satisfactory level of reliability and quality.

Development of a common Nordic Balance Settlement: A new operational company, eSett, has been established in Finland. The company is owned by Fingrid, Svenska Kraftnät and Statnett. The company will act and operate in the role of Nordic Imbalance Settlement Responsible. It must be noted that the national regulations stipulate that each national TSO is still ultimately responsible for balancing operations.

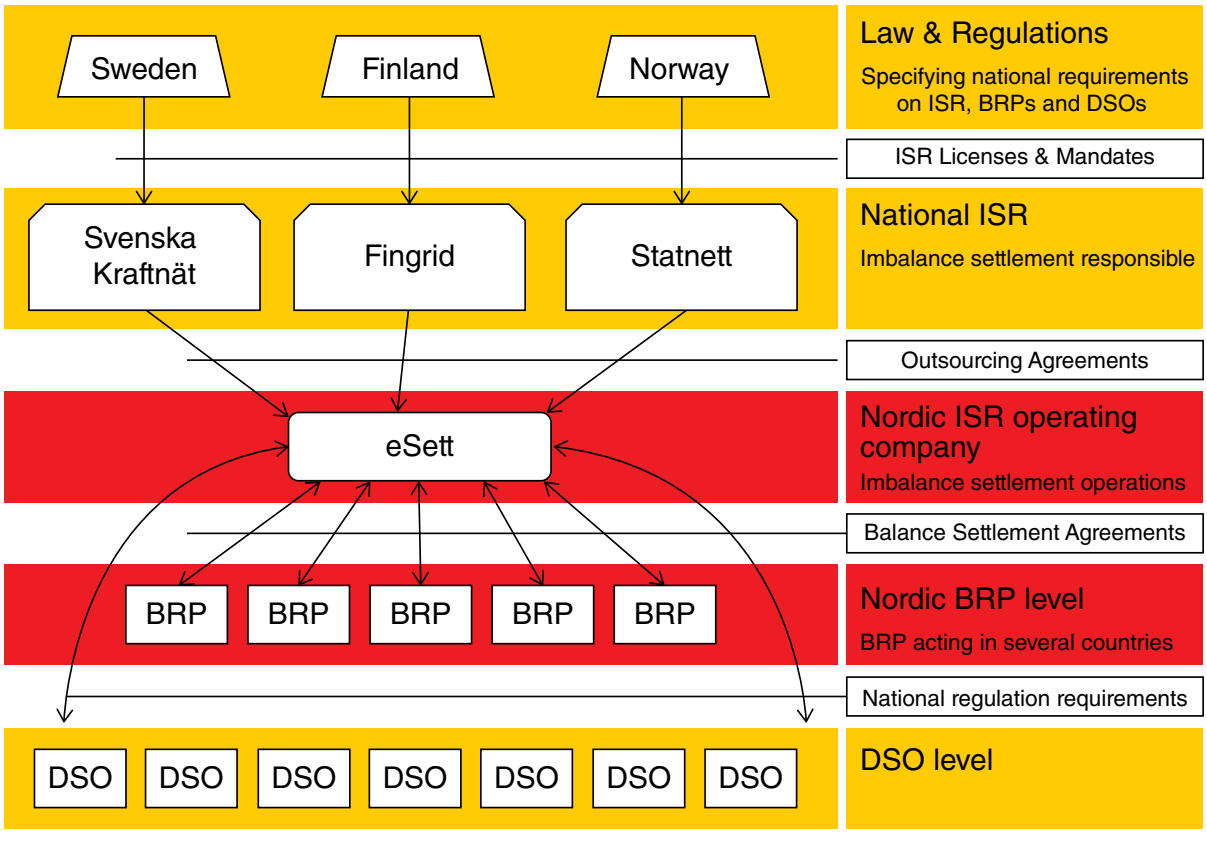


Figure 18: Operational collaboration of functional entities. (eSett, 2015)

Nordic Grid Code 2007

Knud Johansen
Senior System Engineer,
Energinet Denmark

Topics Covered

- Purpose of Nordic Grid Code
- Components of Nordic Grid Code
- Nordic Grid Code and national rules coordination

The purpose of the Nordic Grid Code is to achieve coherent and coordinated Nordic operation and planning between the companies responsible for operating the transmission systems, in order to establish the best possible conditions for development of a functioning and effectively integrated Nordic power market. A further objective is to develop a shared basis for satisfactory operational reliability and quality of delivery in the coherent Nordic electric power system. The operational code and data exchange code are binding agreements with specific dispute resolution.

The Nordic Grid Code concerns the TSOs, the operation and planning of the electric power system and the market actors' access to the grid. The code lays down fundamental common requirements and procedures that govern the operation and development of the electric power system.

The Nordic Grid Code consists of

- General provisions for cooperation
- Planning Code
- Operational Code (System Operation Agreement)
- Connection Code
- Data Cxchange Code (Data Exchange Agreement between the Nordic TSOs)

The Operational Code and the Data Exchange Code are binding agreements with specific dispute solutions. The Planning Code and the Connection Code are rules that should be observed. They correspond to Nordel's recommendations in these areas.

The Nordic Grid Code governs technical cooperation between the TSOs in the interconnected Nordel countries: Norway, Sweden, Finland and Denmark. Ideally, the planning, expansion and operation of all the subsystems would be governed by identical rules. However, this is not yet the case, partly for historical reasons and partly because the different subsystems are subject to different legislation and to supervision by different official bodies. However, an objective is that the Nordic Grid Code should be a starting point for the harmonization of national rules, with minimum requirements for technical properties that influence the operation of the interconnected Nordic electric power system.

The Nordic Grid Code must however be subordinate to the national rules in the various Nordic countries, such as the provisions of legislation, decrees and the conditions imposed by official bodies.

The first edition of the Nordic Grid Code was based on Nordel's former rules (recommendations), the system operation agreement, the Data Exchange Agreement and national codes.

Integration of Renewables in the National Grid

Gitte Agersbæk
Team Leader
Energinet, Denmark

Topics Covered

- Denmark's long-term plan for renewable energy
- Pathway for achieving the target
- Key consideration for high renewable energy integration

Denmark has a strong transmission grid that is monitored and maintained closely by a single owner, Energinet, which is managed directly by the Ministry of Climate and Energy. Consequently, Energinet's efforts very closely align with strategic government policy, including policies regarding wind power deployment.

Europe is in the middle of a historic transition of the energy system and Denmark has a leading position in it. The Denmark has a long-term plan for high penetration of renewable energy in the energy system.

- 2020: Wind power will constitute 50% of the electricity consumption
- 2035: Electricity and heating systems must be fossil-free
- 2050: Denmark must be fossil-independent

In 2009, Energinet developed a holistic plan for the complete overhaul of the high-voltage grid to enable Denmark to meet the 50% wind power by 2020 target. The plan, when implemented, will also address the single greatest non-economic barrier to wind power—public antipathy to new grid infrastructure—by undergrounding much of the high-voltage grid. Grid connection is, at worst, only a slight barrier to variable renewable energy deployment in Denmark, as grid companies have taken swift action to expedite connections.

Denmark is taking important steps to reinforce this position, with a new cable to Norway and a new link to the Netherlands. Trading of controllable power resources to complement variable renewable energy output can be traded across the entire Nordic market. This ability to share resources extends right up to the time of operation, through a shared regulating power market. Wind producers are exposed to the market; they sell their power into it, and if they are out of balance at settlement time, they incur costs. This encourages them to keep as close as possible to their output forecast, and they are compensated to some extent with flat payments on top of the feed-in premium. On land, wind curtailment is a measure of last resort, and is compensated. New offshore wind farms may receive notice to control their production in several ways.

Domestic flexibility is being enhanced with more flexible operation of very common CHP plants, plans for electric vehicles and large-scale deployment of smart meters. Using negative prices in the spot markets adds incentive to controllable and variable power plants alike to give more consideration to the needs of the market. Offshore wind turbines can be not only curtailed but also operated below maximum so that they can provide upregulation if needed. Today wind turbines participate in the market, and downregulation is done voluntarily on market-based terms.

System operation is overseen by a single TSO, Energinet, and has become significantly more complex over the last 20 years. Energinet and the Danish power producers have pioneered practices to manage this complexity. Denmark was the cradle of output forecasting techniques, and it continues to lead the development of system operation planning tools.

List of References

1. Bahar; Sauvage, 2013. Cross-Border Trade in Electricity and the Development of Renewables-Based Electric Power: Lesson from Europe
2. Castalia, 2009. International Experience with Cross-Border Power Trading
3. Economic Consulting Associates, 2010. The Potential of Regional Power Sector Integration
4. Electricity Transmission Tariffs in the Nordic Countries: An Assessment of Pricing Rules 2009
5. ESMAP, 2011. Regional Power Integration: Structural and Regulatory Challenges
6. Nordel, 2007. Nordic Grid Code 2007 (Nordic Collection of Rules)
7. Nordic Grid Development Plan 2014
8. Nordic Imbalance Settlement Handbook Instructions and Rules for Market Participants 2015
9. Nord Pool ASA, 2004. The Nordic Power Market Electricity Power Exchange across National Borders
10. Nord Pool Spot, 2013. Central to European Power Integration Annual Report 2013
11. NordREG, 2006. Development of a Common Nordic Balance Settlement
12. NordREG, 2006. Handling Extreme Situations in the Nordic Countries
13. NordREG, 2006. Nordic Market Report 2006
14. NordREG, 2007. Cost and Benefits of Nordic Retail Market Integration
15. NordREG, 2007. Congestion Management in the Nordic Region A Common Regulatory Opinion on Congestion Management
16. NordREG, 2007. Regulation of the Nordic TSOs- with focus on Market Efficiency and Harmonisation
17. NordREG, 2008. Congestion Management Guidelines Implementation within the Nordic Market
18. NordREG, 2008. Study on Cost-Benefit Analysis of Nordic Retail Market Integration
19. NordREG, 2014. Nordic Market Report 2014
20. NordREG, 2015. Work Programme 2015

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Program Agenda

Day 1: Introduction to Power Market (12th October 2015) Lysaker, Norway	
09:30-10:00	**Welcome address:** USAID **Keynote address:** SARI/EI, IRADe **Introductory Remarks:** Haakon Reiersen Leknes
10.00-11.00	SESSION I: Introduction to Nordic Power Market This session will cover: • Nordic power market installed capacity. • Energy mix of Nordic countries. • Driving force for Nordic countries integration. • Import and export of last 10 years in the Nordic Power market. • Process of evolution of regional power market in Nord Pool region. • Timeline and evolution of regional power market.
11:00-11:15	TEA BREAK
11.15-12.30	Session Continued….
12.30-13.30	LUNCH
13.30-15.00	SESSION II: Role of the Market Institutions in Nord Pool This session will cover: • Regulatory structure at regional level. • Transmission system related activity at regional level. • Long term coordinated plan at regional level. • Regional power trade and exchange in Nordic Power market.
15.00-15.15	TEA BREAK
15:30-17:00	SESSION III: A Market Participants View *Site Visit I: Statkraft – A Large Market Participant* This session will cover: • Statkraft overview • EMPS- Power Market simulator methodology. • Statkraft production planning • Factors for deciding the strategic decision.

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Day 2: Power exchange and its related aspects (13th October 2015) Lysaker, Norway	
09:30-11:00	SESSION IV: Power Exchange Overview This session will cover: • Introduction to power exchange. • Market products such as day ahead market, intra-day market, ancillary/reserves etc. • Regional market integration • Price discovery and market coupling.
11:00-11:15	TEA BREAK
11.15-12.30	SESSION V: Market Coupling and Cross-Border Electricity Trade This session will cover: • Explicit and implicit auction. • Tools for balancing power market. • Types of Market Coupling: Price and Volume coupling.
12:30-13:30	LUNCH
13.30-14.30	Session Continued….
14:30-17:00	SESSION VI: Presentation of the Tasks and Systems used on the Trading Desk *SITE VISIT II: Trading Desk Visit: Nord Pool* • Trading desk functionality visit • Importance and utility of trading desk • Key issue needs to be addressed
Day 3: Commodity Market (14th October 2015) Lysaker, Norway	
09:30-11:15	SESSION VII: Commodity Market and Financial Market including Future Market This session will cover: • Overview of the financial and commodity market in the Nord Pool. • Key elements required in a well-functioning of future market. • Operation of the financial power derivative market.
11.15-11.30	TEA BREAK
11:30-12:30	*TESLA Test Drive* This session will cover: • Basic information about the electric vehicle (EV) and its popularity in Europe. • Test drive of TESLA
12:30-13:30	LUNCH
	Transit Norway to Denmark
Day 4: Commercial and Operational Aspects related to CBET (15th October 2015) Fredericia Denmark	
9.30-10.00	Welcome address at Denmark
10.00-11.00	SESSION VIII: Commercial Aspects of Power Transmission This session will cover: • Introduction of transmission pricing and principle • Components of transmission pricing and methodology • Congestion management. • Scheduling and dispatch

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11.00-11.15	TEA BREAK
11.15-12.30	Session Continued……
12:30-13:30	LUNCH
14:30-17:00	SESSION IX: Planning and Operational Aspects of CBET *SITE VISIT IV: Energinet - The Danish TSO* This session will cover: • Nordic Cooperation for transmission planning • Cost Benefit Analysis • Nordic Grid Development Plan 2014 • Operational Collaboration between Nordic countries • Development of a Common Nordic Balance
Day 5: Technical and Renewable Energy related Aspects (16th October 2015) Fredericia Denmark	
9.30-11.30	SESSION X: Nordic Grid Code-2007: Regional Grid Code This session will cover: • Purpose of Nordic Grid Code • Components of Nordic Grid Code • Nordic Grid Code and National Rules Coordination
11:15-11:30	TEA BREAK
11.30-12.30	SESSION XI: Integration of Renewables in the National Grid This session will cover: • Denmark long term plan for Renewable Energy • Pathway for achieving the target • Key consideration for high renewable energy
12:30-13:30	LUNCH
13:30-15:30	SESSION XII: Study Tour Summary This session will cover: • Recap of study tour and discussion on findings. • Feedback session with the participants.

Annexure

Environment Friendly Electric Vehicle

Peter Tonning Olsen
TESLA Team Representative, Norway

Visiting Team got an opportunity for Tesla test drive by Mr. Peter Tonning-Olsen (TESLA representative). He and TESLA team provided basic information about the electric vehicle (EV) and its popularity in Europe. Tesla Motors, Inc. is an American Automotive and Energy Storage Company that designs, manufactures, and sells luxury electric cars, electric vehicle power train components, and battery products.

An electric vehicle (EV), also referred to as an electric drive vehicle, uses one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery or generator to convert fuel to electricity.

Topics Covered

- Basic Understanding of Electric Vehicle Operation.
- Experience of smooth functioning of TESLA drive.
- Environmental Benefits of Electric Vehicle and TESLA popularity.

Photographs of the Study Tour

Nord Pool Trading Desk


Statkraft Head Office- Norway

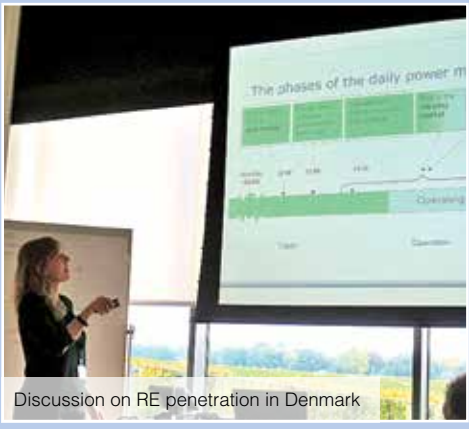

SARI/EI Team for Nord Pool visit

Nord Pool Spot office


Presentation and discussion during Statkraft visit

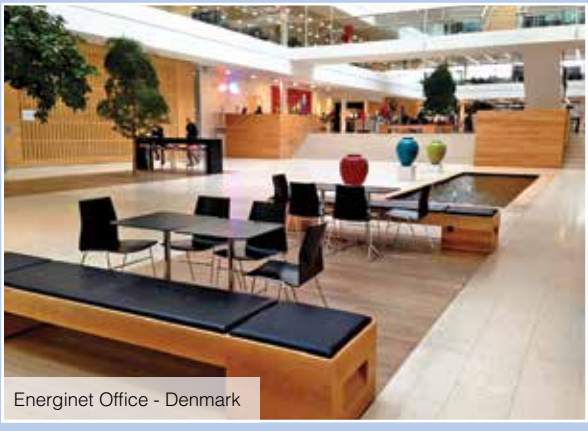

Transmission rights discussion during Nord Pool visit

SARI/EI team with Nord Pool representative



Discussion on RE penetration in Denmark

Energinet Office, Denmark



Energinet Office - Denmark

Discussion on Nord Grid Code - Energinet office

OFGEM Office Norway

Oslo Lakeside view, Norway

About SARI/EI

Over the past decade, USAID's South Asia Regional Initiative/Energy (SARI/E) has been advocating energy cooperation in South Asia via regional energy integration and cross-border electricity trade in eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Pakistan, Nepal, Sri Lanka and the Maldives). This fourth and the final phase, titled South Asia Regional Initiative for Energy Integration (SARI/EI), was launched in 2012 and is implemented in partnership with Integrated Research and Action for Development (IRADe) through a cooperative agreement with USAID. SARI/EI addresses policy, legal and regulatory issues related to cross-border electricity trade in the region, promote transmission interconnections and works toward establishing a regional market exchange for electricity.

About USAID

The United States Agency for International Development (USAID) is an independent government agency that provides economic, development, and humanitarian assistance around the world in support of the foreign policy goals of the United States. USAID's mission is to advance broad-based economic growth, democracy, and human progress in developing countries and emerging economies. To do so, it is partnering with governments and other actors, making innovative use of science, technology, and human capital to bring the most profound results to a greatest number of people.

About IRADe

IRADe is a fully autonomous advanced research institute, which aims to conduct research and policy analysis and connect various stakeholders including government, non-governmental organizations (NGOs), corporations, and academic and financial institutions. Its research covers many areas such as energy and power systems, urban development, climate change and environment, poverty alleviation and gender, food security and agriculture, as well as the policies that affect these areas.

For more information on the South Asia Regional Initiative for Energy Integration (SARI/EI) program, please visit the project website:

www.sari-energy.org