Case Study of a Hypothetical Power Trade in ASEAN

4th Annual International Forum on Interconnectivity and Cross-Border Trade

14 March 2013

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Agenda

1. **Actual cross-border transaction**
2. Hypothetical Thailand transaction
3. Case study of NordPool
4. Taxonomy of international examples

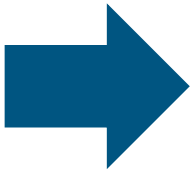
Short-term power export from Singapore to Malaysia – May/June 2011

- Maintenance shutdown of gas production platforms owned by Malaysian state oil company Petronas affected gas supply to the state electricity utility Tenaga Nasional Berhad (TNB)
- TNB approached Energy Market Authority of Singapore (EMA) in early April to buy electricity as there were projected to be capacity shortages due to lack of adequate gas feedstock supply.

Term Sheet	
Seller	PowerSeraya
Buyer	TNB
Quantity	180 MW
Price	$235/MWh (est.)
Dates	7-31 May 2011 4-15 June 2011

Export required regulatory approval by EMA and Minister of Trade and Industry

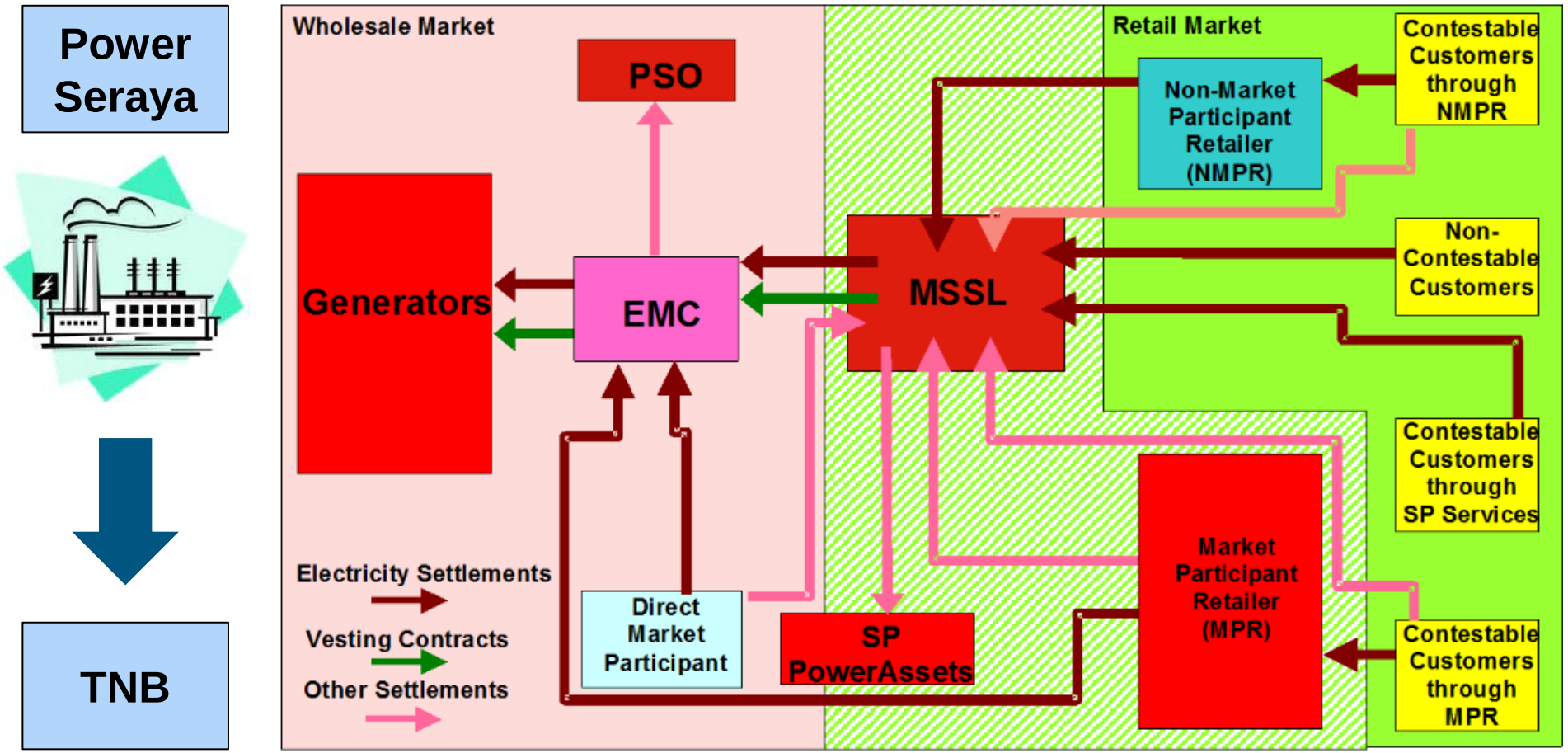
- Section 6(1)(d) of the Electricity Act states that "No person shall import or export electricity unless he is authorised to do so by an electricity licence granted under section 9 or is exempted under section 8"
- EMA has not issued any import or export licenses
- PowerSeraya had to obtain an exemption from Section 6(1)(d) from EMA



Exemption Order Conditions

- Generating unit used shall be SER G1 (250 MW steam unit burning HSFO)
- PowerSeraya shall not register the generating unit under the market rules
- PowerSeraya shall inject the electricity generated using the generating unit into the transmission system for purposes of the export
- PowerSeraya shall comply with any direction by the Authority to cease or suspend the export of electricity

Accordingly, the export sale occurred entirely outside the Singapore market



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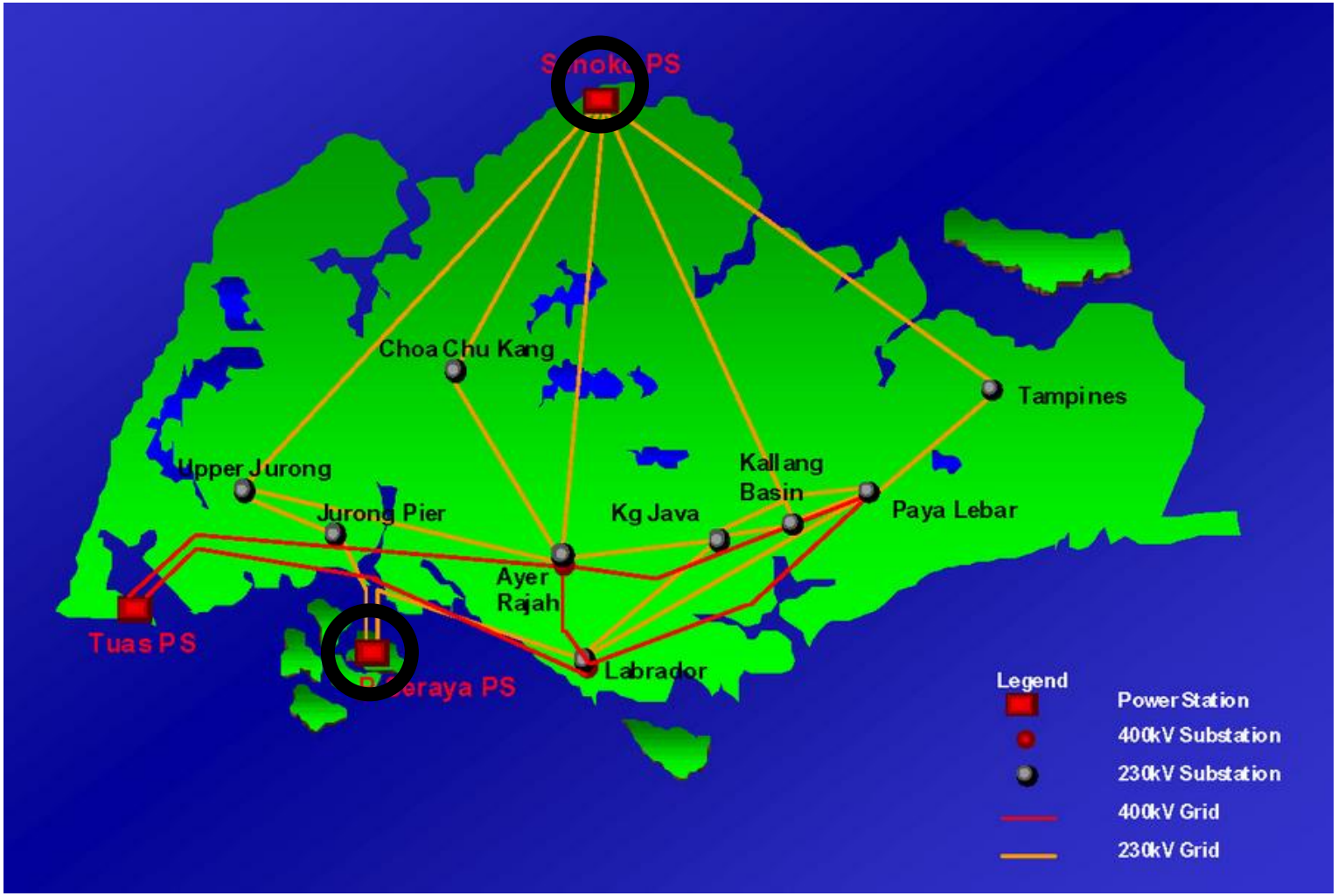
Nonetheless, the export required wheeling across the SP PowerAssets grid



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Cross-border wheeling transactions raise a number of potential regulatory issues

- Transmission access – ensuring that transmission service is available
- Wheeling charge – ensuring that service is provided at a fair price
- Physical or financial transmission rights – providing an ability to lock in the wheeling charge
- Generation sale price – ensuring that generation sales are provided at a fair price and are not cross-subsidized by regulated tariffs
- Congestion costs – determining how to allocate the rents associated with transmission congestion
- Uneconomic bypass – ensuring that wheeling transaction is actually economic and does not impose costs on other parties
- Economic interchange – ensuring that potentially economic wheeling transactions actually do occur

The structure of this deal largely addresses these issues

- Transmission access – independence of SP PowerAssets (SPPA) provides a strong incentive to offer service
- Wheeling charge – no direct reason for SPPA to price fairly
- Physical or financial transmission rights – negotiated charge provides financial certainty
- Generation sale price – competition between generators ensures fair energy pricing
- Congestion costs – lack of transparency in TNB's system operation makes estimation of congestion rents difficult
- Uneconomic bypass – TNB is an integrated monopoly, so there is no potential for bypass
- Economic interchange – interchange only arose due to emergency need; many potentially economic interchanges are missed

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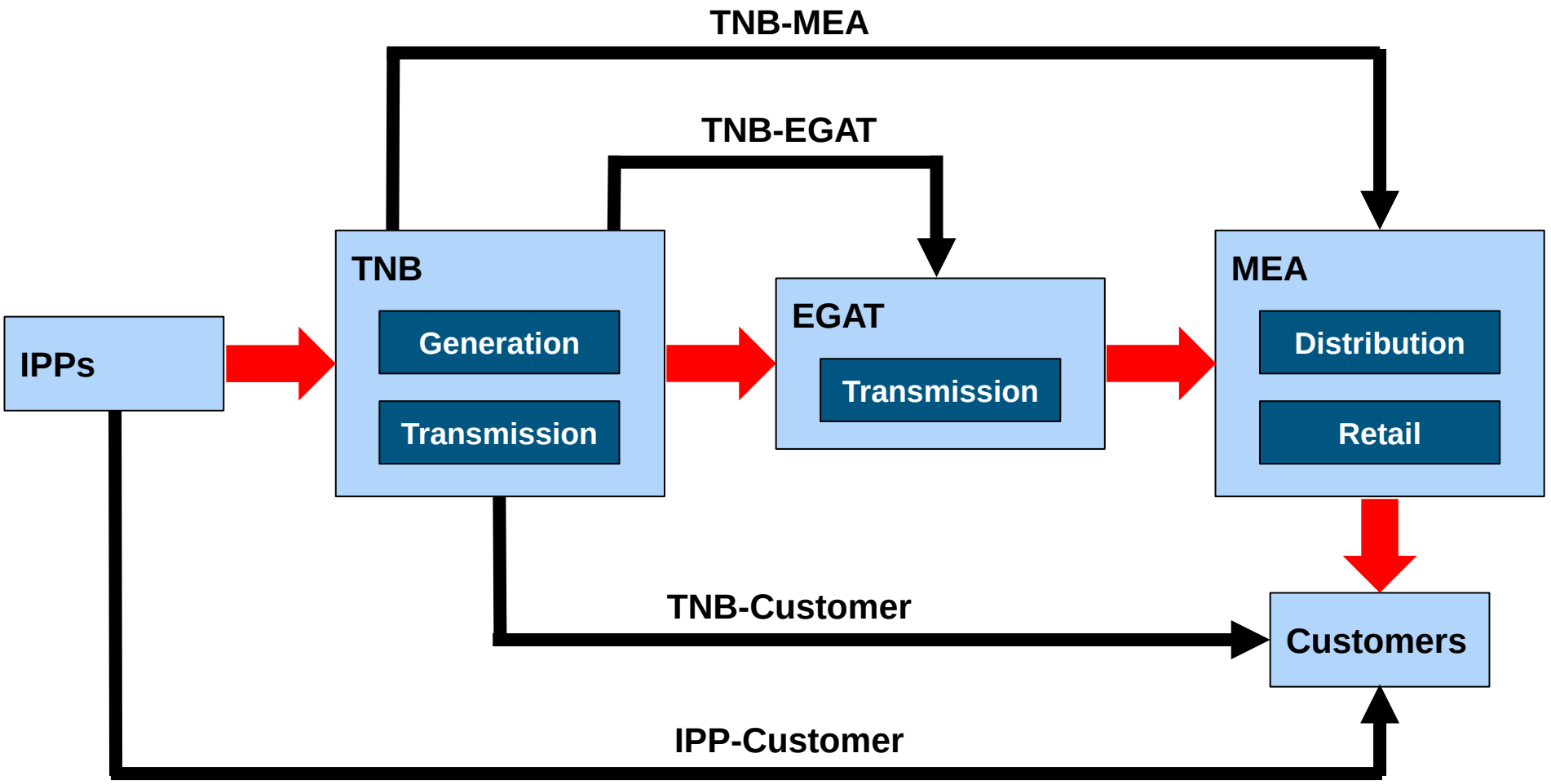
How might a hypothetical cross-border energy sale occur in Thailand?



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Each structure raises potential regulatory issues

Regulatory Issue	TNB–EGAT	TNB–MEA	TNB–Customer	IPP–Customer
Transmission access		Requires open access on EGAT system	Requires open access on EGAT and MEA	Requires open access on TNB, EGAT, and MEA
Wheeling charge		Requires EGAT wheeling charge	Requires EGAT and MEA wheeling charge	Requires TNB, EGAT, and MEA wheeling charge
Transmission rights		Need EGAT rights with congestion prices	Need EGAT and TNB rights with congestion prices	Need EGAT and TNB rights with congestion prices
Generation sale price	Negotiated, potential for cross-subsidy	Negotiated, potential for cross-subsidy	Negotiated, potential for cross-subsidy	Competitive, no potential for cross-subsidy
Congestion costs	Negotiated between TNB and EGAT	Depends on access to EGAT rights	Depends on access to EGAT and TNB rights	Depends on access to EGAT and TNB rights
Uneconomic bypass	Hard to ascertain	Need accurate energy pricing	Need accurate energy pricing	Need accurate energy pricing
Economic interchange	Little incentive	More incentive	More incentive	Most incentive

Transmission access

- Grid capacity is limited, so some mechanism must exist to ration access – e.g., first come, first served; allocation of physical rights; price-based
- Access also requires fair connection and grid expansion policies
- Point-to-point grid capacity depends on network flows – both physical and financial rights exist to deal with these problems
- If transfer capacities are defined broadly, physical rights risk curtailment; if defined conservatively, transfer capacity may be used inefficiently
- Price-based methods ensure efficient use, but can result in highly variable congestion charges

Wheeling charges

- Efficient wheeling charges must lie between the short-run marginal costs of service and the alternative cost of providing service – which typically leaves considerable latitude
- On a congested transmission network, the true short-run marginal costs of service will include congestion costs
- Pricing generally distinguishes firm service (which requires dedicated capacity) from non-firm service that is simply an opportunistic use of excess capacity
- Wheeling charges may also include the cost of implicit energy back-up in the event that a scheduled wheeling transaction does not occur
- Wholesale energy markets explicitly provide such back-up service, but at an uncertain cost

Transmission rights

- Buyers and sellers in wheeling transactions seek guaranteed delivery at a known cost
- As stated, the point-to-point physical capacity of the network varies – thus physical transmission rights will result in possible curtailment or inefficient allocation
- Zonal or nodal wholesale energy markets ensure put-in and take-out access – but the marginal cost of "wheeling" is subject to uncertain congestion charges
- Financial transmission rights (FTRs) allow buyer and sellers to hedge these congestion cost risks
- In the absence of wholesale energy markets, transmission system operators (TSOs) generally bear these congestion costs – which then become part of the allowed revenues for the regulated business

Generation sale price

- Wholesale energy markets provide clear measures of short-run marginal costs (SRMCs) that can be used to price both short-term and long-term power sales
- In the absence of wholesale energy markets, cost-based dispatch protocols by each system operator (SO) can yield good SRMC estimates
- Such SRMC estimates support generally efficient economy energy interchange via "split-savings" calculations
- Absent clear and observable cost-based dispatch protocols, SRMCs may be hard to estimate and unobservable
- Unobservable SRMCs then require active negotiation of each power sale – which inhibits use of short-term opportunistic interchange
- Unobservable SRMCs also create opportunities for cross-subsidies between captive regulated customers and discretionary off-system power sales

Congestion costs

- Network congestion occurs when a unit with a low SRMC must be backed down in preference to a generator with a higher SRMC, in order to avoid violating transmission constraints
- On such a congested transmission network, effecting a wheeling transaction may therefore give rise to incremental congestion costs
- Failure to incorporate these congestion costs into the wheeling tariff forces regulated on-system customers (or the TSO) to subsidize the wheeling transaction
- Congestion at system boundaries gives rise to rents that must be allocated among buyer, seller, and neighboring TSOs (and perhaps the SOs as well)
- Nodal wholesale energy markets account for these costs at every node; zonal markets account for congestion across key interfaces, but “socialize” congestion costs within zones
- TSOs are aware of these costs, even if they cannot accurately quantify them – and the desire to avoid such costs may act as a barrier to open access

Uneconomic bypass

- Uneconomic bypass results when the wheeling transaction creates rents for buyer and seller, but increases total system costs
- Uneconomic bypass can result from many sources:
  - Energy tariffs do not reflect seasonal and time-of-day variation
  - Energy tariffs are static and do not reflect SRMCs under current system conditions
  - Energy tariffs do not reflect the locational value of energy (via congestion and marginal loss charges)
  - Energy tariffs allocate fixed charges too broadly (i.e., across too many hours)
  - Energy tariffs do not incorporate the cost of back-up service associated with the implicit or explicit obligation to serve
  - Transmission and distribution tariffs misallocate fixed costs
- Incumbent utilities often cite the potential for uneconomic bypass as an argument against open access

Economic interchange

- Economic interchange – via long-term firm energy transfers, short-term economy energy, or reserves sharing – lowers overall system costs and can generate rents for both buyer and seller
- Maximizing the value of economic interchange is impossible unless both buying and selling systems can easily and routinely assess incremental costs and benefits
- Long-term firm energy transfers often occur when neighboring countries have unequal native fuel resource endowments (and often unequal demands for power)
- Short-term interchange is more common when neighboring systems have different technology/fuel mixes and where imports and exports are more balanced
- Regulatory structures often do not reward integrated monopolies and single buyers for pursuing economic interchange – or may create incentives for cross-subsidy
- Desire for “energy security” may also hinder the development of cross-border economic interchange

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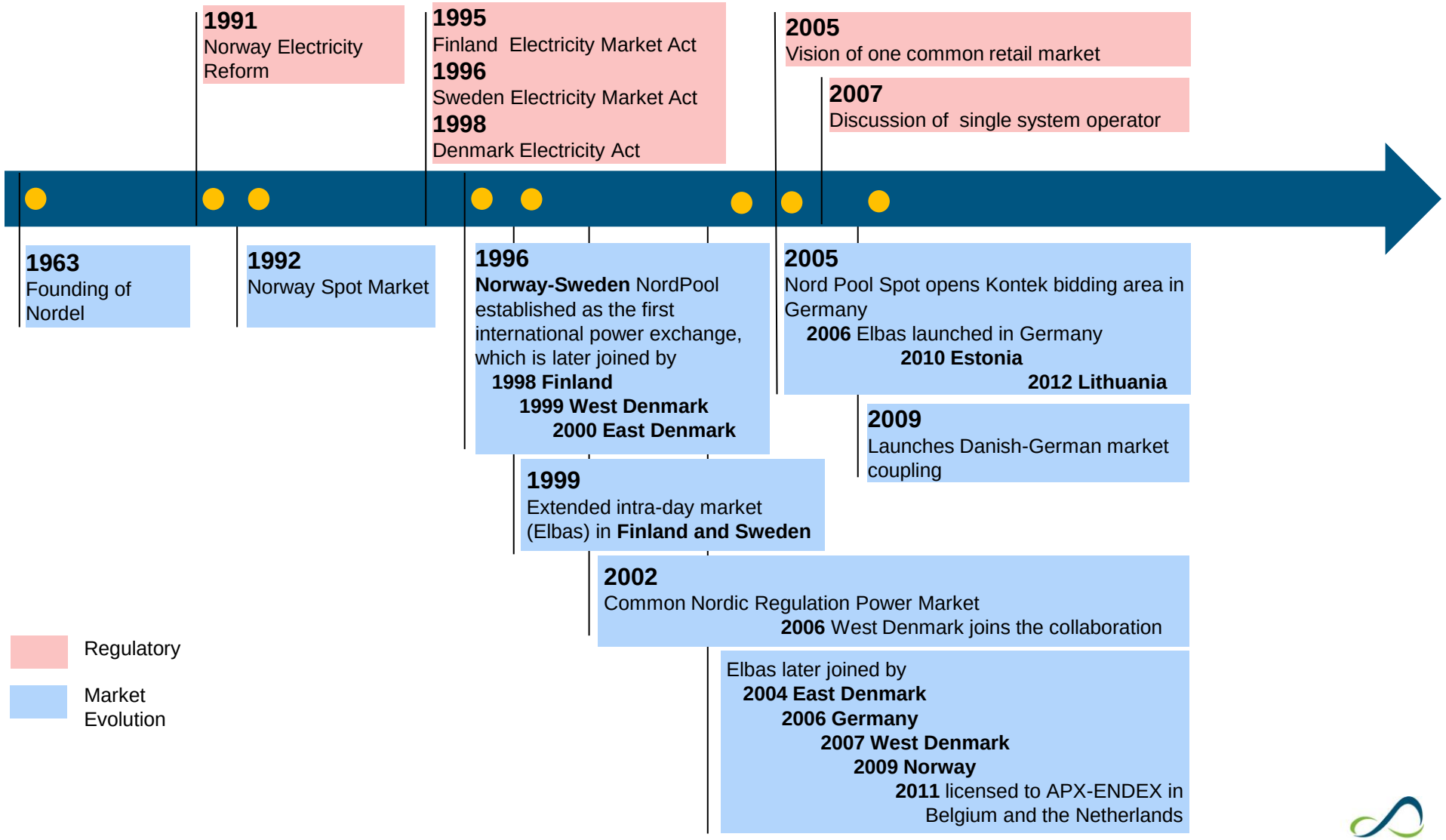
4 Taxonomy of international examples

Nordic cross-border power trading evolved from the founding of Nordel



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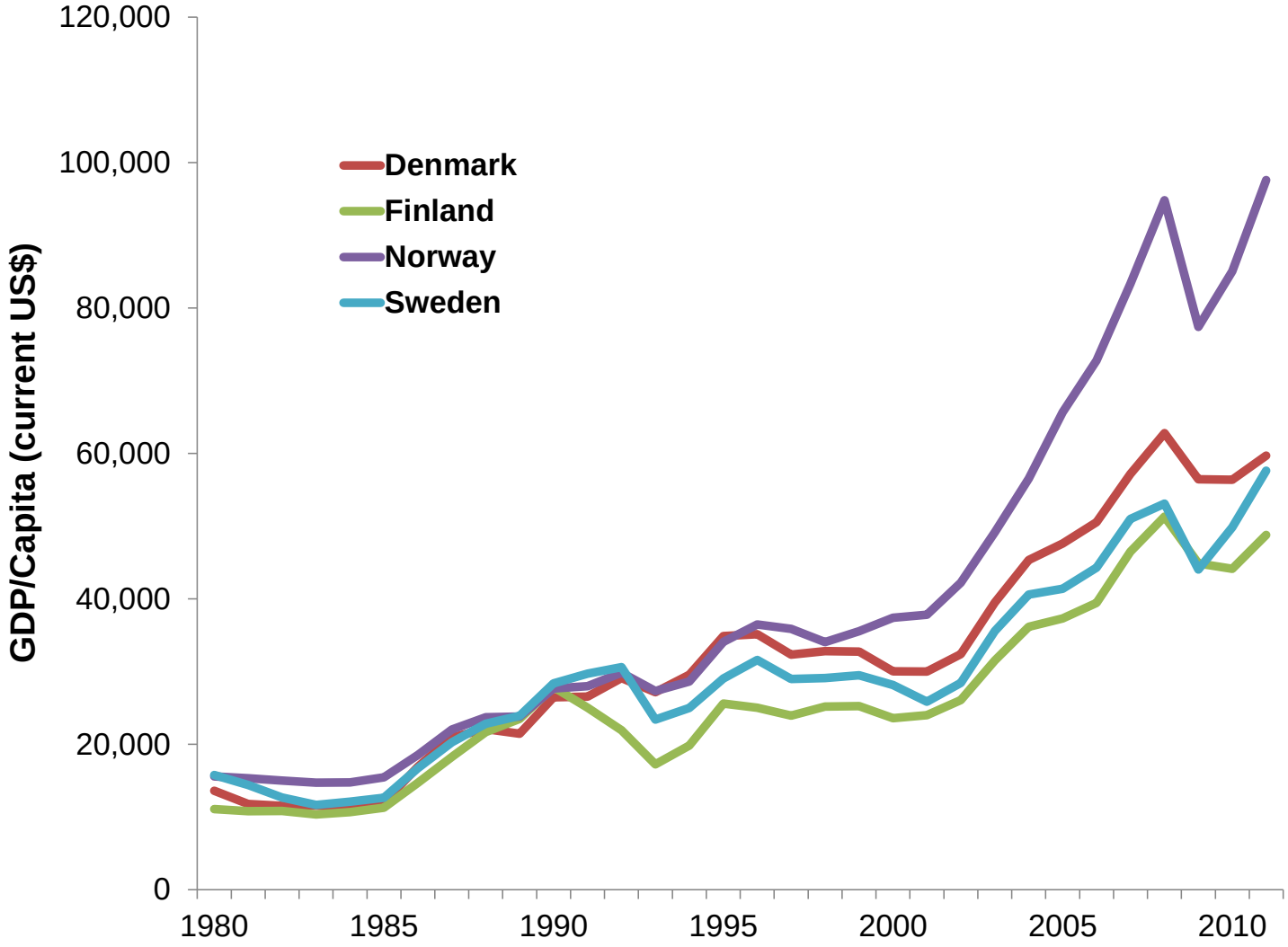
Historical perspective – the role of Nordel

- Nordel was founded in 1963 to promote cooperation among power utilities of the Nordic countries (Norway, Sweden, Finland and Denmark) and optimize dispatch based on member countries' different electricity generation mixes.
- Nordel succeeded for a variety of reasons:
  - The Nordic countries share a common cultural heritage, without violent conflict since 1815, and a large grassroots base of popular cooperation
  - Nordel's policies and operations through 1990 were effected solely through "gentleman's agreements"
  - The Nordic countries are similar demographically and economically
  - Their generation mixes vary significantly, but are complementary
  - Power exchanges between the countries are well-balanced, so that simple sharing rules provide adequate distribution of net benefits.

The economies of the four main Nordic countries (Iceland was also a non-trading member of Nordel) have evolved in remarkably parallel fashion



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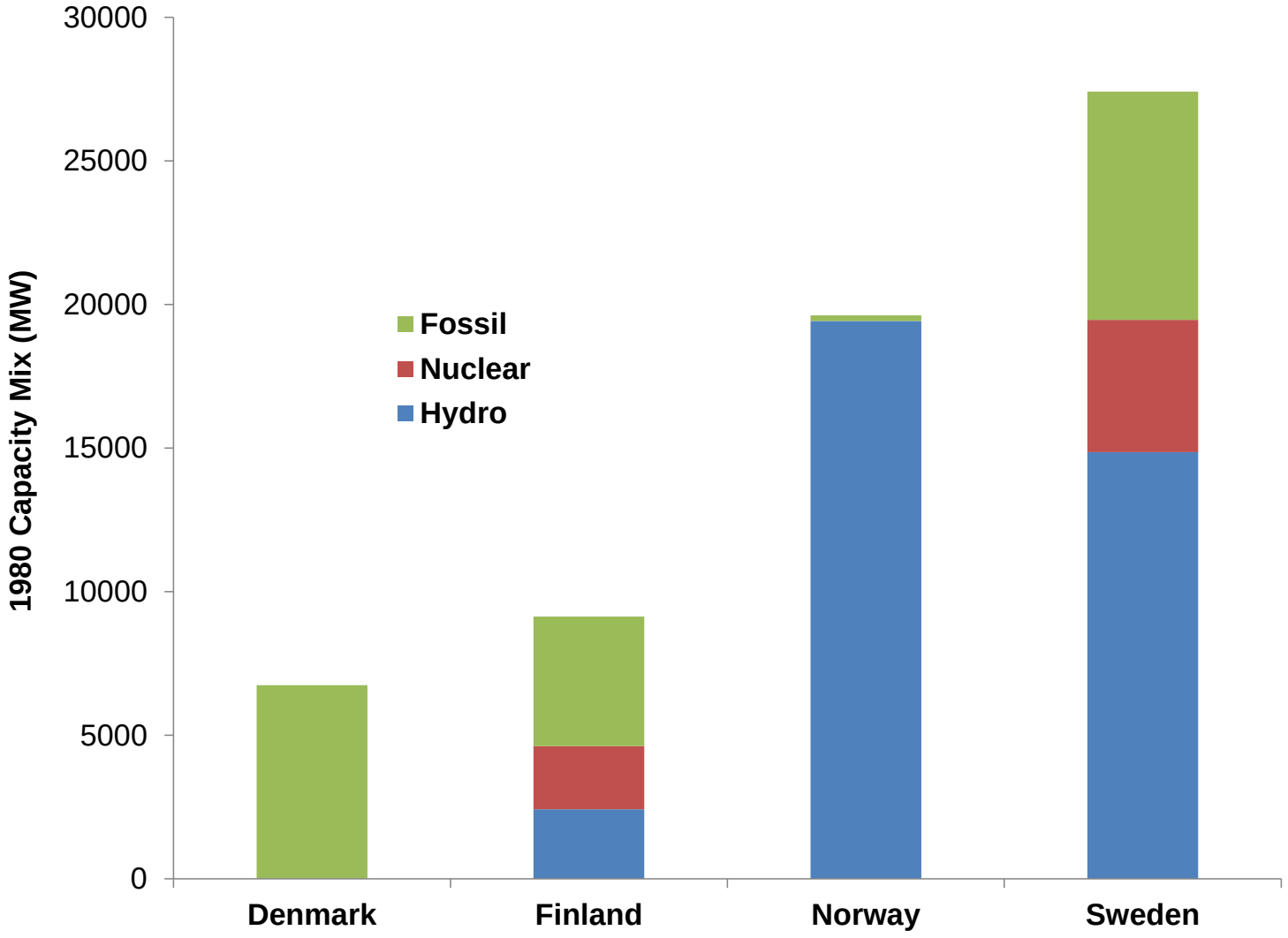
The capacity mixes of the four countries (in 1980) varied from pure thermal (Denmark) to pure hydro (Norway) to a reasonable balance (Finland and Sweden)



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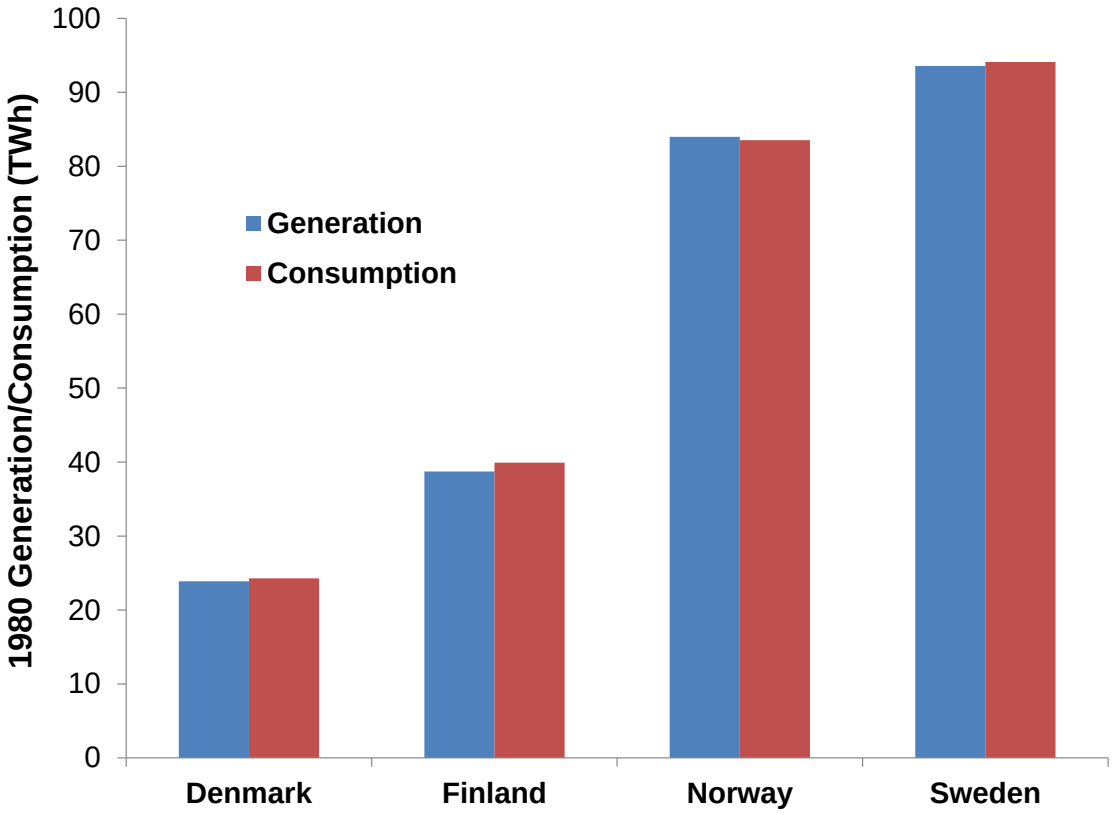
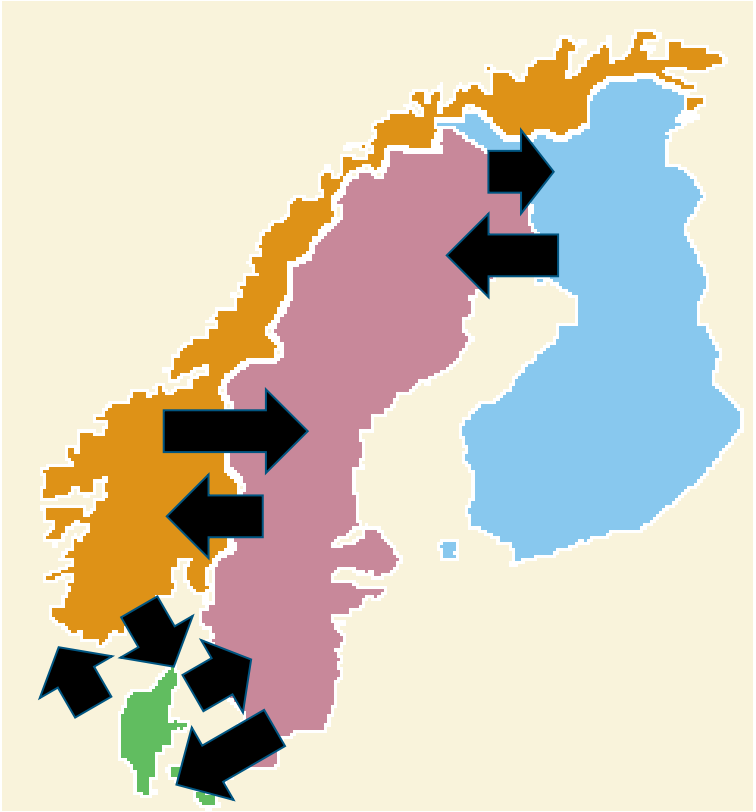
None of the four countries was a major net exporter or importer of power in 1980





Length of arrow is proportional to annual energy flow

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Nordel was founded to promote power trading driven by diverging generation mixes

1963
Establishment of Nordel

1991
Norway Electricity Reform

1992
Norway Spot Market

1996
Norway-Sweden NordPool

1999
Extended intraday market (Elbas)

2002
Common regulation power market

2005
Nordpool Spot opens in Germany

2005
Vision of a common retail market

2007
Discussion of NTSO or NISO

2009
Danish-German market coupling

- Nordel was founded in 1963 to promote cooperation among power utilities of the Nordic countries (Norway, Sweden, Finland and Denmark) and optimize dispatch based on member countries' different electricity generation structures, which is essentially the exchange of hydro and thermal power
- From 1963~1990, the functions of NORDEL remained essentially unchanged. Development over this period focused on technical improvements:
  - System stability models (1967)
  - Common network reliability criteria (1972)
  - Common economic principles applied to determination of reserve capacity requirement (1975)
  - Common technical operating specifications for thermal power plants (1975)
  - Common guidelines for frequency control (1979)
  - Simulation program for economic analysis of mixed hydro-thermal system with internal transmission constraints (1986)
- In the 1990s, the power industry began to be liberalized
- In 1993 and 1998, new bylaws gave the Nordic TSOs greater powers
- In 2000, Nordel was reconstituted exclusively as an organisation of Nordic TSOs governed by legally binding agreements, a transformation from previously "gentlemen's agreements"
- In 2008, Nordel joined the formation of ENTSO-E
- In 2009, Nordel was closed down

Development of the Nordpool day-ahead market (Elspot) and intra-day market (Elbas)

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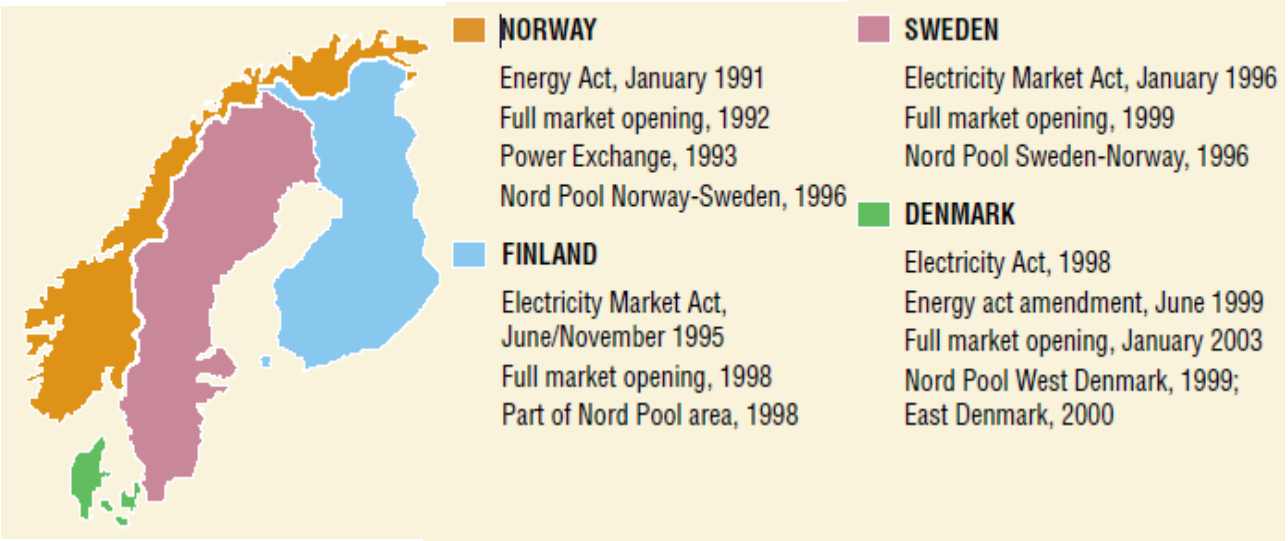
Liberalization in the Nordic Electricity Market
Rapid electricity opening in the 1990s



- Power sector reforms took off in Norway in the early 1990s, preceding the establishment of the Norway spot power market
- The then dominating government-owned integrated utility Statkraft's transmission assets were spun off to form a new national grid company, Statnett SF
- All transmission networks were opened to third-party access
- Vertically integrated utilities were required to separate accounting for generation, distribution, and supply activities

Common regulation power market provides low-cost regulation service

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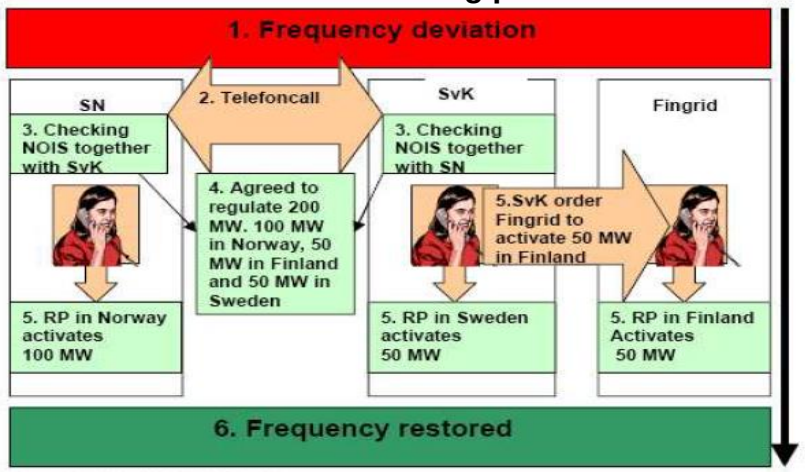
- The Nordic regulation power market was first established in 2002 in four national balancing markets with Western Denmark joining in Jan 2006
- The Nordic TSOs combine their balancing resources for the balancing of the total Nordic system as a whole. The balancing is conducted in such a way that reserves are activated in the area with the lowest cost.

Illustration of Nordel balancing process



- The Nordic regulation market is subject to a more complex monitoring process as the national balancing marketplaces are governed by rules and agreements set by the TSOs, while the Nord Pool markets are organised as a common marketplace with common member agreements and bidding rules.

Driving towards a common retail (end-user) market

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General process towards harmonization

1st Phase

NordREG make Nordic recommendations on the issues
- Billing (already issued recommendation)
- Responsibilities in the customer interface (already issued recommendation)
- Supplier switching
- Tax collection
- Metering
- Making and ending contracts
- Balance settlement
- Risk management and etc.

2nd Phase

National and Nordic political commitment and implementation:
Make the necessary national adaptions of legislation to establish a regulatory framework that supports and facilitates the recommendations

3rd Phase

Market adoption
Stakeholders adapt their processes and IT-systems according to the new harmonised regulatory framework

Nordic retail market by 2015
NordREG targets that by 2015 the end-user markets should be harmonised to the extent that the most critical prerequisites have been achieved

Possibilities investigated for creating a common Nordic System Operator

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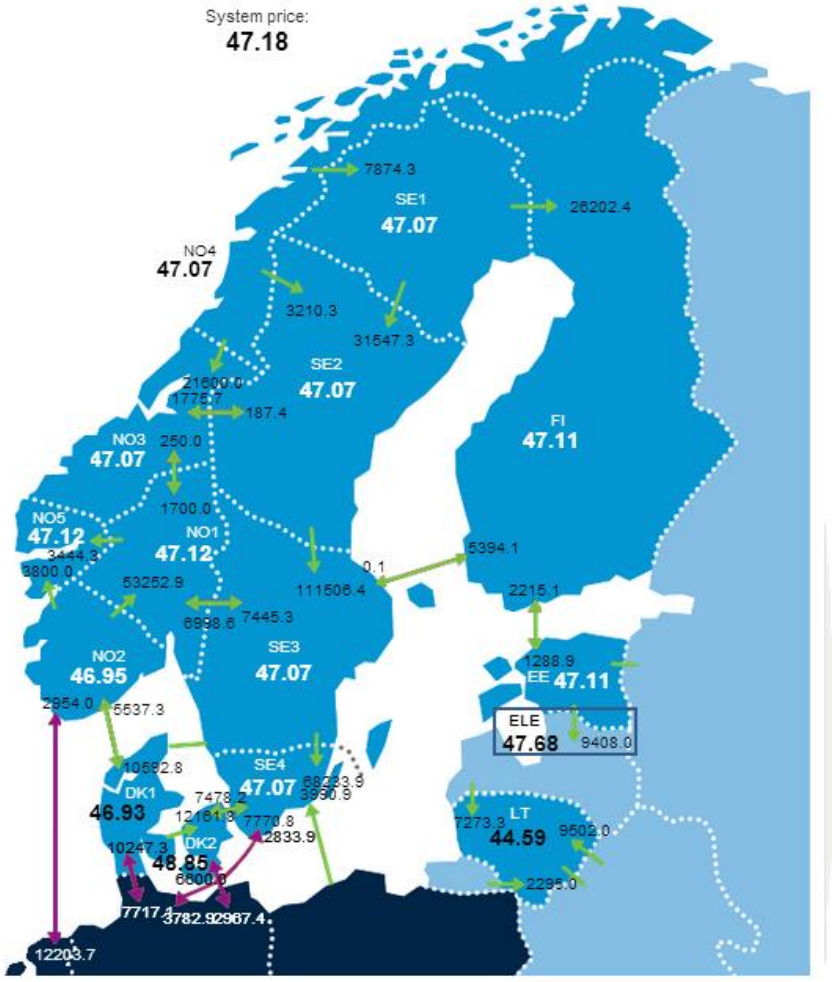
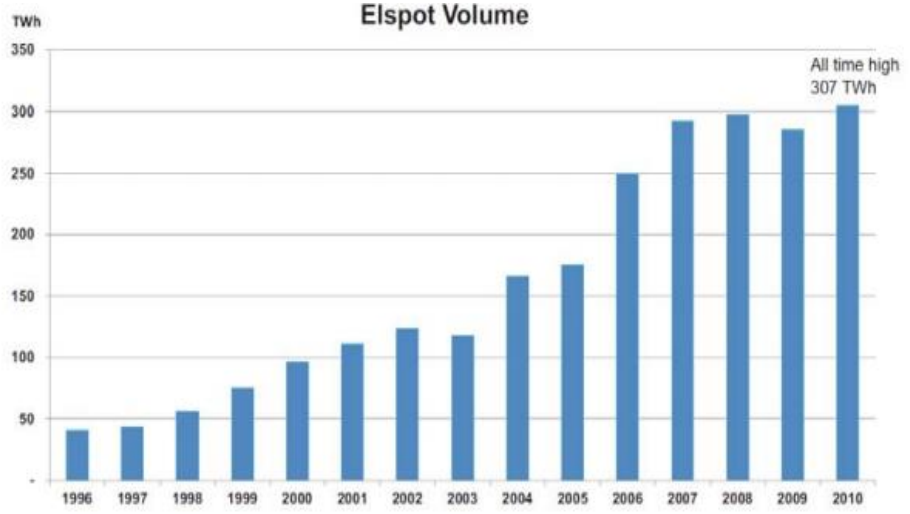
- The Nordic Council of Ministers (NCM) for Trade, Energy and Regional Policies met in Helsinki in September 2007.
- With the focus on the Transmission System Operators (TSOs) in the Nordic Electricity Market, it was decided that the Committee of Senior Officials for Energy should investigate the possibilities for creating a common Nordic System Operator. The ministers wanted to know *if and how,* a Nordic System Operator could be established.

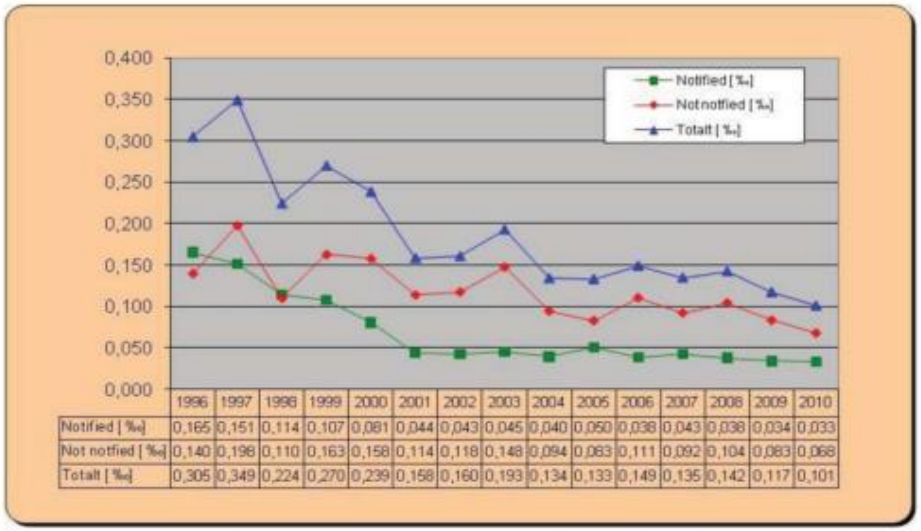
Options	Economic Market Group (EMG) Recommendation
Nordic Independent System Operator (NTSO)	*The EMG does not recommend that a Nordic Independent System Operator is established. In EMGs view, a Nordic ISO is not assessed as being "the tool" to solve the problems at hand in the Nordic electricity market today. Separating the grid ownership from the system operations is not perceived as a step in the right direction*.
Nordic Transmission System Operator (NISO)	*The EMG recommends that the current model of TSO cooperation in the Nordic Region be furthered and improved. Taking the step to a more company based harmonisation of this cooperation is not viewed as realistic at the present.*

NordPool trading is characterized by increasing volume and reliability

Elspot Market overview March 2013







	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Notified [‰]	0,165	0,151	0,114	0,107	0,081	0,044	0,043	0,045	0,040	0,050	0,038	0,043	0,038	0,034	0,033
Not notified [‰]	0,140	0,198	0,110	0,163	0,158	0,114	0,118	0,148	0,094	0,083	0,111	0,092	0,104	0,083	0,068
Totalt [‰]	0,305	0,349	0,224	0,270	0,239	0,158	0,160	0,193	0,134	0,133	0,149	0,135	0,142	0,117	0,101

Energy not supplied (ENS) in per thousand of the energy supplied (ES) to end users in Norway since 1996

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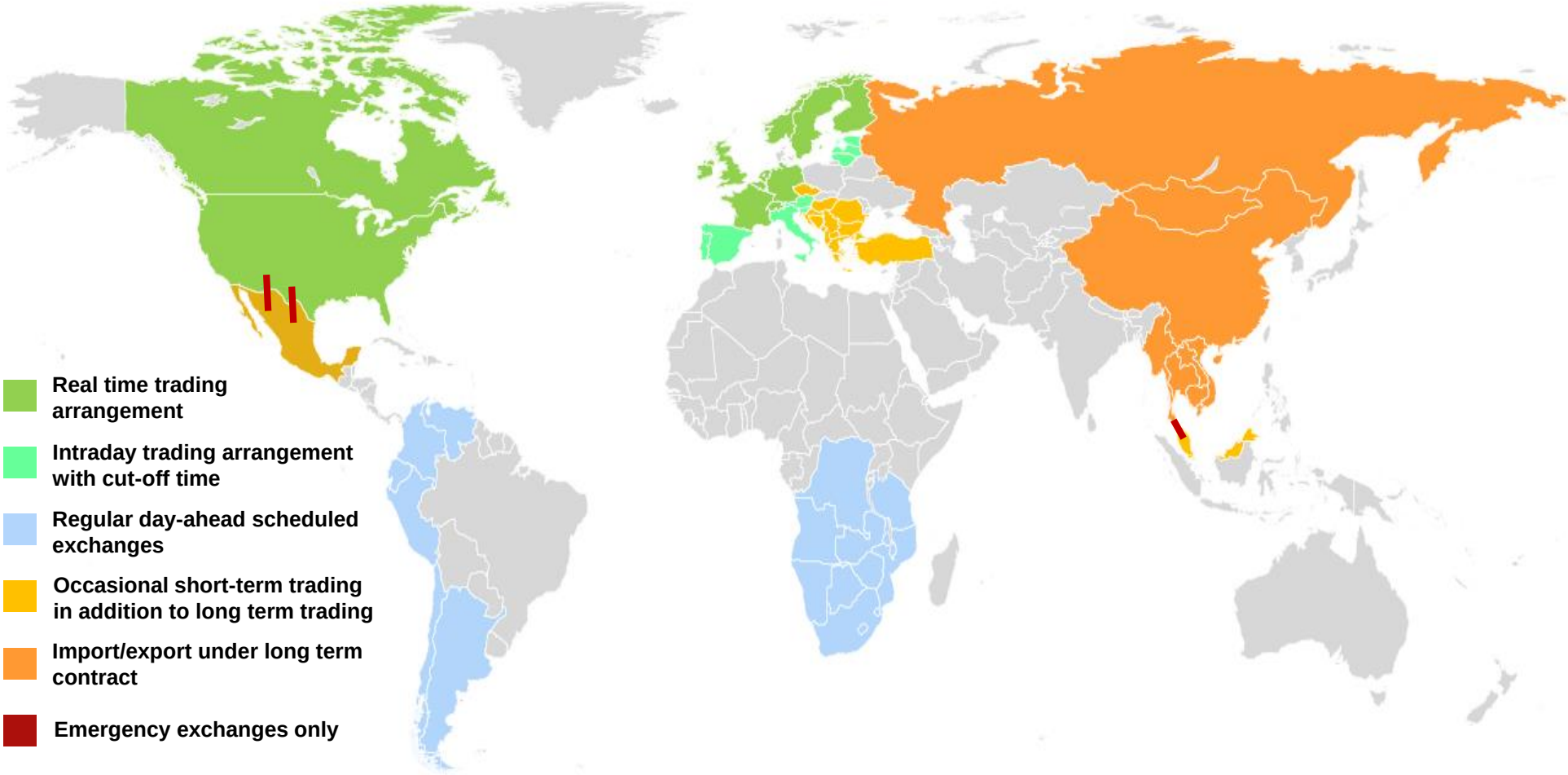
Overview of global power cross-border interchange arrangements



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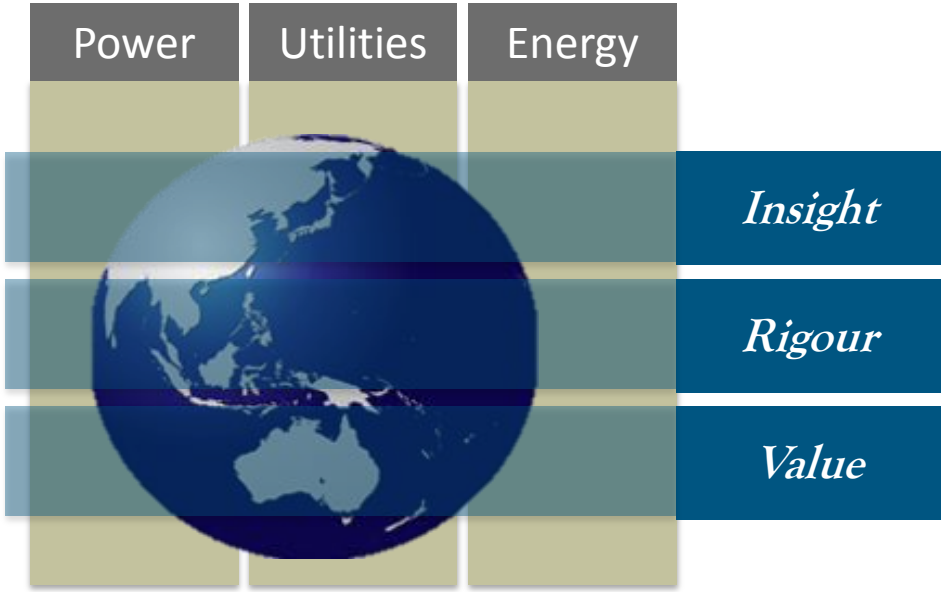
Thank you!



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