Electricity market design and evolution

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Statkraft
Timeline of Internal Energy Market Legislation

**First Package**
- Electricity Directive 96/92/EC

**Second Package**
- Electricity Directive 2003/54/EC
- Regulation (EC) 714/2009 on cross-border exchanges in electricity

**Third Package**
- Electricity Directive 2009/72/EC
- Network Codes and Guidelines

**Fourth Package (CEP)**
- 2016

**Policy Objectives**
- A competitive internal energy market
- Open and fair market
- Cross border cooperation
- Security of supply
- Sustainability
- Consumer and environmental protection

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Energy Community Secretariat
## Basic Highlights of the Successive Legislative Packages

<table>
<thead>
<tr>
<th>First Package</th>
<th>Second Package</th>
<th>Third Package</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No longer in force</strong></td>
<td><strong>No longer in force</strong></td>
<td><strong>In force</strong></td>
</tr>
<tr>
<td>• Partial market opening</td>
<td>• Full market opening</td>
<td>• Full market opening</td>
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<tr>
<td>• nTPA or rTPA</td>
<td>• rTPA</td>
<td>• rTPA</td>
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<tr>
<td>• Separation of accounts</td>
<td>• Legal and functional unbundling</td>
<td>• Effective unbundling</td>
</tr>
<tr>
<td>• No regulator required</td>
<td>• Establishment of independent NRAs</td>
<td>• Establishment of ACER, ENTSO-E and ENTSO-G</td>
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<tr>
<td>• Independent transmission system operation</td>
<td>• Designation of TSOs and DSOs</td>
<td>• Cross-border regulation</td>
</tr>
<tr>
<td>• No harmonisation</td>
<td>• No detailed market design decisions</td>
<td>• Harmonisation of system and market operation</td>
</tr>
</tbody>
</table>

- Partial market opening
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- rTPA
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- Separation of accounts
- Legal and functional unbundling
- Effective unbundling
- Establishment of independent NRAs
- Establishment of ACER, ENTSO-E and ENTSO-G
- Designation of TSOs and DSOs
- Cross-border regulation
- Capacity allocation and congestion management guideline
- Network codes and guidelines
- No harmonisation
- No detailed market design decisions
- Harmonisation of system and market operation
Clean Energy for EU citizens package: What is in?

- **Power market redesign:**
  - Proposal for a revised *electricity regulation* – focus on wholesale markets
  - Proposal for a revised *electricity market directive* – focus on retail markets and consumers
  - Proposal for a revised regulation on a European Agency for the Cooperation of Energy Regulators (ACER) – new tasks and responsibilities for the Agency
  - Proposal for a new regulation on risk preparedness in the electricity sector – focus on government actions to manage electricity crises and prevent short-term threats to the power system.
Clean Energy for EU citizens package: What is in? (Cont.)

- **Energy efficiency**:
  - Proposal for a revised energy efficiency directive
  - Proposal for a revised energy performance of buildings directive

- **Renewables and bioenergy**:
  - Proposal for a revised renewable energy directive – this includes Europe’s first-ever sustainability criteria for biomass and new provisions for biofuels

- **Governance**
  - Proposal for a regulation on the governance of the Energy Union – this calls for and defines national energy and climate plans

New EU target for 2030: from 20% to 30%

New EU target for 2030: from 20% to 27%
The 4th package – the Winter package – Clean Energy for EU citizens package (30 Nov 2016)

This is an unprecedented step in empowering consumers

Commission proposes new rules for consumer centred clean energy transition

Our proposals provide a strong market pull for new technologies
Market Design. Aim: more flexibility …. But why?

- **Article 1 of the Regulation**: This regulation aims at setting the basis for ... increased flexibility

- **Art 3 of the Directive**: speaks about “flexible market” and investments in “flexible generation”

- **Challenge**: increasing sharing of intermittent RES generation

- **General perception**: We have to *increase flexibility*, e.g. by promoting demand side response

- **Statkraft view**:
  - An efficient market will deliver the right amount of flexible capacity at lowest cost
  - “flexibility” is not a separate commodity, the energy market will give the incentives to make capacity more flexible
The flexibility challenge.

What does the Winter package do good?

- Removing price caps
- Exposing retail consumers to dynamic prices
- Removing regulated retail tariffs

But ...

- Is the focus on short term markets correct?
- Should “improving flexibility” be a goal in itself?
- Does it put consumer at center? Or does it regulate the market?
- It allows for scarcity pricing, but does it ensure it?
The Evolution of Power Spot & Derivatives Volume
EPEX, EEX, PXE

Derivatives Market
3,920 TWh traded EEX and PXE volume in 2016

Spot Market
535 TWh traded volume in 2016

EPEX Spot Market

Source: EEX: Markets and Products 2017
Comparison of electricity traded volumes in some important day-ahead, forward and OTC markets, first quarter of 2017

Source: Platts, wholesale power markets, Trayport, London Energy Brokers Association (LEBA) and DG ENER computations

Source: EC Quarterly Report on European Electricity Markets
Expert based configurations already firm

Two additional Model based configurations were foreseen

Bidding Zone configurations under consideration
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<thead>
<tr>
<th>Venue</th>
<th>Code</th>
<th>Qty</th>
<th>Bid</th>
<th>Ask</th>
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<tr>
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**Bid-ask spread DE:** 0.2 Euro/MWh

**Bid-ask spread AT:** 1.4 – 2.8 Euro/MWh

**No bids! No depth**

*Screen on Dec 1, 2017*
Bid-ask spread DE: 0.25 Euro/MWh

Bid-ask spread AT: 3.2 Euro/MWh

Spread DE-AT: lower in summer
Helps liquidity in AT

Overall: Low liquidity
- did not improve since December last year.
- among the poorest in EU.
### MONTHLY AUCTIONS

<table>
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<th>Days</th>
<th>Timetable</th>
<th>Specifications</th>
<th>Results</th>
<th>Price (€/MWh)</th>
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<td>Offered capacity (MW)</td>
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<td>Return (MW)</td>
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<tr>
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<td>4900</td>
<td>46655</td>
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In markets with poor liquidity
Cost of hedging can be significant...

- Hedging as such comes at a cost: the transaction cost, which is a function of liquidity (i.e. bid-ask spread), market depth (i.e. potential price impact of placing relatively high volumes) and transaction fees (i.e. exchange fees).

- The bubble size equals the cost to hedge 10TWh of production or consumption 2 years ahead (i.e. hedge today the exposure in Cal2019) in the different countries, just based on the respective bid-ask spread. Costs related to market depth and exchange fees are not included.

Disclaimer: This is just a snapshot and the situation changes over time, but nevertheless it provides a good representation of current market circumstances.
Sources: Vattenfall, Montel
In markets with poor liquidity
Cost of hedging can be significant…

- Cost of hedging decreases with increasing liquidity – the indices of the five different regions in the chart nicely illustrate the relationship
- The indices suggest that liquidity in CWE improved, CEE stayed stable, whereas a decrease occurred in Nordics & UK since 2010
- Cost of hedging for producers and consumers are in general the same, which means that higher liquidity and thus lower hedging costs lead to higher social welfare at large
- The analysis indicates that liquidity as such is largely connected to the size of price zones – bigger price zones foster liquidity!

Sources: https://analytics.icis.com/, Vattenfall

Utility hedging pattern

Quarters before/in delivery

CWE
UK
CSE
Nordic
CEE

Current
Historic (2010-2016)
ICIS Analytics collect and track reported hedging numbers of various European power companies. In total, the companies they follow account for around 65% of the EU ETS utility short-position within the EU ETS. Their unique historical hedging database allows them to track changes in hedging behavior continuously and compare the latest numbers with the historical averages. All displayed information originates from publicly available documents released by the companies or from official press conferences. They do not publish or share any information originating from bilateral talks with market participants. As European utilities differ in terms of how they hedge their power deliveries, ICIS Analytics incorporated indices for five different regions. The question why companies have different strategies has many different reasons, the most prominent of which are:

1. Extent of liberalization of the electricity market resulting in the necessity/ability to hedge
2. Liquidity in the forward market (i.e. cost of hedging)
3. Company structure (stock-exchange listed, state-owned, private company)
4. Risk appetite / Financial strength
Forward markets & RES integration

Forward markets are also important for integration and financing of intermittent renewables themselves:

Investors in renewable projects normally outsource the market risks of their project by means of long-term power purchase agreements (PPAs). In the case of liquid forward markets, market participants can bid for such PPAs at more competitive prices.
The flexibility challenge.
What does the Winter package do good?

- Removing price caps
- Exposing retail consumers to dynamic prices
- Removing regulated retail tariffs

But …

- Is the focus on short term markets correct?
- Should “improving flexibility” be a goal in itself?
- It allows for scarcity pricing, but does it ensure it?
- Does it put consumer at center? Or does it regulate the market?
Definitions: capacity and flexibility

- **Capacity**: is the ability (or option) to deliver or offtake (sell or buy) electrical energy.

- **Flexibility**: is the ability to use/exploit capacity with few limitations.
  - Flexibility is a characteristic of capacity.
  - Flexibility has many different time dimensions.
    - Example: A battery has short-term flexibility, but no longer term flexibility.

**Flexibility is not a separate commodity.**
Contrary to common belief, the intermittency challenge is not in the balancing time frame but in the forward time frames (intraday – seasonal).
The future “flexibility challenge” in different time frames. Balancing challenge is overrated

Increasing share of intermittent (zero marginal cost) generation poses challenges in different time frames:

**Balancing**: probably smallest challenge

Short-term fluctuations are not extreme. Moreover RES can participate in balancing markets and DSM will play bigger role (but no need for support!)

**Ramping**: bigger challenge

Especially a well functioning **intraday** market will give price signals and incentives to invest in flexibility of assets (like low minimum load level, short start-up times, fast ramping)

**Base load**: biggest challenge!

Longer periods (days/weeks) with low wind, low PV, low reservoirs and high demand seem to be biggest challenge.
Increasing share of RES: decreasing activation of operating reserves & increasing use of intraday market

Graph: Volumes in the activated reserve markets (green) versus intraday market (red) in Germany
Source: Statkraft
Increasing share of RES: ramping challenge solved in intraday market

Source: CalISO
The value of intraday flexibility: Increase asset profits by short term optimization

Exemplary Power Spot and Intraday Price Curves

Exemplary Asset Nominations

- Last Intraday Price
- Average Intraday Price
- Spot Price

- Intraday Renomination
- Dayahead Nomination
- Intraday Nomination
Forecast uncertainties of renewables: Trading 24/7 and forecast management indispensable.
Total installed dedicated storage capacity in the EU (plus CH and NO) is almost 50 GW
Plus about 27 GW seasonal storage capacity: 77 GW
The reservoir capacity of Lake Blåsjø is 7.8 TWh
Norway’s total reservoir capacity is 85 TWh
That is 8.5 million batteries (of 10 MWh each)
Or 6 billion Tesla Powerwalls (of 14 KWh each)

There is ample *flexible capacity* in the market
Like *storage capacity*
There is ample *flexible capacity* in the market. Like *implicit demand side response*, key elements for further deployment are:
- Smart meter roll-out
- Retail competition
- More price volatility
Consommation d'électricité pour la journée du :

Vendredi 18 août 2017

DONNÉES CONSOLIDÉES

MINIMUM MAXIMUM

00:00 03:00 06:00 09:00 12:00 15:00 18:00 21:00 23:45

37700 42200 46600

49331 MW 49100 MW 47500 MW

CONSOMMATION PRÉVISION J PRÉVISION J-1

Consommation réalisée Prévision réactualisée le jour même Prévision calculée la veille pour le jour même

About 3 GW every day

Source: http://www.rte-france.com/fr/eco2mix/eco2mix-consommation
# Types of Demand Response

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<thead>
<tr>
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<th>Implicit</th>
<th>Explicit</th>
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<tbody>
<tr>
<td><strong>Response on retail price</strong></td>
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</table>
| **Direct** by consumer | - Well known for decades  
- Already active to large extent  
- No regulatory barriers  
- No involvement/compensation of supplier  
- Will further develop with roll-out of smart meter | - Already active (larger consumers)  
- Should be allowed (consumer should have right for this model)  
- Requires agreement consumer-supplier. Commercial terms to be negotiated. |
| **Indirect** by aggregator (on behalf of consumer) | - No regulatory barriers  
- No involvement/compensation of supplier  
- Likely to develop with technological developments | - Relatively new business model  
- Should be allowed (consumer should have right for this model)  
- Requires agreement consumer-supplier-aggregator. Commercial terms to be negotiated. |
One idea: better allocation of XB-capacity across time frames

• There is a subordinate treatment of cross-border intraday trading in favour of day ahead cross-border trading.

• The current methodology is designed to facilitate maximal flows on a day ahead basis, which results in an undervaluation of cross-border capacity and an inefficient use of flexible assets across borders.

• Especially in periods when the day-ahead price difference is small, and when there is a likelihood that intraday prices will diverge, it is more efficient to not flow at the day ahead stage and to keep flexible assets available with the possibility to deliver flexibility across borders depending on the price developments on the intraday markets.

• Allocating (i.e. reserving) the entirety of cross-zonal capacity primarily to the Day-Ahead market will not deliver the optimal social welfare in all market circumstances, since it forecloses the opportunity value of flexibility for use in shorter market timeframes.
The flexibility challenge.
What does the Winter package do good?

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• Exposing retail consumers to dynamic prices

• Removing regulated retail tariffs

But …

• Is the focus on short term markets correct?

• Should “improving flexibility” be a goal in itself?

• It allows for scarcity pricing, but does it ensure it?

• Does it put consumer at center? Or does it regulate the market?
PRICE FORMATION IN THE BALANCING TIME FRAME
INFLUENCES PRICES IN OTHER TIME FRAMES

Wholesale power markets

- Derivatives markets
  - Financial
  - Hedging

Physical markets

- Day Ahead Market (DAM)
  - Physical
  - Create initial physical balance
- Intraday Market (IDM)
  - Physical
  - Adjust and fine-tune balance

System operation (performed by TSOs)

- Real-time balancing
  - Balancing Procurement Mechanism (BPM)
    - Physical
    - Balancing generation and consumption
  - System Operation (SO)
    - Physical
    - Ancillary services

Forward prices

DAM prices

IDM prices

Imbalance prices
If market participants are exposed to the real risk that the imbalance price will be set at least at the: VoLL (Value of Lost Load)

Then scarcity prices can materialise and market participants will invest in flexibility
VoLL - pricing, how?

- *Imbalance price* ≥ *VoLL*
  - in case of scarcity driven brown-out
- Not necessarily a single value per Member State
- Can be dependent on time, size and duration of brown-out
- Highest VoLL should be reference for “technical limits” in coupled markets
- TSOs should not buy balancing energy at prices above this value
The flexibility challenge.
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CEP: an “unprecedented step in empowering consumers”?

**Article 4 of the Market Directive:**

Member States shall ensure that all customers are free to purchase electricity from the supplier of their choice.

**Change into:**

Member States shall ensure that all market actors with a connection to the grid are free to purchase and sell electricity from any other market actor or combination of actors of their choice.
Conclusion: No need for a new market design

- **Existing framework already sufficient:**
  - It allows for “new” business models (aggregation, local energy communities, demand side response)
  - Flexibility is not a new commodity. Flexible capacity is valued at the power market.
  - Role of DSOs/TSOs should not change (they can always contract for flexibility services)

- **But improvements are needed:**
  - Allow for scarcity prices and ensure for VoLL pricing
  - Better allocation of cross-border capacity (intra-day!)
  - Improve basic rights of consumers
  - Ensure level-playing field
  - Stop benefits for “behind meter investments”
  - Better calculation of cross-border capacity
Back-up
The Evolution of Wholesale Supply Businesses

Downward trend observed in electricity wholesale prices since 2011

Figure: Evolution of DA electricity wholesale prices in different European power exchanges – 2011–2016 (euros/ MWh)

Source: ACER Market Monitoring Report 2016 – Electricity wholesale market volume

Source: European Network of Transmission System Operators for Electricity (ENTSO-E) and Platts (2017).
Volatility of hourly intraday prices is decreasing
Market Design: how to tackle the flexibility challenge?

<table>
<thead>
<tr>
<th>Key priority</th>
<th>Examples</th>
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<tbody>
<tr>
<td><strong>Price signals are the basis</strong></td>
<td>Examples:</td>
</tr>
<tr>
<td>Price signals are the basis for investments in and dispatch of “flexible capacity” like demand side response</td>
<td>- VoLL-pricing in case of scarcity driven interventions</td>
</tr>
<tr>
<td>Allow free price formation and scarcity prices requires to remove barriers &amp; distortions</td>
<td>- Tackle “behind the meter” generation &amp; storage</td>
</tr>
<tr>
<td>… but avoid “regulating the market”. Promoting certain sources of “flexibility”, will only result in higher cost, because cheaper flexibility will be pushed out of the market</td>
<td>Examples:</td>
</tr>
<tr>
<td></td>
<td>- Specific regulations for “3rd party aggregators”</td>
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<td>- DSOs / TSOs owning and operating storage</td>
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