Status and concept of international grid connection

Market and Technical Requirements

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Agenda

- Overview of the European high voltage grid
- European market overview
- Planned expansions in Europe
- Obstacles for expansion / super grids
- An idea of European super grid: DESIGN GRID
The Supergrid Vision is not new! Today
Synchronous zones in Europe

- Connected via HVDC cables or back-to-back converters
- For smaller zones (UK, Ireland, Baltic region)
  - Frequency stability is of major concern
  - Especially with decreasing inertia due to renewables
  - HVDC, especially VSC offers great flexibility and control
What is the Trend in Europe?
Projects of Common Interest

- Many PCIs between non-synchronous zones
- Many PCIs in vicinity of pumped hydro storage
  - Norway and Alps
- Offshore hub between UK, NL, BE part of PCI list!
- The development around the North Sea is the first step of the super grid.
Average whole sale prices in Europe

- Purely merchant lines are only viable between zones with high price difference
  - E.g. links to UK, Italy or Spain
  - Links from Scandinavia to rest of Europe

- In Central West Europe
  - Often price convergence on wholesale
  - Nevertheless, high balancing costs due to need for renewables
    - In 2015 roughly 1G€ for re-dispatch and other services for quality of supply in Germany
    - Grid expansion essential to increase social welfare and ensure security of supply!
Price convergence in CWE

Full price convergence in CWE region (%)

- 2013 - 2015
- 17.4%

Partial price convergence in CWE region (%)

- 2013 - 2015
- 69.5%

Price convergence to at least one other CWE country (%)

2013 - 2015
- Average Day-Ahead Spotprice [€/MWh]
  - 44
  - 38
  - 34
- 65.6%
- 83.2%
- 70.7%
- 48.9%
What is the Trend in Europe?
Embedded HVDC

- More and more HVDC links within the same synchronous zone
  - Increased power flow control
  - Reactive power support
  - Increased stability

France - Spain
Germany
Belgium – Germany
UK - Westlink
Challenges for coordinated planning
Not necessarily technical...

- **Regulatory challenges for coordinated planning**
  - Not aligned national frames
    - Swedish TSO is not responsible for connection of offshore wind farms
    - German TSO obligation makes cooperation difficult
  - Not aligned renewable support schemes
    - Integrating three national solutions where each country imports the offshore wind produced in its water is not necessarily the best design
    - In case of an interconnector, where does the wind go?
  - Capacity Remuneration Mechanisms
Cost allocation and Regulation (1)

New developments

- Restructuring => Vertical coordination (VC)
- EU energy policy objectives => Horizontal coordination (HC)

Efficient cost allocation solutions required both at national and European level

- Transmission tariff design
- Cross-border cost allocation
Cost allocation and Regulation (2)

Existing cross-border cost allocation solution in Europe

- **Relative to asset hosted**
  - Does not reflect the welfare distribution effect

- **50-50 rule**
  - Does not reflect the welfare distribution effect
  - Limited application

- **Inter TSO Compensation (ICT)**
  - Limited scope and precision
  - Welfare distribution effects ignored

**Summarizing**

- **Not suitable for PCI type projects**
- **Other mechanisms based on Peak Demand – Installed Generation Capacity – RES Installed – TSO involvement – Distance – …**
Operational Rules for HVDC GRIDS

- The control strategy influences the market
  - How to be neutral to all market participants?

- Ancillary services and operation
  - How to operate an overlay grid? Who is responsible?
  - Operational rules need to be considered in planning
    - But, many operational rules between AC and DC systems are not defined, yet (in red)
The way to the future – DESIGN GRID
An integrated offshore grid design for Europe

 ultimo line grid connecting:
- Denmark
- Belgium
- Netherlands
- Germany
- Sweden
- Iceland
- UK
- Norway

Allowing integration North Sea offshore wind farms
DESIGN GRID

DESIGN Grid will allow trade between different markets and price zones
- Denmark, Belgium, Netherlands, Germany, Sweden, Iceland, UK, Norway

This way, TSOs will develop new products and services, based on the possibilities offered by DESIGN GRID

The coordinated operation of the DESIGN GRID links will allow
- Optimal infeed of renewable energy
  - Reducing re-dispatch costs
- Delivery of system services
  - Frequency support
  - Reactive power support
  - Black – start capability
How to get there?

1st STEP: Feasibility study
- Identify technical and regulatory show stoppers and provide solutions
- Risk level: low
- Time horizon: 1-3 years

2nd STEP: Detailed engineering study
- Subsea surveys, technical studies, legal advise, permits, etc....
- Set up as a Newco -> DESIGN GRID
- Acts as commissioning agent for construction
- Risk level: Medium
- Time horizon: ~ 3 years
How to get there?

3rd STEP: Stepwise Construction and Operation

- Different companies can build parts of the grid
  - TSOs, insurance companies, pension funds, manufacturers, asset holders, ....
- The operation is transferred to a commercial system operator -> “DESIGN Operate” (Newco)
- Revenues are passed to DESIGN GRID determined in a specific regulatory scheme
- Risk level: Medium
- Time horizon: 2020 - 2030
Operation and Regulation

- **Operation and maintenance in the hands of DESIGN Operate**
  - Collecting grid fees
  - Maintenance
  - Scheduling and real time operation (ISO approach, e.g. CORESO)
  - Payment of concession holders

- Interaction with national grids is important
  - Although power transfer managed by DESIGN Operate, reactive power control can be given to national TSOs

- Fundamental rewrite of grid codes is required to coordinate interactions
Why are investments stalling?

- TSOs are hesitant to invest in a multinational offshore grid as long as there is not a harmonized regulation.
- Regulators have no means to harmonize and improve regulation as long as there is no multinational offshore grid.
Financing and Regulation

- Regulatory Framework determines feasibility of North Sea Grid Developments:
  - D: DKK, Danish Crown
  - E: EUR, Euro
  - S: SEK, Swedish Crown
  - I: ISK, Iceland Crown
  - G: GBP, British Pound
  - N: NOK, Norwegian Crown

- How to match national operational standards, regulatory and legal framework?
Building Blocks of a Regulatory Framework

- **Planning and Design**
  - Coordination of national and regional transmission expansions

- **Ownership**
  - Ownership by New Third Party Companies (Newco)
  - Impact monopoly of local TSO (parallel path)

- **Cost Allocation**
  - Distribution of the costs amongst regions: new cost allocation methods
  - New tariff schemes (cfr. national regulators)

- **Operation**
  - Network Codes to ensure compatibility local TSO and Newco
  - Redesign of Ancillary Services
  - Coordination maintenance, scheduling and dispatch of transmission assets owned by Newco
DESIGN GRID Revenue Model

Cap & floor set based on:

- **CAPEX**
- **OPEX**
- **Cost of financing**

For the benefit of the **network users** and the **investors**:

- Sharing of revenues in times exceeding the cap
- Helps to being prepared for the time below the floor
Status quo and concept of international grid connection

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