A Review of Regulatory Arrangements for Offshore networks

Challenges for Delivering the Offshore Electrical Networks of the Future

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Project Background

Offshore electrical infrastructure research hub¹
- Collaboration between Strathclyde, Manchester & ORE Catapult
- 5-year programme with co-funding to address all aspects of offshore electrical infrastructure
- “Hub & spoke” model - open to collaboration with industry and academic partners

Project Aim:

“Identify regulatory issues affecting design, deployment & utilisation of offshore networks in the UK”
- Via comparison of various high level regulatory models deployed across Europe
- With a view to achieving 2030 & 2050 offshore wind deployment targets

Types of Offshore Network

4 main configurations options available for offshore networks

Radial Connection

Hub Connection

Interconnector

Hybrid Connection

Offshore wind farm
AC Hub
AC Substation
Types of Offshore Network

4 main configurations options available for offshore networks

- **Radial Connection**
  - Onshore Network A

- **Hub Connection**
  - Onshore Network A

- **Interconnector**
  - Onshore Network A
  - Offshore Network B

- **Hybrid Connection**
  - Onshore Network A
  - Offshore Network B

Legend:
- Offshore wind farm
- DC Converter / Hub
- AC Substation
Types of Offshore Network

4 main configurations options available for offshore networks

- **Radial Connection**
  - Offshore Network A

- **Hub Connection**
  - Offshore Network A

- **Interconnector**
  - Offshore Network A

- **Meshed Connection**
  - Offshore Network A

Legend:
- Offshore wind farm
- DC Converter / Hub
- AC Substation
Regulatory Regimes - Overview

Three main possibilities for offshore transmission asset (OTA) development

Developer led approach
- Offshore wind farm (OWF) developer takes responsibility for development and operation of OTA’s
- Remuneration for OTA factored into the OWF tender process

TSO led approach
- Transmission system operator takes responsibility for development and operation of OTA’s
- OTA part of TSO’s regulated asset base

Third Party approach
- A third party takes responsibility for development and operation of OTA’s
- Separate tender for OTA development

Should be noted that build and operation phase can be separated with possibility for hybrid approaches e.g. UK OFTO regime
Regulatory Regimes - Features

Developer led approach
✓ Co-ordinated development of OWF & OTA
✓ Allows bespoke grid solutions (though typically radial)
✓ High incentive to minimise costs via tender process
✗ Low incentive to consider long term system requirements
✗ Less suited to hub or hybrid approaches

TSO led approach
✓ Enables holistic approach to offshore network planning
✓ Potential for co-ordinated designs and reduced infrastructure vs multiple individual projects
✓ Potential for standardisation & economies of scale
✗ Interface risk between OTA & OWF – delays, stranded assets
✗ More complex designs – increased delivery risk
✗ Low cost pressure associated with regulated monopoly approach

Third Party approach
✓ Features highly dependent on nature of tender process – could be suitable for radial, hub or hybrid approaches
✓ High incentive to minimise costs via tender process
✗ Additional interface risks – TSO : OTA : OWF
Country Comparison - UK

Competitively tendered OFTO regime

- Owner and operator of offshore transmission assets in GB is a separate entity (OFTO)
- “Generator build” option
  - OWF developer has option to build OTA but must sell to OFTO after completion
  - Only option used to date
- “OFTO build” option
  - If OWF developer declines to build the OTA a new tender process would be initiated for third party bidder
- Only radial developments deployed to date
- Clustering/hub connection possible but subject to single entity success in tender process
- Hybrid connection difficult under OFTO model – legal & regulatory barriers
  - OFTOs & interconnectors treated as separate legal entities
  - Different remuneration regimes
Country Comparison - Netherlands

TSO Monopoly on OTA development

• Since 2015 TenneT have operated as “TSO at Sea”

• Grid connection takes place at OWF
  • TenneT fully responsible for building “Grid at Sea”

• Motivated by co-ordinated OWF development
  • Centrally planned roll-out
  • Standardised 700MW design
  • Opportunity to cluster / share assets

• Largely radial developments with some co-ordination

• Hub connections possible but not implemented

• Hybrid connection should be possible under existing regime with few legal / regulatory barriers
  • TenneT own both interconnectors and “Grid at Sea” so fewer legal barriers to merger
Country Comparison - Belgium

**TSO Monopoly on OTA development**

- Elia responsible for all OTA development
- Modular offshore Grid (MoG) concept
  - Elia build “plug at sea” offshore hub and transmission link to shore
  - OWF developers responsible for connection to offshore hub
- Motivated by co-ordinated OWF development
  - Centrally planned roll-out to minimise total infrastructure

- Hub connections currently being implemented
- Hybrid connections potentially possible under current regime
  - Although 50% TSO ownership rule for interconnectors at present that may be tested in multi-terminal offshore grid scenario
Country Comparison - Germany

TSO Monopoly on OTA development

- TenneT (North Sea) and 50Herz (Baltic Sea) responsible for OTA development out to OWF substations
  - TenneT 1st to make use of large scale HVDC deployment in hub design approach
    - 9 operational HVDC platforms and more under development
  - Motivated by co-ordinated OWF development and long distances from shore
  - Experienced a number difficulties with project delays / stranded assets / interface issues
  - Perception of excessively high costs
- HVDC hub connections already implemented
- 1st Hybrid connection under construction with Denmark
- Kriegers Flak Combined Grid Solution
  - 400MW link between existing German and Danish OWFs
  - Facilitated by TSO – TSO co-operation, no third party ownership barriers
Country Comparison - Denmark

TSO build model to date but switching to Developer build model

Pre - 2019
• Energinet responsible for OTA development out to and including OWF substations

Post - 2019
• Tender for new OWF development mandates change to developer build model for OTA’s
• Motivated by perception that increased competition will drive faster and more cost effective solutions
  • “Listened to industry”
• Only radial developments deployed to date
• Clustering/hub connection possible within pre-2019 framework but little opportunity to date
• Hybrid grid being implemented under TSO build model
  • Kriegers Flak Combined Grid Solution
• Greater barriers to future replication under Developer build model
Cost Comparison of Regulatory Regimes

- German report by DIW ECON commissioned by Ørsted Offshore wind:
  - Compares GB vs German offshore transmission asset (OTA) developments
  - Levelised cost of energy calculation – much higher costs found for German developments
  - Even after correcting for distance, technology & other factors still a large gap (€6.7bn to 2030)
  - Attribute this to a lack of:
    i) competition in the regulatory arrangement
    ii) integration in OWF & OTA development
  - Is a comparison between long established near shore HVAC project designs and new far shore HVDC projects really fair?
    - Could natural learning curve drive costs of HVDC options lower in future?

Source: DIW ECON – Market design for an efficient transmission of offshore wind energy, 2019
Cost Comparison of Regulatory Regimes

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Cost Comparison of Regulatory Regimes

- Dutch report by Navigant commissioned by TenneT & RTÉ:
  - Compares six GB OFTO projects vs FR, DK, NL, BE offshore transmission asset developments
  - Sub-system level CAPEX comparison made between a range of comparable projects
    - Offshore substation, onshore substation, offshore cable, onshore cable
  - UK OFTO projects deemed to be more expensive with higher costs for export cables and onshore substations in particular
  - Conclude that TSO development model can be delivered at lower cost than OFTO model even before considering wider system benefits of holistic approach
  - Some limitations to approach
    - Relatively small sample of projects
    - Excludes German examples
    - Max GB offshore substation capacity 400MVA vs 800MVA for Dutch comparison. Economies of scale could factor

Source: Connecting Offshore Wind Farms: a comparison of offshore electricity grid development models in Northwest Europe, 2019
The need for Co-ordination

• GB OFTO developer led model successful to date
  • Competitive tenders seen to drive down costs
  • however tailored to radial approach
• TSO model can be cost competitive and allows more co-ordinated approaches

Co-ordination will be key in delivering on UK’s 2030 and 2050 deployment targets:

1. To reduce total infrastructure footprint and cost
   • Number of past studies have alluded to overall cost benefits of co-ordinated solutions
2. To minimise number of onshore connection points
   • Avoid duplication of effort and mitigate extent of public opposition
3. To minimise the extent and cost of onshore system upgrades
   • Some onshore transmission corridors already congested and upgrades will be required
Recommendations for GB

How to unlock barriers to Co-ordination in offshore network development?

1. Develop ways of incentivising anticipatory investment
   • Revert to a TSO led approach?
   • Allow zonal development within existing OFTO model? Single entity for zone?
2. Work to ensure greater certainty of the future OWF project pipeline
3. Investigate ways of co-ordinating onshore and offshore network development
4. Retain a competitive tendering process
5. Undertake regulatory reforms to facilitate hybrid cross-border transmission projects
Recent Industry Action in UK

- Since completion of the review project the idea of co-ordinated offshore network development has gained traction in the UK
- Ofgem Decarbonisation Action Plan included reference to offshore co-ordination
- National Grid ESO leading the “Offshore Coordination Project”
  - Phase 1 findings reported for consultation at end Sept
NG ESO – Offshore Co-ordination Project: Phase 1 Consultation

Three main focus areas of study to date:

1. **Holistic Approach to Transmission Planning**
   - Technical comparison of current approach with an integrated approach to 2030 & 2050
   - Concludes majority of enabling technology is in place for integrated
     - Increased cable capacity & commercial DC Circuit Breaker to be realised
   - Grid Code and SQSS changes likely required to enable
   - Up to 50% fewer onshore landing points by 2050 in integrated approach
   - 35-60% reduction in onshore network flows by 2050 in integrated approach

2. **Cost-benefit Analysis**
   - £6bn+ savings identified to 2050 via co-ordination
   - ~£5.5bn in CAPEX and ~£1bn in OPEX
Three main focus areas of study to date:

3. **Offshore Connections Review**
   - Assessed the Regulatory changes required to enable co-ordinated offshore network development
   - No consideration of a shift towards TSO led regulatory model
   - Suggests changes to existing connection agreement framework - hope to enable developer driven co-ordination:
     - Enable groups of geographically close connection agreements to be considered in a single process
     - Enable closer involvement of developers and ESO in group connection studies
     - Enable bundling of connection agreement with seabed lease agreement
     - Review allocation of risks & liabilities to incentivise co-ordination while giving confidence to developers/investors

Detailed work pending in Phase 2 to show how these changes can enable the required level of Co-ordination