A specialist energy consultancy

RFI Response

New England Transmission Initiative

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TNEI - Who we are

TNEI is an independent specialist energy consultancy that has been providing international technical advisory services for more than 22 years to electricity transmission and distribution network owners and operators, electricity regulators, independent power producers and investors. Our expertise is in transmission and distribution network planning and analysis, renewable energy integration, electrical system modelling and design, and electricity sector regulation and policy.

TNEI has significant electrical design experience in the offshore wind sector, having worked on many offshore wind farms in the UK, Europe, and the Far East at different stages of development, covering assessment of innovative technologies, concept design and Front-End Engineering Design (FEED) through to project system studies, post construction fault analysis and transaction advice. In the UK alone TNEI has been involved in the concept design, delivery, or technical evaluation of almost all transmission connected offshore wind farms totaling more than 15GW.

We have a staff complement of 80 technical consultants located in our offices in Manchester, Newcastle, Glasgow, Dublin and Cape Town. TNEI incorporated in the USA in September 2022, and we are in the process of creating a local consultancy team. We are working in close collaboration with the Department of International Trade and the British Consulate looking for ways to support the emerging offshore wind industry.

We have reviewed the topics covered in the Request for Information (RFI) and have elected to comment on selected ones where we believe we can add value. For further information or clarification about our response, please contact our US director, Dieter Gütschow at dieter.gutschow@tneigroup.com

Comments on Changes and Upgrades to the Regional Electric Transmission System

Topic 2: Comment on ways to minimize adverse impacts to ratepayers including, but not limited to, risk sharing, ownership and/or contracting structures including cost caps, modular designs, cost sharing, etc.

TNEI Response:

One of the models that has worked well for market interconnection in the UK is a "Cap and Floor" regime. This provides a guaranteed minimum annual revenue (the "floor") for the asset, which ensures the scheme can be suitably financed. However, in return for this guaranteed revenue, the operator agrees to return to consumers anything over a maximum allowed revenue (the "cap"). Generally, this is for a period of 25 years. Experience to date shows that the cap and floor have been set at relatively low thresholds, but the scheme has still proven popular with financiers due to the certainty that it provides.

A more unusual model would be that used by the Moyle Interconnector, a HVDC interconnector that links Northern Ireland and Scotland. Moyle is owned and operated by Mutual Energy which is a mutualized company. This means it is run commercially, but any profits are returned to Northern Ireland electricity consumers. In return, if there is a major issue (and there have previously been cable faults), subject to regulatory approval, Mutual Energy can place a levy on consumer bills to raise funds. But ordinarily, it is expected to return savings to ratepayers.

In Europe, most HVDC schemes have been on an Engineer, Procure and Construct (EPC) basis, generally under FIDIC or NEC forms of contract. Generally, the contracts have been let based on separate lots for HVDC converters and cables. Sometimes a "Lot 3" option is provided, which would provide a single contracting entity (on a JV basis) for the scheme. This has not been a popular option for the last 10 years, although there are signs that some players may not be considering this approach.

Topic 3: Identify the advantages and disadvantages of utilizing different types of transmission lines, like alternating current (AC) and direct current (DC) options for transmission lines and transmission solutions. Should 1200MW/525kV HVDC lines be a preferred standard in any potential procurement involving offshore transmission lines?

TNEI Response:

HVAC is the most common system design for large offshore wind farms and is proven for point-to-point as well as meshed networks, being able to transform voltage levels and split power with relative ease. HVDC is the preferred technology for low-loss bulk power transfer over long distances and has improved power flow control and stability benefits compared to HVAC technologies. HVDC systems are subdivided into conventional Current Source Converter (CSC) or the more recently developed Voltage Source Converter (VSC) HVDC technology. The former has inherent design limitations which make it unsuitable for use with offshore wind farms and thus to date all HVDC connected wind farms use VSC technology.

Up to circa 200km (124 miles) the choice between HVAC and HVDC is primarily one of cost. Above 200km the HVAC solution becomes prohibitively more expensive and less practical requiring more and larger cables and/or additional reactive compensation to overcome the cable 'charging current', a natural constraint of AC cables, to facilitate the necessary power transfer. Increasing voltage at such long lengths offers negligible benefit as 'charging current' increases with voltage due to the larger cables used, to such a degree that any gain in current rating is negated.

The choice of HVDC voltage is driven by a combination of cost and technology limitations of both convertor valve and cable current ratings. With cost increasing with voltage, the optimized solutions tend to maximize capability at the lowest possible voltage. European experience suggests that 320kV is optimal up to 1,200MW. Above that cable limits/and or valve limits are reached. Above 1,200MW up to circa 2,000MW 525kV is required.

Topic 4: Comment on whether certain projects should be prioritized and why. For example, should a HVDC offshore project that eliminates the need for major land-based upgrades be prioritized over another HVDC offshore project that does not eliminate such upgrades

TNEI Response:

Prioritization would depend largely on the social and economic drivers. However, developers tend towards the most cost-effective solutions with least risk and quickest build (i.e. fastest returns on investment) which generally aligns with capacity build (integration of wind as fast as possible). Unlike with AC solutions where onshore connection is best afforded at or close to the shoreline, no such limit is necessary for HVDC which affords connection of the windfarm to connection points further inland and thus can alleviate the need for reinforcements to be built towards the coast. Essentially buildout follows a path of lowest hanging fruit. The least onerous offshore sites connected to the most accessible onshore substations tend to naturally be consented/approved and constructed first.

Topic 5 Identify any regional or interregional benefits or challenges presented by the possibility of using HVDC lines to assist in transmission system restoration following a load shedding or other emergency event and particularly from using the black start capabilities of HVDC lines in the event of a blackout

TNEI Response:

Whilst VSC HVDC technology has inherent black start capability, its use is largely limited to interconnectors connecting two strong independent networks. The technology is grid forming but relies on external generation for the power source. For offshore windfarms connected on a point-to-point basis the power source would be the WTGs. However current WTG designs require supply from the onshore grid to operate. An outage onshore results in shutdown offshore and with currently no means to restart the wind turbines.

TNEI is currently involved in several European innovation projects (e.g. SelfWind and ReStart) that are looking at the possibility of developing black start capable WTG's. It is expected that this technology will be commercially available in the future, and it is expected to play a key part in providing network resilience as conventional fossil fueled black start providers are gradually phased out.

Topic 6: Identify the benefits and/or challenges presented by using land based HVDC lines or other infrastructure to increase the integration of renewable energy (other than offshore wind) in New England to balance injections of offshore wind

TNEI Response:

The share of renewables in the US' generation capacity mix is 25.4% and is expected to reach 80% of the capacity mix by 2030[1]. Renewable energy targets, specifically the planned expansion of offshore wind along with legislative changes and the loan guarantees from the Department of Energy for transmission projects, will be the main drivers of the HVDC transmission systems market in US.

Building new overhead transmission lines running hundreds of miles has several challenges such as lands rights and encroachment on private properties, impact on local ecosystems, technical challenges etc. apart from significant investments. HVDC solution is an attractive option in this case as bulk power transfer over long distances is where its strength lies, and unlike AC transmission system, HVDC needs only a single line to transfer power.

The use of land based HVDC connections will depend on specific circumstances where AC solutions will not be feasible from technical and/or commercial point of view. A good example is the 700km north-south HVDC scheme "SuedLink" in Germany which is expected to be the longest underground HVDC cable system in the world. A push towards 70% electricity from renewable energy by 2050 means that Germany needs to harness wind power from the north of the country and solar power from the south. The generation profiles of wind and solar are very different and to make it even more challenging, the electricity demand centers are mostly in the south of the country. The existing transmission infrastructure is inadequate to evacuate the generated energy from the north leading to high congestion and constraint costs.

According to Power Technology Research, Germany is planning to add around 16 GW of HVDC transmission capacity by 2035 to strengthen their nationwide HVDC infrastructure along with cross-border HVDC interconnections. To increase public acceptance and the speed of building the new lines, the German federal government have decided to give priority to underground cables instead of (less costly) overhead lines.

The use cases from EU countries will provide valuable inputs in designing land based HVDC infrastructure in the New England area.

Topic 7: Comment on the region's ability to use offshore HVDC transmission lines to facilitate interregional transmission in the future

TNEI Response:

Until recently, the development of offshore electricity infrastructure has been relatively uncoordinated and planned on a project-by-project basis. This means that offshore wind farms have been connected individually to the shore (in most cases) and only a handful of point-to-point subsea interconnectors exist such as Nordlink, BritNed etc which qualify as offshore HVDC transmission. To enable interregional transmission or to allow countries/states to trade energy from dispersed renewable sources, a more coordinated approach is necessary such as regions linked by multi-terminal interconnectors and eventually forming a meshed offshore grid. A major benefit of a meshed grid would be increased security of supply in the same way as provided by onshore transmission systems.

[1] https://powertechresearch.com/comprehensive-overview-of-the-hvdc-market-of-north-america-and-europe/

With existing HVDC technology it is already possible to build simple multi-terminal systems. However, several challenges need to be addressed for the development of reliable and affordable meshed HVDC grids, not just in terms of technology but also in establishing standards and the regulatory framework. The EU-funded Horizon2020 project 'Progress on Meshed HVDC Offshore Transmission Networks' (PROMOTioN) showed that hardware-based technologies, such as HVDC circuit breakers and gas insulated substations, are ready for use. Similarly, software-based solutions such as HVDC system control and protection are interoperable and requires real-world pilot projects for further advancements.

Topic 9: Comment on how to develop transmission solutions that maximize the reliability and economic benefits of regional clean energy resources.

TNEI Response:

System Operators around the world have different approaches to developing transmission solutions that are economical and improve the reliability of the system. As more clean energy resources are adopted, the planning process becomes more complex and, in some cases, the current methods and approaches may not be adequate. The investment recommendations depend on several factors that interact with each other such as the representation of the system operation, investment decision structure, representation of the future etc. These factors are impacted as the penetration of renewable sources increases, leading to a fundamental shift in the level of uncertainties that need to be considered in the planning process.

Representation of the future by a single scenario is no longer suitable and the planning process should be sophisticated enough to identify investment options that can help the system across several scenarios rather than just one. To capture more investment flexibility new heuristic approaches should be considered in the short term that are capable to identify "compromise" solutions among the global set of reinforcements that are being considered. A single stage model may not be able to identify these options and an integrated operation-investment multistage decision through scenario-based model may be necessary to consistently assess the role of network and non-network options.

In addition, the temporal and spatial considerations in planning need to be expanded, for example system security analysis needs to be performed for different periods, rather than just a peak snapshot, to reflect the volatility of renewable energy output across a year.

Comments on the Draft MOWIP (Modular Offshore Wind Integration Plan)

Topic 15: Comment on cost allocation mechanisms that would prevent cost-shifting between the states based on their policy goals and ensure that local and regional benefits remain quantifiably distinct. How should any future potential procurement identify and distinguish local, regional, and state-specific benefits (e.g., reliability) such that ratepayers only pay for services that they benefit from?

TNEI Response:

This is a common question that many interconnector assets need to decide. Some do it on the length of cable within their territory (i.e. primarily concerned with CAPEX). Others take economic modelling and agree an upfront percentage (e.g. the Celtic Interconnector, which will connect Ireland and France is a 60:40 split).