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Ms. Swain,

Anbaric appreciates the opportunity to provide the following comments in response to the Department of Energy Resources (DOER) Request for Public Comment on Massachusetts' 83C Round 4 Offshore Wind Solicitation. Anbaric is a US-based company focused on planning and scaling renewable energy. Anbaric develops clean energy infrastructure to accelerate the deployment of renewable energy across North America, specializing in the design, development, financing, and construction of large-scale electric transmission and storage systems.

The Need for Independent Transmission

As the offshore wind (OSW) industry matures in the United States there is growing recognition of the need to plan and develop independent offshore transmission to de-risk and expedite interconnection, to enhance reliability, to protect the environment, and to reduce costs. The existing grid is not configured to integrate power from gigawatts of intermittent electricity sources located 100+ miles from major demand centers. Initial OSW projects can connect to nearshore locations, but subsequent projects risk overloading the onshore grid and lack resiliency when export cables fail. The challenge of interconnecting additional OSW increases as scarce cable routes and accessible points of interconnection (POIs) are used up. The Commonwealth's Decarbonization Roadmap show that New England will need 30 GW or more of OSW by 2050,[i] and interconnecting 30 or more 1 GW wind farms without planning shared transmission infrastructure would require a multitude of seabed cables, shore landings, and unnecessarily expensive upgrades to the onshore grid. The challenge of interconnecting OSW farms to the grid individually, in the absence of planning, is evidenced in the 'Cluster Study' processes that ISO-NE launched in response to just five project-specific OSW interconnection requests, finding the need for hundreds of million to over a billion dollars in upgrades.[ii]

The more effective approach is to plan and develop an ocean grid for OSW. Planned offshore transmission – built independent of and in advance of offshore wind farms – reduces risk by streamlining some of the most complex parts of the development process: connection to the onshore grid, permitting the onshore and near-shore routes, and securing support of coastal communities. Utilizing fewer, higher-capacity transmission lines protects the environment by minimizing seabed and shoreline disturbances and ensures that each interconnection point absorbs as much OSW as possible. The transmission-first approach reduces costs to ratepayers by providing every generator an equal ability to secure transmission capacity on open-access transmission systems that can be utilized by multiple wind farms, thus creating level competition among early entrants to the market and more recent entrants. This approach has worked effectively in Germany, The Netherlands, and Belgium, and is now being embraced by Great Britain.[iii]

Aligning Transmission and Generation Procurements

Development of transmission for offshore wind should precede development of offshore wind generation. Developing transmission in advance of generation ensures optimal transmission solutions for generation projects and provides time to place transmission in service before wind farms energy service. While transmission should be *developed and built* in advance of generation, solicitations for transmission and generation can be sequenced to occur in parallel. Maine recently ran an integrated transmission and generation solicitation in under one year, selecting a transmission line and wind farm from separate bidders.[iv] On December 30, 2022, DOER determined that the combined project is beneficial to the Commonwealth and committed Massachusetts ratepayers to cover 40% of the project costs.[v]

As elaborated below in response to specific questions, a similar, integrated approach to procuring offshore wind transmission and generation could be utilized in Massachusetts. Such an approach would facilitate integration of the 83C Round 4 solicitation with ongoing regional transmission initiatives, particularly the Joint State Innovation Partnership for Offshore Wind (herein after referred to as the "Joint Partnership"). To achieve optimal integration with the Joint Partnership, the 83C Round 4 solicitation should be structured to provide Massachusetts the opportunity to utilize coordinated, regional transmission solutions to interconnect generation projects selected in 83C Round 4. Such an approach would be consistent with the 2022 *Act driving clean energy and offshore wind*, which authorizes DOER to procure independent transmission for offshore wind,[vi] and which establishes that DOER "may condition the determination of any winning bid…upon the bidder's agreement to utilize transmission procured in a separate solicitation conducted by the department."[vii]

Integrating the 83C Round 4 solicitation with the Joint Initiative will enhance Massachusetts' ability to access competitively awarded federal funding. The Department of Energy (DOE) is offering billions of dollars in funding for independent transmission that is developed and paid for using innovative approaches. Interconnecting the next round of offshore wind projects via status quo generator lead lines does not reflect the innovation that DOE is seeking to promote. In contrast, developing shared, networked transmission in conjunction with other New England states maximizes the Commonwealth's ability to secure federal funds and reduce ratepayer costs.

1. *Procurement Size: What should be the maximum procurement target, in megawatts (MW), for the 83C Round 4 solicitation?*

In setting the procurement target and other requirements of the 83C Round 4 solicitation, a uniform objective should be to enable integration with solicitation of transmission through the Joint Partnership. While technical details of the Joint Partnership transmission procurement have yet you be established, certain design preferences have been indicated that can inform the 83C Round 4 solicitation. In the Modular Offshore Wind Integration Plan (MOWIP) proposed within the New England states September 1st, 2022 Request for Information, [viii] states indicated a preference for 525 kilovolt (kV) high voltage direct current (HVDC) transmission.[ix] 525kV HVDC is becoming state-of-the-art in the industry, enables efficient transmission over long distance to strategic POIs, and facilitates interoperability and interconnectivity of offshore converter stations in a network configuration that enhances controllability and flexibility.

In order to integrate with the Joint Partnership, bidders should thus be required to submit at least one bid capable of interconnecting with 525kV HVDC transmission or an alternate preferred voltage standard if 525kV HVDC is not the preferred standard under the Joint Initiative. (Additional detail on technical requirements for network-capable 525kV HVDC transmission is provided below in response to question 4.) Requiring bidders to submit a bid compatible with 525kV HVDC or another uniform standard will achieve three objectives:

i. *Optionality*: selecting a generation project utilizing 525kV HVDC transmission or an alternate uniform standard will provide Massachusetts the opportunity to integrate the generation project utilizing transmission procured through the Joint Partnership. Integrating generation projects selected in 83C Round 4 with separate transmission was envisioned and authorized by the General Court, which established in the *Act driving clean energy and offshore wind* that "the department of public utilities may allow contractual adjustments for project cost differentials attributable to the utilization or non-utilization of separate transmission procured by the commonwealth."[x]

ii. *Market intelligence*: competitive bids for 525kV HVDC transmission or an alternate uniform standard will provide information on market pricing and equipment procurement timelines that Massachusetts and partner New England states can use to support implementation of the Joint Partnership.

iii. *Flexibility*: requiring at least one bid utilizing 525kV HVDC transmission or an alternate uniform standard would not require DOER to select such a bid, and if a different transmission configuration is in the public interest, it could be selected.

The maximum procurement target for 83C Round 4 solicitation should be 1,200 MW. The Joint Partnership notes that 525kV HVDC transmission, while capable of transmitting 2,000 MW of capacity, is currently limited to injecting 1,200 MW under ISO-NE standards.[xi] Accordingly, the 83C Round 4 solicitation should be limited to a maximum of 1,200 MW. While Massachusetts is presently authorized to procure up to an additional 2,400 MW of offshore wind generation, interconnecting this quantity of generation with radial lines for individual offshore wind farms would represent a missed opportunity to integrate future OSW generation with transmission procured through the Joint Partnership, and would exacerbate challenges with the status quo interconnection framework cited above and in the Joint Partnership Concept Paper to DOE. Further, withholding procurement authority for future solicitations will enable Massachusetts to procure offshore wind from the existing MA/RI lease areas and Gulf of Maine lease areas, thus increasing competition and driving down the cost of offshore wind generation.

Conversely, no minimum capacity threshold should be established in the 83C Round 4 solicitation, so that leaseholders are able to propose development of residual lease area that may otherwise be uneconomical to develop. As illustrated in the slide below from Brattle Group's 2020 report *Offshore Wind Transmission in New England: The Benefits of a Better-Planned Grid*,[xii] after initial, larger wind farms are developed in lease areas, unutilized residual lease areas will remain, and these lease areas would be most efficiently interconnected with shared transmission systems.

BENEFITS OF PLANNED OFFSHORE TRANSMISSION

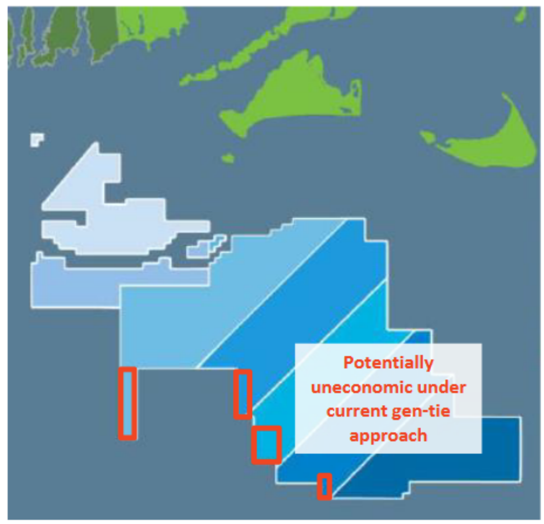
Realize the full potential of existing lease areas

Without a well-planned offshore grid, some of the existing offshore lease sites may not be economic to develop

- After developers interconnect the bulk of their lease sites, it may be cost prohibitive to interconnect the residual areas (of perhaps 50 MW to 250 MW each) using AC generator lead lines sized to carry ~400 MW each
- This increases the risk of inefficient use of lease sites and stranded assets

An offshore grid with well-located offshore collector stations would increase the likelihood that residual lease areas could be developed cost-effectively, and that the full potential of all lease areas can be realized

Developers May Find Residual Areas Uneconomic to Interconnect With Generator Lead Lines



Map Source: Massachusetts CEC, “Massachusetts Offshore Wind Initiatives,” EBC Sixth Annual Offshore Wind Conference.

Wind farms developed in these residual lease areas may be too small to carry the cost of shared transmission systems on their own. However, receiving bids to interconnect offshore wind generation from these residual lease areas via 525kV HVDC transmission would enhance Massachusetts' optionality to integrate this capacity via shared transmission procured through the Joint Partnership.

2. *<u>Procurement Schedule</u>: The 83C Round 4 RFP must be issued within 24 months of the prior solicitation pursuant to Section 83C.*

   a. *What should the RFP drafting parties consider when designing the schedule for the 83C Round 4 solicitation, including deadlines for bid submission and selection of projects for negotiation?*

Drafting parties should seek to align the 83C Round 4 procurement schedule with the Joint Partnership to the greatest extent possible. The Joint Partnership Concept Paper establishes that "Participating States will endeavor to design and begin implementation of a solicitation process prior to the May [Grid Innovation Program] deadline".[xiii] This timeline aligns with the required issuance by May of the 83C Round 4 solicitation. If the Joint Partnership solicitation process establishes a transmission solicitation process leading to selection of transmission projects in 2023 or 2024, selection of generation projects for negotiation in 83C Round 4 should be sequenced to occur after selection of transmission projects, or awards should be conditioned on potential use of transmission procured through the Joint Partnership. As noted above, under the *Act driving clean energy and offshore wind*, contractual adjustments for offshore wind projects using shared transmission is explicitly authorized. Thus, the 83C Round 4 procurement could allow for adjustments to the generation bids once a winning transmission project or projects are selected through the Joint Partnership. Alternatively, 83C Round 4 could establish a two stage generation bid: the first bid for pricing the generation, and the second bid for shortlisted generation bids to add their costs to connect to the selected transmission. This framework is further elaborated in response to question 4, below.

In order to minimize bidder exposure to changing market conditions between bid submission and award, 83C Round 4 bids should be due as late as possible to a) enhance alignment with the Joint Partnership and b) enable the next generation solicitation within 24 months of the issuance of the 83C Round 4 solicitation. Deferring the deadline for bid submission under 83C Round 4 until the second quarter of 2024 would provide additional benefit by reducing risks associated with current supply chain disruptions and inflation.

b. *How could the 83C Round 4 schedule be designed to best align with other offshore wind procurements being conducted or planned in neighboring Northeastern states?*

New York, Rhode Island and New Jersey are currently conducting offshore wind energy procurements, and the 83C Round 4 solicitation should be designed to follow awards in those procurements. Offshore wind leaseholders who have bid into the New York and Rhode Island procurements, or who are planning to bid into the New Jersey procurement will be constrained from bidding projects from the same lease areas into a Massachusetts procurement. Once awards in all procurements are announced, bidders will be capable of submitting bids not conditioned on awards in other states. Thus, in order to promote administrative efficiency and certainty, Massachusetts should not require bids to be due until after the award dates of each of these procurements. New York intends to announce an award in Q2 of 2023, Rhode Island on June 21st, 2023, and New Jersey in Q4 of 2023. While remaining lease area in the MA/RI lease block is distant from New Jersey, bids utilizing HVDC transmission over long-distances have been submitted and selected in recent procurements.[xiv] Further, if a wind farm in the MA/RI lease areas is selected in New Jersey's procurement, it would provide an opportunity to facilitate future interconnection between New England and PJM, in addition to interconnection with NYISO contemplated in the MOWIP.[xv]

3. <u>*Commercial Operation Date*</u>*: What should be the latest allowable commercial operation date for projects bidding into 83C Round 4, and why?*

The latest allowable commercial operation date for projects bidding into 83C Round 4 should be set to enable integration of wind farms utilizing transmission procured through the Joint Partnership. The Joint Partnership Concept Paper states that "Joint Participants will explore a solicitation process that seeks a modular development structure to facilitate the initial deployment of offshore HVDC systems in the near term while enabling upscaling of the system to accommodate a first-in-the-nation networked or "meshed" multi-terminal high voltage direct current (MTDC) system as that technology becomes available."

As further elaborated below, HVDC technology with MTDC capability is progressing rapidly, and initial elements of a MTDC offshore grid can be procured now, with commercial operation achievable by 2030. Offshore wind farms solicited through 83C Round 4 should be allowed to proposed commercial operation dates in the early 2030s to provide a buffer between commercial operation of independent transmission and generation. Requiring bidders to submit at least one bid at 525kV or an alternate preferred standard will enable Massachusetts to gather valuable information on the commercial availability and timeline for MTDC systems. This information can inform the Joint Partnership solicitation and timing considerations for integrating wind farms selected through 83C Round 4 with transmission procured through the Joint Partnership.

The following summarizes the status of technology required for MTDC transmission:

- **Multi-Terminal Projects** – Several multi-terminal HVDC projects have been successfully put into operation in China, demonstrating the technology's viability. In Europe, which has a more comparable transmission development approach to the United States, 13 'multi-terminal ready' HVDC grid projects are being developed with commercial operation dates ranging from six to eight years from now.[xvi] Notably, TenneT, the Transmission System Operator for the Netherlands and Northwest Germany, has developed and standardized a 2 GW, 525 kV platform design that is multi-terminal ready and that anticipates the development of HVDC circuit breakers to enable MTDC capability.[xvii] TenneT already has eleven of these projects scheduled for in-service dates between 2028 to 2030.

- **Full Bridge Converters** – Full bridge converters – which will be commercially operating in 2027 -- are an alternative that can be used in projects now being developed until HVDC circuit breakers become available. Like HVDC circuit breakers, full bridge converters will enable the re-routing of power flows after a fault in an HVDC network without requiring the reenergization of the entire network. The ULTRAnet project in Germany is a three-terminal project that will use full-bridge converters and a non-selective ultrafast protection strategy (capable of clearing a fault in 100-200 milliseconds) to enable the instantaneous re-routing of power. ULTRAnet is expected to enter service in 2027.[xviii] Over time full bridge converters will likely be less economic than HVDC circuit breakers due to higher energy losses and greater capital cost but they currently provide a transitional step to the performance and cost advantages of HVDC networks and HVDC circuit breakers.

- **HVDC Circuit Breakers** – HVDC circuit breakers are a key component of the future of networked HVDC transmission systems. HVDC circuit breakers enable the nearly seamless reconfiguration of the network to support a variety of grid needs, from low frequency events such as loss of an export cable to regular needs including redistributing the flow of power to respond to the real-time needs of the onshore transmission grid.

  Full-scale prototypes of different HVDC circuit breaker technologies from multiple vendors have been successfully demonstrated up to 350 kV in Europe.[xix] Since most HVDC circuit breaker technologies are modular in nature, they can be scaled to higher voltages relatively easily and without a fundamental change in technology. Pre-standardization activities have been completed[xx] and the first commercial application of a 525 kV HVDC circuit breaker is expected to enter service in 2032 in Germany[xxi]. Recent market developments show that offshore wind transmission equipment suppliers are coupling advanced MTDC technology with competitive manufacturing capabilities in order to build a commercial supply chain for HVDC circuit breakers.[xxii]

To be clear, HVDC circuit breakers are not required at present to begin procuring and building initial elements of a MTDC offshore grid. What is needed now is to require that offshore wind transmission systems can integrate with a MTDC system, either by using full bridge converters, or by including anticipatory investments that enable integration of HVDC circuit breakers. These technical specifications are provided below in response to question 4.b.

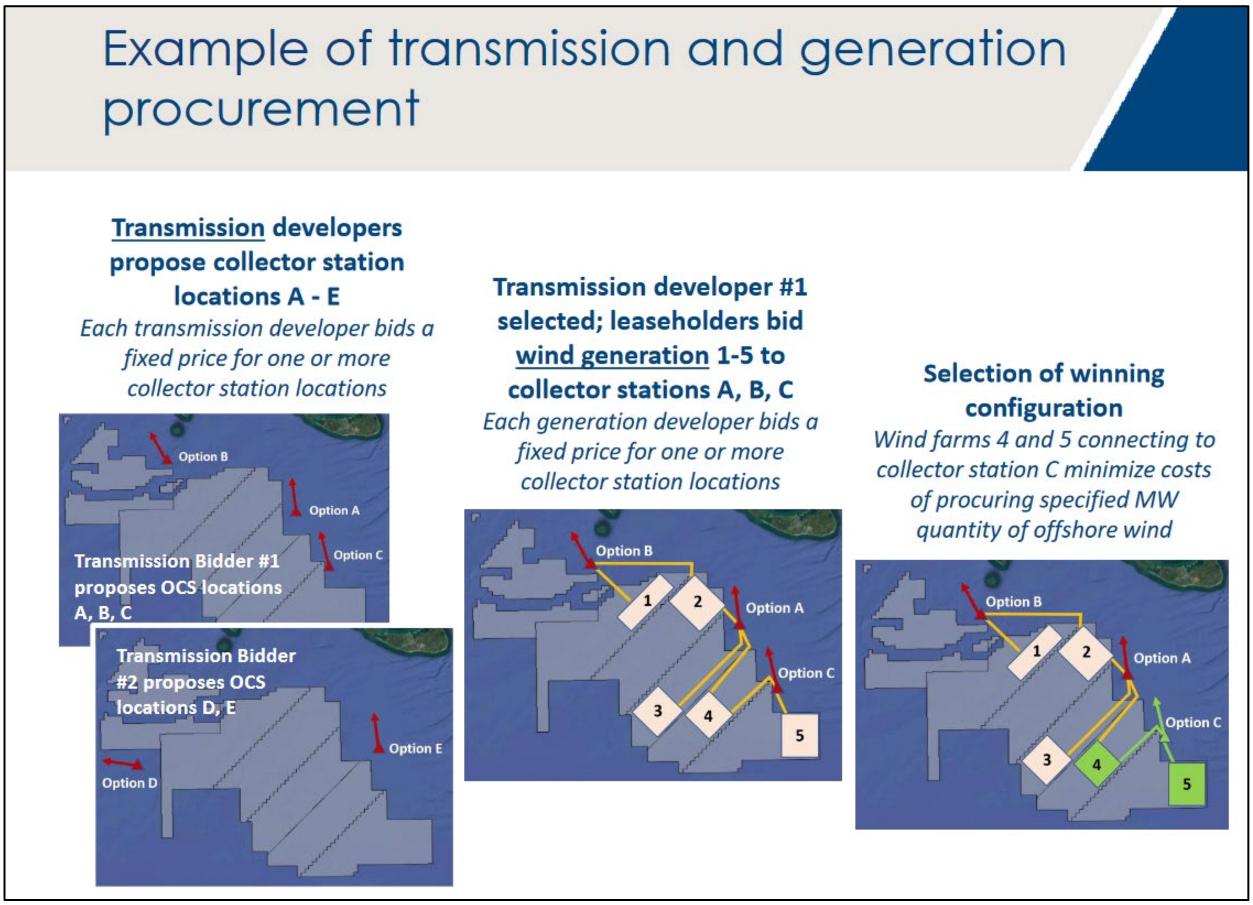
The global deployment of offshore wind and HVDC transmission will continue to drive significant and rapid advancements in networked HVDC transmission systems. If policymakers do not anticipate and prepare for this rapid technological advancement, systems procured now will have unnecessarily constrained functionality when placed in service, and may be technologically obsolete within years of construction. With a goal of integrating 15 GW of offshore wind, Massachusetts must take steps now to prepare for a future where networked HVDC transmission systems are commercially available and broadly utilized to enable the most flexible and resilient transmission for offshore wind.

4. *Transmission:*
   a. *How should the 83C Round 4 requirements regarding transmission and interconnection of proposed projects be designed to maximize efficient use of the onshore transmission system?*
   b. *Please comment on potential ways to integrate 83C Round 4 with ongoing regional transmission initiatives, including the Joint State Innovation Partnership for Offshore Wind.*

Once initial OSW projects have utilized accessible POIs with manageable upgrade costs, the best practice is to plan and develop transmission for OSW separately from OSW generation. Mature offshore wind markets in Europe including Germany, The Netherlands and Belgium are developing transmission separately from generation. The United Kingdom is transitioning to development of independent transmission for offshore wind, driven in part by a study from National Grid UK finding that planned transmission could reduce costs by 18% and reduce cable landings and total transmission infrastructure by 70%.[xxiii]

Since Massachusetts is required by statute to issue a solicitation for offshore wind by May of 2023, there are two principal ways that the 83C Round 4 solicitation can be structured to maximize efficient use of the onshore transmission system.

i. Massachusetts should set a solicitation timeline that enables interconnection of projects selected through 83C Round 4 utilizing separate transmission procured through the Joint Partnership. Massachusetts should provide the maximum practical time between issuance of the RFP and bid submission to enable evaluation of generation bids in conjunction with transmission bids received through the Joint Partnership. Under current law, Massachusetts' next OSW generation solicitation must be issued by May of 2025 (assuming issuance of the 83C Round 4 solicitation in May of 2023). Establishing a response deadline of April or May of 2024 for 83C Round 4 bids would provide time for Massachusetts and partner states in New England to issue a transmission solicitation in 2023 under the Joint Partnership, with responses due before April/May of 2024. Key specifications (i.e. technical specifications and location of offshore collector station{s}) from all or a subset of preferred transmission bids could be provided to generation bidders. OSW leaseholders could then bid OSW generation projects interconnecting to the independent transmission projects. This process would replicate the Maine PUC's recently completed procurement of transmission and generation projects.[xxiv] Applying this process to offshore wind is described in the slide below from Brattle Group's 2020 report *Offshore Wind Transmission in New England: The Benefits of a Better-Planned Grid*,[xxv]



ii. The 83C Round 4 procurement should require bidders to submit at least one bid for each proposed wind farm that either a) utilizes network-capable 525kV HVDC transmission (or an alternate uniform standard) to connect to the onshore grid, or b) is designed to interconnect with separately developed and owned network-capable 525kV HVDC transmission. Requiring bidders to provide network capable 525kV HVDC transmission options will provide three key benefits:

   1. It will provide Massachusetts with the option of selecting a wind farm and associated network-capable 525kV HVDC generator lead line that could be integrated with independent transmission procured through the Joint Initiative.

2. It will facilitate interconnection of wind farms selected through 83C Round 4 with independent transmission selected through the Joint Partnership. Establishing technical bid requirement for network-capable 525kV HVDC transmission and replicating those requirements in procurement(s) issued in the Joint Partnership will create common technical standards and thus provide Massachusetts with the option of substituting independent transmission procured through the Joint Initiative for project-specific generator lead lines if independent transmission is determined to be in the public interest.
3. Requiring bids capable of integrating with network-capable 525kV HVDC transmission from all projects – including smaller projects – will provide Massachusetts (and other states) the option of interconnecting projects from residual lease areas most cost-effectively. As described above in response to question 1, residual lease areas remaining after development of initial projects may be too small to utilize the full capacity of 525kV transmission or 230kV HVAC transmission (typically sized to transmit ~400MW). Developing these residual lease areas as add-ons to existing projects, or through use of new over-sized generator lead lines will be less cost-effective than interconnecting residual lease areas using independent transmission serving multiple wind farms.

Technical Specifications

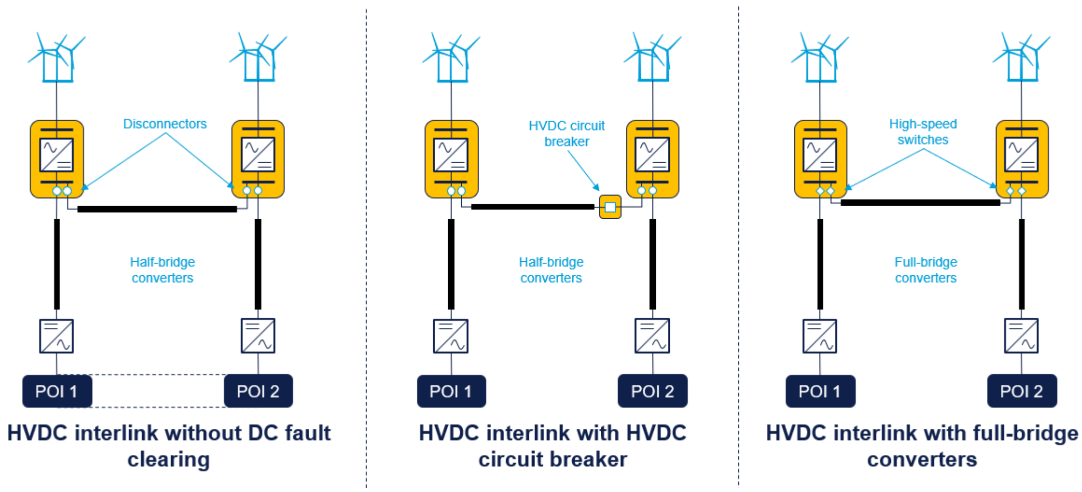
Suggested technical specifications for network-capable 525kV HVDC bids provided below are modeled on specifications for the thirteen 2,000 MW network-capable 525kV systems being developed by the Dutch-German transmission system operators TenneT and Amprion.[xxvi] These uniform standards are driving industry and supply chain convergence, and procuring to these standards will reduce costs by building on established technology. The standards can be tailored to meet local considerations such as ISO-NE's current limit of 1,200 MW for a single contingency, though single contingency limits may be addressable through innovative project design. Additionally, minimizing modifications from the technical specifications established by TenneT will maximize supply chain efficiency by mirroring designs currently being fabricated by original equipment manufacturers.

<u>Meshed Grid Capability</u>

In order to ensure MTDC functionality of 525kV HVDC systems, Massachusetts should require offshore HVDC converter stations be built with square disconnector bays and associated equipment to support the future addition of HVDC interlinks (these disconnectors will be operated as normally open points when interlinks between offshore collector station are installed). This configuration (shown in the left panel of Figure 3, below) will allow for the HVDC network to be reconfigured in the event of a fault in an HVDC export cable even without HVDC circuit breakers.

To minimize the risk of stranded assets, Anbaric recommends the installation of any future HVDC circuit breakers on a separate platform, as shown in the middle panel of Figure 1. HVDC circuit breaker platforms would ideally be sited adjacent to converter platforms, as this results in cost savings from shared auxiliary systems, accommodation, and accessibility systems. HVDC circuit breaker platforms can be placed at any point in the HVDC interlink, which provides significant flexibility if there are siting constraints adjacent to the existing converter platforms.

Figure 1. Design Configurations for HVDC Interlinks. ***Source: DNV***



<u>Voltage Standard</u>

To enable MTDC functionality an HVDC voltage standard must be established for export links and future interlinks. HVDC systems with different operating voltages are not physically compatible. In contrast to the role of transformers in connecting AC systems with different voltages, no cost-effective technology for high-voltage and high-power DC voltage transformation exists today. For this reason, a common DC voltage rating is a pre-requisite for being able to connect different HVDC systems into a multi-terminal HVDC grid.

Three voltages have emerged as de facto standard voltage ratings from which Massachusetts could chose:

- 320 kV is technically mature but is limited by maximum circuit capacity of around 1200 MW, which reduces the economy of scale benefits of utilizing higher-capacity transmission.
- 400 kV is technically mature and is in use by multiple projects onshore, but it is not a standardized solution for offshore projects and has been superseded by 525kV HVDC.
- 525 kV is the emerging standard in Europe, and the industry will focus on developing MTDC capability for 525kV. [redacted]

<u>Equipment Specifications and Installation Requirements</u>

The equipment specifications and installation requirements necessary to create an HVDC mesh ready system should focus on components of the offshore system that need to be flexible and expandable as the system of transmission links develops. In most cases, anticipatory installation and investment that makes the platform ready for growth during the initial platform construction is less expensive than offshore retrofitting.

To enable expansion, offshore substation specifications should include the following provisions:

- **Primary equipment** to enable the physical connection of an additional cable:
    - High voltage busbar is necessary to accommodate a HV interlink connection.
    - An additional switchgear bay is needed to connect the additional interlink cable to the offshore power system. For HVDC connections, the air insulated HVDC circuit breaker should be installed on a separate platform due to its large size. A spare HVDC disconnector bay should be installed in the primary converter station to accommodate a future interlink. Utilizing HVDC gas insulated disconnectors would not require increasing the converter platform size. The ability to include an HVDC interconnector without increasing the platform size is an important benefit of HVDC interlinks, as AC interlinks would require an additional transformer and possibly a dynamic breaking resistor (a.k.a. chopper), which would increase the platform size.

- **Secondary equipment** to enable the electrical operation of the primary equipment:
    - Bay control and protection for each additional switchgear bay.
    - Metering to enable dispatch and market settlement of any additional power system user that is connected as part of the offshore grid expansion.
    - Instrumentation wiring to connect the additional primary and secondary equipment. In modern digital substation design the need for additional wiring can be kept to a minimum by using substation bus systems.

- **Auxiliary systems** to ensure the required operational conditions for the additional primary and secondary equipment:
    - HVAC, firefighting and lighting in any additional space that is necessary to host additional primary and secondary equipment.
    - Low voltage wiring is needed for the power supply to the additional primary and secondary equipment.
    - Diesel generator and uninterrupted power supply capacity (e.g., additional batteries) are required to serve the increased auxiliary load demand due to the additional primary and secondary equipment, and due to additional HVAC and lighting requirements.

- **SCADA system upgrades** to integrate the functionality of additional equipment.
    - Special control modes necessary for the operation of more complex offshore grid topologies must be enabled.

- **System ratings** need to be compatible with the foreseen offshore grid expansions:
    - Basic insulation level and rated voltage of offshore grid expansions need to be the same (e.g., 525kV) to avoid the need for additional transformers and overvoltage protection equipment.

  - Power ratings of transformers and cables need to ensure sufficient margin for any possible additional loads resulting from future expansions.
  - Current ratings of busbars, switchgear and instrumentation need to ensure sufficient margin for any possible additional currents resulting from future expansions.
  - System grounding design must be sufficiently flexible to accommodate more complex offshore grid topologies where multiple grounding points could be possible and to ensure changes in short-circuit currents due to system expansions are compatible with equipment and protection settings.
  - Harmonic stability could be affected by the connection of additional equipment (i.e., adjacent converters) and require retuning and possible additional filter equipment. Accordingly, control & protection replicas should be delivered with each project, including contractual requirements for OEMs to ensure the software on these replicas is updated every time the real system is updated.
  - Circuit energization equipment ratings such as pre-insertion resistors need to be expandable to accommodate the connection of additional equipment and space should be reserved to add additional resistor banks in the future.

- **Structural support** to host the additional primary, secondary and auxiliary equipment:
  - Space for additional primary, secondary and auxiliary equipment. Sufficient footprint and headroom must be available for the installation, operation, and repair of the equipment. The location of the additional space must be chosen such that it easily facilitates the integration of any additional equipment with existing systems. This includes the availability of free space for cables and wiring in sealed wall crossings, additional space for power cable installation, instrumentation and low voltage wire trays.
  - J-tubes are required to enable the pull-in of additional power and communication cables. The spare J-tube will need to be designed with sufficient room and bending radius to accommodate the future expansion cable. Sufficient space must be available on the cable deck to pull-in the additional cable.
  - Seabed cable arrangement must leave sufficient space for the installation and repair of an additional submarine cable.
  - Support structure design must be sufficient to support the installation of additional weight and offer space and support points to host any additional modules.

- **Substation expansion to enable interlinks** – There are three options for developing topside equipment needed to add interlinks and related equipment between offshore substations. The options described below range from more to less up-front investment. Reflecting the modular approach outlined in the Joint Initiative, Anbaric recommends requiring topside infrastructure for HVDC interlinks to be installed on separate platforms, as described and depicted in section iii below.

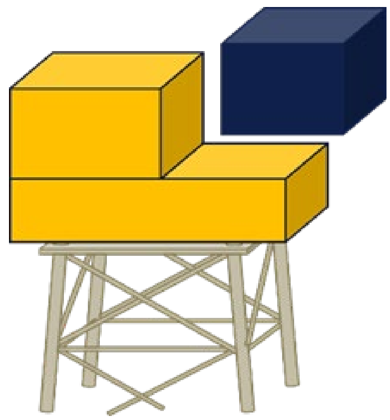
  i. **On the same support structure, within the existing topside:**

- Plug and play: All necessary provisions are installed during construction and ready to use at the time of expansion.
- Expandable: Only minimum provisions such as space, structural support and interfaces for necessary equipment are installed during construction and available and accessible for future installation.

ii. **On the same support structure, adjacent to the existing topside:**

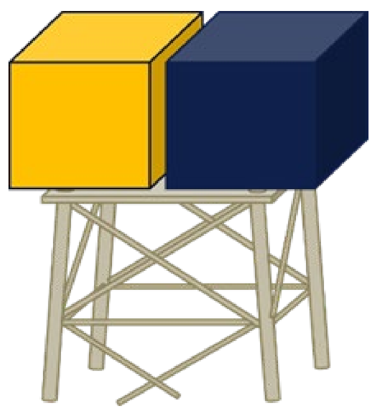
- By installing an additional module onto the existing topside, as shown in Figure 4.

Figure 2. Additional Module on Existing Topside. *Source: DNV*



- By installing a separate additional topside onto the same support structure, as shown in Figure 5.

Figure 3. Separate Additional Topside on Same Support Structure. *Source: DNV*

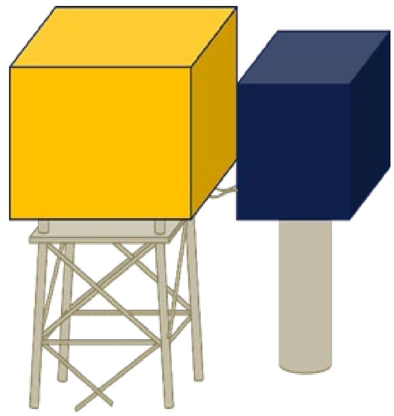


- In both cases, space, structural support and interfaces for the future installation of the module must be present from the start.

iii. **On a separate adjacent support structure and topside:**

- Connected by a bridge, as shown in Figure 6, if the offshore substations are closely located (e.g., less than a few hundred feet apart). The bridge will allow for easy personnel accessibility between the platforms and can be used to support connections such as HV cables, GIL, LV power supply, communications, and other amenities.

Figure 4. Additional Support Structure and Topside. ***Source: DNV***



- Connected by submarine cable, if the offshore platforms are located too far away from each other to be connected by bridge. In both cases, space on the seabed, and additional electrical switchgear bays for the future installation and connection of the additional offshore substation must be present from the start.

c. *Please comment on the advantages and challenges of the "Meshed Ready" transmission requirement in the 2022 NYSERDA offshore wind RFP (ORECRFP22-1) and what factors would need to be considered for such an approach to be applicable in a Section 83C solicitation.*

Anbaric respectfully recommends that Massachusetts not follow the approach laid out in NYSERDA's "Meshed-Ready Technical Requirements" guidance document[1]. Instead, Anbaric recommends an approach consistent with evolving technology that will help the industry reach significant scale in a short period of time. The difficulties with NYSERDA's approach rest on the limitations of alternating current (AC) technology to link offshore wind platforms, the potential for stranded assets, and the rapid development of direct current (DC) technology.

The perceived benefits of NYSERDA's approach are (1) the ability for offshore wind projects to use different HVDC voltage levels; and (2) the use of established AC technology. These perceived benefits must be weighed against the downsides of AC interlink cables: (1) lower capacity of AC cables (~400 MW for 230kV cables vs. 2,400 MW for 525kV HVDC cables) and the need for as many as six times the number of interlink cables and associated platform equipment, (2) reduced flexibility and controllability, and (3) the shorter distances over which AC interlinks can be used (~50-60 miles), which may preclude interlinks to floating wind in the Gulf of Maine and to neighboring regions.

[1] Technical Requirements (ny.gov)

Instead of following the approach laid out by NYSERDA, Anbaric recommends that design requirements for a mesh network follow the examples envisioned by the New England States' Regional Transmission Initiative and set forth by the German, Dutch, and Danish governments. Namely, Massachusetts should (1) establish a technical (e.g. voltage) standard to enable future HVDC interlinks and (2) set forth criteria that are in close alignment with TenneT's multi-terminal ready framework.[xxvii]

The use of HVDC interlinks will deliver three key benefits over the use of AC interlinks:

1. HVDC interlinks require significantly fewer upfront capital investments than AC interlinks. As a result, there is a much smaller risk of stranded assets when pursuing HVDC interlinks. This is particularly notable given that AC interlinks face a real risk of technology obsolesce from the rapid advancement of HVDC technology.
2. Establishing an HVDC voltage standard (as required for HVDC interlinks) will accelerate the maturation of the industry and decrease supply chain risks.
3. HVDC interlinks will enable the development of controllable interregional transmission capacity, which is critical for maintaining grid reliability as renewable penetrations increase.

Several additional considerations should be taken into account when setting standards for offshore transmission.

First, establishing an AC interlink standard will slow the maturation of the industry. By failing to define an HVDC voltage standard at this stage in the industry's development, regulators are pushing the industry toward several avoidable supply side challenges. The most significant of these will be a continuation of the limited supply of HVDC cable. Without standardization, cable manufacturers will likely continue to delay investment in manufacturing facilities.

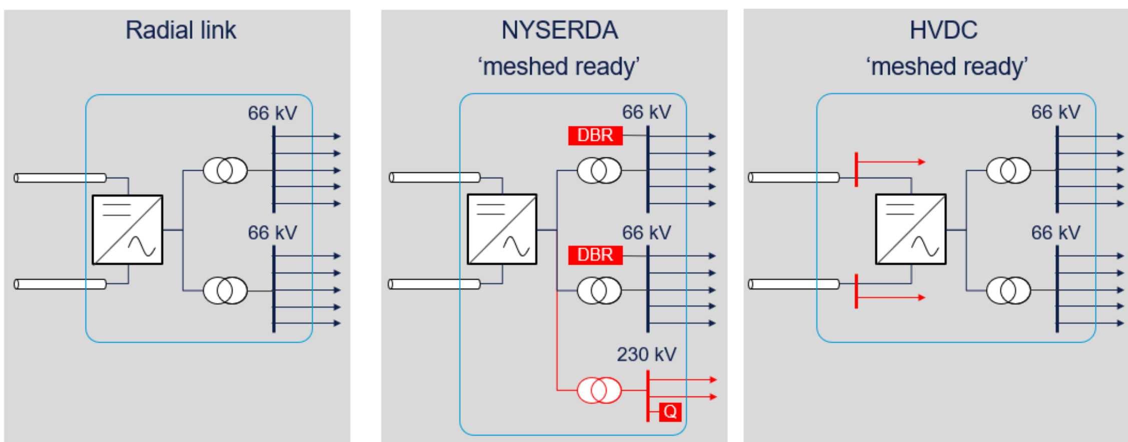
A second major challenge with NYSERDA's meshed-ready standards and resulting HVDC voltage differences from platform to platform is that it inhibits the use of higher performing, lower cost HVDC interlinks in the future. As discussed above HVDC circuit breakers will be commercially available in the timeframe for deployment of the next round of offshore wind farms. Europe is committed to the development of HVDC networks and TenneT has developed a standard for multi-terminal ready HVDC platforms that presumes the use of HVDC interlinks. HVDC interlinks will thus likely be a more attractive solution than AC interlinks at the point in time regulators seek to invest in the development of a mesh network. However, the option to use HVDC interlinks will not be available to regulators unless they act now to establish an HVDC voltage standard.

Third, the assumption of technological certainty for AC interlinks is also not without question. AC interlinks will be able to use existing AC circuit breakers to interrupt fault currents and isolate fault. Circuit breakers, however, are not the only technological constraint facing the development of mesh-networks for offshore applications. Notably, there are significant stability and controllability issues that AC interlinks will have to address for DC converters that are closely coupled through an AC interlink, particularly when these converters are supplied by different vendors.

Fourth, HVDC interlinks able to span longer distances can enhance offshore wind resource diversity for Massachusetts and the entire East Coast. Wind farms located farther apart will greater diversity. As a more general point, HVDC interlinks unlock the benefit of integrating markets with diverse production mixes and load characteristics, ensuring the consumer has access to the lowest cost and lowest carbon energy.

A fifth and final point regarding the tradeoff between AC and HVDC interlinks is that the design criteria for AC interlinks will require significantly more equipment installed on the offshore platform at the time of initial development. This equipment includes the installation of dynamic braking resistors (a.k.a. 'AC Choppers', labeled "BDR" in the image below) and shunt reactors (labeled "Q" in the image below), neither of which are required for HVDC interlinks, as shown in red in the middle panel of Figure 5. In contrast, the equipment required for HVDC interlinks is an additional disconnector bay for each pole and associated auxiliary equipment, as shown in the right panel of Figure 5. The additional equipment needed to support AC interlinks (the dynamic braking resistors and shunt reactors) will require larger platform sizes and represents a larger potential for stranded assets should either the need for AC interlinks not materialize or, more likely, HVDC interlinks make AC interlinks technologically obsolete before they would be procured.

Figure 5. Offshore Platform Designs. *Source: DNV*



For the reasons laid out above, Anbaric respectfully recommends that Massachusetts continue to pursue the offshore transmission buildout envisioned through the Modular Offshore Wind Integration Plan rather than NYSERDA's mesh-ready standard.

5. *Federal Funding:*

   a. *How could 83C Round 4 be designed to ensure Massachusetts ratepayers receive the maximum benefits of the new federal funding opportunities, tax credits, and/or other programs available to offshore wind developers under the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA)?*

Integrating the 83C Round 4 solicitation with the Joint Initiative will maximize Massachusetts' ability to access funding for transmission made available through the Bipartisan Infrastructure Law. The Grid Innovation Program[xxviii] to which Massachusetts and other New England States submitted the Joint Initiative Concept Paper provides up to $250 million per project and is intended to support innovative transmission projects. As noted in the Funding Opportunity Announcement:

> "DOE is interested in both technical and non-technical approaches that improve grid reliability and resilience on a local, regional, and interregional scale. Innovative approaches can include advanced technologies, innovative partnerships, financial arrangements, deployment of projects identified by innovative planning and cost allocation approaches, and environmental siting and permitting strategies."

The use of advanced network-capable 525kV HVDC transmission capable of expanding into a MTDC offshore grid is aligned with DOE's objective to drive innovation. Continued utilization of generator lead lines serving individual wind farms represents a continuation of the status quo approach to offshore wind deployment in the United States, and as such is less likely to attract funding from the Grid Innovation program. As such, taking steps to integrate the 83C Round 4 solicitation with the Joint Initiative positions Massachusetts to receive $250 million per transmission system used to integrate the next round of offshore wind farms procured by Massachusetts.

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[i] MA Decarbonization Roadmap, Energy Pathways to Deep Decarbonization, available at: https://www.mass.gov/doc/energy-pathways-for-deep-decarbonization-report/download

[ii] ISO-NE's First Cape Cod Resource Integration Study found that the 3rd and 4th OSW projects connecting to Cape Cod would require $335 million in transmission upgrades on Cape Cod, and that connecting additional OSW projects would require transmission to the Boston area or major upgrades to the Southeast New England grid. See: https://www.iso-ne.com/system-planning/interconnection-service/cluster-interconnection-studies/

[iii] See presentation of Dr. Biljana Stojkovska, Offshore Technical Manager for National Grid, UK, presented to the New England States Energy Vision Transmission Planning Technical Conference, available at: https://newenglandenergyvision.files.wordpress.com/2021/02/bstojkovska-02-02-2021-draft.pptx?force_download=true.

[iv] Maine PUC case number 2021-00369, available at: https://mpuc-cms.maine.gov/CQM.Public.WebUI/Common/CaseMaster.aspx?CaseNumber=2021-00369

[v] See: https://mpuc-cms.maine.gov/CQM.Public.WebUI/Common/ViewDoc.aspx?DocRefId={CD92FB4A-D35C-4446-A562-BDCAFAE3B6DD}&DocExt=pdf&DocName={CD92FB4A-D35C-4446-A562-BDCAFAE3B6DD}.pdf

[vi] Chapter 179 of the Acts of 2022, Section 70. Available at: https://malegislature.gov/Laws/SessionLaws/Acts/2022/Chapter179

[vii] I.d. Section 61(c).

[viii] The Modular Offshore Wind Integration Plan is available at: https://newenglandenergyvision.files.wordpress.com/2022/09/transmission-rfi-notice-of-proceeding-and-scoping-revised.pdf

[ix] International standardization is moving towards a definition of a 500 kV nominal voltage class, which will cover 525 kV systems.

[x] Supra, note v, section 61(c).

[xi] Available at: https://newenglandenergyvision.com/new-england-states-transmission-initiative/

[xii] Available at: https://newengland.anbaric.com/wp-content/uploads/2020/07/Brattle_Group_Offshore_Tranmission_in_New-England_5.13.20-FULL-REPORT.pdf

[xiii] The Joint State Innovation Partnership for Offshore Wind concept paper to the Department of Energy is available at: https://newenglandenergyvision.com/new-england-states-transmission-initiative/

[xiv] Sunrise Wind is connecting from the MA/RI lease areas to New York utilizing a 100-mile HVDC transmission system (see: https://sunrisewindny.com/news/2021/10/sunrise-wind-will-be-first-offshore-wind-project-in-united-states--to-use-hvdc-transmission-technology) and Beacon Wind is utilizing a 115-mile HVDC export cable to connect from the MA/RI lease areas to New York (https://www.beaconwind.com/wp-content/uploads/2022/07/BW1_Exhibit-9_Cost-of-Proposed-Facility_REDACTED-1.pdf)
[xv] Supra, note vii.
[xvi] Eight projects are being developed by TenneT in the Netherlands, three by in TenneT Germany, and two by in Amprion Germany.
[xvii] Additional information can be found at: https://www.tennet.eu/our-grid/offshore-outlook-2050/the-2gw-program/
[xviii] See: https://www.amprion.net/Grid-expansion/Our-Projects/Ultranet/
[xix] See: https://www.promotion-offshore.net/fileadmin/PDFs2/D10.9_Reporting_on_HVDC_circuit_breaker_testing.pdf
[xx] See: https://e-cigre.org/publication/873-design-test-and-application-of--hvdc-circuit-breakers
[xxi] See: https://tennet-drupal.s3.eu-central-1.amazonaws.com/default/2022-07/Windstrom-Booster-Concept_English.pdf and https://www.50hertz.com/en/News/FullarticleNewsof50Hertz/12105/50hertz-and-tennet-to-jointly-bring-wind-power-from-the-north-sea-into-the-extra-high-voltage-grid-for-the-first-time
[xxii] The recent acquisition of Scibreak by Mitsubishi as a sign of the supply chain gearing up for the growth in multi-terminal HVDC systems. See: https://www.businesswire.com/news/home/20230219005035/en/Mitsubishi-Electric-Acquires-DC-Circuit-Breaker-Developer-Scibreak
[xxiii] Supra, note iii.
[xxiv] Supra, note iv.
[xxv] Available at: https://newengland.anbaric.com/wp-content/uploads/2020/07/Brattle_Group_Offshore_Tranmission_in_New-England_5.13.20-FULL-REPORT.pdf
[xxvi] See https://www.tennet.eu/2gw-program
[xxvii] Supra, note xxvi.
[xxviii] Department of Energy Grid Deployment Office of Clean Energy Demonstrations Grid Resilience and Innovation Partnerships Funding Opportunity Announcement Number DE-FOA-0002740, available at: https://www.fedconnect.net/FedConnect/default.aspx?ReturnUrl=%2ffedconnect%2f%3fdoc%3dDE-FOA-0002740%26agency%3dDOE&doc=DE-FOA-0002740&agency=DOE