PPL TransLink and WindGrid Response to RFI

WindGrid | Elia Group

PPL TransLink

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INTRODUCTION

PPL TransLink and WindGrid welcome the opportunity to respond to and provide feedback on the Notice of Request for Information (RFI) issued by the States of Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island (Participating States). We would like to thank the Participating States for this opportunity to provide comments to the Regional Transmission Initiative.

The Participating States face real challenges. With a thoughtful yet ambitious approach, these challenges could become transformational opportunities.

Addressing climate change requires significant action. The Participating States have taken the first steps- to combat climate change through their emissions targets and renewable energy procurements. In doing so, the Participating States have rightly recognized the advantages of being located near an abundant renewable resource off their coasts. Accessing this resource through innovative partnerships and advanced technologies will lead the Participating States to becoming a green energy powerhouse, generating significant economic growth for the region. However, interconnecting significant offshore generation resources presents challenges, primarily from transmission system constraints and limited interconnection availability, necessitating expensive system upgrades and longer project timelines.

To solve these challenges and capitalize on opportunities for the region, unique and forward-thinking solutions must be adopted. We therefore applaud the Participating States for initiating this process to seek experienced partners to help address these challenges. We believe a comprehensive procurement of competitive, holistic transmission-only solutions is critical to meet the Participating States' renewable energy targets.

PPL TransLink and WindGrid believe a holistic transmission solution featuring an offshore transmission backbone will be an important part of the Participating States' energy system of the future. The offshore transmission design must encourage modularization and interoperability, which will result in cost-efficiencies and expedited implementation, while enhancing grid reliability and minimizing environmental impacts. Specifically, these design considerations will enable the ability to interconnect offshore wind generation in tranches, first on the southern coast of New England, swiftly followed by the eastern coast of New England, to achieve the ultimate build out of 30 GW of wind generation. We recommend leveraging experience from more mature offshore markets, specifically Europe, and the use of innovative technology, including connecting multiple offshore HVDC converter stations in 2000 MW increments at 525 kV. An ambitious regional and interregional approach that fosters the next wave of development and growth in the renewable energy economy well positions the Participating States and their chosen partners for accessing federal funding, particularly under the IIJA. We are confident in the success of these recommendations thanks to the unique combination of our partnership's hands-on transmission experience in integrating offshore wind, implementing HVDC, and other advanced transmission technologies for the benefits of customers in the U.S. and Europe.

PPL TransLink is a subsidiary of U.S. based PPL Corporation, a major utility holding company with a proven track record of developing, owning, and operating transmission facilities. PPL TransLink participates in competitive windows and develops unregulated transmission projects. PPL TransLink is also a co-developer and owner of SOO Green, a proposed 350-mile HVDC transmission line connecting renewable energy resources in Iowa to the PJM grid in Illinois.

WindGrid is a subsidiary of international electricity transmission utility Elia Group, the 5th largest transmission utility in Europe. WindGrid develops, builds, owns, and operates offshore transmission infrastructure, leveraging Elia Group's decades of experience in offshore transmission infrastructure, gained from its subsidiaries, Elia and 50Hertz, transmission system owners and operators in Belgium and Germany. Elia Group's experience covers radial connections, HVDC (such as NEMOLink 1 GW interconnector) and hybrid interconnectors (like Kriegers Flak Combined Grid Solutions), offshore collector substations (including Ostwind 1 + 2, Modular Offshore Grid), and artificial islands as transmission hubs in the North and Baltic Seas.

Together, PPL Corporation and Elia Group serve 30 million customers worldwide and have more than 100 years of experience in the energy industry. With our collective experience in transmission technologies, including 5 GW of offshore projects in service, and more than 15+ GW in construction and development, we are well placed to support the Participating States achieve their ambitious clean energy targets and are looking forward to continued engagement in this process.

For a detailed response to the RFI, please see below:

Comments on Changes and Upgrades to the Regional Electric Transmission System Needed to Integrate Renewable Energy Resources

1. **Comment on how individual states, Participating States, or the region can best position themselves to access U.S. DOE funding or other DOE project participation options relating to transmission, including, but not limited to funding, financing, technical support, and other opportunities available through the federal Infrastructure and Investment Jobs Act.**

As noted in the RFI, the Infrastructure Investment and Jobs Act (IIJA) signed into law in November 2021 includes numerous provisions for funding the development of transmission projects that provide regional reliability benefits and integrate renewable energy resources. This federal investment will accelerate the progress already made by the Participating States and the northeast region towards enhancing the resilience and reliability of the electric grid and achieving a net zero energy future.

RECOMMENDED POSITIONING FOR THE NEW ENGLAND STATES

The IIJA provides multiple opportunities for supporting energy infrastructure development. PPL TransLink and WindGrid recommend the following approaches to strengthen the Participating States position for U.S. Department of Energy (DOE) funding:

- **Consider the use of a modular transmission solution.** A modular transmission line will allow for multiple offshore wind generators to connect to a transmission line at different phases, with the ability to service more than one interconnection point on the existing grid. The design will allow for future scalability and reliability of the grid. This approach would incorporate existing leases in the Rhode Island and Massachusetts Wind Energy Areas and future Gulf of Maine leases. A modular transmission system will strongly position the Participating States under Topic Area 3 of the IIJA by demonstrating a forward-thinking approach that would support future growth while meeting existing decarbonization goals. Regional cooperation among states and collaboration with grid owners and operators is a clear priority for the DOE.
- **Pursue an anchor tenant option**. DOE can serve as an "anchor tenant" on new and upgraded transmission lines by buying up to 50% of the planned commercial capacity of lines for a term of up to 40 years. This approach would allow for a larger transmission infrastructure project to be built in anticipation of future needs, bridged by support from DOE. DOE's purchase of capacity will provide needed financial security, effectively de-risk the investment and allow the Participating States an opportunity to build a more robust transmission infrastructure to accommodate future capacity. The Participating States would only bear the portion of the cost for the infrastructure's construction and operation for their present needs, while reaping the benefits of economies of scale for meeting the future needs of the region.
- **Consider the participation of one or more of New England's federally recognized Tribes.** This participation may come in many forms, including financial partnerships or targeted vocational education programs in support of the green energy economy. This approach will ensure that green energy benefits reach a broad audience within the Participating States, acknowledge DOE's recommendation that projects from applicants put up a larger non-federal cost share and attract additional private investment. It also meets the spirit of the Environmental Justice, Equity, and Workforce Development initiatives in the IIJA.

- **Pursue an innovative offshore transmission HVDC solution.** HVDC is a proven and mature technology with decades of operating experience, yet there is additional room for advancements in technology and innovation. For example, some European transmission utilities working with equipment manufacturers have advanced HVDC technologies, such as DC breakers, grid forming capabilities, and interoperability standardization. Given the benefits that such technology will bring to the U.S., we believe that investing in a HVDC offshore transmission grid will position the Participating States strongly for funding support.

For more information on available funding, please refer to Appendix A.

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.**

Coordinated transmission solutions to integrate offshore wind and optimize onshore upgrades for interconnection are expected to reduce costs and associated risk for the region's ratepayers. For example, an extensive study commissioned by the Electric System Operator (European RTO/ISO equivalent) and Department for Business, Energy and Industry in the United Kingdom concluded that coordinated offshore transmission would save consumers 18% (approximately $6 billion) compared with radial generation-led offshore transmission connections. This study also highlighted the significant environmental and social benefits provided by an integrated approach, as the number of new electricity infrastructure assets, including cables and onshore landing points, could be reduced by around 50%. Finally, this study stressed the need to implement coordinated transmission solutions at the earliest opportunity. It is estimated that delaying such an approach by five years would reduce consumers' savings to 8% (instead of 18%).

One recommended solution for the Participating States is to build offshore substation platforms with a modular design approach. A modular design approach allows for flexibility of expansion when needed. When this design is considered from the beginning of a project, it can help avoid costly expansions or adjustments by preparing for growth and enabling future interconnection. A modular design reduces risks to the offshore wind developer as it provides a fixed interconnection location and reduces overall cost by removing the risk developers put into generation pricing. This design also allows for greater geographic distribution of offshore wind output and helps to interconnect future offshore wind areas that are located far from the current lease area. The Participating States should ensure coordination of transmission development and the procurement of offshore wind for full long-term benefits.

Cost containments are also an effective way to create cost competition among transmission developers. Cost containments may include capping overall project cost or include more specific caps, such as on materials and financing. These can minimize costs to the Participating State's ratepayers as the project developer bears the risk and expenses of the project. However, the Participating States should recognize that cost containment is only a single tool in the toolbox. The lowest cost project may not be the best solution or provide the suite of benefits the RFI is seeking to procure. We therefore encourage that any proposal is evaluated through a multiple-criteria assessment with cost containment as a single component of a broader evaluation process.

Please refer to our response to question 4 for more information on this proposed assessment.

At worst, an evaluation focused solely on costs and cost containments can result in a race to the bottom that will not necessarily be visible to bid evaluators. In extreme cases, the lowest cost proposal may camouflage issues such as limited equipment functionality, lower quality materials, or lower quality work. This could result in significant project delays, reliability issues, such as repeated outages, and higher maintenance costs once the project is built. Any evaluation should assess the developer's experience and proven delivery capabilities in designing, building, and operating similar infrastructure in recent years.

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.**

The technology used for a project will depend on the need and requirements. There are different design choices to be made related to transmission technologies such as: AC/DC, voltage levels, topology layout, and point-of-interconnection (POI). When deciding whether AC or HVDC technology should be the preferred solution, the following should be prioritized: the maximum capacity to be transmitted, the distance to the next POI, and any relevant environmental constraints, limitation of landfall and cable corridors in particular. Generally, HVDC offshore transmission is more cost effective than AC offshore transmission for distances exceeding 40-60 miles, and for maximum capacity exceeding 1000 MW. HVDC solutions will thus be preferred for connecting most of the remaining offshore wind around the Participating States. This technology is also expected to reduce the adverse impact on the environment by eliminating multiple AC cables. HVDC connections can also provide additional grid services, such as voltage support and black start, and would require fewer upgrades on a weak POI.

For a more detailed comparison on AC and HVDC transmission lines, please refer to Appendix B.

Should 1200 MW/525 kV HVDC lines be a preferred standard in any potential procurement involving offshore transmission lines?

No; this standard will result in suboptimal transmission solutions for asset owners and consumers. Selecting 1200 MW as the power rating to be transmitted at 525 kV DC will underutilize the inherent power capability of transmission cables, high voltage, and power electronics equipment in converter stations, as well as the footprint set for converter stations rated at 525 kV DC.

In Europe, various Transmission Utilities, together with manufacturers of HVDC cables and HVDC Converter Station systems, have worked to adopt Offshore HVDC Transmission Systems rated at 2000 MW/525 kV DC as the industry standard solution for future offshore transmission assets. This standard solution also foresees the implementation of bipole configurations with dedicated metallic return, enabling transmission of 50% of the scheme capacity when a single pole becomes unavailable, either for scheduled maintenance or failure. This not only increases the availability of offshore wind farm transmission but reduces the impact from infeed loss on the grid.

Given the inherent reliability benefits of HVDC bipole configuration, some System Operators in Europe have reviewed relevant Grid Codes to model HVDC bipole configurations as two separate transmission circuits and differentiate pole failure (normal infeed loss) from bipole failure (infrequent infeed loss), enabling 2000 MW/525 kV DC bipole with dedicated metallic return to comply with the restrictions imposed by the maximum infeed loss requirement. We understand that current interconnection practices limit new generators to a maximum of 1200 MW injection on the grid. However, we would suggest that this limit be further assessed in the context of HVDC bipole transmission configuration and required adjustments be safely implemented to accommodate a 2000 MW/525 kV standard before such projects reach commercial operation.

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?**

To evaluate and identify the best, most cost-effective solution for ratepayers we **recommend a multi-criteria assessment**, which can prioritize different proposals. Given the long-lasting impact of such infrastructure decisions for the whole region, it is highly recommended to evaluate proposals from a holistic system view looking at offshore potential, but also at each proposal's onshore impact.

A holistic system view and network design will result in a collective approach on how to efficiently connect and integrate the future offshore wind resources in New England's energy system. Depending on the ambition of the Participating States, this could amount to more than 30 GW of offshore wind capacity.

The selected projects need to support the overall goal of a net-zero emissions future and expansion of offshore wind generation in the Participating States, while addressing the limited availability of interconnection points and the current onshore transmission system. Otherwise, there is a risk that projects may not optimize the scarce inland transmission capacities or landfall corridors, and drive cost inefficiencies that are ultimately borne by ratepayers.

Therefore, **we strongly support the need for prioritization where all transmission projects are transparently evaluated based on a set of pre-defined criteria to identify the most optimal solution for New England**. For that purpose, it will be important that the Participating States provide guidance on their objectives, including renewable, or even offshore wind integration, as well as an expected timeline, to allow a holistic cost-benefit analysis of each project.

Potential references for multi-criteria and holistic assessment could be the ENTSO-E Guidelines for CBA of transmission projects in Europe or the Holistic Network Design proposed in the UK. Both frameworks evaluated transmission infrastructure proposals according to the following criteria:

- Public interest,
- Cost for ratepayers,
- Impact on environment,
- Impact on local communities,
- Deliverability,
- Operability, and
- Reliability.

The following includes details on how competing transmission projects may be transparently evaluated for prioritization by the Participating States:

- **Holistic cost-benefit analysis:** A cost-benefit analysis should be conducted for each project reviewing the impact on the existing onshore grid reinforcement, associated costs for new land, new towers, lifecycle costs for depreciation and maintenance, CAPEX, OPEX, availability, reliability guarantees, and offshore wind energy capacity, considering system losses.

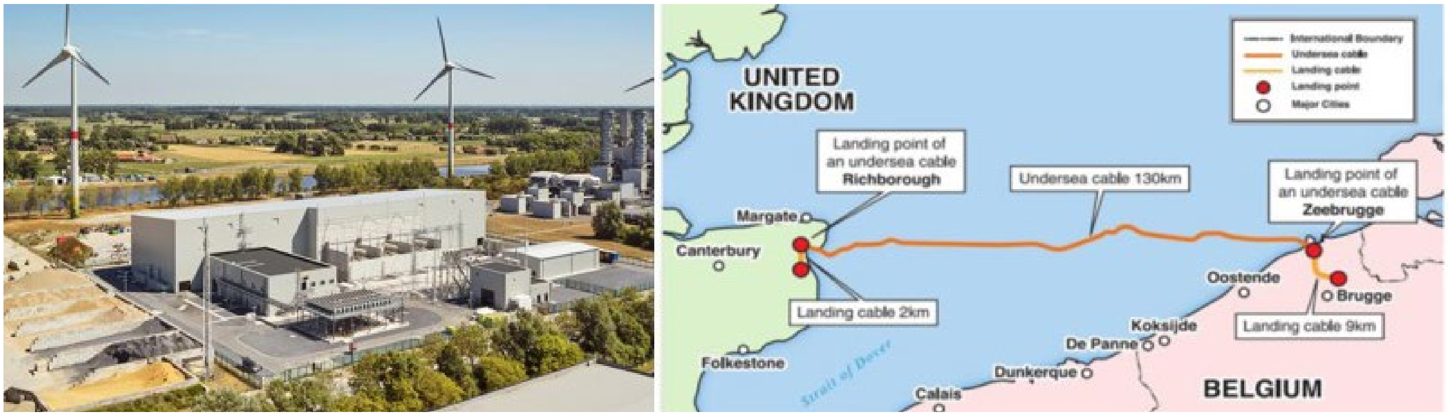
- **Environmental impact:** The total footprint of the proposal should be evaluated, considering the right of way (ROW), grid reinforcements, offshore platforms, and onshore substations. Proposals with fewer offshore platforms and less disruption to the natural environment, as well as those sectors of the economy dependent upon our waters, should be prioritized.

- **System reliability:** Solutions which have fewer reliability impacts on the existing grid, including less over/under voltages, less overloads in the system, and more reliable performance should be prioritized.

- **Future readiness:** Considering the future of the economy and improving technologies, the least expensive solutions today might not be the best solutions tomorrow. For example, a multi-terminal solution can increase the availability of wind power and, therefore, the penetration of renewables in an overall system. It can also interconnect and enable power exchange between states and reduce overall cost for ratepayers over the long term. Proposals with future-proofed solutions should be prioritized.

Other criteria might be considered by the Participating States, such as regional economic benefits, but those should not overshadow the primary benefits of building a reliable and cost-effective offshore transmission infrastructure for ratepayers.

For more information, please refer to our response to question 17.



NEMOLink 1000MW/400kV HVDC interconnector achieved >99% availability in 2021

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.

As noted earlier, HVDC transmission lines are advantageous for interconnecting offshore resources located more than 40-60 miles apart. Long distance HVDC lines offer a unique opportunity to expand the ability of offshore wind generation to support interregional capabilities.

In Europe, several HVDC interconnectors, including NEMOLink 1 GW HVDC connecting the UK and Belgium grids[1] can be utilized to provide black-start services on either end of the interconnector. NEMOLink also provides ancillary services, such as reactive support and frequency response, and contributes to security of supply though its participation in the capacity markets.

However, there are often strict performance requirements for resources to participate as a black-start unit. Offshore wind generators connected radially through HVDC may not qualify.

Aside from this challenge, the following regional and interregional benefits can be achieved by extending bipole connections to a multi-terminal HVDC (MTDC) solution:

- Improved availability of wind power by interconnecting diversely located wind resources,
- Improved reliability and resiliency of the system by providing options to reroute power from one area to another in the event of N-1 contingency,
- Reduced wind curtailment under N-1 contingency, and
- Potential for black-start capabilities.
  - MTDC can offer a steady supply of MW needed for cranking the system under black-start conditions.

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.

Increased integration of onshore renewables to balance the injections of offshore wind would make the electric grid more reliable and resilient, providing diversity of geography and availability of resources. The hybrid approach can provide a more timely and cost-effective way to meet the Participating States' clean energy targets as compared to relying on either approach exclusively.

There are practical hurdles, however, to relying too heavily on increased onshore renewables to balance offshore wind. For one, locally available solar resources alone will be insufficient to balance offshore wind injections. The average size of a solar generator in ISO-NE is 30 MW or less. As such, it will take at least 40 solar generator resources to match the nameplate rating of a typical 1200 MW offshore plant. The multiple would be even larger after normalizing the data with the capacity factor and annual energy requirements. It would be challenging to site and build local solar facilities at that scale. Further, solar plants will need to be integrated with battery storage to provide renewable energy when sunlight is not available, significantly affecting the economics of onshore renewables. Additionally, the resulting large number of requests for the interconnection of local solar and battery facilities can clog the interconnection process, impeding the Participating States' overall goal of expediting renewable integration.

If distant hydro or other onshore resources are used instead of local renewables, securing ROW to build long transmission corridors to interconnect renewables far from load centers would be extremely challenging. In some cases, the corridor would need to be extended beyond the ISO-NE footprint, which will require approval and coordination with other ISOs, states, and potentially authorities outside of the U.S. There are recent examples of local opposition and legal challenges adding significant delays and complexity to such projects. The use of land based HVDC lines will still implicate ROW and

[1] *Jointly owned by Elia and the Electric System Operator (European equivalent to an RTO/ISO)*

permitting challenges like the AC lines. While these challenges can be reduced by using HVDC underground cables, costs would significantly increase.

Alternatively, a robust offshore HVDC grid with MTDC connections could reduce the need to rely on onshore renewables, enabling power exchanges between states and regions and providing flexibility to manage overgeneration. Offshore wind resources offer access to continuous renewable power, unlike some other intermittent renewable resources such as solar, which have limited availability during non-sunlight periods and winter. The offshore resources are the quickest solution to meeting the 100% renewable goals if processes are established to build the HVDC transmission infrastructure.

For more information, please see our response to question 11.

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

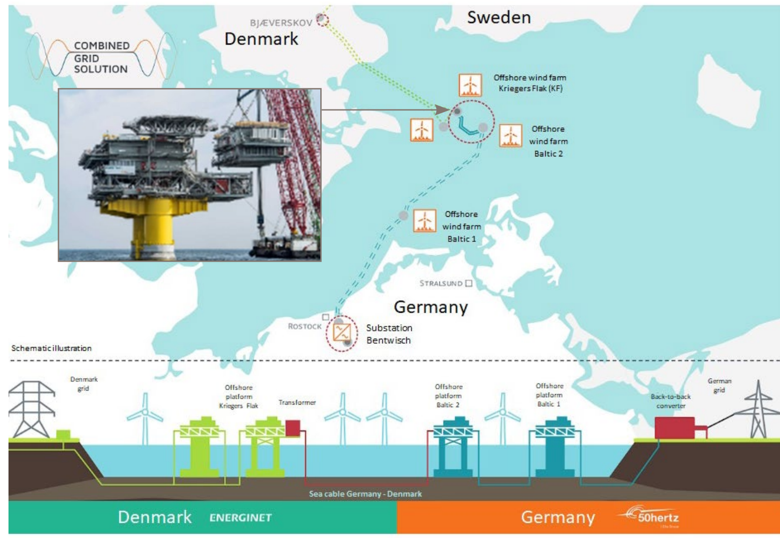
By utilizing a comprehensive approach in the planning and development of offshore HVDC transmission, the Participating States can enable interregional transmission in the future. Offshore multi-terminal HVDC connections will enable power exchange between states and regions and may ultimately allow the Participating States to become a net energy exporter to adjacent states.

It is the perfect time to recommend and facilitate interregional transmission since the offshore grid has yet to be designed. To comment on the region's ability to use this technology, the Participating States must envision how they'll expand, along with neighboring regions, in the future. As a member of the Technical Review Committee on the Atlantic Offshore Wind Transmission Study, WindGrid may be able to share valuable insights on viable pathways to the "global optimum" and long-term scenarios of decarbonization and transmission planning. To the extent possible, the New England States should advocate for regional and interregional standardization of requirements for offshore transmission so that facilities will be as interoperable as possible.

A pathway should describe the need for developing offshore generation and transmission on a temporal and geographical basis. It will be critical to identify technical elements where interregional interconnection could be implemented. For example, if there are two or more offshore substations or converters nearby, it may make sense from a technical and economical perspective to anticipate extra space or busbars on the platforms to create a future multi-terminal solution. This would enable greater interstate and even interregional transmission interconnections. This has been successfully implemented by "Combined Grid Solution – Kriegers Flak," in the world's first hybrid interconnector between Denmark (TSO Energinet) and Germany (TSO 50Hertz – subsidiary of Elia Group). In this project, two nearby offshore substations collecting offshore wind in their respective countries, have been subsequently interconnected via an additional subsea cable to support interregional transfer when the windfarms are not utilizing their full rated capacities.

For this innovative pilot project, a new operational control system called Master Controller for Interconnector Operation (MIO), was developed to control and optimize the available capacities and flows of such a complex system. In other words, if offshore wind is generated and needed by the system, the transmission integrates the wind energy into both markets. If no wind is generated, the available capacity is provided to the market to exchange and trade electricity between the two markets. Through this shared infrastructure approach, the grid is optimally utilized and operated while creating additional value for the public through electricity trading and market integration.

For more information about this project, click here.



8. Comment on any just-transition, environmental justice, equity, and workforce development considerations or opportunities presented by the transmission system buildout and how these policy priorities are centered in decisions to develop future infrastructure;

The successful transmission developers must engage their communities to be successful in this project. Engagement may include philanthropic investments and partnership with nonprofit and community organizations, as well as a focus on diversity, equity and inclusion, education, economic and workforce development, health and safety, and sustainability. The benefits must be realized by as many residents as possible to consider New England's decarbonization goals a success.

One central step the Participating States can take to advance these important concepts is to ensure that their chosen partners are equally focused on staying engaged with key stakeholders, listening to, and addressing concerns, and reinforcing support for communities. Any partner must be able to fully commit to the following:

OVERALL POLICY

- Conduct business in an environmentally responsible manner, including sincere engagement with regulators, customers, employees, tribes, commercial and recreational groups, and the community at large to support the Participating States' ambitious decarbonization plans.

EQUITY CONSIDERATIONS AND OPPORTUNITIES

- Seek grid improvements and innovations that reduce environmental impact, invest in new infrastructure, and empower customers with new options.
- Connect clean energy to communities that both want and need it.
- Facilitate equitably distributed clean energy. Decarbonization and grid resiliency have broad benefits to be enjoyed across all communities.
- Care, understand, and respect the deep heritage of New England and the regional tribes' relationship with the marine environment.
- Maximize tools for realizing an equitable and just transition, including:
  - Long-haul transmission that brings high-paying jobs for both construction and future operations.
  - Available Federal support, such as: *Section 50152 of the Inflation Reduction Act (IRA) provides resources that can help the Participating States deliver on this commitment. Although primarily intended to assist with the siting, planning and analysis associated with construction of transmission lines, DOE can award grants to states under this section for "economic development activities for communities that may be affected by the construction and operation of a covered transmission project." Additional details will become available as DOE implements this provision, but it has the potential to deliver direct value to communities impacted by these necessary infrastructure projects.*

ENVIRONMENTAL JUSTICE CONSIDERATIONS AND OPPORTUNITIES

- **In the ocean,** implement a coordinated strategy that minimizes the number of transmission routes. HVDC technology utilizes a narrower corridor, which will help reduce impact on fisheries and the environment. A modular approach will decrease the environmental footprint and number of landfall points.
- **For landfall**, use existing ROWs or brownfields, as much as reasonably possible.
- **Promote conservation** of natural resources, cultural resources, traditional cultural properties unique to the tribes of New England, protect biodiversity and reduce pollution.
- **Engage with key stakeholders** early and frequently through public open houses and surveys.
- **Use leading research** and invest in innovation to advance sustainable resource management and reduce environmental impact consistent with the Massachusetts Ocean Management Plan, Long Island Sound Blue Plan, and Rhode Island SAMP.

This undertaking is a prime opportunity to contribute to President Biden's goal that 40% of the overall project benefits flow to disadvantaged communities (Justice40 Initiative)."

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

Participating States have a unique opportunity to access significant wind capacity off their shores. Several studies have identified more than 30 GW offshore wind potential for the New England region. This could amount to approximately 150 TWh, which is more than New England's current annual energy consumption, which is approximately 120 TWh. Such available wind resources have the potential to transform New England into a green energy powerhouse with the ability to export energy. However, these offshore wind resources are not located close enough to high demand load centers.

Therefore, the key challenge is to build the most efficient transmission solution, harness these available generation resources in a cost-effective manner, and maximize reliability and economic benefits for customers. Participating States should plan and anticipate the most optimal offshore transmission system, with the following recommendations:

- Consider holistic transmission solutions that alleviate capacity constraints and solve reliability issues.
- Include mesh reliability concepts. This has market efficiency advantages such as lower capacity prices. It also supports reliability of the generation allowing for additional export capabilities if a cable were to fail.
- Evaluate transmission solutions that are sized appropriately to avoid curtailment of renewable energy resources and ensure capacity factors for the region's renewable resources remain high.
  - This is best achieved by implementing a modular design solution or anticipating future expansion.
- Consider proposals that make efficient use of existing infrastructure and maximize the reliability benefits of the region's clean energy sources and utilize existing ROW or brownfields.
- Reduce the need to curtail renewables by delivering power where it can be used to heat homes and charge vehicle batteries. Delivering renewable energy to parts of the grid without significant load to absorb it will either result in curtailment or dispatching of existing generation to prevent overloading.
- Incentivize resources to connect to New England, rather than alternative coastal options such as New York.

- Utilize tie lines to neighboring control areas. Several studies have shown that the region can lower the cost of decarbonization and increase system reliability through improved utilization of its tie lines. New England's tie lines can be used to reduce curtailment of renewable energy by exporting power during times of overgeneration and importing power when weather for renewables is poor. As weather patterns move across neighboring control areas and into New England, renewable generation and load will shift in ways that will enable these control areas to support each other, according to ISO-NE's Future Grid Reliability Study. The study specifically mentions developing an energy bank, which would take advantage of Quebec's large hydroelectric resources to store excess renewable generation. Another study by MIT found that increasing tie lines to Quebec would reduce the cost of deep decarbonization by 17% to 28%.

The successful buildout of offshore transmission will unlock New England's offshore wind energy and economic potential, attracting new investment to New England's shore. Examples of this can already be seen across the region's economies and further development of the offshore wind supply chain will foster new economic and job growth opportunities across multiple sectors. Moreover, by investing in an ambitious HVDC offshore transmission infrastructure, the region would be well placed to become the first HVDC "Center of Excellence" in the U.S, with the aim to drive further innovations in transmission development, manufacturing capacities, installation, operations, and maintenance facilities.

In addition to the direct benefits described above, wide-spread availability of affordable, reliable, non-emitting energy can have beneficial effects. For example, as more companies seek to decarbonize their operations, there will be an increased need to find clean energy suppliers. A well-anticipated offshore wind integration program, along with other clean energy efforts, has the potential to become a magnet for economic activity that is seeking to balance profit with environmental stewardship.

10. Identify potential Points of Interconnection (POIs) in the ISO-NE control area for renewable energy resources, including offshore wind. What are the benefits and weaknesses associated with each identified POI? To the extent your comments rely on any published ISO-NE study, please cite accordingly.

The ISO NE 2050 Transmission Study identified several potential POIs in New England. Based on the POIs referenced in the study and the proposed MW capacities, future POIs in Cape Cod will need significant onshore grid reinforcement. Therefore, POIs in the Boston and New Haven areas are most favorable for existing grid reinforcement. Optimal POIs should be identified by multi-criteria assessments, aiming to lower overall system costs and environmental and public impact. This may mean optimizing solutions with higher offshore transmission cost to reduce the need for costly onshore, space constrained, upgrades.

With additional information on MW integration targets from the Participating States, proposals could better evaluate optimal POIs.

11. Similarly, comment on whether there are benefits to integrating offshore wind deeper into the region's transmission system rather than simply interconnecting at the nearest landfall (*e.g.,* using rivers to run HVDC lines further into the interior of New England). If there are enough benefits to make this approach feasible, please comment on any obstacles, barriers, or issues that Participating States should be aware of regarding such an approach.

The ISO-NE system is quickly reaching a point where all available low-cost POIs near the coastal area have already been acquired or are under the interconnection process. As noted in the RFI's background section, the cost to interconnect offshore wind beyond the first 5.8 GW of generation will be significantly higher. Further, additional interconnection to the existing POI may not be feasible for reliability reasons.

POIs further inland can be the next step once all the low-cost coastal POIs are taken. However, securing ROW and appropriate permits to build an extended HVDC generator lead line to a new deep POI would be challenging. Finding space to build a HVDC converter station next to an existing deep POI location would be difficult because most of the deep POI are in densely populated areas and present challenges for building new converter stations. Overall, the decision to select a deep land or coastal POI will depend upon the overall interconnection cost and ability to acquire ROW for building the HVDC line and converter stations. It also depends on specific offshore generation goals, both immediate and long-term.

12. Identify likely offshore corridor options for transmission lines. Please comment on the potential for such corridor options, include size of the corridor footprint and potential number of cables that can be accommodated, to minimize the number of lines and associated siting and environmental disturbance needed to integrate offshore wind resource. For any offshore corridor identified, please indicate how the corridor avoids or minimizes disturbances to marine resources identified in the applicable plan, including the Connecticut Blue Plan and the Massachusetts Ocean Management Plan.

Several logical offshore and overland routes are available to the New England states to accommodate the burgeoning offshore industry. While specific routing of subsea transmission has yet to occur, there are several logical POIs within Massachusetts, Rhode Island, and Connecticut to land a subsea cable. All three maintain resource management plans for their marine environments, the Massachusetts Ocean Plan, Connecticut's Long Island Sound Blue Plan, and Rhode Island's SAMP.

All three resource management plans are guided by inputs from the scientific community, academia, and commercial and recreational user groups. These inputs have culminated in comprehensive mapping that displays the diverse uses and habitats that make New England unique, including:

- Threatened and endangered species habitats and occurrences,
- Commercial fishing and benthic species habitat,
- Recreational boating and fishing areas,
- Subsea utility lines, and
- Sanctuaries restricting the development of electric generation.

For marine transmission siting considerations, the robust mapping resources presented by the Ocean Management Plan, Blue Plan, and SAMP would be utilized to route the subsea transmission line to the shortest route possible while minimizing harm to the marine environment and its constituent user groups. Routing would be primarily designed to avoid impact to known marine resources. In situations where impact to these resources is unavoidable, they will be minimized.

13. Identify strategies to optimize for future interconnection between offshore converters, either AC or DC, to permit power flow between converters to facilitate the transmission of power from offshore to multiple POIs as needed. Similarly, comment on the ability of offshore converters from competing manufacturers to communicate with one another in this future case.

There are different strategies on how to optimize future interconnections between offshore converter stations. Early coordination and technological standardization will assist in ensuring future operability. Radial offshore wind connections cannot provide electricity in the event of a failure. Therefore, linking offshore substations and converters with each other will increase the overall availability and quality of offshore wind power infeed.

There is also value for the market through directing the wind generation to the most valuable POI within the region via this shared infrastructure. As such, onshore congestion can be alleviated, and the power can be transported closer to the end-users.

An example of an interlink between AC offshore substations in Europe is Elia Group's "Combined Grid Solutions - Kriegers Flak" as presented in *question 7*. The initial interconnection strategy proposed an offshore HVDC back-to-back converter as an intermediate platform since the Danish grid and the German grid are not synchronized in frequency. However, further assessment allowed the relocation of the HVDC back-to-back converter station on land, near the POI, thus significantly reducing the cost of offshore substation interconnections.

To interconnect HVDC offshore converters, it is important to create the optimal design from the very beginning. If, for instance, 2000 MW HVDC offshore converters are interlinked, their control system should be interoperable. Assuming another 2000 MW offshore converter might be added at a later stage to tie in, it will be essential that extra DC busbars and J-Tubes for the DC cables are anticipated at the start. Depending on the topology of the offshore grid, there might be the need for DC-Breakers to operate safely in the event of a failure.

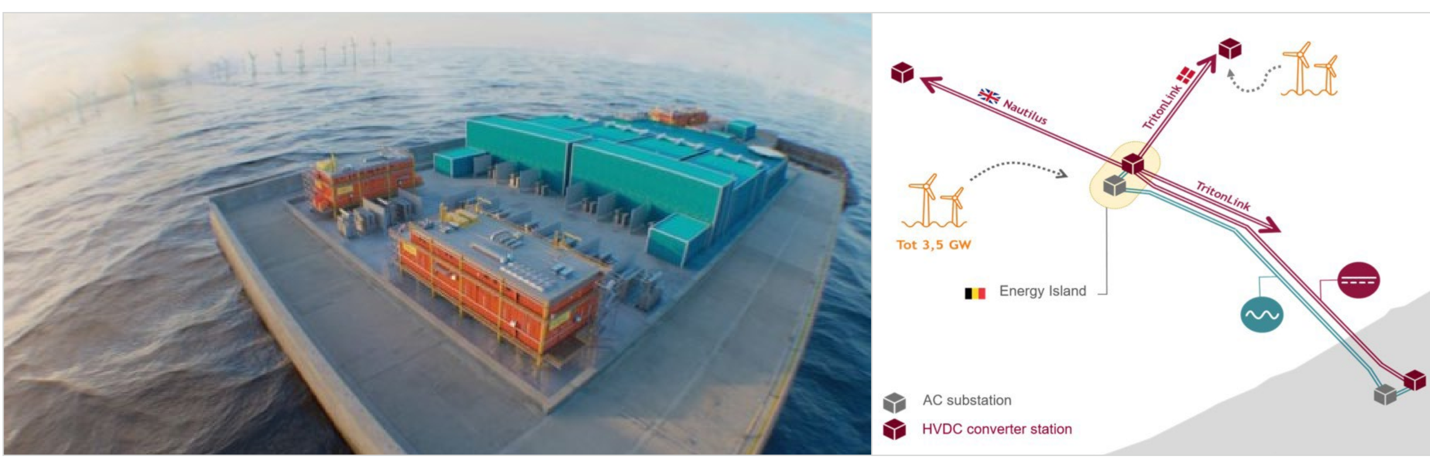
A strategy currently being developed in Europe to allow for future expansion of the transmission offshore grid, including inter-regional power exchange, consists in moving transmission equipment onto either natural or artificial islands.

If there is a natural island nearby the offshore generation and transmission, it should be considered to allocate the electrical equipment on that island instead of building a dedicated platform, as planned for Denmark's Bornholm Energy Island.

If there is no natural island nearby and it's economically viable and technically feasible, depending on needed space, water depth, among other design parameters, artificial islands may be the appropriate alternative. Artificial energy islands may be the most cost-effective and future-proofed solution when multiple converters and transformers are planned within proximity to one another.

Elia Group, as a frontrunner in developing innovative offshore transmission projects, aims to develop the world's first artificial energy island "Princess Elisabeth" which will become a European hub for offshore wind energy connecting Belgium with Denmark and the United Kingdom (Link)

See image below.



The Princess Elisabeth artificial island will combine both direct current (HVDC) and alternating current (HVAC) and be developed in different modules and phases. The island's high-voltage infrastructure will bundle the wind farm export cables from the Princess Elisabeth zone together, while also serving as a hub for future interconnectors with the UK (Nautilus) or Denmark (TritonLink). These hybrid interconnectors have a dual function and will therefore be more efficient. They will ensure the exchange of electricity between countries and will also be connected to the substantial offshore wind farms in the North Sea that will provide Belgium and surrounding markets with large volumes of renewable energy.

This reinforces the importance of anticipating a future modular design and interlinked concept at the initial design, since there are different quality standards for the technical solutions:

Topology design and need for operational redundancy: A hybrid or meshed system can hardly be envisioned without a metallic return, which provides a redundant current pathway, to limit impact on the wholesale markets due to line outages.

Interoperability single vendor: The control system of the HVDC system is fundamentally different for a radial connection (two HVDC terminals) than for a modular and expandable design (at least 3 HVDC terminals).

Interoperability multi-vendor: Given the absence of an HVDC standard at this stage, the compatibility between different vendors is not guaranteed by default. For the interoperability of converters from competing manufacturers, the industry has recognized the need for interoperability and multivendor converters. There are significant efforts including all major manufacturers to standardize this topic and be available in near future.

Standardization: The development of a radial connection by an offshore wind generator promoter might lead to a choice of voltage level which is optimized for an individual offshore wind generator, but sub-optimal from a regional perspective, or incompatible with the system voltage.

Lifetime of assets: A developer of offshore wind generation will typically try to align the average lifetime of the transmission cables with the average lifetime of the offshore generation, while a holistically planned approach would anticipate a longer lifetime for the transmission system.

In summary, the need for efficient transmission solutions has shaped different interconnection strategies and flagship projects, particularly in Europe. Elia Group has a proven track record to successfully adapt to the local needs and deliver cutting-edge and innovative transmission solutions in the interest of the ratepayers. This approach is a prime target for federal funding given the nature of interregional projects and multiple involved stakeholders For instance, the European Commission has launched the Horizon Program which calls for the support of all the preparatory phases among all stakeholders (HVDC systems manufacturers, TSOs, wind turbine manufacturers, and windfarm developers) leading to a demonstration project to de-risk the technology to enable the installation of the first Multi-Vendor Multi-Terminal HVDC system with Grid Forming Capability in Europe.

14. Comment on the benefits and/or weaknesses of different ownership structures, such as a consortia of developers with transmission owners or use of U.S. DOE participation as an anchor tenant through its authorizations in the federal Infrastructure and Investment Jobs Act, for new offshore transmission lines;

PPL TransLink and WindGrid recommend the approaches *outlined in our response to question 1* to strengthen the Participating States position for DOE funding and build a more reliable transmission infrastructure to support future capacity needs.

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?

Lengthy negotiations over cost allocation have the potential to derail otherwise valuable transmission development. *As referred to in question 2,* any delay in the implementation of coordinated offshore transmission solutions will reduce consumer savings. Therefore, PPL TransLink and WindGrid support a binding cost allocation determined before project selection. If the Participating States can agree to such a cost allocation, that is likely to be the best outcome for all parties.

16. Comment on the benefits and/or weaknesses of using a public-private partnership that might include one or more states or U.S. DOE as part owners with private developers or other sources.

For purposes of pursuing IIJA funding, when more states and partners are involved in a project, it demonstrates greater regional commitment, which is criteria that DOE is looking for when funding projects. As described in *our response to question 1,* DOE is prioritizing large scale, transformative projects that foster regional and interstate collaboration. At the same time, co-ownership among states, the federal government, and private developers introduces additional complexities that may be a hinderance to an already complex regional and interregional initiative.

PPL TransLink and WindGrid recognize that there may be many potential upsides to a public-private partnership for developing transmission infrastructure and that this model should continue to be studied. However, we also note there are aspects of such a structure that could increase the complexity of these projects, potentially leading to inefficiencies, cost increases, or delays. At a minimum, public-private partnerships should not be required in this process but should be considered alongside other models.

17. Comment on the co-benefits of landfalling offshore transmission lines, such as improvements to reliability and/or resilience (*i.e.*, through the use of HVDC converters or otherwise), economic development (*e.g.*, port development, hydrogen production, *etc.*) and any local system benefits. Identify ways to measure and maximize these co-benefits when evaluating transmission buildout.

The successful development of offshore generation and transmission will offer the Participating States a unique opportunity to transform into a "green electricity powerhouse." Several studies have identified more than 30 GW offshore wind potential for the New England region.

The efficient integration of offshore wind resources will have positive impacts on the region's industry and economic potential. Maximizing co-benefits, for example through sector-coupling, is a key factor in realizing these impacts. Sector-coupling involves the increased integration of energy supply with end users. For example, abundant green energy can be used first to electrify sectors of the economy previously reliant on fossil resources, such as transportation. After this is completed, further surpluses can be exported or redirected toward attracting green industrial processes, such as production of green hydrogen, ammonia or other chemical products. This is already happening in Europe. 50Hertz, a subsidiary of Elia Group, has developed a strategy to reach 100% annual renewable generation by 2032. Because many companies seek a reliable source of carbon-free power, 50Hertz has been able to leverage that strategy toward attracting new investment in Northeastern Germany. For more information, see our strategy.

When done correctly, sector-coupling improves the efficiency and flexibility of the energy system as well as its reliability. The result is to reduce the costs of decarbonization.

To develop, install, and operate offshore generation and transmission, local ports must provide the necessary infrastructure to the developers and expand their services. In addition, the construction and operation of the future transmission grid will create sustainable and well-paid jobs for residents.

Further local economic development could be achieved by attracting manufacturing industries and its suppliers to produce technical equipment and parts needed to interconnect offshore wind, such as cables, turbines, and converters directly in the region.

Next to the economic benefits there are direct reliability enhancements from an HVDC POI, such as:

- Supply of local demand in the area, such that load service will be more reliable with the generation source nearby,
- Improved voltage performance of surrounding onshore grid from the MVAr reactive capability,
- The potential for more timely restorations during a blackout, and
- The ability of the HVDC converter working as a STATCOM to be used anytime, independent of wind power production.

For the measurement of direct and indirect benefits of different transmission buildout solutions, we recommend a multi-criteria cost-benefit analysis covering at least the energy system of New England. The sophisticated CBA approach in Europe could serve as a potential blueprint but needs to be adapted and complemented by regional and strategic requirements or considerations. One key aspect we would like to highlight is the evaluation of the "Delta" of costs and benefits through a certain technical solution in comparison to the reference scenario. Therefore, a reference case (counterfactual) needs to be defined (and modelled) and all the different solutions shall be added one by one (potentially in clusters) to quantify and evaluate its benefits in contrast to its costs.

It will be important for the Participating States to identify and align the key benefits and how those shall be evaluated, both qualitatively and quantitatively, to provide a level-playing field for the market.

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APPENDIX A

IIJA FUNDING

For quick reference, the chart below summarizes the main opportunities:

Program Name	Description	Eligible Entities	Funding Level	Funding Mechanism
Transmission Facilitation Program (IIJA Section 40106)	To facilitate the construction of electric power transmission lines and related facilities to enable greater clean energy growth and provide low-cost clean energy to more Americans.	Transmission developers	$2.5 billion	Loan, Direct Financing, or Capacity Purchase
Grid Resilience Innovation and Partnerships – Topic Area 3: Grid Innovation Program (IIJA Section 40103b)	Competitive grants for innovative and transformative technical and non-technical approaches, which 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.	State; Multiple state partnerships; Tribes; Public Utility Commissions	$5 billion over 5 years	Competitive grant program. Requires a 50% cost share.

IIJA GRIP COMPETITIVE GRANT PROGRAM

IIJA sections 40101(c), 40107, and 40103(b) provide approximately $10.5 billion for the five-year period from FY2022-2026 for competitive grant programs focusing on improving the resilience and reliability of the nation's electric power infrastructure and achieving the Biden Administration's target of a 100% carbon pollution free electricity system by 2035 and a net zero emission economy by 2050.

In the draft Funding Opportunity Announcement (FOA) released on 8/30/2022, the Department of Energy (DOE) organizes these provisions into the consolidated "Grid Resilience and Innovation Partnerships" (GRIP) program and anticipates distributing roughly $3.9 billion of funding (covering FY2022 and FY2023) through this initial application cycle.

An RFI on the draft FOA solicited comments due on October 14, 2022. The draft projects publication of the final FOA as soon as Q1 FY2023 (November/December 2022). These dates, as well as all program details in the draft are subject to change by DOE until published in the final FOA.

Within the GRIP program, the Participating States are well positioned to pursue funding under proposed Topic Area 3: Grid Innovation Program.

The Grid Innovation Program prioritizes projects that "improve grid reliability and resilience on a local, regional, and interregional scale" and "contribute to the decarbonization of the electricity and broader energy system in a way that supports system resilience reliability, and affordability by improving access to technologically and geographically diverse energy resources…"

Within the transmission priority area, DOE is specifically focused on projects that address:

- Investments and strategies that accelerate interconnection of clean energy generation and/or storage
- Interregional or cross-ISO/RTO projects that address key grid reliability, flexibility and/or resilience challenges
- Projects addressing grid access challenges for remote, stranded, or novel low-carbon resources
- Planning, modeling, cost allocation, or other approaches that enable a transition to innovative financial and/or regulatory constructs that accelerate transmission expansion
- Underground or underwater HVDC systems in challenging environments
- Capacity enhancing approaches such as advanced conductors or dynamic line rating systems
- Congestion management techniques including energy storage and integrated controls
- Transmission-scale reactive power devices
- Flexible alternating current transmission system FACTS devices
- Solid state transformers
- Power flow controllers for AC or High Voltage Direct Current (HVDC) systems

In discussing the criteria that will be used to evaluate applications, DOE states they will “prioritize large scale and complex system projects that demonstrate innovative approaches while offering the greatest public benefit with a clear path to replication, scale and ability impact decarbonization objectives.”

Eligibility for Topic Area 3 is limited to “a state; a combination of two or more states; an Indian Tribe; a unit of local government; or a public utility commission.” This is the only one of the three GRIP programs designed exclusively for public entities like the Participating States. DOE is particularly interested in projects that “enhance collaboration between and among eligible entities and private and public sectors owners and operators on grid resilience, including in alignment with regional resilience strategies and plans. This includes collaboration across state and other territorial boundaries…”

Regional cooperation among states and collaboration with grid owners/operators is a clear priority for DOE. The well demonstrated collaborative regional approach taken by the Participating States on this effort puts them in a uniquely strong position on this criterion.

DOE anticipates making between 4 and 40 total rewards for this program during this funding cycle with a maximum award size of $250 million. That maximum award size can increase up to $1 billion for “interregional transmission projects only.” A minimum of a 50% non-federal cost share is required, but DOE encourages projects from applicants that put up a larger non-federal cost share and attract additional private investment.

IIJA TRANSMISSION FACILITATION PROGRAM

Beyond direct funding through competitive grant programs, the IIJA created a new federal transmission financing under Section 40106 being implemented by DOE as the Transmission Facilitation Program (TFP). Through this program, DOE will make $2.5 billion available through annual solicitations. DOE is authorized to borrow up to this amount in outstanding repayable balances at any one time from the Treasury. Unlike federal grants, these programs contemplate a return of the investment

- The three forms of facilitation to assist with new, replacement, and upgraded high-capacity transmission lines (for new, it must be at least 1000 MW line; for upgrade or replacement 500 MW) are: 1) **capacity contracts, 2) loans, and 3) public-private partnerships**.
- Anchor Tenant/Capacity Contracts: DOE can purchase up to 50% of the capacity for term of up to 40 years.
- Loans: for the costs of carrying out an eligible project.
- Public Private Partnership: DOE participates with an eligible entity in “designing, developing, constructing, operating, maintaining, or owning” a project. The project must be in an area designated as a national interest electric transmission corridor OR it must be a multistate project (which this would be).

DOE programs goals (and thus meeting these will best position the Participating States to access available federal assistance):

- Clean energy goals: Increasing the availability of lower cost and low carbon electricity sources to support the Administration’s clean energy goals.
- Transmission system goals: The IIJA directs DOE to prioritize projects that, “to the maximum extent possible, improve resilience and reliability of the grid; facilitate inter-regional transfer of electricity; lower electric sector greenhouse gas emissions, and use technology that enhances the capacity, efficiency, resilience, or reliability of the transmission system.”
- Commercial feasibility: Additionally, the program is looking for projects that “provide a reasonable expectation that the costs of the capacity contracts, loans, or public-private partnerships borne by the Federal Government will be repaid.”
- Equity and EJ: Equity and environmental and energy justice principles and priorities is prominent in the implementation of the TFP.
- Workforce development: The support of creation of “good paying jobs with the free and fair choice to join a union, the incorporation of strong labor standards, and high-road workforce development, especially registered apprenticeship and quality pre-apprentice-ship.” The program will also support the Jucie40 Initiative.
- Note: The solicitation announcement may identify particular paths or regions that DOE prefers for the location of the projects.

TFP Timing considerations

- The first solicitation is anticipated “in 2022” and is limited to capacity contracts. The projects must commence commercial operation no later than December 31, 2027. The second solicitation is anticipated in “early 2023” and open to all three forms of TFP support: capacity contracts, loans, and public private partnerships.

APPENDIX B

DC Solutions	
Advantages:	**Disadvantages:**
• Significantly reduced environmental impact offshore (fewer cable routes, fewer offshore platforms) and onshore due to the expected smaller grid reinforcement • Flexibility in the power flow control • Ability to transport power across long distances with reduced losses • Lower offshore connection costs for longer distances to the POI as well as grid reinforcement costs • HVDC converter onshore strongly supports the existing onshore grid: reactive power and voltage control, black start, grid recovery, fault ride through capability… • Mature technology • HVDC is a kind of firewall for onshore grid and offshore wind not allowing that failures from one side propagate to the other side. • Coupling two asynchronous grids (e.g., with different frequencies) • Power flow controllability without the need for PARs. • Possibility of building multi-terminal HVDC connections (like shown in MOWIP illustration) for different areas/ regions/States increasing offshore power availability	• Higher cost for short distances if purely considering installation cost of the onshore-offshore transmission • Space required for onshore converter • Reduced number of equipment manufacturers • Multi-terminal solutions are not yet a mature technology

AC Solutions	
Advantages:	**Disadvantages:**
• Mature technology • Smaller footprint at onshore station • Proven concept widely used in offshore wind projects	• Large cable corridors required for higher capacity (multiple parallel cables) • Reactive compensation needed • Less suited for large future expansions