Connecticut Energy & Environment
Delaware DNREC Division of Climate, Coastal and Energy
Maine Department of Energy Resources
Executive Office of Energy & Environmental Affairs
Maryland Energy Administration
New Jersey Board of Public Utilities
State of Rhode Island Office of Energy Resources
Vermont Department of Public Service
New York State
NYSERDA | Department of Public Service

June 15, 2026

Subject: Release of the Finalized Reports on Planning Offshore Interregional Network Standardization ("POINTS")

As representatives of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island, and Vermont, we are pleased to share the three finalized reports from the Planning Offshore Interregional Network Standardization ("POINTS") Consortium. Prepared by DNV, Johns Hopkins University, and a distinguished group of industry professionals, these reports were developed for the Northeast States Collaborative on Interregional Transmission to advise on offshore transmission systems and High Voltage Direct Current ("HVDC") equipment options.

Over the past year, the POINTS Consortium has convened numerous in-person meetings and webinars, engaged with a broad range of stakeholders, and drawn on deep industry expertise to craft actionable recommendations to improve and expedite offshore transmission project procurement and construction for state governments.

The three POINTS reports address critical needs across the region. Together, they offer recommendations on standard offshore transmission network designs and compatible equipment, pathways to standardized HVDC transmission and modernized HVDC reliability criteria, and HVDC equipment procurement and contracting strategies for Northeastern states.

We are thrilled to grow this momentum by deepening coordination among Atlantic Coast states and translating these recommendations into action to chart a shared path forward on interregional transmission.

Katie S Dykes

Katie S. Dykes
Commissioner, Department of Energy and Environmental

Kimberly Cole, Director,
Division of Climate, Coastal and Energy, Department of

Celina Cunningham

Celina Cunningham
Acting Commissioner,
Department of Energy Resources
On behalf of Maine

Protection
On behalf of Connecticut

Natural Resources and
Environmental Control
On behalf of Delaware

Kelly Speakes-Backman
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Rebecca Tepper, Secretary,
Massachusetts Executive
Office of Energy and
Environmental Affairs
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Christine Guhl-Sadovy
President, Board of Public
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On behalf of New Jersey

Rory M. Christian
Chair and Chief Executive
Officer, New York Public
Service Commission
On behalf of New York

Doreen M. Harris

Doreen M. Harris
President and CEO, New York
State Energy Research and
Development Authority
On behalf of New York

Chris Kearns

Chris Kearns
Acting Commissioner, Office of
Energy Resources
On behalf of Rhode Island

Signed by:
Kerrick Johnson
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Kerrick Johnson
Commissioner, Vermont
Department of Public Service
On behalf of Vermont

Offshore Transmission Standardization

POINTS Consortium

Date: June 25, 2026

Picture: Baltic Eagle Offshore Substation (HVAC) from Elia Group.

About POINTS Consortium

In December 2024, the U.S. Department of Energy's Grid Deployment Office (GDO) awarded Johns Hopkins University and DNV a grant to develop and lead their 'Planning Offshore Interregional Network Standardization ("POINTS") Consortium. The consortium brings together technical experts and state governments to address the growing need for harmonized transmission infrastructure as offshore energy generation scales regionally.

The scope of the POINTS Consortium encompasses the development of standardized offshore transmission planning practices and technical specifications to support a meshed and interoperable offshore grid along the U.S. Atlantic Coast. It focuses on standardizing equipment designs, harmonizing procurement strategies across states, and enabling compatibility among transmission systems built by different developers and vendors. The consortium also aims to inform near-term offshore wind solicitations and facilitate coordinated infrastructure deployment by aligning technical, regulatory, and operational frameworks across jurisdictions.

Ultimately, the POINTS Consortium is a strategic effort to lay the groundwork for a future-proof offshore grid, enabling shared transmission solutions and accelerating the integration of offshore energy resources into the U.S. power system.

About the authors

This report was developed and authored by DNV, Glatz Energy Consulting, The Brattle Group, Aker Solutions, and Johns Hopkins University.

Co-Lead Author, Morgan Putnam of DNV, was responsible for coordinating the research, working with the team to define the Development Pathways (Section 3), creating the Design Options (Section 4), undertaking the cost portion of the Benefit-Cost analysis (portions of Section 5 and 6), developing the Key Takeaways (Section 8) and the Recommendations (Section 9).

Co-Lead Author, Suzanne Glatz of Glatz Energy Consulting, developed the Risk Assessment Framework (Section 7) and contributed to the overall technical analysis and review (All Sections).

Contributing Author, Joe DeLosa III of The Brattle Group, developed the Benefits Discussion within the Benefit-Cost Analysis (portions of Sections 5 and 6) and contributed to the overall technical analysis and review (All Sections)

Contributing Author, Oystein Larsen of Aker Solutions, developed the Cost Discussion within the Benefit-Cost Analysis and provided review for the Design Options (portions of Sections 4, 5, and 6).

Johannes Pfeifenberger of The Brattle Group, and Abe Silverman and Ashleigh Angel of Johns Hopkins University drafted portions of the report and provided strategic review to ensure the accuracy, clarity, and relevance of the final report (All Sections).

Lastly, a special thank you to the members of the POINTS Consortium that validated cost assumptions and provided technical feedback. This included the HVDC Original Equipment Manufacturers and multiple HVDC transmission developers.

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GLOSSARY

Auxiliary systems: Essential utilities such as heating, ventilation, air conditioning and emergency power systems that support the operation of main equipment but are not part of the primary equipment.

Cable Bays: A concrete box placed underground that connects the undersea cable to the cable leading to the onshore substation.

Export Cable: An export cable is a high-voltage transmission cable designed to transport electricity generated by offshore wind farms (or other offshore energy sources) to the onshore grid. In this report, export cables are assumed to be either 320 kV or 525 kV HVDC transmission cables.

Helper Platform: A helper platform is an offshore platform (independent of the offshore substation) that is used to facilitate the creation of an offshore transmission network or the integration of offshore wind into an interconnector.

High voltage equipment: Depending on the pathway, this might include transformers, shunt reactors, GIS and DC breakers.

HVDC: High-voltage direct current transmission.

Inter-array Cables: Subsea power cables connecting offshore wind turbines to a local offshore substation. The overall layout of the cables, including routing, burial depth, and protection methods all influence energy yield and economic viability.

Interconnector: In this report, an interconnector is an HVDC transmission system utilizing two onshore HVDC converters and an offshore HVDC transmission cable (interlink). An interconnector facilitates electricity transfer between regions and enhances energy security

Interlink Cables: Interlink cables are high-voltage transmission lines used to create an offshore transmission network by connecting two or more offshore substations (and their associated export cables). These cables enable power sharing, redundancy, and load balancing across the offshore grid, supporting meshed or multiterminal HVDC configurations. By linking separate offshore assets, interlink cables enhance system reliability, operational flexibility, and overall transmission efficiency.

ISO/RTO: An Independent System Operator (ISO) facilitates open-access to transmission for wholesale market participants, independently operates the transmission system, and fosters competition for electricity generation. Regional Transmission Organizations (RTO), similar in nature and function to an ISO, operate transmission systems and develop procedures to manage transmission equitably.

Jacket: The foundation of an offshore substation, typically designed as a four-legged structure. A steel lattice structure that supports the topside and anchors it to the seabed. The foundation is fixed to the seabed using four piles. The jacket foundation supports J-Tubes for export and array cables, boat landings, and boat fenders. The top of the jacket provides an interface with the cellar deck of the topside.

Multi-Purpose Interconnector: In this report, a multi-purpose interconnector is an interconnector that enables the integration of offshore wind, by coupling the injection of offshore wind into the onshore grid via an interconnector.

Offshore Substation: An offshore based electrical facility that collects power generated by offshore generation sources and transforms it to a higher voltage for efficient transmission to the onshore grid. Offshore substations typically house transformers, switchgear, and control systems, and may be configured for either AC or DC transmission depending on the project design.

Point of Interconnection (POI): A designated location where an offshore transmission system connects to the onshore grid or another transmission network. It serves as the formal boundary between the offshore transmission developer and the grid operator or utility, defining responsibilities for grid compliance, metering, and operational control.

Topside: Includes the main deck and superstructure, housing high voltage equipment and auxiliary systems. It also integrates cable hang-off points, J-tubes, and termination hardware to facilitate future interconnections.

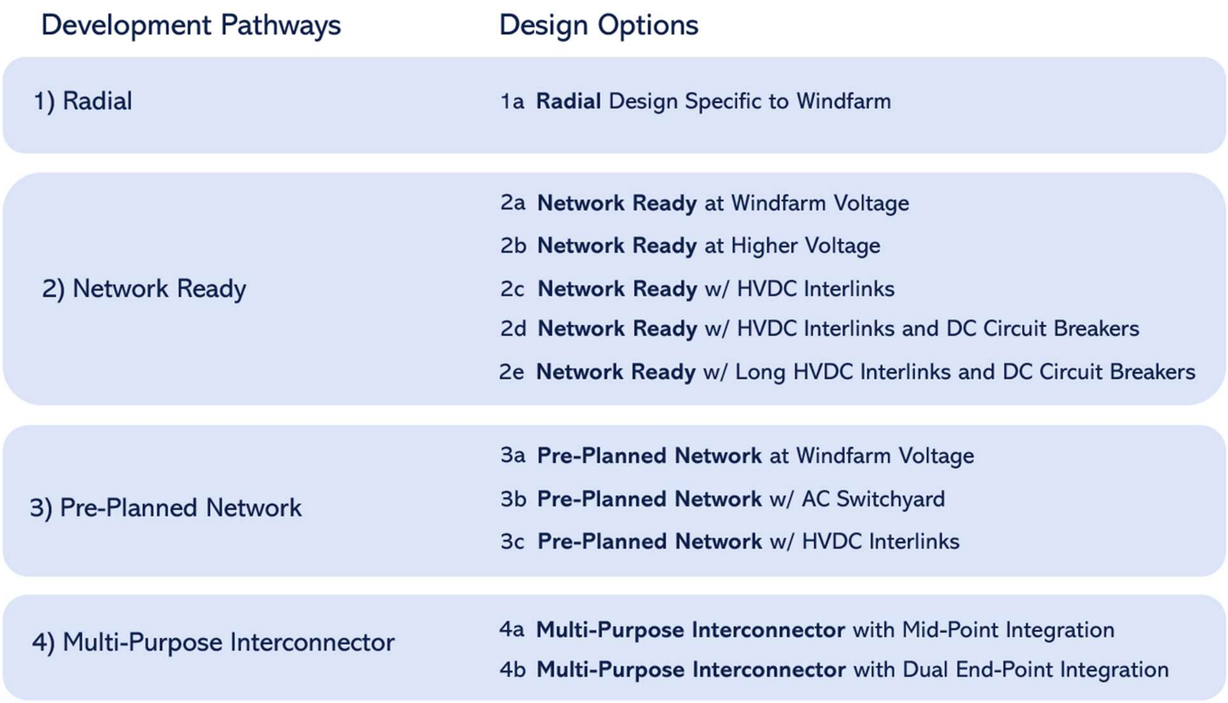
1 EXECUTIVE SUMMARY

This report serves as the second in a series of reports dedicated to enhancing offshore transmission solutions for States within the Northeastern and Mid-Atlantic United States. The primary objective is to provide comprehensive guidance and best practices aimed at fostering the development of offshore transmission networks. The following subsections summarize the key sections of this report.

Development Pathways and Design Options Studied by the POINTS Consortium

Eleven Development Pathways and Design Options were selected by the POINTS Consortium for consideration as offshore transmission standardization. They are shown in Figure 1.1. The first scenario (1a) is the baseline scenario against which the benefits and costs for the other scenarios will be calculated. The next five scenarios (2a-2e) are intended to cover the range of interlinking Design Options for the Network Ready Development Pathway. The next three scenarios (3a-3c) are for the Pre-Planned Development Pathway and again cover a range of interlinking options. The final two scenarios (4a-4b) are for the Multi-Purpose Interconnector Development Pathway.

The Development Pathways and Design Options are explained in detail in Section 4 of the report.



Development Pathways	Design Options
1) Radial	1a **Radial** Design Specific to Windfarm
2) Network Ready	2a **Network Ready** at Windfarm Voltage 2b **Network Ready** at Higher Voltage 2c **Network Ready** w/ HVDC Interlinks 2d **Network Ready** w/ HVDC Interlinks and DC Circuit Breakers 2e **Network Ready** w/ Long HVDC Interlinks and DC Circuit Breakers
3) Pre-Planned Network	3a **Pre-Planned Network** at Windfarm Voltage 3b **Pre-Planned Network** w/ AC Switchyard 3c **Pre-Planned Network** w/ HVDC Interlinks
4) Multi-Purpose Interconnector	4a **Multi-Purpose Interconnector** with Mid-Point Integration 4b **Multi-Purpose Interconnector** with Dual End-Point Integration

Figure 1.1. Development Pathways and Design Options Evaluated by the POINTS Consortium

Benefit-Cost Analysis

A Benefit-Cost Analysis was used to compare the different Development Pathways and Design Options. The methodology for the Benefit-Cost Analysis is presented in Section 5. The results from the Benefit-Cost Analysis are presented in Section 6.

The Benefit-Cost Analysis found that interlink costs (more than interlink benefits) influenced the observed benefit-to-cost ratios (BCRs). Design Options with shorter interlink distances and without the need for helper platforms yielder the highest BCRs.

Critically, the POINTS Consortium identified Design Options (2a, Network Ready at the Windfarm Cable Array Voltage AND 2c, Network Ready with HVDC Interlinks) that exhibited highly favorable BCRs across all three of the tested benefits scenarios.

Risk Assessment Findings

The Network Ready, Pre-Planned Network and Multi-Purpose Interconnector Development Pathways each provide a path to the desired objective of an offshore transmission grid. Each Development Pathways carries certain risks, such as stranded investment and regulatory barriers to achieving an offshore network, which can impact the project cost and overall timelines. A key decision for states will be whether to address risks upfront or opt for an initial more conventional/less risky path that defers resolution of regulatory risk of interlinking to a future date. Below is a summary of the key takeaways from the risk assessment, which are discussed in greater detail in Section 7.

Development Pathway	Risk Assessment
Radial	• Straightforward conventional design • Least risk overall • Minimizes investment per project • Least opportunity for future interlinking
Network Ready	• Straightforward conventional design • Defers networking to future years, deferring regulatory and permitting risk • Risks stranded investment and future incompatibility
Pre-Planned Network	• Ensures networked facilities are technologically compatible at outset • Addresses regulatory and permitting risks upfront • Provides opportunity to optimize design as a network • May result in a more onerous process to complete the projects
Multi-Purpose Interconnector	• Ensures onshore converter systems are technically compatible. • Initial capital cost may be significant for long distance interconnector • Requires state coordination on technical requirements and cost allocation • Potential to create an offshore POI • Defers resolution with offshore interconnection

Figure 1.2. Risk Assessment Findings for each Development Pathway

Key Takeaways

Through the techno-economic analysis contained in this report and through meetings of the POINTS Consortium three key takeaways for offshore transmission standardization emerged:

- Opportunistic Interlinks exhibit Benefit-to-Cost ratios up to 25-fold and should be a near-term focus for offshore transmission infrastructure investments
- DC Interlinks without DC Circuit Breakers are an attractive alternative to AC interlinks

- Network Ready can be the default Development Pathway; but it should not be the only Development Pathway

Recommendations

Immediate Recommendations: States should establish Network-Ready as the default Development Pathway

1. Use DC interlinks without HVDC Circuit Breakers
2. Require one cable bay for interlinking on each offshore substation
3. Focus on identifying Opportunistic Interlinks between two offshore substations

Near-Term Recommendations: States should procure one (ideally two) projects that interconnect two or more RTOs

4. Allow the submission of Pre-Planned Network and Multi-Purpose Interconnector bids into coordinated offshore solicitations
5. Require multi-vendor interoperability on all projects delivered after 2040

Benefits from the Recommendations

- Increased interconnection capacity at lower costs
- Alignment with the global supply chain AND the supply chain can plan for future requirements
- Discover and take advantage of opportunistic networking opportunities by allowing developers to propose cost-effective solutions
- Learn from the solicitation responses (i.e., price discovery)
- Develop the solicitation and other processes needed to enable cross-RTO projects

2 INTRODUCTION

This is the second in a series of reports on offshore transmission solutions for the Northeastern and Mid-Atlantic United States. The purpose of this report is to provide guidance and develop best practices to promote interconnection and interoperability of transmission projects to support near term state offshore transmission solicitations and potential shared transmission planning.

The members of the Northeast States Collaborative on Interregional Transmission (“States Collaborative”) have identified specifications of High-Voltage Direct Current (“HVDC”) configurations as a key element of accelerating deployment of low-cost ocean transmission infrastructure. Effective offshore transmission networks can provide savings that significantly exceed the incremental investment, while improving the reliability of the bulk power system.

The States Collaborative, with the support of the U.S. Department of Energy (“DOE”) invited stakeholders from across the offshore transmission ecosystem to join the Planning Offshore Interregional Network Transmission Standardization (“POINTS”) Consortium to help provide member states actionable guidance and best practices on offshore transmission standardization.

The purpose of this report is to memorialize potential standardization recommendations for the Atlantic Region state transmission procurement and planning. This report explores transmission development and design pathways for evaluation, an assessment framework for offshore transmission standardization, project benefit-to-cost ratios, offshore transmission options and recommendations for near- and mid-term solutions for states, and strategic procurement considerations and recommendations for state entities.

3 DEVELOPMENT PATHWAYS FOR OFFSHORE TRANSMISSION

In seeking to standardize the development of offshore transmission, the co-leads of the POINTS Consortium found it necessary to define and compare different ‘Development Pathways.’ Each Development Pathway represents a unique method of developing offshore transmission, and each Development Pathway allows different degrees of standardization.

Development Pathways Evaluated by the POINTS Consortium

1) Radial
2) Network Ready
3) Pre-Planned Network
4) Multi-Purpose Interconnector

The four Development Pathways considered by the POINTS Consortium are listed here. The Radial and Network Ready pathways are the two Development Pathways which the states in the States Collaborative are pursuing today. The Pre-Planned Network and Multi-Purpose Interconnector pathways are two additional Development Pathways that the POINTS Consortium wished to evaluate alongside the Radial and Network Ready pathways.

The feedback received from POINTS Consortium and States Collaborative members influenced the following Development Pathways. In particular, the chosen Development Pathways and the associated Design Options strongly considered three consensus takeaways that emerged during group discussions at the virtual and in-person meetings.

Consensus Takeaways that Influenced the Development Pathways Evaluated by the POINTS Consortium:

1) **States remain committed to offshore energy goals but need to minimize near-term expenditures**
2) **States desire the future option to interconnect projects, where reasonable and cost-effective to do so**
3) **All parties benefit by minimizing project risks while the US market reaches maturity**

The Development Pathways selected also considered: (i) that several recent European projects have been simplified to enable deliverability in response to supply chain constraints; and (ii) that knowledge of the future network reduces project risk and complexity (i.e., standardization alone is not always sufficient for minimizing project risk).

The remainder of this section will discuss the four Development Pathways in additional detail and then conclude with a discussion of ‘Opportunistic Interlinks’.

3.1 Radial

The Radial Development Pathway is the baseline option for offshore transmission development. The Radial Development Pathway assumes that offshore transmission is developed solely to bring power to shore for a specific offshore generation project. Radial Development optimizes offshore transmission for the needs of a specific offshore generation project and does not plan for future connections to adjacent offshore transmission infrastructure.

Radial
Description: Independent procurements of offshore wind projects; technical design is optimized for each project and does not contemplate any future interconnection to other projects
Initial Buildout: A single offshore wind farm
Future Buildout: None

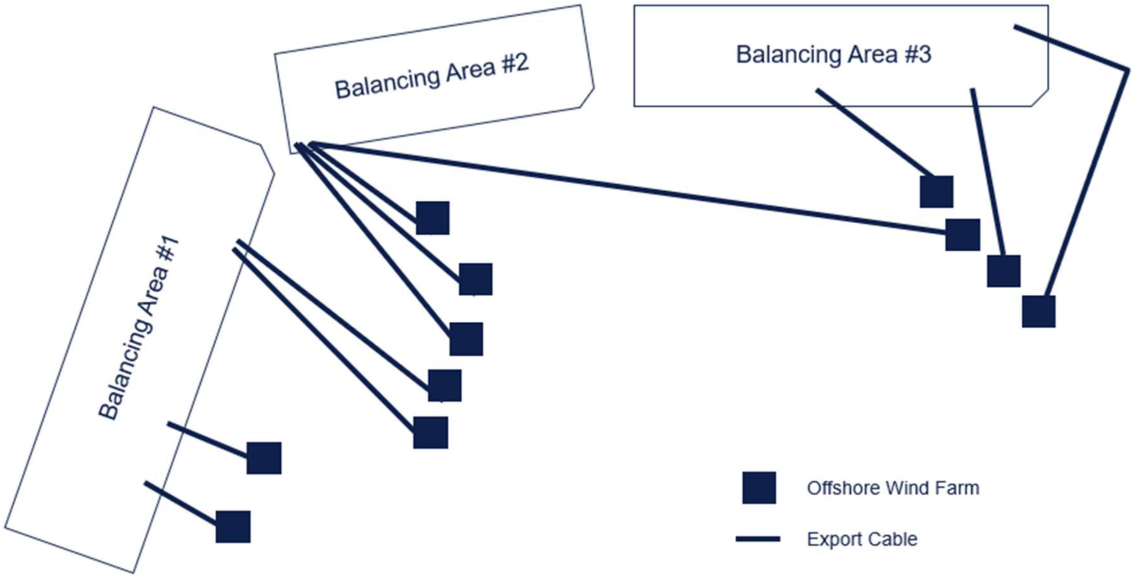


Figure 3.1. Radial Offshore Wind

3.2 Network Ready

Like the Radial Development Pathway, the Network Ready Development Pathway initially develops offshore transmission for a specific offshore generation project. Unlike the Radial Development Pathway, the Network Ready Development Pathway establishes technical requirements that allow for future connections to separate offshore transmission. The over-arching goal of Network Ready Development Pathways are to greatly reduce the cost and technical challenges of interconnecting offshore transmission in the future through modest initial investments.

No existing offshore transmission project in the US has been interlinked to date, and additional tariff and regulatory changes would be necessary to clarity on the implementation process. The Network Ready Development Pathway defers the resolution of regulatory uncertainties until there is a need for the future build.

Key technical requirements that can be established through a Network Ready Development Pathway include:

- the type and voltage of the interlinks that would connect offshore transmission projects (e.g., 132 kV AC cables; 230 kV AC cables; 320 kV DC cables)
- the type and voltage of the export cable from the offshore substation to the shore (e.g., a 320 kV HVDC cable)
- the number and type of cable bays on the offshore substation that are available for interlinking (e.g., four 132 kV AC cable bays; one 320 kV DC cable bay)
- the type and voltage of the windfarm inter-array cables that would be used by the offshore wind projects (e.g., 66 kV AC cables; 132 kV AC cables)

Two states in the States Collaborative are currently pursuing a Network Ready approach to the development of offshore transmission. New York's Network Ready Development Pathway established "Mesh Ready" requirements, while New Jersey requires compliance with its "Network Ready Pathway" rules.

Network Ready
Description: Independent procurement of offshore wind projects; procurement requirements enable future interlinks through technical standardization
Initial Buildout: Offshore wind projects and investments in the offshore substation to support future interlinks
Future Buildout: Interlink and associated helper platforms (if required for interlink)

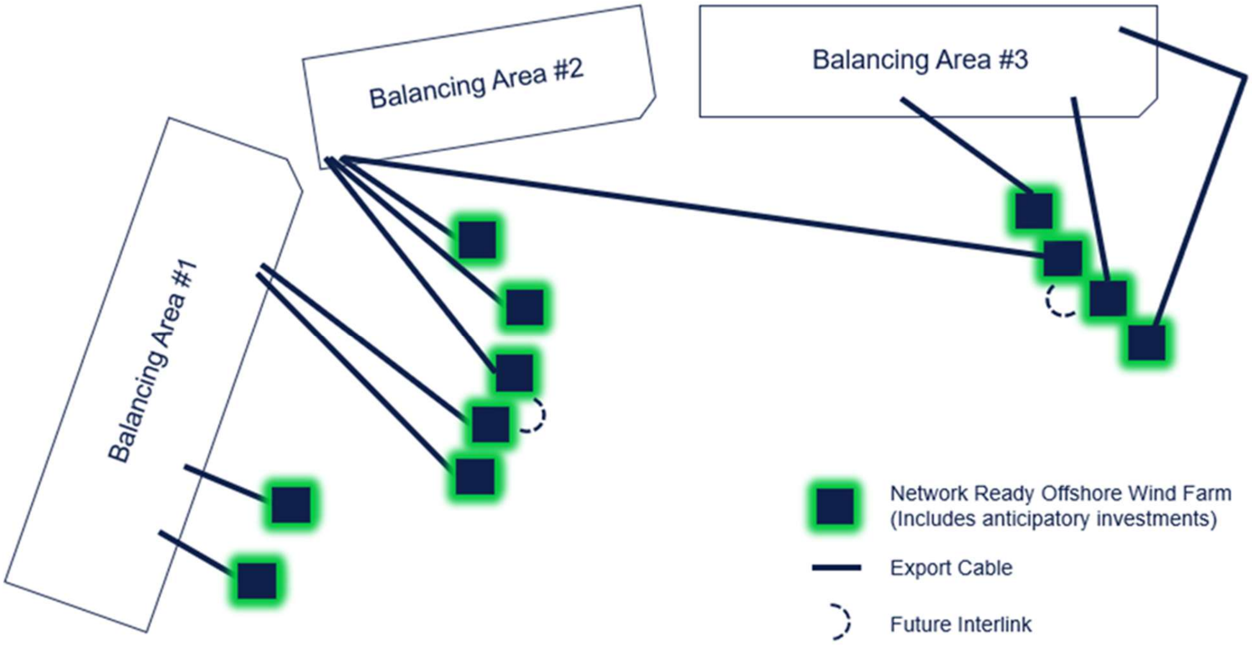


Figure 3.2. Network Ready – Potential Future State

3.3 Pre-Planned Network

The Pre-Planned Network Development Pathway aligns the planning of the offshore transmission network and the development of two (or more) offshore wind projects and the associated export cables.

The overarching goal of Pre-Planned Networks is to reduce electrical and physical design risks. This pathway enables HVDC equipment manufacturers and engineering consultants to design the HVDC converters and the offshore transmission network with complete knowledge of the necessary equipment for the future.

Additionally, Pre-Planned Networks have advantages for optimized designs that separately planned windfarms do not offer (e.g., the optimal placement of offshore substations and inter-array cabling within the windfarms). Planning the offshore transmission network from the outset may also allow for strategic coordination of the critical transportation and installation vessels needed to install the offshore substations and offshore transmission cables.

Pre-Planned Network
Description: Coordinated procurement and interconnection of two (or more) offshore windfarms
Initial Buildout: Two offshore windfarms and an interlink
Future Buildout: None

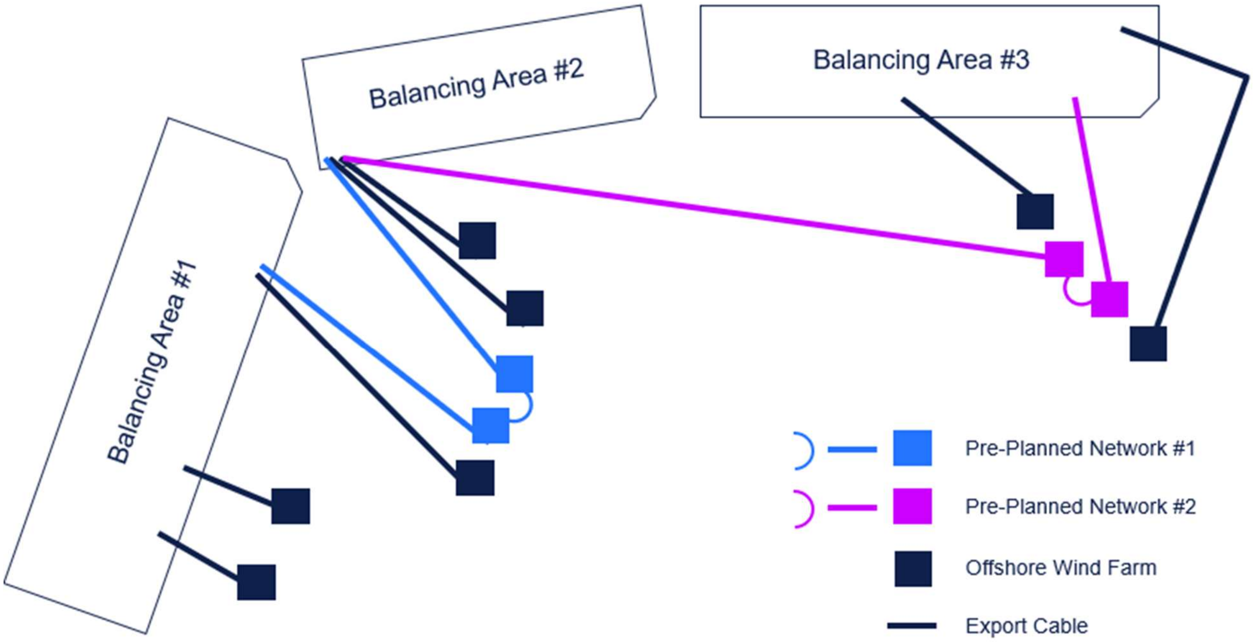


Figure 3.3 Pre-Planned Network

Unlike the Radial and Network Ready Development Pathways, Pre-Planned Networks involve the coordinated procurement of two (or more) offshore wind projects. Often, coordinated procurement introduces additional work and risk into the process, especially if the project involves the participation of multiple states and multiple RTOs.

As noted with the Network Ready Pathway, there are uncertainties with the regulatory process.[1] However, by opting to pursue the Pre-Planned Development Pathway, states can address regulatory issues at the outset and incorporate the solutions into the initial project planning and development.

> **As envisioned by the POINTS Consortium, wind solicitation processes could integrate Pre-Planned Networks into existing offshore wind solicitation processes by allowing developers to provide states with the *option* to procure the interlink(s) at the same time the state decides to procure the offshore wind.**

Currently, the members of the States Collaborative are not pursuing Pre-Planned Networks. Some members, such as New Jersey, did explore the creation of an offshore transmission network without the simultaneous procurement of

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[1] Regulatory uncertainties discussed further in Section 7: RISK ASSESSMENT FRAMEWORK FOR OFFSHORE TRANSMISSION.

offshore wind through a State Agreement Approach. Ultimately, New Jersey decided to not procure an offshore transmission network for a variety of reasons, including higher upfront capital costs due to the existence of federal tax benefits for offshore transmission when developed directly by an offshore windfarm project.

3.4 Multi-Purpose Interconnector

The Multi-Purpose Interconnector Development Pathway first develops interregional transmission,[2] followed by the subsequent integration of offshore wind generation.

There are multiple different configurations of Multi-Purpose Interconnectors. For this work, we have considered two configurations: 1) A Multi-Purpose Interconnector with mid-point integration of offshore wind in an offshore environment (Interconnector 1 in Figure 3.4)[3], and 2) a Multi-Purpose Interconnector with dual end-point integration of offshore in an onshore environment (Interconnector 2 in Figure 3.4).

The Multi-Purpose Interconnector Development Pathway allows for the development of interregional transmission in a timely manner, allowing states to secure the reliability and financial benefits associated with additional interregional transmission.

The States Collaborative members are not currently pursuing the Multi-Purpose Interconnector Development Pathway. However, there are examples of Multi-Purpose Interconnectors under development in Europe. Translating the European interconnector concept to the US will require additional regulatory evolution governing how multi-RTO HVDC lines would be operated and rules for interconnecting to an HVDC interconnector.

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[2] Experts often refer to regional transmission as an interconnector in the above context.

[3] This configuration of a Multi-Purpose Interconnector requires a cable connector platform to connect the HVDC cable from an offshore wind farm. The analysis assumes that developers manufacture the cable connector platform alongside the HVDC interconnector (e.g., at the outset of the project).

Multi-Purpose Interconnector
Description: Procurement of an interconnector with the potential to later integrate offshore wind
Initial Buildout: HVDC interconnector (onshore converters and HVDC cable) and offshore cable connector platform
Future Buildout: Offshore windfarm and HVDC export cable connecting to the offshore cable connector

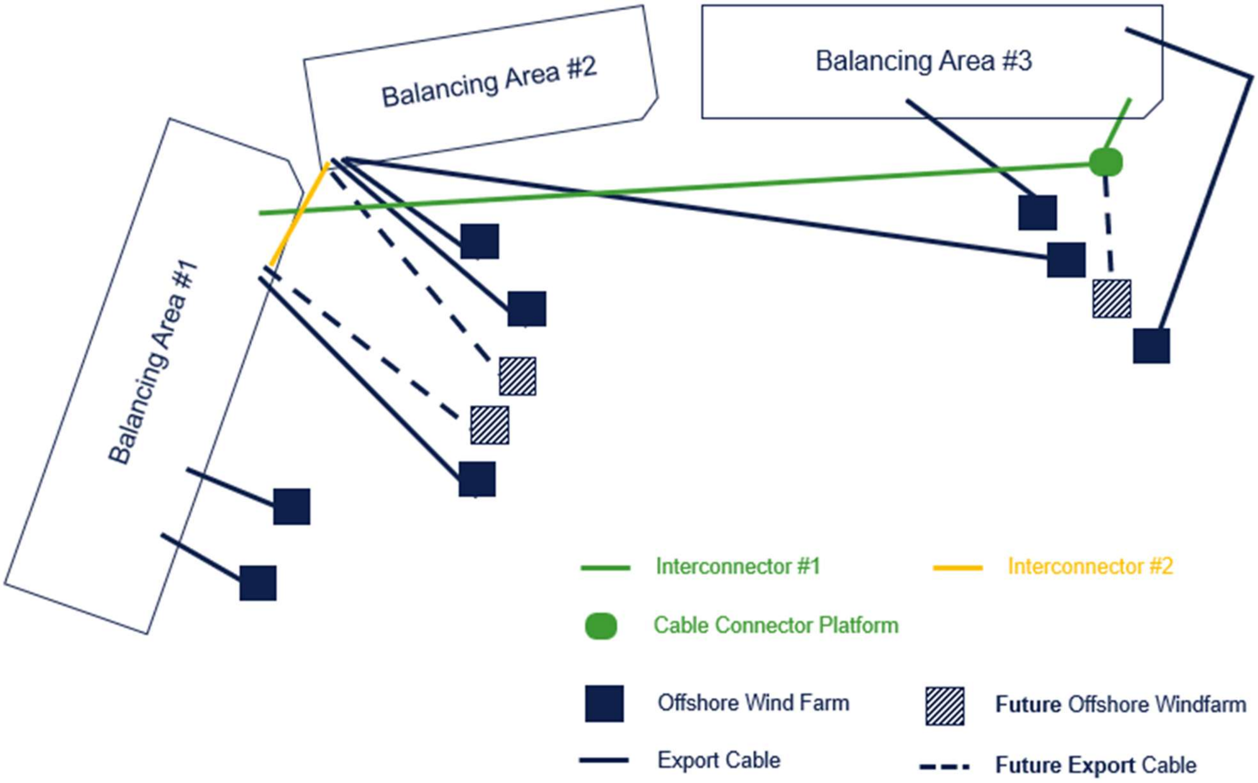


Figure 3.4. Multi-Purpose Interconnector

3.5 Opportunistic Interlinks

The potential to create ‘Opportunistic Interlinks’ was a central consideration in the generation and selection of the Development Pathways and the associated Design Options.

Opportunistic Interlinks are relatively short interlinks (<20 miles) that create interregional transmission capabilities (or significant intra-regional transmission capabilities). The short distance of Opportunistic Interlinks helps to keep costs low. The inter-regional or significant intra-regional transmission capability of Opportunistic Interlinks offer higher benefits than interlinks that provide an additional transmission pathway between well-connected and established onshore points of interconnection. As a result of their low costs and high benefits, Opportunistic Interlinks are a key focus area for states as they evaluate the development of offshore transmission options.

The potential to create Opportunistic Interlinks can arise from:

1. Offshore wind lease regions which have a favorable geographic location for serving two (or more) different balancing areas (e.g., portions of the NY Bight lease area and the Southern New England lease area)
2. Offshore wind lease regions which have a favorable geographic location for connecting two electrically distant (and often spatially separated) points within a single balancing area (e.g., portions of Gulf of Maine lease area)

Three EXAMPLES of Opportunistic Interlinks are shown in Figure 3.5 below.

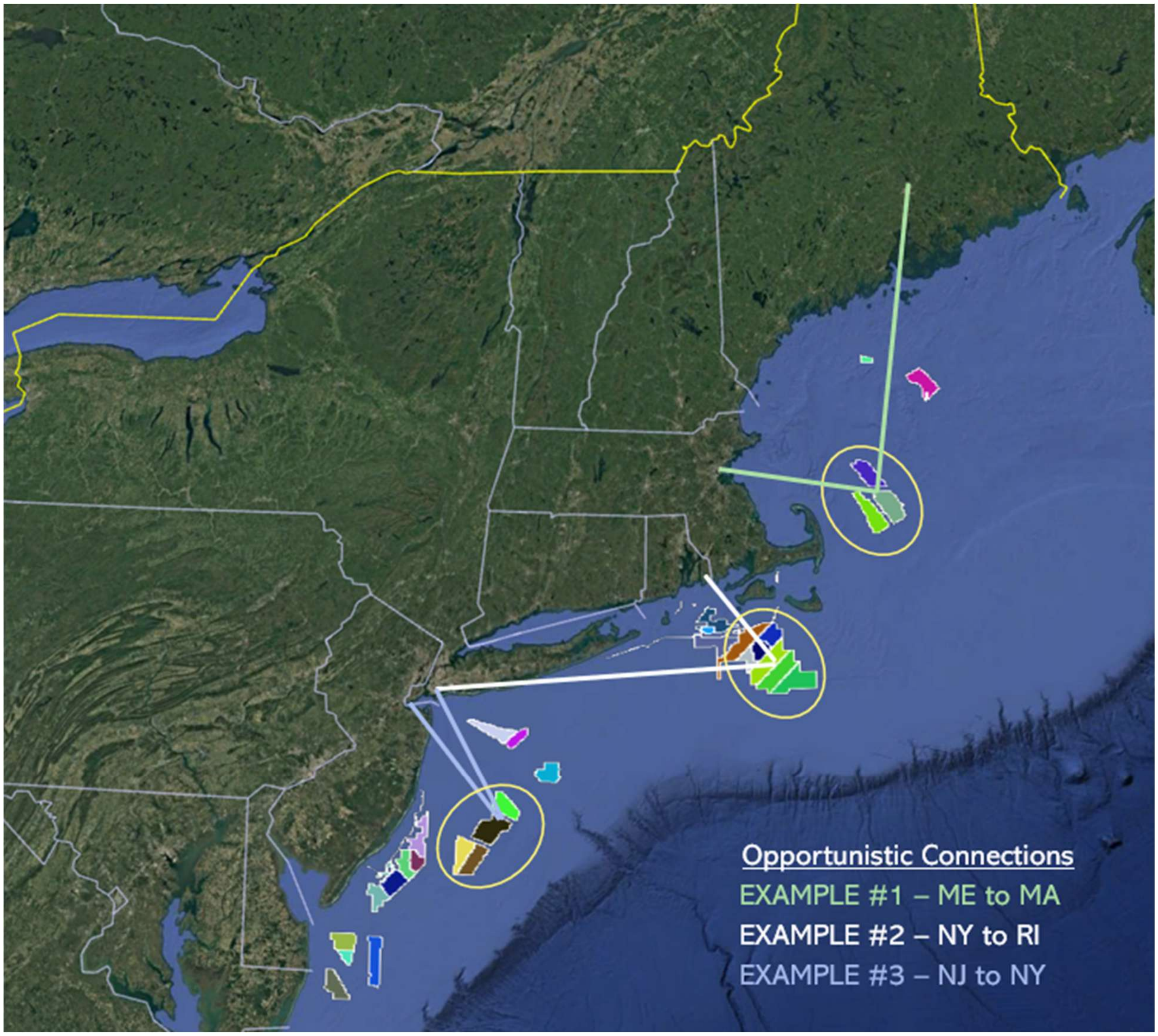


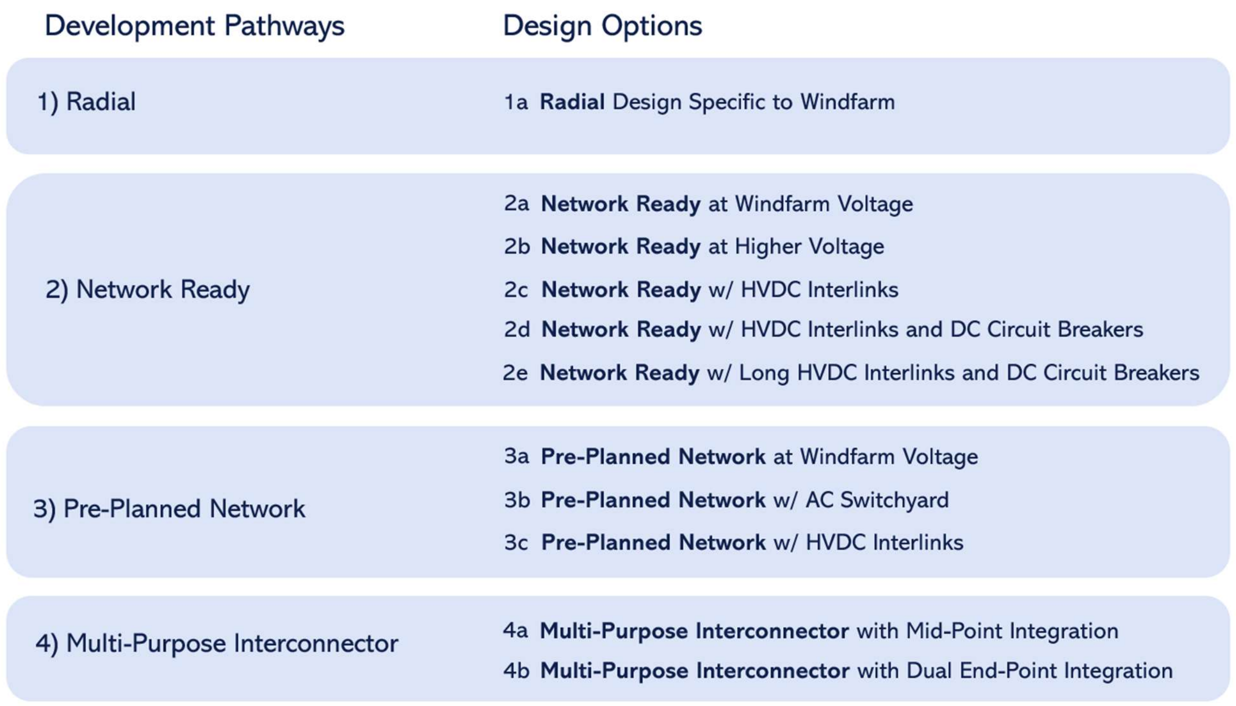
Figure 3.5. EXAMPLES of 'Opportunistic' Interlinks

4 DESIGN OPTIONS FOR DEVELOPMENT PATHWAYS

4.1 Development Pathways and Design Options

The offshore transmission Development Pathways discussed in the preceding section are generalized pathways. Each of the Development Pathways has a multitude of technical designs possible, henceforth known as Design Options. To facilitate comparison between the different Development Pathways and across the different Design Options for a given Development Pathway, the POINTS Consortium selected eleven different Development Pathway / Design Options configurations for analysis.

The eleven Design Option scenarios selected by the POINTS Consortium are shown in Figure 4.1. The first scenario (1a) is the baseline scenario against which the benefits and costs for the other scenarios will be calculated. The next five scenarios (2a-2e) are intended to cover the range of interlinking Design Options for the Network Ready Development Pathway. The next three scenarios (3a-3c) are for the Pre-Planned Development Pathway and again cover a range of interlinking options. The final two scenarios (4a-4b) are for the Multi-Purpose Interconnector Development Pathway.



Development Pathways	Design Options
1) Radial	1a **Radial** Design Specific to Windfarm
2) Network Ready	2a **Network Ready** at Windfarm Voltage 2b **Network Ready** at Higher Voltage 2c **Network Ready** w/ HVDC Interlinks 2d **Network Ready** w/ HVDC Interlinks and DC Circuit Breakers 2e **Network Ready** w/ Long HVDC Interlinks and DC Circuit Breakers
3) Pre-Planned Network	3a **Pre-Planned Network** at Windfarm Voltage 3b **Pre-Planned Network** w/ AC Switchyard 3c **Pre-Planned Network** w/ HVDC Interlinks
4) Multi-Purpose Interconnector	4a **Multi-Purpose Interconnector** with Mid-Point Integration 4b **Multi-Purpose Interconnector** with Dual End-Point Integration

Figure 4.1. Development Pathways and Design Options Evaluated by the POINTS Consortium

4.2 Number of Networked Offshore Substations

The Design Options evaluated by the POINTS Consortium focused on the development of offshore transmission networks comprised of two offshore substations and two onshore converter stations.

The POINTS Consortium focused on the creation of two offshore substation networks for two reasons. First, offshore transmission networks with two offshore substations should be the focus until the U.S. offshore wind industry matures and there is a high likelihood for successful and timely project delivery. Until then, adding additional offshore substations into an offshore network will increase the probability of a project being delayed or over-budget. Second, an offshore transmission network with two offshore substations provides a straightforward model to compare the Design Options while still offering representative results for larger offshore transmission networks.

4.3 Evaluated Design Options

In this section, we discuss the evaluated Design Options for each of the Development Pathways. To support this discussion, Figure 4.2 through Figure 4.5 provide high-level illustrations of the evaluated Design Options. These figures include the following information for each of the Design Options:

- the interlink type (AC or DC and voltage)
- the interlink capacity (in MW)
- the presence and type of offshore platforms
- the number of interlink cables
- the assumed interlink distance (in miles)

4.3.1 Network-Ready Design Options – Opportunistic Interlinks

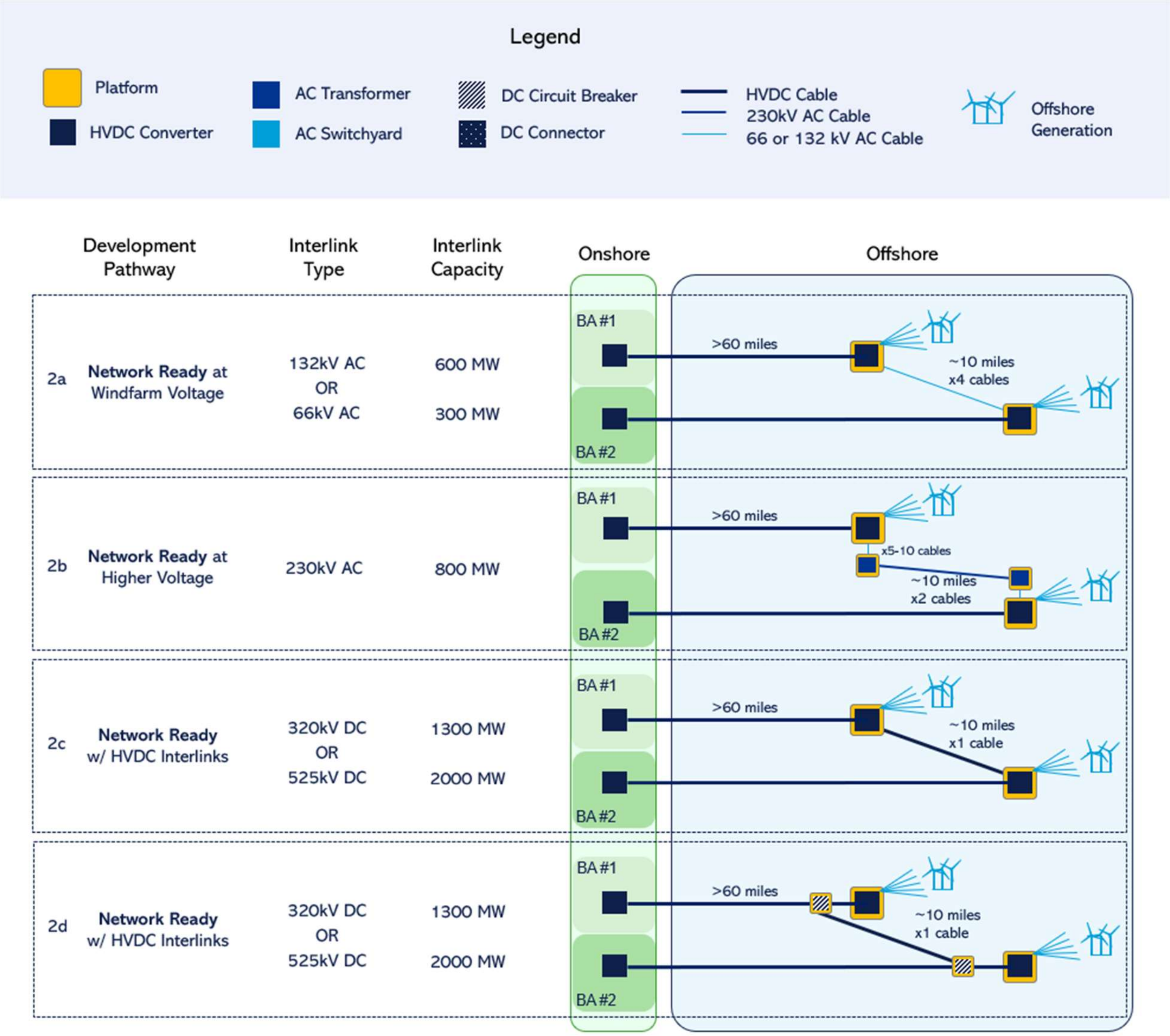
For the Network-Ready Development Pathway, a total of five different Design Options were evaluated. The first four of these related to the development of Opportunist Interlinks and are illustrated below in Figure 4.2. Of these four Design Options, two involved the use of AC interlinks (2a and 2b) and two involved the use of DC interlinks (2c and 2d). The fifth Design Option (2e) related to the development of longer interlinks and is discussed later in the report.

Design Option 2a creates an AC interlink at the same voltage as the windfarm cable array voltage (i.e., 66 kV or 132 kV). Design Option 2b creates an AC interlink at a higher voltage (230 kV) than the windfarm cable array voltage.

The key difference between Design Options 2a and 2b is that Design Option 2a does not require helper platforms to enable the creation of the AC interlink. An explanation of why the helper platform is required for Design Option 2b is provided in Additional Offshore Helper Platforms. A secondary design difference between Design Options 2a and 2b is the number of cables required for interlinking. Design Option 2a would utilize four cables (either 66 kV or 132 kV), while Design Option 2b would utilize two cables (230 kV) to span the bulk of the interlinking distance and either ten 66 kV cables or five 132 kV cables to connect each of the helper platforms to the offshore substations.

The interlink capacity of Design Options 2a and 2b are similar. Design Option 2a has an interlink capacity 600 MW when using 132 kV cables, while Design Option 2b has an interlink capacity of 800 MW. Note, Design Option 2a has a smaller interlink capacity of 300 MW when using 66 kV cables. The higher interlink capacity associated with the use of 132 kV cables is a key factor in our recommendation for the states to require the use of 132 kV cables for future offshore windfarms.

Design Options 2c and 2d involve the use of DC interlinks. Both Design Options 2c and 2d use a single HVDC cable to create an interlink of equivalent capacity to the HVDC export cables: 1300 MW for a 320 kV network; ~2000 MW for a 525 kV network. The key difference between Design Options 2c and 2d is the type of DC interlink they use, whether they require an HVDC helper platform, and whether there are any restrictions as to when the DC interlink can be utilized. **Design Option 2c uses a DC interlink without HVDC circuit breakers or helper platforms** but limits the use to certain operational states of the offshore network. **Design Option 2d uses a DC interlink with HVDC circuit breakers and helper platforms** and does not limit the use to certain operational states of the offshore network. Please see DC Interlinks for further discussion.



	Development Pathway	Interlink Type	Interlink Capacity
2a	**Network Ready** at Windfarm Voltage	132kV AC OR 66kV AC	600 MW 300 MW
2b	**Network Ready** at Higher Voltage	230kV AC	800 MW
2c	**Network Ready** w/ HVDC Interlinks	320kV DC OR 525kV DC	1300 MW 2000 MW
2d	**Network Ready** w/ HVDC Interlinks	320kV DC OR 525kV DC	1300 MW 2000 MW

Figure 4.2. Network Ready Design Options – Opportunistic Interlinks

4.3.2 Pre-Planned Network Design Options – Opportunistic Interlinks

The Pre-Planned Network Design Options sought to take advantage of the offshore transmission design and cost optimization that would be possible through a coordinated procurement process. To this end, the Pre-Planned Network Design Options examined the possibility of locating the offshore substations near each other (~1 mile) to minimize the cost of the interlink, as shown in Figure 4.3. While this high degree of spatial alignment may not prove feasible for a given wind lease area(s) or cost-effective due to an increase in the inter-array cabling costs of the windfarms, it nonetheless illustrates the type of design and cost optimization that would be possible through a Pre-Planned Network Development Framework.

After accounting for the difference in the location of the offshore substations, the Pre-Planned Network Design Options are similar to the Network Ready Design Options apart from a few key differences.

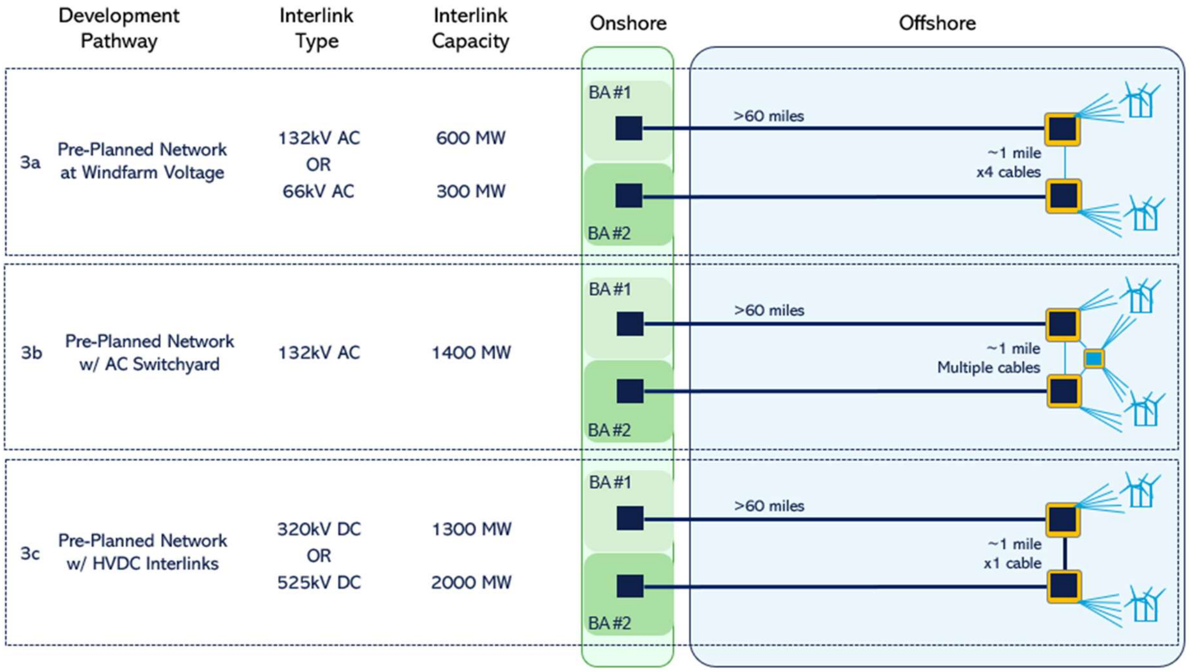


Figure 4.3. Pre-Planned Network Design Options – Opportunistic Interlinks

Like the Network Ready Design Option 2a, the Pre-Planned Network Design Option 3a uses an AC interlink at the same voltage as the windfarm cable array voltage. Like the Network Ready Design Option 2c, the Pre-Planned Network Design Option 3b uses a DC interlink without HVDC circuit breakers or helper platforms.

Unlike the Network Ready Design Option 2b, there is no Pre-Planned Network Design Option utilizing an AC interlink at a higher voltage than the windfarm cable array voltage. This was because the Network Ready Design Option 2b is the most expensive form of interlink and, while useful to show for the Network Ready analysis, was not useful to reexamine here.

Unlike the Network Ready Design Option 2d, there is no Pre-Planned Network Design Option using a DC interlink with HVDC circuit breakers and helper platforms. Initially, the POINTS Consortium expected that the inclusion of

HVDC circuit breakers and helper platforms for short interlinks would not be cost-effective relative to DC interlinks without HVDC circuit breakers and helper platforms.[4]

Unlike the Network Ready Design Options, the analysis included a Pre-Planned Network Design Option with an AC collector platform (Design Option 3b). The purpose of Design Option 3b was to explore what it would take to create an AC interlink with the same capacity as a DC interlink. The AC collector platform in Design Option 3b would have several array cables from both offshore windfarms and would have several cables to each of the offshore substations, as well as AC switchgear. This design approach would allow the cable bays on the offshore substation to function as cable bays for either windfarm array cables or AC interlinks, thereby increasing the interlinking capacity of the offshore substations without meaningfully increasing the number of cable bays relative to existing optimized offshore substation designs.

4.3.3 Network-Ready Design Options – Long Interlinks

The fifth and final Network-Ready Design Option was Design Option 2e. Design Option 2e focused on the creation of long interlinks (~150 miles in length). The analysis assumed that once the Opportunistic Interlinks are no longer readily available that projects would default to the use of long interlinks. Evaluating long interlinks now yields insights into the cost differences with Opportunistic Interlinks, as well as with separate onshore interregional transmission options which the states may evaluate.

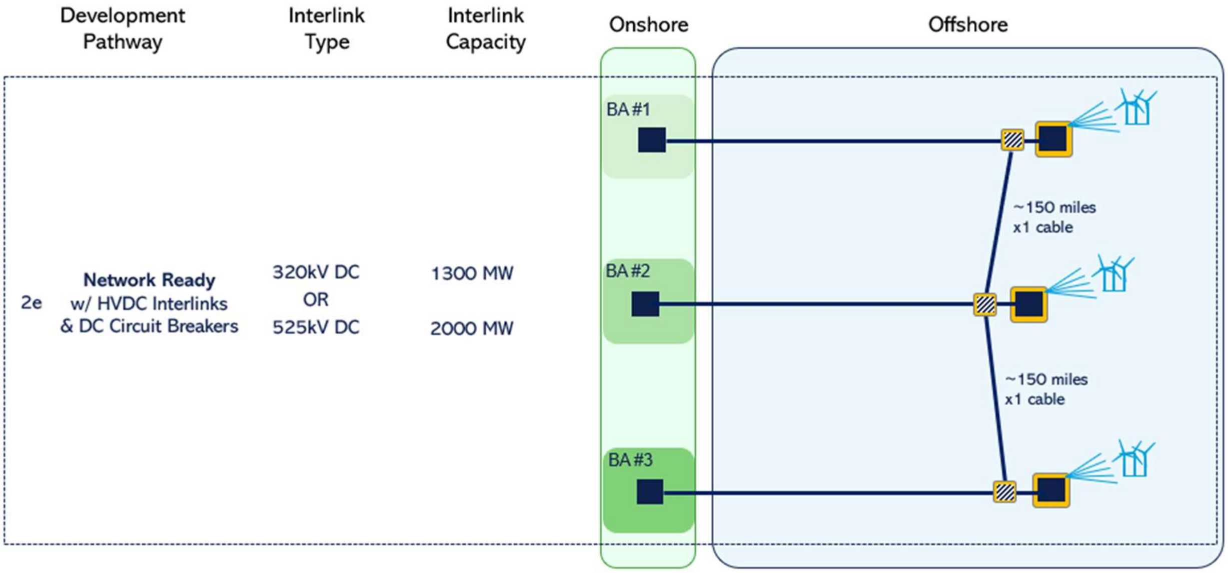


Figure 4.4. Network Ready Design Option – Long Interlinks

Design Option 2e uses DC interlinks with HVDC circuit breakers and helper platforms. The analysis did not evaluate AC interlinks as the cost of cables and cable capacity limitations are widely known to favor DC interlinks for long interlinks.

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[4] This was a hypothesis already being tested by Network Ready Design Options 2c and 2d.

Design Option 2e was also the one Design Option that assumed three offshore substations. This was done to align Design Option 2e with the previous Atlantic Offshore Wind Transmission Study.[5]

The analysis did not include a Design Option using DC interlinks without HVDC circuit breakers and helper platforms. If time permits, a future analysis will include such a Design Option prior to the end of the POINTS Consortium project.

4.3.4 Multi-Purpose Interconnector Design Options

The Multi-Purpose Interconnector Development Pathway is the Development Pathway with the largest number of potential Design Options. As such, there will be *significant variability* in the benefits and costs for projects following the Multi-Purpose Interconnector Development Pathway.

For the POINTS Consortium work, the Consortium chose two different Design Options that provide an indication of the technical designs, costs, and benefits that are possible with the Multi-Purpose Interconnector Development Framework.

The first Multi-Purpose Interconnector Design Option evaluated was Design Option 4a. Design Option 4a focused on the creation of an HVDC interconnector, followed by the future connection of two offshore wind projects at a location along the length of the interconnector, referenced as Mid-Point Integration. To facilitate the future connection of an offshore wind project, the analysis assumed that both an offshore connector platform and the initial construction of the interconnector occurred in tandem.

The second Multi-Purpose Interconnector Design Option evaluated was Design Option 4b. Design Option 4b focused on the creation of an HVDC interconnector, followed by the onshore connection of two offshore wind projects, one by each of the interconnector's onshore HVDC converter stations. This was referred to as Dual End-Point Integration and did not require any offshore connector platforms.[6]

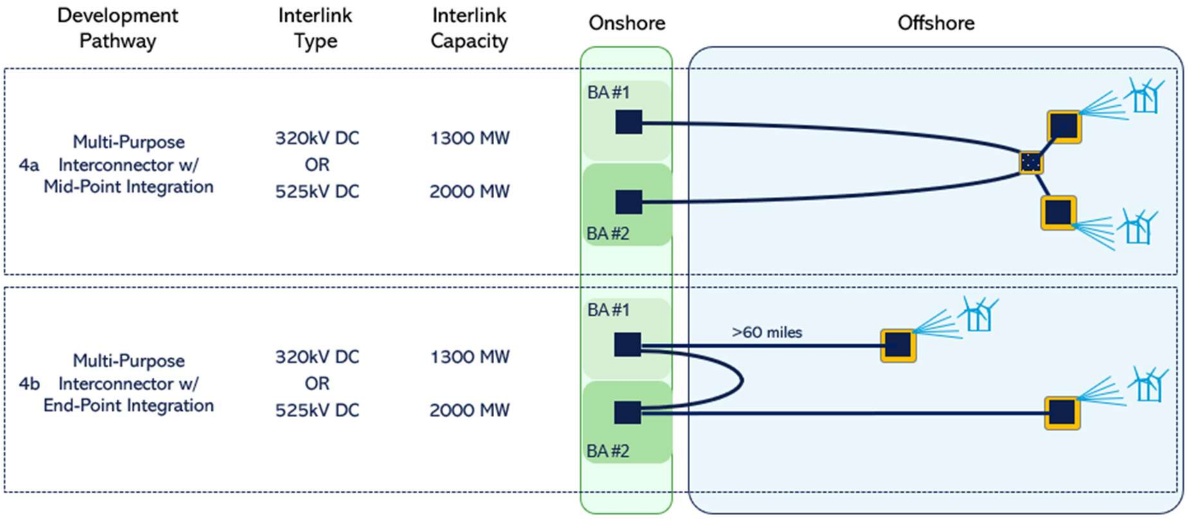

Figure 4.5. Multi-Purpose Interconnector Design Options

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[5] https://www.nrel.gov/wind/Atlantic-offshore-wind-transmission-study

[6] The process is referred to as Dual End Point Integration.

4.4 Additional Offshore Helper Platforms

Several of the evaluated Design Options require the use of additional[7] offshore platforms to enable the creation of the offshore transmission network. Design Option 2b requires the presence of 'helper' platforms to hold the AC transformers and associated equipment needed to transform AC power from the windfarm cable array voltage to a higher voltage (230 kV). Design Option 2d requires the presence of helper platforms to hold the DC circuit breakers. Design Option 3b requires the presence of an AC collector platform to collect power from the two separate windfarms and, as needed, the switchgear needed to reroute it between the offshore substations. Design Option 4a requires the presence of an offshore connector platform to integrate the power from the offshore windfarm into the interconnector.

Design Options 2b, 2d, and 3b require helper platforms helper platforms due to weight and space constraints for the existing offshore substation designs. While accommodating additional weight and space on the offshore substation and avoiding the helper platforms is theoretically possible, it is not practically viable. Avoiding helper platforms is not viable for the following reasons: (i) the states' desire to minimize costs prior to the creation of an interlink; (ii) the industry need for engineering redesign of the offshore substation; and (iii) weight limitations for offshore substation transportation and installation vessels.[8]

Please see Figure 4.2, Figure 4.3, and Figure 4.5 to gain a better understanding of how these additional offshore platforms are incorporated into Design Options 2b, 2d, 3b, and 4a.

4.5 DC Interlinks

Design Options 2c, 2d, 3c, 4a, and 4b involve the use of DC interlinks, but they do not all assume the same type of DC interlinks. This is critically important as **the choice of DC interlink type has important technical and cost implications.**

Design Options 2c and 3c assume the use of DC interlinks with disconnect switches but without HVDC circuit breakers. The advantage of not having HVDC circuit breakers is that Design Options 2c and 3c do not require costly helper platforms to hold the HVDC circuit breakers. The disadvantage of not having HVDC circuit breakers is that Design Options 2c and 3c will lose the entirety of the offshore network in the case of a DC fault. For this reason, onshore grid operators will likely require that Design Options 2c and 3c limit the use of the interlink to times when the entirety of the offshore network could be lost without material impact to the onshore grid.[9]

Design Options 2d and 4a assumes the use of DC interlinks with HVDC circuit breakers. The advantage of having HVDC circuit breakers is that DC faults can be quickly isolated, preventing the full loss of the offshore transmission network in the event of a DC fault. As a result, there are no inherent limitations to the use of the interlinks. However, the disadvantage in using HVDC circuit breakers is the necessity of costly helper platforms to bear the spatial and weight requirements.

Design Option 4b assumes the use of HVDC interlinks with onshore HVDC circuit breakers. Most of the cost of an offshore HVDC circuit breaker cost is due to the cost of the helper platform. As such, projects can more easily include HVDC circuit breakers for a lower cost when built onshore.

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[7] Offshore platforms in addition to the offshore substation (i.e., in addition to the offshore platform containing the HVDC converter)

[8] This is especially true for the 320 kV offshore substations. Additional discussion of this topic can be found in the Offshore Transmission Overview produced by the POINTS Consortium.

[9] In our analysis, we conservatively assume that grid operators would limit the use of the interlink to times when the loss of source for the offshore network is less than the loss of source of a single HVDC system. For an offshore network consisting of two offshore substations, this would mean that the interlink should only be used when the average capacity factor of the networked offshore wind is less than 50%.

5 COST BENEFIT ANALYSIS

In this section, the Brattle Group authors worked with the National Laboratory of the Rockies (NLR) to update the initial transmission benefits analysis provided in the DOE's Atlantic Transmission Study (2024) to analyze transmission deployment in the Eastern United States. DNV and Aker then provided a combined cost-benefits analysis section to provide further information for the four pathways studied for this report.

The POINTS Consortium found that total project cost is the sum of the offshore cable and platform costs. However, not all costs occur during the initial project phase for all transmission Design Options. The different Design Options distribute expenditures across multiple stages of development. This section provides further detail on the timing of expenditures for each Design Option.

5.1 Cost Benefit Analysis Methodology

The POINTS Consortium team developed a cost benefit analysis to enable a techno-economic comparison of the different Development Pathways and Design Options. To build consensus across the POINTS Consortium, the cost benefit analysis methodology and its results were reviewed with the consortium membership and partner states throughout the fourth quarter of 2025 and into early 2026.

This section of the report provides a high-level overview of the methodology for the cost benefit analysis. This section also includes a summary of key cost inputs into the cost benefit analysis. For more granular insight into how the cost benefit analysis was conducted, please see the POINTS Cost-Benefit-Analysis spreadsheet (available separately through the POINTS Consortium).

The results and conclusions from the cost benefit analysis are covered in Section 6.

5.2 Cost Analysis

To develop a representative cost estimate for the various Development Pathways and Design Options, the POINTS Consortium relied on a build-up of individually vetted assumptions reviewed with the POINTS membership.

The cost exercise presented in this study, each pathway has been evaluated in three categories:

1. Additional cost to the main HVDC platform
2. Additional cost for helper platforms (not relevant for all pathways)
3. Additional cost of AC/DC interlink cables

A top-down estimate methodology determined the cost of the first two categories, whereas the third category, which covered additional cables for various pathways, used an average cost-per-mile basis estimate. All estimates leverage experience from previously executed offshore platform projects of similar size and complexity, though they are not tailored to the specific conditions of the U.S. East Coast.

The cost analysis identifies the appropriate quantity and size of each component required to construct the envisioned offshore network and aggregates these to determine the total pathway cost. Importantly, the analysis accounts for the timing of component installation, and recognizes the potential for delayed networking for certain Development Pathways.

5.2.1 Additional cost to the offshore substation (i.e., the main HVDC platform)

The estimated additional cost for the main offshore platform accounts for several key provisions to ensure future flexibility and ease of expansion. The following measures facilitate the integration of new connections or upgrades while minimizing the need for costly and disruptive retrofits.

The main items included in the additional cost are:

- **Additional high voltage equipment:** For the AC-interlinking this includes additional gas insulated switchgear (GIS) bays to accommodate future cable connections or interlinks, enabling new circuits to be added without major modifications to the existing electrical system. For DC interlinking this includes additional air insulated switchgear (AIS) bays to accommodate future cable connections or interlinks.
- **Additional J-Tubes:** The platform includes more J-tubes than initially required. These protective conduits allow submarine cables to be brought onto the platform, supporting future cable installations.
- **Space for Cable Hang-Off:** Sufficient physical space is reserved for the hang-off and termination of future cables, including structural support and necessary clearances for safe installation.
- **Topside Structural Modifications:** The topside structure is reinforced or adapted to support additional equipment and expansion. These modifications involve strengthening the deck, adding mounting points, or enlarging specific areas to accommodate future installations.

The cost estimates (shown in Table 5-1) include the above provisions for each Design Option, ensuring the future expansion of the platform. By making these investments upfront, the project can avoid costly and complex modifications later.

Development Pathway & Design Option	Interlink Voltage (kV)	Interlink Type (AC or DC)	Additional Cost per Offshore Substation ($ in Millions)
2a - **Network Ready** at Windfarm Voltage	66 kV	AC	$10
2a - **Network Ready** at Windfarm Voltage	132 kV	AC	$10
2b - **Network Ready** at Higher Voltage	230 kV	AC	$15
2c - **Network Ready** w/HVDC Interlinks	320 kV	DC	$20
2c - **Network Ready** w/HVDC Interlinks	525 kV	DC	$25
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	320 kV	DC	$20
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	525 kV	DC	$25
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	320 kV	DC	$20
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	525 kV	DC	$25
3a - **Pre-Planned Network** at Windfarm Voltage	66 kV	AC	$10
3a - **Pre-Planned Network** at Windfarm Voltage	132 kV	AC	$10
3b - **Pre-Planned Network** w/ AC Switchyard	132 kV	AC	$10
3c - **Pre-planned network** w/ HVDC interlinks	320 kV	DC	$20
3c - **Pre-planned network** w/ HVDC interlinks	525 kV	DC	$25
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	320 kV	N/A	n/a
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	525 kV	N/A	n/a
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	320 kV	N/A	n/a
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	525 kV	N/A	n/a

Table 5-1. Offshore substation cost increase/decrease for each of the different Development Pathways and Design Options.

5.2.2 Cost of helper platform

The total cost estimate for a helper platform in offshore wind network development comprise several key elements, each contributing to the platform's functionality, reliability, and future adaptability. The main cost components are:

Topside: Includes the main deck and superstructure, housing high voltage equipment and auxiliary systems. It also integrates cable hang-off points, J-tubes, and termination hardware to facilitate future interconnections.
Jacket: A steel lattice structure that supports the topside and anchors it to the seabed.
High voltage equipment: Depending on the pathway, this might include transformers, shunt reactors, GIS and DC breakers.
Auxiliary systems: Essential utilities such as heating, ventilation, air conditioning and emergency power systems.

This study used a top-down approach to find the cost of helper platforms (shown in Table 5-2). The costs are based on the above primary components and leverage experience from similar projects of comparable size and complexity.

Development Pathway & Design Option	Interlink Voltage (kV)	Interlink Type (AC or DC)	Helper Platform Cost Per Platform ($ in Millions)
2a - **Network Ready** at Windfarm Voltage	66 kV	AC	n/a
2a - **Network Ready** at Windfarm Voltage	132 kV	AC	n/a
2b - **Network Ready** at Higher Voltage	230 kV	AC	$175
2c - **Network Ready** w/HVDC Interlinks	320 kV	DC	n/a
2c - **Network Ready** w/HVDC Interlinks	525 kV	DC	n/a
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	320 kV	DC	$200
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	525 kV	DC	$250
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	320 kV	DC	$200
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	525 kV	DC	$250
3a - **Pre-Planned Network** at Windfarm Voltage	66 kV	AC	n/a
3a - **Pre-Planned Network** at Windfarm Voltage	132 kV	AC	n/a
3b - **Pre-Planned Network** w/ AC Switchyard	132 kV	AC	$100
3c - **Pre-planned network** w/ HVDC interlinks	320 kV	DC	n/a
3c - **Pre-planned network** w/ HVDC interlinks	525 kV	DC	n/a
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	320 kV	N/A	$175
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	525 kV	N/A	$200
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	320 kV	N/A	n/a
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	525 kV	N/A	n/a

Table 5-2. Helper platform cost for each of the different Development Pathways and Design Options.

5.2.3 Cost of cables

The total estimated cost of submarine cables for offshore wind network development is on a cost-per-mile basis (see Table 5-3) using data from previously executed cable projects. This method provides a transparent and scalable way to budget for cable systems across varying project sizes and distances.

Development Pathway & Design Option	Cable Voltage (kV)	Cable Type (AC or DC)	Installed Cable Cost ($ in Millions / mile)
2a - **Network Ready** at Windfarm Voltage	66 kV	AC	2
2a - **Network Ready** at Windfarm Voltage	132 kV	AC	2.5
2b - **Network Ready** at Higher Voltage	230 kV	AC	3.2
2c - **Network Ready** w/HVDC Interlinks	320 kV	DC	4.5
2c - **Network Ready** w/HVDC Interlinks	525 kV	DC	6.5
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	320 kV	DC	4.5
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	525 kV	DC	6.5
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	320 kV	DC	4.5
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	525 kV	DC	6.5
3a - **Pre-Planned Network** at Windfarm Voltage	66 kV	AC	2
3a - **Pre-Planned Network** at Windfarm Voltage	132 kV	AC	2.5
3b - **Pre-Planned Network** w/ AC Switchyard	132 kV	AC	2.5
3c - **Pre-planned networ**k w/ HVDC interlinks	320 kV	DC	4.5
3c - **Pre-planned networ**k w/ HVDC interlinks	525 kV	DC	6.5
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	320 kV	N/A	4.5
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	525 kV	N/A	6.5
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	320 kV	N/A	4.5
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	525 kV	N/A	6.5

Table 5-3. Cable capacity and cost assumptions by cable type and voltage.

The limitation of the per mile cost assumption is that start-up costs, such as vessel mobilization and initial production, represent a significant percentage of the total cost for short-distance projects. As such, routes with shorter cable lengths may appear more cost effective as a result.

For the purposes of this study, the POINTS Consortium assumes three-core submarine AC cables with an 800 mm² cross-section at 66 kV and 132 kV, which are common dimensions for wind farm array cables interfacing with HVDC platforms. The cost difference between 66 kV and 132 kV primarily results from increased insulation thickness. For 230 kV AC cables, which require an interphase to a separate helper platform, the assumed cross-section is 1,200 mm². The cost increase compared with 132 kV includes cost of conductor material as well as the increased insulation thickness.

For HVDC cables, the study assumed a 2,500 mm^2 cross section for both the 320 kV and 525 kV configurations. This dimension aligns with typical HVDC export cables used from offshore substations to shore. The cost difference between 320 kV and 525 kV cables primarily results from additional insulation thickness and the inclusion of a third conductor, the dedicated metallic return cable for the 525 kV configuration.

Table 5-4 summarizes the estimated cable costs associated with each development pathway. These figures reflect the assumptions outlined in this study, including cable type, voltage level, and cross-sectional dimensions. The table provides a comparative view of cost implications across different pathways.

Development Pathway & Design Option	Interlink Capacity (MW)	Interlink Type (AC or DC)	Cable Cost ($ in Millions)
2a - **Network Ready** at Windfarm Voltage	300	AC	$80
2a - **Network Ready** at Windfarm Voltage	600	AC	$100
2b - **Network Ready** at Higher Voltage	800	AC	$64
2c - **Network Ready** w/HVDC Interlinks	1300	DC	$45
2c - **Network Ready** w/HVDC Interlinks	2000	DC	$65
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	1300	DC	$45
2d - **Network Ready** w/HVDC Interlinks & DC Circuit Breakers	2000	DC	$65
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	1300	DC	$1,350
2e - **Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	2000	DC	$1,950
3a - **Pre-Planned Network** at Windfarm Voltage	300	AC	$8
3a - **Pre-Planned Network** at Windfarm Voltage	600	AC	$10
3b - **Pre-Planned Network** w/ AC Switchyard	1300	AC	$20
3c - **Pre-planned networ**k w/ HVDC interlinks	1300	DC	$5
3c - **Pre-planned networ**k w/ HVDC interlinks	2000	DC	$7
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	1300	N/A	$900
4a - **Multi-Purpose Interconnector** w/ Mid-Point Integration	2000	N/A	$1,300
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	1300	N/A	$450
4b - **Multi-Purpose Interconnector** w/ Dual End-Point Integration	2000	N/A	$650

Table 5-4. Cable capacity and cost assumptions by cable type and voltage.

5.3 Benefit Analysis

To calculate benefits for each development pathway scenario, this study relies on first projecting a “Base Case” future, which will capture a scenario without any additional interregional transmission. To isolate the benefits of interregional transmission, the Base Case assumes the same generation profile across all transmission Development Pathways. The POINTS benefit analysis sources its Base Case from the NLR 2024 Standard Scenarios *High Demand Growth* scenario, with minor adjustments. The POINTS Base Case relies on the scenario’s ‘high demand’ assumptions, in line with current industry expectations of rapidly growing demand.

Some of the key assumptions for the model[10] used for the POINTS Base Case include:

- Start with NLR 2024 Standard Scenarios *High Demand Growth* scenario.

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[10] Presentation reference forthcoming.

- Gas price projections updated by the POINTS team to reflect the latest forecasts, using futures prices for mid-term years, with EIA adjustments beyond 2040.
- No new interregional transmission; interregional transmission is added as described below in the scenarios.
- Peaking capacity added as necessary to the scenario due to removal of interregional transmission.
- Hurdle rates between regions are $1/MWh in this assessment,[11] under the assumption that a future network would pair with a method of more-efficiently dispatching the new investment.

The standard scenario is a zonal model, producing one price per zone per hour for the purposes of this analysis. Most zones within each relevant region have a similar price due to within-regional transmission expansion. This granularity is appropriate when comparing development pathways, focusing on the design of the interlink itself instead of comparing specific points of interconnection ("POI"). Annual prices were interpolated from 2035, 2040, and 2050 model years. Similarly, the study modelled interlinks in sizes of 300MW, 800MW, and 2,000MW with calculated adjustments to reflect benefits of other interlink sizes.

In addition to the production cost benefits of the identified network, the benefits assessment also includes estimates of rescued curtailment attributable to the networked interconnection, and the resource adequacy benefits of the new interregional transmission. Adjustment factors often apply to represent operational experience of offshore AC cables and DC cable and converter station outages to identify the MW of rescued curtailment.[12] The rescued curtailment MW are the equivalent of $100/MWh, which is a conservative estimate for the value of offshore generation. The analysis includes an estimate of resource adequacy benefit of interregional transmission at 50% of the production cost benefits, based on findings from the Atlantic Transmission Study.[13]

To align with identified lower-cost design options, the benefits assessment also sought to identify the benefits of a DC network without DC circuit breakers. The benefits of such a network are discounted by the reduction in flow on the DC network that would be required to remain within single-source limits. That is, in designing and modelling the DC network without circuit breakers, the network facility is disconnected (open) when the sum of the networked offshore generators exceeds the capability of either one of the export cables.[14] This constrains the total flow on the onshore transmission network from the full offshore network (including both offshore wind generators) to be less than the size of one offshore wind generator, and is required because a fault on any portion of the HVDC network without circuit breakers could cause the disconnection of the entire offshore system (and both offshore generators simultaneously). The production cost benefits were therefore discounted by removing the share of benefits that occur when the network was assumed to be disconnected. Notably, this is a relatively small share of overall benefits of the offshore network, which tend to be largest when the offshore generation is relatively low (i.e., enabling additional real-time transfer capability on the network facility not used for delivery of offshore generation to shore).

The annual networking benefits will accrue on a future completion date for the offshore network in the development pathway (e.g., 2035 for pre-planned networks and 2040 for network-ready designs). To calculate the net present value ("NPV") of benefits for different in-service years, the assessment captures 25 years of benefits from the

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[11] Hurdle rates represent the minimum price difference between regions that would have to exist for the model to exchange power.

[12] See, e.g., ENTSO-E, ENTSO-E HVDC Utilisation and Availability Statistics 2024, at Figure 4.2 (June 30, 2025). The rescued curtailment was calculated based on an assumed annual outage rate of 2% for the HVDC export cable and an additional 2% for the converter station.

[13] See, e.g., National Laboratory of the Rockies, Atlantic Transmission Study.

[14] Said differently, for an HVDC network without circuit breakers using a 1300 MW link to connect two 1300 MW windfarms, the link is disabled (opened) in operations when the sum of the output of the two windfarms exceeds 1300 MW.

assumed network service date. That is, for pre-planned networks, the NPV captures 25 years of benefits starting in 2035; for network ready, the NPV captures 25 years of benefits starting in 2040.[15]

In addition to the Base Case high-load scenario described above, the team developed two additional scenarios which provide more conservative benefit estimates. The first alternate case relied on the 2035 modelled benefits escalated by the level of gas price projections over the time horizon. This alternative represents a lower-bound benefit estimate, reflecting a highly unlikely future where decarbonization progress ceases in 2035. The second alternate case provided the model with the option of deploying and operating relatively low-priced peaker plants (compared to a relatively high-cost dispatchable-emissions-free resource deployed in 2040 in the Base Case).

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[15] NPV calculations use an 8% discount rate.

6 BENEFIT-COST ANALYSIS – RESULTS

In this section we provide the results from the cost analysis, the benefits analysis, and the combined Benefit-Cost Analysis.

The results presented in this report focus on the Design Options for the Network Ready Development Pathway: Design Options 2a-2e. The full results (for all Design Options) are available via the associated spreadsheets.

We chose to focus on the results from the Network Ready Design Options as (i) the POINTS Consortium is recommending that the states adopt Network Ready as the default Development Pathway and (ii) the results from the Network Ready Development Pathway played the greatest role in influencing the recommendation to the states to standardize on DC interlinks without DC circuit breakers for the development of offshore interlinks.

6.1 Results from the Cost Analysis

Table 6-1 presents the interlink cost on a per MW basis, as well as interlink capacity on a MW basis, for Design Options 2a-2e. The results in Table 6-1 make it clear that:

- Opportunistic Interlinks (2a-2d) have much lower costs than Longer Interlinks (2e)
- Interlinks without helper platforms (2a and 2c) are much less expensive than comparable interlinks with helper platforms (2b and 2d)
- DC interlinks are less expensive than AC interlinks on a per MW basis (compare 2c and 2a OR 2d and 2b)

	Development Pathway & Design Option	Interlink Cost ($ in Millions/MW, NPV)	Interlink Capacity (MW)
	Opportunistic Interlinks		
2a	Network Ready at Windfarm Voltage – 66 kV	$0.25*	300
	Network Ready at Windfarm Voltage – 132 kV	$0.15*	600
2b	Network Ready at Higher Voltage – 230 kV	$0.39	800
2c	Network Ready w/ HVDC Interlinks – 320 kV	$0.05	1300
	Network Ready w/ HVDC Interlinks – 525 kV	$0.05	2000
2d	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 320 kV	$0.27	1300
	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 525 kV	$0.22	2000
	Longer Interlinks		
2e	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 320 kV	$1.07	1300
	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 525 kV	$0.96	2000

Table 6-1. Interlink cost on a per MW basis and interlink capacity on a MW basis for Design Options 2a-2e. *Indicates that specific engineering solutions are not yet fully known and that helper platforms could up being required, which would meaningfully increase the interlink cost.

6.2 Results from the Benefit Analysis

The results from the benefits assessment include the estimated production cost benefit, resource adequacy benefit, and avoided curtailment benefit of each interlink. The Consortium identified these benefits for the Base Case, a Downside Case (Low-Cost Peaker), and a Worst Case (2035 In Perpetuity) for each Design Option.

Notably, even the Base Case benefits assessment understates the likely future benefits of these interconnectors. Benefits are understated because the model (a) simulates mostly normalized grid conditions (i.e., does not include heat waves, cold snaps, or fuel price spikes associated with many real-world conditions that disproportionately drive transmission value, particularly into ISO-NE); (b) does not consider the impacts of transmission outages (including construction-related transmission outages) that occasionally reduce regional and interregional transfer capabilities; and (c) has perfect foresight of all system conditions (i.e., do not capture the higher costs, including renewable generation curtailments, during unexpected, limiting, real-time market conditions).

Interlink benefit results are presented in $/MW to facilitate easy comparison across the differently sized interlinks.

Generally, the interlinks with less capacity (e.g., 300 MW) tend to have higher $/MW interlink benefit estimates than larger sized interlinks (e.g., 2000 MW). This is because the first MWs of interlink capacity provide greater value than the last few MWs of interlink capacity. As such, $/MW interlink benefit decreases slightly as interlink capacity increases (holding all else equal).

Due to the need to limit the computationally intensive modelling runs, the 1300 MW and 2000 MW HVDC interlinks were modelled once (for the 2000 MW capacity) and thus share the same benefit estimates. Having said that, we expect slightly higher benefits for the 1300 MW interlinks because of the aforementioned decline in benefits with increasing interlink capacity.

As it relates to the interlinking benefits between the two different interfaces, the New England – New York (NE-NY) interface tends to have greater interlinking benefits than the New York – PJM (NY-PJM) interface. For the Base Case and Downside Case using HVAC interlinks, initial benefits in 2035 are larger across the NE-NY interface, with benefits growing larger on the NY-PJM interface by 2050. For the Base Case using HVDC interlinks, greater benefits on the NE-NY interface are present throughout. The Worst Case shows all Design Options to be more beneficial across the NE-NY interface.

		Interlink Benefits: New England – New York ($ in Millions/MW, NPV)		
	Development Pathway & Design Option	**Base Case**	**Downside Case (Low-Cost Peaker)**	**Worst Case (2035 in Perpetuity)**
	Opportunistic Interlinks			
2a	Network Ready at Windfarm Voltage – 66 kV	$4.47	$1.89	$1.11
	Network Ready at Windfarm Voltage – 132 kV	$4.19	$1.75	$1.08
2b	Network Ready at Higher Voltage – 230 kV	$4.00	$1.66	$1.06
2c	Network Ready w/ HVDC Interlinks – 320 kV	$2.35	$0.92	$0.50
	Network Ready w/ HVDC Interlinks – 525 kV	$2.35	$0.92	$0.50
2d	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 320 kV	$2.97	$1.18	$0.62
	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 525 kV	$2.97	$1.18	$0.62

Table 6-2. Benefits Estimate for Opportunistic Interlinks between New England and New York.

For Design Option 2c (HVDC interlinks without DC circuit breakers), the modelling found that the production cost portion of the interlink benefits were reduced by 17% in 2035, 18% in 2040, and 21.5% in 2050 relative to Design Option 2d (HVDC interlinks with DC circuit breakers).

	Development Pathway & Design Option	Interlink Benefits: New York – PJM ($ in Millions/MW, NPV) Base Case	Downside Case: Low-Cost Peaker	Worst Case: 2035 in Perpetuity
	Opportunistic Interlinks			
2a	Network Ready at Windfarm Voltage – 66 kV	$5.15	$2.13	$0.33
	Network Ready at Windfarm Voltage – 132 kV	$4.84	$1.98	$0.29
2b	Network Ready at Higher Voltage – 230 kV	$4.63	$1.88	$0.26
2c	Network Ready w/ HVDC Interlinks – 320 kV	$1.82	$0.71	$0.07
	Network Ready w/ HVDC Interlinks – 525 kV	$1.82	$0.71	$0.07
2d	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 320 kV	$2.29	$0.90	$0.07
	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 525 kV	$2.29	$0.90	$0.07

Table 6-3. Benefits Estimate for Opportunistic Interlinks between New York and PJM.

Interlink benefits were also calculated for 'Longer Interlinks' for Design Option 2e. These 'Longer Interlinks' connected across both the NE-NY and NY-PJM interface and matched the interlink design modelled by NREL (now NRL) in their Atlantic Offshore Wind Transmission Study. The modelled benefits reveal that connecting across both interfaces delivers even larger benefits than connecting across a single interface (compare Design Options 2d and 2e).

	Development Pathway & Design Option	Interlink Benefits: New England – New York – PJM ($ in Millions/MW, NPV) Base Case	Downside Case (Low-Cost Peaker)	Worst Case (2035 in Perpetuity)
	Longer Interlinks			
2e	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 320 kV	$3.94	$2.63	$0.90
	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 525 kV	$3.94	$2.63	$0.90

Table 6-4. Benefits Estimate for Opportunistic Interlinks between New England, New York, and PJM.

6.3 Results from the Benefit-Cost Analysis

Results from the Benefit-Cost Analysis are presented in Table 6-5 (Base Case), Table 6-6 (Downside Case), and Table 6-7 (Worst Case).

	Development Pathway & Design Option	Base Case Benefit-to-Cost Ratio New England to New York	New York to PJM	New England to New York to PJM
	Opportunistic Interlinks			
2a	Network Ready at Windfarm Voltage – 66 kV	18*	21*	Not studied

	Network Ready at Windfarm Voltage – 132 kV	28*	32*	Not studied
2b	Network Ready at Higher Voltage – 230 kV	9	11	Not studied
2c	Network Ready w/ HVDC Interlinks – 320 kV	44	34	Not studied
	Network Ready w/ HVDC Interlinks – 525 kV	49	38	Not studied
2d	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 320 kV	11	8.6	Not studied
	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 525 kV	14	10	Not studied
	Longer Interlinks			
2e	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 320 kV	Not studied	Not studied	3.7
	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 525 kV	Not studied	Not studied	4.1

Table 6-5. Base Case Benefit-to-Cost Ratios. *Indicates that specific engineering solutions are not yet fully known and that helper platforms could be required. If a helper platform is required, it would meaningfully increase interlink cost and decrease the benefit-to cost ratio.

		Downside Case Benefit-to-Cost Ratio		
Development Pathway & Design Option		New England to New York	New York to PJM	New England to New York to PJM
	Opportunistic Interlinks			
2a	Network Ready at Windfarm Voltage – 66 kV	7.6*	8.5*	Not studied
	Network Ready at Windfarm Voltage – 132 kV	12*	13*	Not studied
2b	Network Ready at Higher Voltage – 230 kV	3.9	4.4	Not studied
2c	Network Ready w/ HVDC Interlinks – 320 kV	17	13	Not studied
	Network Ready w/ HVDC Interlinks – 525 kV	19	15	Not studied
2d	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 320 kV	4.5	3.4	Not studied
	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 525 kV	5.4	4.1	Not studied
	Longer Interlinks			
2e	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 320 kV	Not studied	Not studied	2.5
	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 525 kV	Not studied	Not studied	2.7

Table 6-6. Downside Case Benefit-to-Cost Ratios. *Indicates that specific engineering solutions are not yet fully known and that helper platforms could be required. If a helper platform is required, it would meaningfully increase interlink cost and decrease the benefit-to-cost ratio.

		<u>Worst Case</u> Benefit-to-Cost Ratio		
Development Pathway & Design Option		**New England to New York**	**New York to PJM**	**New England to New York to PJM**
	Opportunistic Interlinks			
2a	Network Ready at Windfarm Voltage – 66 kV	4.4*	1.3*	Not studied
	Network Ready at Windfarm Voltage – 132 kV	7.2*	1.9*	Not studied
2b	Network Ready at Higher Voltage – 230 kV	2.5	0.6	Not studied
2c	Network Ready w/ HVDC Interlinks – 320 kV	9.3	1.2	Not studied
	Network Ready w/ HVDC Interlinks – 525 kV	11	1.4	Not studied
2d	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 320 kV	2.3	0.3	Not studied
	Network Ready w/HVDC Interlinks & DC Circuit Breakers – 525 kV	2.8	0.3	Not studied
	Longer Interlinks			
2e	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 320 kV	Not studied	Not studied	0.8
	Network Ready w/ Long HVDC Interlinks & DC circuit breakers – 525 kV	Not studied	Not studied	0.9

Table 6-7. Worst Case Benefit-to-Cost Ratios. *Indicates that specific engineering solutions are not yet fully known and that helper platforms could be required. If a helper platform is required, it would meaningfully increase interlink cost and decrease the benefit-to-cost ratio.

Overall, the BCR results show that:

- Design Option 2c (HVDC Interlinks) offers the highest BCRs across all three benefit scenarios
- Design Options that do <u>not</u> have helper platforms have significantly higher BCRs (2a vs 2b; 2c vs 2d)
- Opportunistic Interlinks have significantly higher BCRs than longer interlinks (as expected)

Further, the BCR results reveal almost entirely favorable BCRs for the Opportunistic Interlink Design Options (2a-2d). The BCR results are:

- Highly favorable (>9) for the Base Case
- Favorable (>4) for the Downside Case
- Modest (>2) for New England to New York for the Worst Case
- Neutral to unfavorable (<2) for New York to PJM for the Worst Case

Having said all of this, it was flagged to the POINTS Consortium at a very late stage that Design Option 2a (AC interlinks at the windfarm cable array voltage) might still require the use of helper platforms. This is not yet definitively known and may not be true for all HVDC suppliers. If true, the observed BCRs for Design Option 2a would fall considerably and be comparable to those of Design Option 2b. This would leave Design Option 2c (DC interlinks without DC circuit breakers as the clear overall winner). It is for this reason that we have added an asterisk after the BCR results for Design Option 2a.

7 RISK ASSESSMENT FRAMEWORK FOR OFFSHORE TRANSMISSION

This evaluation examined three Development Pathways to address the identified challenges, recognizing that a uniform approach may not be feasible given the differing policy objectives of individual states and the conditions present at the time of solicitation. The assessment intended to establish a structured framework through which decision-makers can evaluate potential benefits and tradeoffs in the context of state-specific objectives for each Development Pathway. The design of the Risk Assessment Framework supports state decision-making while accounting for evolving regulatory, political, and industry conditions, and over time as those conditions change.

Each Development Pathway presents distinct implications for practical implementation. Key considerations include total project cost; allocation of initial versus future costs; stranded asset risk; regulatory approval requirements; acceptance by RTOs; technology readiness and advancement; and political and policy feasibility. In response to these considerations, the Consortium developed a set of evaluation criteria to support state energy officials in assessing transmission planning strategies and informing long-term grid development decisions.

A comprehensive assessment must also consider the overall feasibility of constructing and operating the project as envisioned, including factors that are not readily quantifiable and therefore require qualitative evaluation. For example, risks associated with the pace of HVDC equipment interoperability development—necessary to ensure commercial availability within a defined timeframe—are best assessed qualitatively. Similarly, the likelihood of obtaining timely and coordinated approvals from multiple ISOs or RTOs for offshore generation projects with interconnections spanning multiple markets requires qualitative risk assessment.

7.1 Categories Considered in the Assessment Framework

The following table presents the criteria to assess the costs and benefits, the risks and challenges, and the supply chain impacts of the development options for achieving interlink capability. Both state and industry experts provided input during the development of the risk assessment framework on the different challenges of developing transmission projects and how the implementation approach impacts project risk. Table 7-1 below provides an overview of the assessment criteria.

Development Pathways				
Project Description	Radial OSW	Network-Ready	Pre-Planned Network	Multi-purpose Interconnector
Benefit/Risk Category				
Project Cost	Baseline	Size and timing of Initial Capex vs Future Capex Ability to optimize individual project design, potential cost impact to future projects Potential for federal (DOE) funding and/or tax credits		
Interregional Transmission Capability		Ability to interconnect two POIs (either interregionally or intra-regionally) Enables a future offshore network for future offshore connections		
Project Delivery Risk		Technical viability Supply chain implications, e.g. commercial viability, major equipment lead times. Project on project risks, including coordination required between projects.		
Regulatory Project Complexity		Feasibility of RTO acceptance and time to complete Feasibility of BOEM approvals and time to complete Coordination of state procurement processes Coordination required between ISO/RTOs Potential to utilize state sponsored transmission process via RTO tariff processes		
Funding Mechanism		OSW State Procurement Potential to utilize state sponsored transmission process via RTO tariff processes		
OSW Procurement Competitiveness		Limits or enables competitiveness between offshore wind developers,(proximity of potential offshore POIs to wind lease areas)		
Political Viability		Challenge of state-to- state coordination Variation of state energy polices and viability of cost commitment to long term investment Challenge of state to federal coordination		

Table 7-1. Risk Assessment Framework

Project Cost: The Project Cost category considers the size and timing of initial capital expenditures that would be necessary versus future capital expenditures to enable interlinking. This criterion considers other factors such as a developer's ability to optimize individual project design, potential cost impact to future projects, and the potential to obtain federal funding or tax credits for the project.

Interregional Transfer Capability: The Interregional Transfer Capability category evaluates the project's ability to interconnect two points of interconnect either inter-regionally or intra-regionally. This category assesses whether a project has the capacity to enable a future offshore network for future offshore connections.

Project Delivery Risk: The Project Delivery Risk category assesses the technical viability of an OSW project. It considers supply chain implications such as commercial viability and major equipment lead times. The standard measures project-on-project risks, including the coordination required between projects.

Regulatory Project Complexity: The Regulatory Project Complexity category measures the feasibility of Regional Transmission Organizations (RTO) accepting an OSW project and the coordination between RTOs for an OSW project.

Funding Mechanism: The Funding Mechanism category analyzes OSW state procurement options for projects. In addition, this category evaluates a project's potential use of a state sponsored transmission process via RTO tariff processes.

OSW Procurement Competition: The OSW Procurement Competition category examines the competition between OSW developers by the proximity of potential points of interconnect to offshore lease areas.

Political Viability: The Political Viability category assesses the challenge of state-to-state coordination. The category evaluates the variation of state energy policies and viability of cost commitment to long term investment and the challenge of state to federal coordination.

7.2 Timing Considerations in the Risk Assessment Framework

For each Development Pathway, the framework establishes assumptions for completed work during the initial project phase and work deferred to future phases. Assumptions such as work deferred are inherent to options such as the Network Ready and Multi-Purpose Interconnector Pathways. In contrast, the Pre-Planned Network Pathway allows all work completion during the initial project phase.

Phased development, as compared to concurrent network development, presents distinct challenges at different stages of the project. In particular, obtaining regulatory approvals and achieving certainty in the interconnection process are especially complex for offshore network configurations. The network stage timing can defer or accelerate depending on the need to resolve open issues.

Accordingly, the risk assessment criteria evaluated for both the initial and future phases of each Development Pathway to clarify not only the nature of the risks involved, but also the timing at which the project may be exposed to those risks.

7.3 Results from the Risk Assessment Framework

Each Development Pathway presents distinct opportunities and trade-offs, primarily related to the timing of development activities and the regulatory, technical, and market hindrances that need to be overcome at each project stage. The states’ overarching objective is to advance offshore wind development in a cost-effective and practical manner that ultimately enables offshore networked transmission. Achieving this objective can unlock economic benefits sufficient to justify the capital investment required to interconnect offshore platforms.

Regardless of the selected Development Pathway, realization of networked transmission will require resolution of regulatory and RTO process issues; however, the timing and sequencing of these efforts vary by pathway. In addition, the chosen development approach may influence the extent to which certain benefits—such as interregional power flows—can be realized and how well the pathway aligns with evolving political and policy conditions. Figure 7.1 and the following section summarize the key findings of the risk assessment of the Development Pathways.

Summary of Findings of Risk Assessment

Development Pathway	Risk Assessment
Radial	• Straightforward conventional design • Least risk overall • Minimizes investment per project • Least opportunity for future interlinking
Network Ready	• Straightforward conventional design • Defers networking to future years, deferring regulatory and permitting risk • Risks stranded investment and future incompatibility
Pre-Planned Network	• Ensures networked facilities are technologically compatible at outset • Addresses regulatory and permitting risks upfront • Provides opportunity to optimize design as a network • May result in a more onerous process to complete the projects
Multi-Purpose Interconnector	• Ensures onshore converter systems are technically compatible. • Initial capital cost may be significant for long distance interconnector • Requires state coordination on technical requirements and cost allocation • Potential to create an offshore POI • Defers resolution with offshore interconnection

Figure 7.1. Summary of Risk Assessment Findings

7.3.1 Radial

Overall, the favored approach to offshore generation development has been radial projects, with a few states implementing a Network Ready design. Radial projects face the least risk in that they follow conventional development and interconnection processes. States may customize each project to optimize its lease location, POI choice, technology choice and schedule. This approach, however, precludes it from being economically interconnected in the future to leverage the initial capital investment for realizing other benefits from a more interconnected offshore grid.

7.3.2 Network Ready

Several states have already begun to implement a Network Ready Development Pathway as practical low cost first step to prepare for future interlinking of platforms. Similar to the Radial Development Pathway, Network Ready projects face low risk in initial development phase as they follow conventional development and interconnection processes. States may design each project to optimize around its lease location, POI choice, technology choice and schedule while incorporating relatively modest anticipatory investment. The Network Ready approach defers the both the larger capital investment and resolution of regulatory issues of networking until a future date. The approach leaves open the opportunity of the initial anticipatory investment being incompatible with neighboring projects or simply unused as at some locations that are not interconnected.

7.3.3 Pre-Planned Network

The Preplanned Network Development Pathway involves developing the network and one or more offshore generation projects at the outset, thus ensuring technical compatibility and interregional transmission capability with the initial installation. This approach accelerates the need to resolve the regulatory uncertainties with offshore interregional tie line with offshore POIs for generation, which would be a first of its kind interconnection in each of the northeast RTOs. State-to-state coordination will be resource-intensive to reach consensus on aspects such as scope, cost allocation, and timing. Coordinating with the affected RTOs on transmission planning processes also presents an important consideration when assessing this pathway in the context of a particular state's goals.

7.3.4 Multi-Purpose Interconnector

The Multi-Purpose Interconnector Development Pathway is a phased approach to development that allows the initial project, the interconnector, to be built following relatively conventional interconnection and planning processes. The development of the interconnector as an interregional tie line first establishes the interregional or intra-regional network facility and creates the opportunity to connect future offshore generation projects to the interconnector. This approach could require significant capital investment, depending on the distance between onshore POIs. Developing an interregional tie line would likely require significant state coordination to reach consensus on cost allocation, scope and schedule. This approach does assure compatibility with equipment, provides an offshore POI, partially defers risk associated with offshore interconnection of a generation project.

7.4 Risk Assessment Executive Summary

The table below summarizes the risk assessment of the Development Pathways based on the categories laid out in the Assessment framework. For each category, as discussed above, we considered the issues through the timing lens as the timing of the work affects when some issues would need to be addressed or can be deferred. The details of the risk assessment by subcategory are provided in the appendix.

The Risk Assessment findings, which consider many factors, also reflect a snapshot in time. The risk determinations in this report are subject to change as the industry evolves, as the transmission technology advances, as RTO processes evolve, and as the political landscape changes. This assessment is a living document intended for periodic review and revisions to consider the present risks and impacts and their impacts on the development pathway at that time.
Details of the rationale for the specific categories can be found in Additional Results from the Cost Analysis.

APPENDIX A provides expanded detail on the cost assumptions, design variations, and analytical considerations that support the report's conclusions. The purpose of APPENDIX A is to:

- Summarize total cost and cost per capacity metrics across the Design Options.
- Highlight the cost drivers associated with helper platforms, interlink cable lengths, voltage levels, and HVDC/AC configurations.
- Support greater understanding of the cost results.

Readers should refer to the report for broader context, methodology, design descriptions, and system diagrams.

Detailed Risk Assessment in APPENDIX B.[16]

Development Pathways Risk Assessment								
Project Description	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
Risk Category	Initial	Future	Initial	Future	Initial	Future	Initial	Future
Project Cost	Low	NA	Low	Med	Med	NA	Med	Low
Interregional Transmission Capability	NA	NA	NA	Med	Med	NA	Low	Low
Project Delivery Risk	Low	NA	Med	Med	Med	NA	Low	Med
Regulatory Project Complexity	Low	NA	Low/M	High	High	NA	Med	Med
Funding Mechanism	Low	NA	Low	Low	Med	NA	High	Low
OSW Procurement Competitiveness	Low	NA	Low	NA	Med	NA	NA	Low
Political Viability (1)	Med	NA	Med	Med/H	Med/H	NA	Med/H	Med

(1) The current landscape is characterized by rapidly evolving energy policies. Given the shifting landscape surrounding offshore generation, it is essential to periodically re-evaluate the context at key milestones throughout development of an energy project.

Table 7-2. Risk Assessment Summar

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[16] The risk assessment findings reflect an initial determination and may be revised, pending further feedback from the Consortium participants and state representatives.

8 TAKEAWAYS FOR TRANSMISSION STANDARDIZATION

Through the techno-economic analysis contained in this report and through meetings of the POINTS Consortium three key takeaways for offshore transmission standardization emerged:

1. Opportunistic Interlinks exhibit Benefit-to-Cost ratios up to 25-fold and should be a near-term focus for offshore transmission infrastructure investments
2. DC Interlinks without DC Circuit Breakers are an attractive alternative to AC interlinks
3. Network Ready can be the default Development Pathway; but it should not be the only Development Pathway

The following sections discuss each of these key takeaways.

8.1 Opportunistic Interlinks exhibit Benefit-to-Cost ratios up to 25-fold and should be a Near-Term Focus

The work of the POINTS Consortium further validated and refined existing thinking[17] regarding the value of Opportunistic Interlinks.

Most notably, the POINTS Consortium demonstrated that Opportunistic Interlinks are likely to have higher B/C ratios for the Development Framework and Design Options considered. For example, compare the B/C ratios presented for Design Option 2d with those for Design Option 2e. The reason Opportunistic Interlinks have more favorable B/C ratios is the short interlinking distances and thus their dramatically lower cable costs.

Having drawn this conclusion, it is worth noting that if states were ultimately able to co-plan and co-fund an offshore transmission network (which is not a Development Framework that makes sense to consider today), then there are additional benefits that could be provided through longer offshore interlinks that may help to narrow the gap in the B/C ratios.[18]

Additionally, the POINTS Consortium refined the notion of Opportunistic Interlinks to focus on the creation of interregional interlinks between two offshore substations. Previously, Opportunistic Interlinks constructs have focused on the creation of short distance interlinks (which may or may not be interregional) and the coupling of more than two offshore substations. By focusing on the creation of interregional interlinks involving only two offshore substations, the POINTS Consortium sought to maximize the B/C ratios of the interlinks while minimizing project risk and complexity.

8.2 DC Interlinks without DC Circuit Breakers are an Attractive Alternative to AC Interlinks

The POINTS Consortium demonstrated that DC Interlinks without DC Circuit Breakers are an attractive alternative to AC interlinks.

The B/C ratios of DC interlinks are modestly higher than the B/C ratios of AC interlinks. For example, compare the B/C ratios of Design Option 2c (DC interlinks without DC Circuit Breakers) with those of Design Option 2a (AC interlinks at the windfarm voltage).

The key advantage of DC interlinks is that DC interlinks have had greater technical risk reduction than AC interlinks, as the HVDC suppliers have repeatedly stated. Two additional advantages of DC interlinks are that: (1)

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[17] Existing thinking around the creation of Opportunistic Interlinks is probably best represented by NY's Mesh-Ready requirements and NJ's OTN requirements, as well as the concept of 'W' networks that Brattle has proposed.

[18] The main benefit would be the ability to increase the utilization of the offshore transmission network by designing a network where the offshore wind generation capacity exceeded the offshore transmission network capacity on a nameplate capacity basis but not on a capacity-factor basis.

they do not have the same distance limitations of AC interlinks; and (2) their cost increase slower than the cost of AC interlinks as the interlink distance increases.

The temporary disadvantage of DC interlinks is that they require multi-vendor interoperability between HVDC converters. While this is sometimes perceived as a large barrier to the use of DC interlinks, there are two reasons this is not the case. First and foremost, the InterOPERA project in Europe is actively working to develop multi-vendor interoperability between HVDC converter suppliers. While an exact date for interoperability has not been set, it is reasonable to expect that interoperability will be possible starting around 2035, which aligns well with the likely development timeline of future offshore transmission infrastructure in the United States. Second, the limited number of HVDC converter suppliers (three main suppliers) means that there is a good chance that converters from the same supplier will be located sufficiently close to one another offshore to enable cost-effective interlinking.

8.3 Network Ready Can Be the Default Development Pathway; but it Should Not Be the Only Development Pathway

The results presented in this report make a compelling case that Network Ready can be the default Development Pathway used by states in their offshore wind solicitations AND that the Pre-Planned Network and Multi-Purpose Interconnector Development Pathways have considerable merits and should be allowed options in offshore wind solicitation processes.

The Network Ready Development Pathway can be the default Development Pathway in offshore wind solicitations for several reasons. First and foremost, it represents minimal additional spend over the Radial Development Pathway. The initial costs of the Network Ready Development Pathway are between $10 and $20 million per offshore substation (please see Design Options 2a and 2c and note that the initial costs reported above are for an offshore network with two offshore substations). Second, the Network Ready Development Pathways allows the construction of the interlink to be delayed until there is a favorable B/C ratio for the interlink. Please note, the cost-benefit modelling results presented here do not indicate that such a delay is needed.[19] Third, while none of the Development Pathways are risk free, the risks facing the Network Ready Development Pathway are in aggregate no higher (and potentially slightly lower) than the risks in aggregate facing the Pre-Planned Network and Multi-Purpose Interconnector Development Pathways. Finally, the Network Ready Development Pathway is already in use by two of the states in the NE States Collaborative.

In offshore solicitation processes, the Pre-Planned Network Development Pathway should be a permissible option for several reasons. First, it is simple change in offshore wind solicitations to allow developers to submit optional bids for an offshore transmission system comprising two or more windfarms and their associated interlink(s). Second, the Pre-Planned Network Development Pathway addresses one of the key concerns raised by the HVDC converter suppliers during the POINTS Consortium: the Network Ready Development Pathway has inherent technical compatibility risks, whether with AC interlinks or with DC interlinks. The HVDC converter compatibility risks are due to the manufacturer’s lack of complete knowledge of the future offshore transmission system. Third, the Pre-Planned Network Development Pathway will result in the lowest cost interlinks. This is because the developers and equipment suppliers will be able to optimize the design and installation of the offshore windfarms and the interlink(s) based on knowledge of the complete offshore transmission network. Finally, the Pre-Planned Network Development Pathway shares largely the same risks as the future state of the Network Ready Development Pathway.

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[19] The cost-benefit modelling results presented here show favorable B/C ratios starting in 2035 (i.e., at roughly the earliest time windfarms without an existing offtake contract would be coming online in the United States).

If possible, offshore wind solicitations should include the Multi-Purpose Interconnector Development Pathway as an option based upon its design flexibility. Design Option 4b provides one example of a Multi-Purpose Interconnector where the offshore wind farms and the associated HVDC transmission could be built first and then later connected by an interconnector between their onshore HVDC converters. This method offers the most straightforward way for the Multi-Purpose Interconnector to be optionally bid into offshore wind solicitation processes. Overall, the design flexibility inherent to the Multi-Purpose Interconnector Development Pathways makes it challenging to offer generalizations about Multi-Purpose Interconnectors, as well as broad comparisons with the other Development Pathways. Therefore, the design flexibility of Multi-Purpose Interconnectors will add increasing value as interlinks distances get longer and as the available Opportunistic Interlink options decrease.

8.4 Additional Takeaways

Three additional takeaways for offshore transmission standardization are worth noting:

1. Spare cable bays are critical to interlinking efforts
2. AC Interlinks should be at the windfarm cable array voltage
3. Multi-vendor interoperability is progressing and can be further nurtured by the NE States Collaborative

8.4.1 Spare Cable Bays are Critical to Interlinking Efforts

In developing the Design Options for consideration, the space available for the addition of cable bays to connect interlink cables emerged as a key design consideration.

If states proceed forward with Network Ready as the default Development Pathway, then states (or a consultant to them) should work with the HVDC converter suppliers to determine the number of cables bays that could be dedicated to the creation of interlinks without exceeding key weight thresholds.[20] Further, since AC cable bays and DC cable bays are not interchangeable, it must be determined how many AC cable bays would be available for interlinking (if AC interlinks were used) AND how many DC cable bays would be available for interlinking (if DC interlinks were used).

The working hypothesis for this report was that ***either*** four AC cable bays ***or*** one DC cable bay[21] would be available for interlinking offshore substations (320 kV, HVDC substations).

8.4.2 AC Interlinks Should be at the Windfarm Cable Array Voltage

Through its techno-economic analysis the POINTS Consortium demonstrated that AC interlinks at the windfarm cable array voltage are a more cost-effective solution with similar interlinking capacity than AC interlinks at voltages higher than the windfarm cable array voltage (e.g., 230 kV). This can be readily seen by comparing the interlinking cost on a $/MW basis for Design Options 2a and 2b. Further, interlinking at the windfarm cable array voltage reduces project complexity and supply chain risk by eliminating the need for helper platforms to hold the AC transformation equipment.

While interlinking distances longer than twenty miles could start to favor the use of AC interlinks with voltages higher than the windfarm cable array voltage (from a cost perspective), these AC interlinks would cost significantly more

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[20] As discussed in the Offshore Transmission Review produced by the POINTS Consortium, there are weight limitations for offshore substations created by a highly limited number of transportation and installation vessels (roughly four vessels available globally that can be used for the installation of 320 kV HVDC offshore substations).

[21] But not both AC cable bays and a DC cable bay

than DC interlinks. DC interlinks are already a less expensive option for short distances (compare Design Options 2a and 2b with Design Option 2c) and the cost of DC interlinks rises more slowly than the cost of AC interlinks as the interlinking distance increases.

For this reason, the POINTS Consortium recommends that states in the NE States Collaborative remove requirements for AC interlinks to interlink at a voltage higher than the windfarm cable array voltage, as called out in the next section of the report.

8.4.3 Multi-Vendor Interoperability is Progressing and Can be Further Nurtured by the NE States Collaborative

The InterOPERA project in Europe has done considerable work to advance multi-vendor interoperability between HVDC converter vendors. InterOPERA is currently slated to end in 2027. The four German transmission system operators have a cooperation framework with the main three HVDC converter vendors to advance interoperability. At the same time, no firm dates and/or requirements for multi-vendor interoperability yet exist. The NE States Collaborative could lend support to these existing multi-vendor interoperability efforts by setting a target goal for all projects delivered after 2040 to have multi-vendor interoperability.

9 RECOMMENDATIONS TO THE NORTHEAST STATES COLLABORATIVE

The co-leads of the POINTS Consortium developed the following recommendations based upon internal technical and economic studies, the industry's need to minimize near-term costs and project risks, and feedback from the Consortium members. The recommendations have two distinct time periods:

1. **Immediate (actions that can be taken today)**
2. **Near-Term (actions to be taken before 2030)**

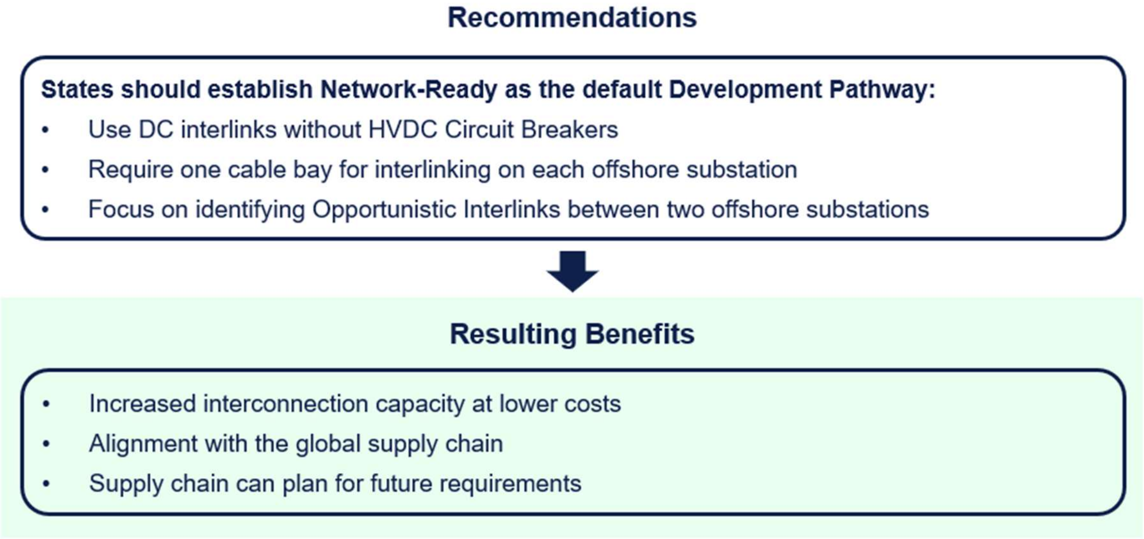
The following sections detail standardization recommendations for the states.

9.1 Immediate, No Cost and No Regret, Recommendations:

In the immediate future, should states establish Network Ready as the default Development Pathway.

Further, states should adopt DC interlinks without DC circuit breakers as the baseline configuration for Network Ready. This would require one DC cable bay to be available for interlinking on each offshore substation. Notably, this baseline configuration (DC interlinks without DC circuit breakers) can be readily extended to include DC circuit breakers through the addition of a helper platform(s) should DC circuit breakers be desired and cost-effective.

As a result of the above recommendations, states will likely realize the following benefits: 1) increased interconnection capacity at lower costs and with higher Benefit-to-Cost ratios, 2) alignment with the global supply chain, and 3) advanced notice to the supply chain of states' standardization requirements.



Recommendations

States should establish Network-Ready as the default Development Pathway:

- Use DC interlinks without HVDC Circuit Breakers
- Require one cable bay for interlinking on each offshore substation
- Focus on identifying Opportunistic Interlinks between two offshore substations

Resulting Benefits

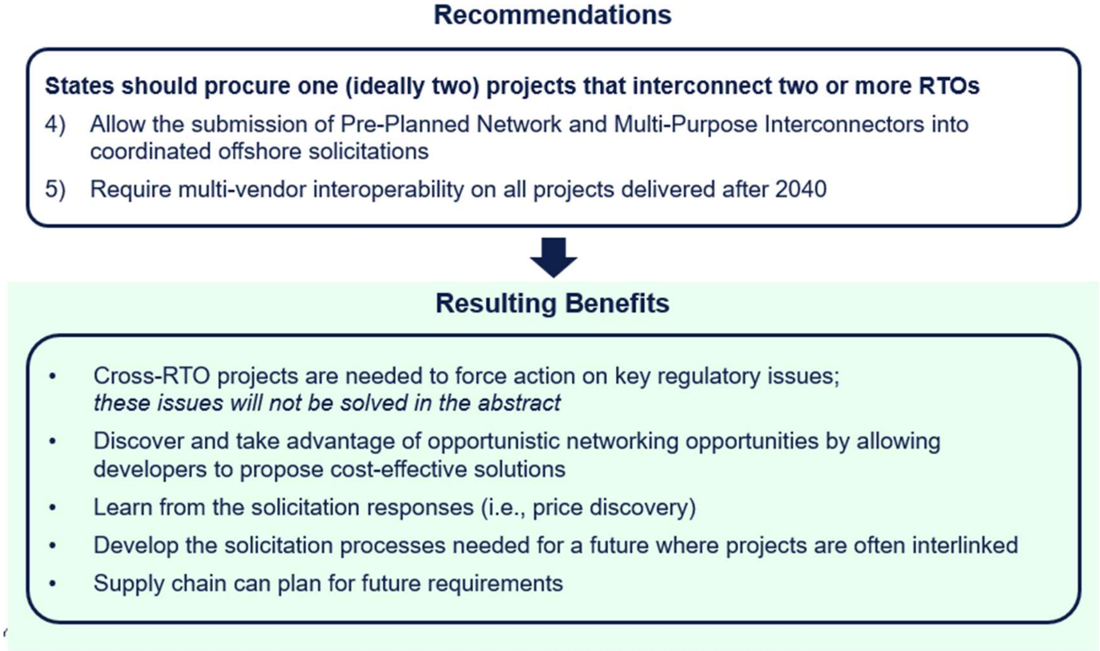
- Increased interconnection capacity at lower costs
- Alignment with the global supply chain
- Supply chain can plan for future requirements

Figure 9.1. Immediate Recommendations and their Resulting Benefits

9.2 Near-Term Recommendations

Between present day and 2030, the POINTS Consortium recommends that states should consider procuring at least one project, ideally two projects, that interconnect two or more RTOs. Further, states should allow for bidders to submit Pre-Planned Networks and Multi-Purpose Interconnectors into coordinated offshore solicitations. Lastly, the transmission project bidding process should require multi-vendor interoperability on all projects delivered after 2040.

As a result of implementing these recommendations, states will likely need to force action on key regulatory issues that cannot be resolved in the abstract. State governments will also discover and take advantage of opportunistic networking opportunities by allowing developers to propose cost-effective solutions. By implementing solicitation processes for these transmission projects, states will have the opportunity to learn from solicitation responses and solidify transmission solicitation for standard interlink locations. By establishing and regulating solicitation processes, states can assist the industry to prepare and plan for future requirements and development opportunities.



Recommendations

States should procure one (ideally two) projects that interconnect two or more RTOs

4) Allow the submission of Pre-Planned Network and Multi-Purpose Interconnectors into coordinated offshore solicitations
5) Require multi-vendor interoperability on all projects delivered after 2040

Resulting Benefits

- Cross-RTO projects are needed to force action on key regulatory issues; *these issues will not be solved in the abstract*
- Discover and take advantage of opportunistic networking opportunities by allowing developers to propose cost-effective solutions
- Learn from the solicitation responses (i.e., price discovery)
- Develop the solicitation processes needed for a future where projects are often interlinked
- Supply chain can plan for future requirements

Figure 9.2. Near-Term Recommendations and their Resulting Benefits

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APPENDIX A. ADDITIONAL RESULTS FROM THE COST ANALYSIS

APPENDIX A provides expanded detail on the cost assumptions, design variations, and analytical considerations that support the report's conclusions. The purpose of APPENDIX A is to:

- Summarize total cost and cost per capacity metrics across the Design Options.
- Highlight the cost drivers associated with helper platforms, interlink cable lengths, voltage levels, and HVDC/AC configurations.
- Support greater understanding of the cost results.

Readers should refer to the report for broader context, methodology, design descriptions, and system diagrams.

Total Platform Cost

As detailed in DESIGN OPTIONS FOR DEVELOPMENT PATHWAYS, the required number of offshore platforms varies by Design Option. This is of critical importance as offshore platforms are large and complex steel structures that are expensive to manufacture and install, making them significant contributors to the cost of an interlink.

Table 1 presents the number of platforms associated with each Design Option. Table 2 provides a cost overview for offshore platforms across Design Options. The cost review shows that while modifications to the main HVDC platforms have modest cost impacts, the addition of helper platforms results in large increases in total platform cost.

	Development Framework and Design Option	# of Main Platforms	# of Helper Platforms	Total # of Offshore Platform Installations
2a	**Network Ready** at Windfarm Voltage	2	0	2
	Network Ready at Windfarm Voltage	2	0	2
2b	**Network Ready** at Higher Voltage	2	2	4
2c	**Network Ready** w/HVDC Interlinks	2	0	2
	Network Ready w/HVDC Interlinks	2	0	2
2d	**Network Ready** w/ HVDC Interlinks & DC Circuit Breakers	2	2	4
	Network Ready w/ HVDC Interlinks & DC Circuit Breakers	2	2	4
2e	**Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	3	3	6
	Network Ready w/ LONG HVDC Interlinks & DC Circuit Breakers	3	3	6
3a	**Pre-Planned Network** at Windfarm Voltage	2	n/a	2
	Pre-Planned Network at Windfarm Voltage	2	n/a	2
3b	**Pre-Planned Network** w/ AC Switchyard	2	1	3
3c	**Pre-planned network** w/ HVDC interlinks	2	n/a	2
	Pre-planned network w/ HVDC interlinks	2	n/a	2
4a	**Multi-Purpose Interconnector** w/ Mid-Point Integration	n/a	1	1
	Multi-Purpose Interconnector w/ Mid-Point Integration	n/a	1	1
4b	**Multi-Purpose Interconnector** w/ Dual End-Point Integration	n/a	n/a	0
	Multi-Purpose Interconnector w/ Dual End-Point Integration	n/a	n/a	0

Table 1. Number of platforms associated with the different Design Options.

	Development Framework and Design Option	Main Platform Cost Delta ($ in millions)	Helper Platform Cost ($ in millions)	Total Additional Platform Cost ($ in millions)
2a	**Network Ready** at Windfarm Voltage	$20	n/a	$20
	Network Ready at Windfarm Voltage	$20	n/a	$20
2b	**Network Ready** at Higher Voltage	$30	$350	$380
2c	**Network Ready** w/HVDC Interlinks	$40	n/a	$40
	Network Ready w/HVDC Interlinks	$50	n/a	$50
2d	**Network Ready** w/ HVDC Interlinks & DC Circuit Breakers	$40	$400	$440
	Network Ready w/ HVDC Interlinks & DC Circuit Breakers	$50	$500	$550
2e	**Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	$60	$600	$660
	Network Ready w/ LONG HVDC Interlinks & DC Circuit Breakers	$75	$750	$825
3a	**Pre-Planned Network** at Windfarm Voltage	$20	n/a	$20
	Pre-Planned Network at Windfarm Voltage	$20	n/a	$20
3b	**Pre-Planned Network** w/ AC Switchyard	$20	$100	$120
3c	**Pre-planned networ**k w/ HVDC interlinks	$40	n/a	$40
	Pre-planned network w/ HVDC interlinks	$50	n/a	$50
4a	**Multi-Purpose Interconnector** w/ Mid-Point Integration	n/a	$175	$175
	Multi-Purpose Interconnector w/ Mid-Point Integration	n/a	$200	$200
4b	**Multi-Purpose Interconnector** w/ Dual End-Point Integration	n/a	n/a	n/a
	Multi-Purpose Interconnector w/ Dual End-Point Integration	n/a	n/a	n/a

Table 2. Platform cost for the different Design Options

Total Cable Cost

Cable cost is the most distance-sensitive component in all evaluated Design Options. While platform-related costs depend primarily on functionality and capacity requirements, cable cost scales closely with interlink length.

This distinction becomes clear when comparing the cable costs of the Network Ready and Pre-Planned Network Design Options. The very short interlink distance assumed in the Pre-Planned Network options results in cable costs that are only a fraction of those seen in the Network Ready configurations.

Design Options with long interlinks (e.g., 2e, 4a and 4b) demonstrate how quickly cable cost can escalate. These Design Options will make the most sense to consider as the potential to create Opportunistic Interlinks is depleted. These Longer Interlink options should also be seen as potential substitutes for long distance onshore or offshore interregional transmission infrastructure.

	Development Framework and Design Option	Interlink Distance (Miles)	Interlink Capacity (MW)	Cable Type (AC/DC)	Cable Voltage (kV)	# of Interlink Cables	Cable Cost ($ in Millions)
2a	**Network Ready** at Windfarm Voltage	10	300	AC	66	4	80
	Network Ready at Windfarm Voltage	10	600	AC	132	4	100
2b	**Network Ready** at Higher Voltage	10	800	AC	230	2	64
2c	**Network Ready** w/HVDC Interlinks	10	1,300	DC	320	1	45
	Network Ready w/HVDC Interlinks	10	2,000	DC	525	1	65
2d	**Network Ready** w/ HVDC Interlinks & DC Circuit Breakers	10	1,300	DC	320	1	45
	Network Ready w/ HVDC Interlinks & DC Circuit Breakers	10	2,000	DC	525	1	65
2e	**Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	300	1,300	DC	320	1	1,350
	Network Ready w/ LONG HVDC Interlinks & DC Circuit Breakers	300	2,000	DC	525	1	1,950
3a	**Pre-Planned Network** at Windfarm Voltage	1	300	AC	66	4	8
	Pre-Planned Network at Windfarm Voltage	1	600	AC	132	4	10
3b	**Pre-Planned Network** w/ AC Switchyard	1	1,300	AC	132	9	20
3c	**Pre-planned networ**k w/ HVDC interlinks	1	1,300	DC	320	1	5
	Pre-planned network w/ HVDC interlinks	1	2,000	DC	525	1	7
4a	**Multi-Purpose Interconnector** w/ Mid-Point Integration	200	1,300	DC	320	1	900
	Multi-Purpose Interconnector w/ Mid-Point Integration	200	2,000	DC	525	1	1,500
4b	**Multi-Purpose Interconnector** w/ Dual End-Point Integration	100	1300	DC	320	1	450
	Multi-Purpose Interconnector w/ Dual End-Point Integration	100	2000	DC	525	1	650

Table 3. Cable Cost for the different Design Options

Total Cost of Interlink

The total cost of the interlink, shown in Table 4, is the sum of the offshore cable and platform costs that were presented in Table 2 and Table 3.

Key takeaways include:

- Opportunistic Interlinks exhibit significantly lower interlink costs than Longer Interlinks due to their significantly lower cable costs.
- Design Options that do not require helper platforms have significantly lower interlink costs than Design Options that require helper platforms
- The additional cost of a helper platform becomes less impactful for Longer Interlinks (because of the high cable costs) and may be justified when developing Longer Interlinks due to the increase operational uptime that would be enabled.

The portion of total cost of the interlink associated with offshore platform infrastructure increases significantly when additional helper platforms are included. When Design Options can rely on existing HVDC platforms, required modifications are minor and relatively cost-effective. Conversely, concepts requiring entirely new platforms introduce higher structural complexity and capital expenditure. As an example, the inclusion of offshore DC circuit breakers in Design Option 2d enables the interlink to be operated across all operational states for the offshore wind farms (i.e., when the average offshore wind capacity factor exceeds 50%), but results in substantial additional platform cost when compared with Design Option 2c (which can only operate when the offshore wind capacity factor is less than 50%).

The Pre-Planned Network Design Options (3a–3c) exhibit lower cable costs than their Network Ready counterparts (2a–2d) due to the very short distance between the HVDC platforms (1 mile versus 10 miles, respectively). However, positioning the HVDC platforms adjacent to one another increases the total length of inter-array cables required to connect each wind farm to both platforms. This additional inter-array cable cost is an important consideration, as it may offset some of the savings achieved by reducing the interlink length. In some cases, the additional inter-array cabling causes the Network Ready option to be more economical overall. Ultimately, the optimal design solution will be project specific for projects developed using the Pre-Planned Network Development Framework.

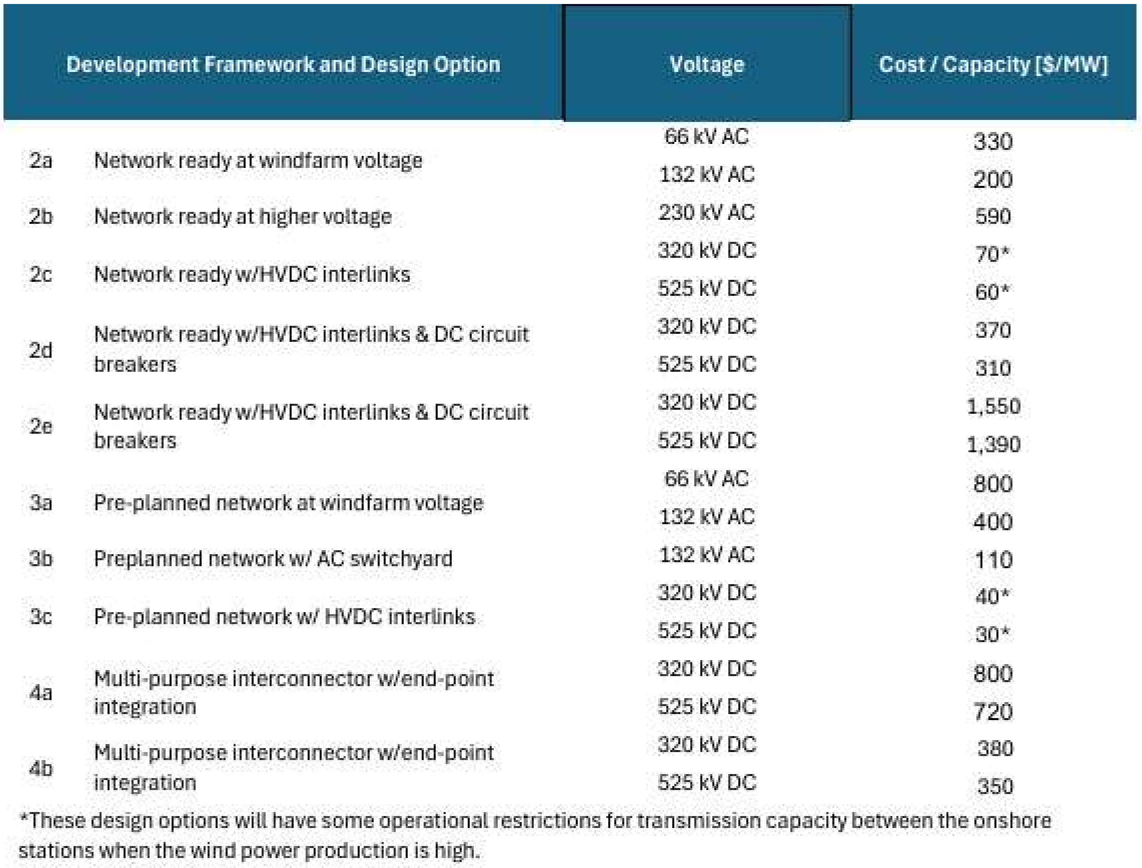
Finally, it is worth noting that not all costs occur at the initial stage. Several Design Options distribute investment across multiple phases, allowing for lower initial commitments and deferring significant expenditures until future interconnections are required. The complete analysis conducted by the POINTS Consortium accounts for this by calculating and comparing costs on a net present value (NPV) basis. For ease of comprehension, we have presented total costs here (before adjusting to an NPV basis). Costs on an NPV basis can be found in the associated workbook.

	Development Framework and Design Option	Initial Interconnector Cost ($ in Millions)	Future Interconnector Cost ($ in Millions)	Future Export Cable Cost Savings ($ in Millions)	Future Converter Cost Savings ($ in millions)	Total Interconnector Cost ($ in Millions)
2a	**Network Ready** at Windfarm Voltage	$20	$80	n/a	n/a	$100
	Network Ready at Windfarm Voltage	$20	$100	n/a	n/a	$120
2b	**Network Ready** at Higher Voltage	$30	$414	n/a	n/a	$444
2c	**Network Ready** w/HVDC Interlinks	$40	$45	n/a	n/a	$85
	Network Ready w/HVDC Interlinks	$50	$65	n/a	n/a	$115
2d	**Network Ready** w/ HVDC Interlinks & DC Circuit Breakers	$40	$445	n/a	n/a	$485
	Network Ready w/ HVDC Interlinks & DC Circuit Breakers	$50	$565	n/a	n/a	$615
2e	**Network Ready** w/ LONG HVDC Interlinks & DC Circuit Breakers	$60	$1,950	n/a	n/a	$2,010
	Network Ready w/ LONG HVDC Interlinks & DC Circuit Breakers	$75	$2,700	n/a	n/a	$2,775
3a	**Pre-Planned Network** at Windfarm Voltage	$28	n/a	n/a	n/a	$28
	Pre-Planned Network at Windfarm Voltage	$30	n/a	n/a	n/a	$30
3b	**Pre-Planned Network** w/ AC Switchyard	$143	n/a	n/a	n/a	$143
3c	**Pre-planned networ**k w/ HVDC interlinks	$45	n/a	n/a	n/a	$45
	Pre-planned network w/ HVDC interlinks	$57	n/a	n/a	n/a	$57
4a	**Multi-Purpose Interconnector** w/ Mid-Point Integration	$2,075	n/a	($720)	($500)	$855
	Multi-Purpose Interconnector w/ Mid-Point Integration	$2,950	n/a	($1,040)	($725)	$1,185
4b	**Multi-Purpose Interconnector** w/ Dual End-Point Integration	$1,500	n/a	n/a	($1,000)	$500
	Multi-Purpose Interconnector w/ Dual End-Point Integration	$2,150	n/a	n/a	($1,450)	$700

Table 4. Initial, Total, and Future Costs by Design Option

Total Cost of Interlink per MW of Capacity

Substantial variation exists between Design Options in both total project cost and achievable interlinking capacity. To evaluate the efficiency of each Design Option, the ratio of cost to transmission capacity is presented in Table 5.



Development Framework and Design Option		Voltage	Cost / Capacity [$/MW]
2a	Network ready at windfarm voltage	66 kV AC	330
		132 kV AC	200
2b	Network ready at higher voltage	230 kV AC	590
2c	Network ready w/HVDC interlinks	320 kV DC	70*
		525 kV DC	60*
2d	Network ready w/HVDC interlinks & DC circuit breakers	320 kV DC	370
		525 kV DC	310
2e	Network ready w/HVDC interlinks & DC circuit breakers	320 kV DC	1,550
		525 kV DC	1,390
3a	Pre-planned network at windfarm voltage	66 kV AC	800
		132 kV AC	400
3b	Preplanned network w/ AC switchyard	132 kV AC	110
3c	Pre-planned network w/ HVDC interlinks	320 kV DC	40*
		525 kV DC	30*
4a	Multi-purpose interconnector w/end-point integration	320 kV DC	800
		525 kV DC	720
4b	Multi-purpose interconnector w/end-point integration	320 kV DC	380
		525 kV DC	350

*These design options will have some operational restrictions for transmission capacity between the onshore stations when the wind power production is high.

Table 5. Cost/MW by Design Option

The most cost-efficient Design Options are 2c and 3c, which interconnect on the DC side without using offshore DC circuit breakers. This approach imposes certain operational restrictions, but in terms of transmission capacity per dollar invested, these configurations are a fraction of the cost of the alternatives.

Among the AC interlinks, Design Option 3b, the pre-planned network with a 132 kV AC switchyard, is the most cost-effective. It offers full operational flexibility, enabling wind power to be directed to whichever onshore region has the highest price, and allows the HVDC system to operate at full capacity as an interconnector during periods of low wind generation.

Design Option 3a, the pre-planned network using direct 132 kV AC interlinks, has a slightly higher cost-capacity ratio than 3b but remains among the most economical AC interlinks. As with the other pre-planned design options, it is highly sensitive to the selected interlink capacity. Because the HVDC platforms are collocated, the incremental cost of adding an additional AC cable is small while the incremental capacity gain is significant. If the topside layouts allow the number of AC interlink cables to increase from four to five, the resulting cost-capacity ratio would be comparable to Option 3b.

Design Option 2d, which interconnects on the DC side using offshore DC circuit breakers, is marginally more expensive than the AC-based alternatives. The high cost of the required helper platforms outweighs the operational benefits, despite the high interlink capacity.

Design Options 2e, 4a, and 4b are significantly more expensive than the other configurations. These options should only be considered when the project can displace or defer costly onshore grid reinforcements by contributing to long-distance interregional power transfer.

APPENDIX B. DETAILED RISK ASSESSMENT TABLES

Project Cost								
Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
Developer Cost Control								
Initial	LOW	Conventional development. Single POI. OSW developer controls full project. Project design/development can be optimized. No coordination with other projects.	LOW	Initial development similar to radial project. Additional requirements for future interlinks. Future requirements may not be fully defined. Future requirements may change	MED	Coordinated design can minimize overall costs. No anticipatory costs based on future unknowns. Additional risk if multiple developers. Need for near-term coordination between 2 states/RTOs may present challenges	MED	Initial CapEx may be very high. Conventional development for an intertie. Intertie developer controls full project. No coordination with other OSW projects. Additional cost for optional cable termination platform.
Future	NA	No expectation of future intertie capability.	MED	Initial design may not meet future need to add intertie. Deferring RTO and state coordination issues may result in additional unplanned future costs. Deferring coordination between OSW projects may have additional unplanned costs or development challenges.	NA	The project is fully networked at the initial build.	MED	Offshore interconnector creates an offshore POI option. Interconnection of OSW project follows standard process. Cable termination platform locations may not be optimal for OSW projects. RTO process issues may emerge for 1st OSW project connection to an offshore POI.
Stranded Asset Risk								
Initial	LOW	No anticipatory investment planned for network ready.	MED	Some risk that a future connection may not occur. Anticipatory investment on the platform might not be used or usable; the risk may vary with the design option.	NA	Full project planned at outset. no need for anticipatory investment.	LOW	Initial investment would be modest. Stranded assets would include 1-2 cable term platforms.
Future	NA	No future plans to interlink.	MED	Future needs are unknown.	NA	Full project planned at outset..	LOW	Converter equipment is known for future connections. Cable platforms may not be ideal for future projects.
Project Cost/ ITC/PTC eligibility								
Initial	MED	PTC/ITCs tax credits have been eliminated.	MED	PTC/ITCs tax credits have been eliminated.	MED	PTC/ITCs tax credits have been eliminated.	MED	PTC/ITCs tax credits have been eliminated.
Future	NA	No future plans to interlink.	MED	No current expectation of reinstating.	NA	Full project planned at outset..	MED	No current expectation of reinstating.

Interregional Transmission Capability								
Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
Functionality/ Interlink Flexibility to interconnect two POIs								
Initial	NA	Project is not designed for networking.	NA	Future interlinking is contemplated. No initial capability for interregional flow.	MED	Initial design includes interlinking at outset. Intertie capacity may be limited by equipment. HVAC capacity limited and distance limited relative to intertie flows may be limited by OSW operation.	LOW	Project is designed for interregional flows at outset.
Future	NA	Project is not designed for networking.	MED	Technology may not support future project design. Additional investment may be needed to due to technology changes.	NA	Interlinking completed at project outset.	LOW	Project is designed for interregional flows at outset.
Future Potential; establish offshore transmission as network facilities for future projects								
Initial	NA	Project is not designed for networking.	NA	Future interlinking only is contemplated. No plans for future OSW project connections.	NA	Future interlinking only is contemplated. No plans for future OSW project connections.	LOW	Project is designed for future generation connection.
Future	NA	Project is not designed for networking.	NA	na	NA	No plans for future OSW project connections.	LOW	Project is designed for future generation connection.

Project Delivery Risk

Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
Supply Chain (technical/commercial viability)								
Initial	LOW	Project is optimized based on available technology and supply chain conditions.	MED	Requires consideration of potential future interconnection in technology selection.	LOW	Concurrent design of transmission and interlinking ensures compatibility.	LOW	Establishes the HVDC converter technology for injections at the two onshore POIs. Establishes clear requirements for future offshore generation projects.
Future	NA	No future work is contemplated.	MED	Potential incompatibility between new and existing technology. Potential to limit OEM options for interlink equipment. Potential to limit use of newer advancements of technology.	NA	Full project planned at outset..	MED	Potential incompatibility between new and existing technology. Potential to limit use of newer advancements of technology.
Project-on-Project Risk								
Initial	LOW	No coordination of projects required. OSW generation and transmission are developed as a project.	LOW	Requires clear requirements for network readiness, does not require coordination with other developers initially.	HIGH	Requires building two projects together; full coordination. Requires coordination with ISO/RTO interconnection process. Development by a single developer could mitigate some risk.	LOW	No coordination is required with wind farm developer for the interconnector project.
Future	NA	No future project connections are contemplated.	MED	Requires significant coordinated planning between developers. Required coordination with affected RTOs.	NA	Full project planned at outset..	MED	Requires future OSW project to be compatible with existing HVDC technology. Timing of development of each can introduce risk.

Regulatory Project Complexity

Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
RTO Interconnection Process								
Initial	LOW	Standard process, single project, single POI onshore.	LOW	Standard process, single project, single POI onshore.	HIGH	First of its kind to build offshore network with generation. Requires addressing interconnection process unknowns at project outset. RTO acceptance is uncertain. Allows opportunity to incorporate RTO requirements with initial design.	MED	Network tie line requires identification in RTO processes. Potential to be identified based on economics. Potential for state sponsorship as public policy. Interregional planning processes are not robust. (assumes the interconnector is not a merchant facility)
Future	NA	No future work is contemplated.	HIGH	First of its kind to interlink offshore projects. RTO acceptance is uncertain. Requires the export cable to operate as a network facility. Requires agreement among OSW projects and interlink owner for changed.	NA	Full project planned at outset..	MED	Connection would follow standard interconnection process. Long term firm reservations for transmission service could impact future interconnection. Building the intertie as a network facility mitigates future change of export line to network asset.
BOEM								
Initial	LOW	Offshore siting/permitting of the export cable is standard process. Export cable siting requires engagement with USACE and state environment entities for the shore landing.	LOW	Offshore siting/permitting of the export cable is standard process. Export cable siting requires engagement with USACE and state environment entities for the shore landing.	HIGH	Requires coordination of two shore landings. Requires coordination of two offshore site approvals. Requires coordination of interlink. Requires consideration of full project by BOEM and other agencies. HVDC could mitigate siting impacts.	MED	BOEM process would likely follow standard permitting process for a submarine cable project. Routing approval could be more difficult for longer lines.
Future	NA	No future work is contemplated.	MED	Siting approval for intertie cable would likely follow a typical process of submarine cable project. No engagement with USACE and state agencies likely required.	NA	Full project planned at outset.	LOW	POI at cable platform is pre-established with initial interconnector. No onshore connection is required. Mitigates need to involve other agencies.

Regulatory Project Complexity

Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
Coordination between states								
Initial	LOW	No coordination required.	MED	Requires states coordination. Requires states to agree on network ready requirements.	HIGH	Requires states to agree on cost and benefits of planned network. Requires significant coordination to recognize and account for impacts to OSW procurement commitments. Requires states to coordinate on RTO processes.	HIGH	Requires states to agree on cost and benefits of interconnector. Requires states to coordinate on RTO public policy planning processes. Requires coordination on cable platform requirements. Requires states to agree to T&Cs for future interconnection.
Future	NA	No future work is contemplated.	HIGH	Requires significant coordination to recognize and account for impacts to OSW procurement commitments. Requires agreement by states on intertie benefits. Requires states to agree to cost for intertie.	NA	Full project planned at outset.	MED	Future connection T&Cs identified with interconnector. Interconnector T&Cs might not contemplate future conditions.
Coordination between RTOs								
Initial	LOW	Limited coordination required. An affected system study may be required.	LOW	Limited coordination required. An affected system study may be required.	HIGH	RTO coordination is significant. Coordination varies between RTOs. No current examples of interlinking offshore projects. The intertie could be a merchant project or a network facility.	MED	RTO coordination is significant but follows interregional planning protocols Coordination varies between RTOs. Process varies if a merchant project or a network facility.
Future	NA	No future work is contemplated.	HIGH	RTO coordination is significant. Coordination varies between RTOs. No current examples of interlinking offshore projects. The intertie could be a merchant project or a network facility.	NA	Full project planned at outset.	LOW	Moderate coordination required. An affected system study would be required. Interconnection impacts a tieline.

Regulatory Project Complexity

Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
Potential for RTO public policy for planning offshore transmission.								
Initial	MED	Project is eligible. Requires significant state engagement.	MED	Project is eligible. Requires significant state engagement.	HIGH	Pre-planned network is eligible. Requires significant state engagement. Involves 2 or more RTO planning processes. Onshore network upgrades may complicate process. Segregating the intertie work could complicate the process.	MED	The interconnector could be eligible for state sponsorship. Initial cost may exceed benefits.
Future	NA	No future work is contemplated.	HIGH	Intertie is eligible. Requires significant state engagement. Involves 2 or more RTO planning processes. Onshore network upgrades may complicate process.	NA	Full project planned at outset.	MED	Project is eligible. Requires significant state engagement.

Funding Mechanism

Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
State OSW Procurement process								
Initial	LOW	OSW development is driven by state legislation or policy. State policy is subject to change with election cycles.	LOW	OSW development is driven by state legislation or policy. State policy is subject to change with election cycles.	MED	OSW development is driven by state legislation or policy. State policy is subject to change with election cycles. Potential to incorporate intertie into OSW solicitation.	HIGH	No current state policy requires development of interregional ties.
Future	NA	No future work is contemplated.	HIGH	Intertie is not contemplated with state OSW public policy.	NA	Full project planned at outset.	LOW	OSW development is driven by state legislation or policy. State policy is subject to change with election cycles.
Potential for DOE funding								
Initial	HIGH	No current path is anticipated for DOE funding for OSW projects.	HIGH	No current path is anticipated for DOE funding for OSW projects.	MED	Potential to receive $ via DOE Speed to Power RFI if it can be demonstrated that project supports data center load growth.	MED	Potential to receive $ via DOE Speed to Power RFI if it can be demonstrated that project supports data center load growth.
Future	NA	Unknown	NA	Unknown	NA	Unknown	NA	Unknown

Project Competitiveness

Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
Initial	LOW	Projects can optimize design based on WEA location, project size and potential POIs.	LOW	Could impact the project design to accommodate interlinking, project size, and potential POIs. May impact decision to compete with projects not subject to intertie technical requirements.	MED	The requirement to develop a pre-planned Network with two projects may limit what projects can bid in and compete with radial projects.	NA	No OSW is procured with the interconnector.
Future	NA	No future work is contemplated.	NA	Does not impact future OSW projects.	NA	Full project planned at outset.	LOW	Offshore POIs could advantage some projects and disadvantage others based on lease areas.

Political Viability

Time	Radial		Network-Ready		Pre-planned Network		Multi-purpose Interconnector	
State to State Coordination, schedule, policy and cost alignment								
Initial	LOW	No coordination required.	LOW	Limited coordination for network requirements.	MED	Significant coordination is required.	HIGH	Significant coordination is required between states.
Future	NA	No future work is contemplated.	HIGH	Significant coordination at time of networking.	NA	Full project planned at outset.	MED	Future connection T&Cs identified with interconnector. Interconnector T&Cs might not contemplate future conditions.
State to Federal Coordination								
Initial	HIGH	Limited ability. BOEM is suspending OSW work.	HIGH	Limited ability. BOEM is suspending OSW work.	HIGH	Limited ability. BOEM is suspending OSW work.	MED	BOEM suspended OSW work but approval process may be viable for an interconnector. Certainty of future connection of OSW projects remains uncertain.
Future	NA	No future work is contemplated.	NA	Unknown	NA	No future work is contemplated.	NA	Unknown