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April 29, 2022

VIA E-FILING & E-MAIL

Carmen D. Diaz, Acting Secretary
New Jersey Board of Public Utilities
44 South Clinton Avenue, 9th Floor
Post Office Box 350
Trenton, New Jersey 08625-0350
board.secretary@bpu.nj.gov

Re: I/M/O Offshore Wind Transmission
BPU Docket No. QO20100630

Dear Acting Secretary Diaz,

On behalf of our client, LS Power Grid Mid-Atlantic, LLC ("LS Power Grid"), please see attached stakeholder comments submitted pursuant to the Board of Public Utilities Revised Stakeholder Notice dated March 7, 2022 in the above matter.

Please do not hesitate to contact me if you have any questions. Thank you for your time and consideration and we look forward to our future correspondence.

Very truly yours,

Murray E. Bevan

Enclosure

Post-Stakeholder Meeting Comments of LS Power Grid

April 29, 2022

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I. Introduction

On November 18, 2020, the New Jersey Board of Public Utilities ("BPU") issued the Order In the Matter of Offshore Wind ("OSW") Transmission ("Order") in Docket No. QO20100630, directing PJM Interconnection LLC ("PJM") to initiate a State Agreement Approach ("SAA") competitive transmission solicitation process under the PJM tariff. In the Order, the BPU explained its belief that a coordinated approach under the SAA can deliver many benefits including a more efficient or cost-effective transmission solution, reduction in risk, and minimization of environmental impacts relative to a non-coordinated approach. The Order identified three categories of facilities: Option 1: Onshore Facilities; Option 2: Onshore Substations to Offshore Collector Platforms; and Option 3: Offshore Transmission. On April 15, 2021 PJM opened a SAA proposal window to support NJ OSW, further refining Option 1 into Option 1A as facilities to resolve reliability violations associated with OSW injection and Option 1B proposals as exclusively onshore facilities that facilitate OSW interconnection. When the competitive solicitation window had closed on September 17, 2021, PJM and BPU had received 80 proposals under all options.

LS Power Grid Mid-Atlantic, LLC ("LS Power Grid") submitted five Option 1B proposals and one Option 2 proposal collectively referred to as the "Clean Energy Gateway". PJM, BPU Staff, and their consultants are currently in the process of reviewing these proposals, along with the many other proposals submitted by competing developers.

A significant problem facing the OSW industry in New Jersey is insufficient transmission system capability at the existing interconnection points proximate to the shore. LS Power Grid's Clean Energy Gateway extends the existing extra-high voltage alternating current ("AC") grid towards the shore (Option 1B) with a further expansion of the AC grid offshore (Option 2) to accommodate generation from OSW lease areas near the New Jersey shore via AC cables without a need for midpoint series compensation.

The Clean Energy Gateway provides a number of benefits relative to alternatives, which generally rely on high voltage direct current ("HVDC") technology, including:

- ✓ Most affordable plan with strongest cost containment and risk mitigation provisions for ratepayers. LS Power Grid estimates over $1 billion in cost savings from an entirely AC approach as compared to HVDC alternatives;
- ✓ Increased reliability and reduced risk for OSW generators through the increased system redundancy and interconnectivity with the existing grid; and
- ✓ Reduced environmental impacts with minimal disruptions to shore communities.

II. Overview of LS Power Grid Proposals

LS Power Grid studied numerous potential solutions to integrate OSW into the New Jersey grid. This included different configurations of onshore and offshore networks using both AC and HVDC technologies and considered the default and alternative points of interconnections. The key conclusions of this analysis included:

- ✓ Given the location of the OSW lease areas and viable shore landing locations combined with required onshore upgrades, an entirely AC network is the most efficient, affordable solution;
- ✓ Impacts to the environment and communities are minimized by a coordinated plan with consolidated corridors and shore landings;
- ✓ Flexibility is important in order to accommodate a wide range of interconnection scenarios;
- ✓ New connections between eastern and western New Jersey accomplish the goal of OSW integration with reliability and economic benefits;
- ✓ A new geographically central hub significantly reduces the footprint of cable corridors, reducing impacts and reducing costs relative to direct connections to existing points of interconnection to the north and to the south.
    - A centralized hub is preferable to connections to South New Jersey due to sensitive environmental areas as well as a weak transmission system, which will require significant onshore transmission upgrades to accommodate more than 900 MW.
    - A centralized hub is preferable to connections to North New Jersey, since northern points of interconnection are farther from OSW lease areas and present greater risks including shipping interference, environmental contamination areas in the Raritan Bay, and increased cultural resource and geotechnical risks.

The Clean Energy Gateway provides certainty that New Jersey can integrate 7,500+ megawatts of OSW in a manner that is cost-effective and reliable with the lowest overall impact to the environment and local communities. Compared to a traditional generator lead/radial approach and other alternatives, the Clean Energy Gateway Project is:

- ✓ *More efficient*, seamlessly integrating OSW into the existing AC system and allowing generation from any future OSW solicitation to have certainty of electrical interconnection;
- ✓ *More cost-effective*, optimizing the entire system cost including generator lead lines and onshore upgrades, and eliminating the unnecessary high capital and maintenance cost of offshore HVDC terminals;
- ✓ *Lower risk* for ratepayers through significant cost containment and risk mitigation provisions and lower risk for OSW generators by reducing the interconnection queue/upgrade risk;
- ✓ *Lower environmental impact,* with a single, centralized shore landing location, new submarine transmission lines in common corridors and by avoiding repeated disturbances; and
- ✓ *More reliable*, with storm-hardened substations, a networked solution onshore and with multiple redundant submarine transmission circuits offshore.

LS POWER GRID MID-ATLANTIC

Option 1B Proposals

LS Power Grid proposes a new 500 kV substation near the shore (Lighthouse Substation) connecting to a new high-voltage on-shore backbone consisting of redundant 500 kV transmission circuits in existing rights-of-way that connect to the existing 500 kV system and to the Larrabee 230 kV substation. Solution options are represented in Figure 1 and summarized below. Each solution can integrate BPU's Solicitation 2 OSW and allow New Jersey to exceed its 7,500 MW OSW goal, while enhancing resiliency and reliability of the existing transmission grid.

Proposal ID 781 integrates up to 6,000 MW with the lowest impact to the environment and communities and most resilience by placing all new transmission underground. This solution eliminates the need to rebuild existing infrastructure, limits transmission outages required during construction and provides simplified outage sequencing to reduce risk and energy market impacts during construction. Proposal ID 294 reflects phasing the project in a manner to achieve an initial delivery of 4,200 MW.

Proposal ID 629 integrates up to 5,600 MW utilizing new overhead transmission construction in existing rights-of-way to achieve a lower upfront cost. This solution removes existing 230 kV transmission lines and replaces them with 500 kV transmission lines entirely within existing rights-of-way. Proposal ID 627 reflects phasing the project in a manner to achieve an initial delivery of 4,200 MW. Proposal ID 72 increases system connectivity with an additional overhead 500 kV transmission line in existing rights-of-way to enhance system stability.

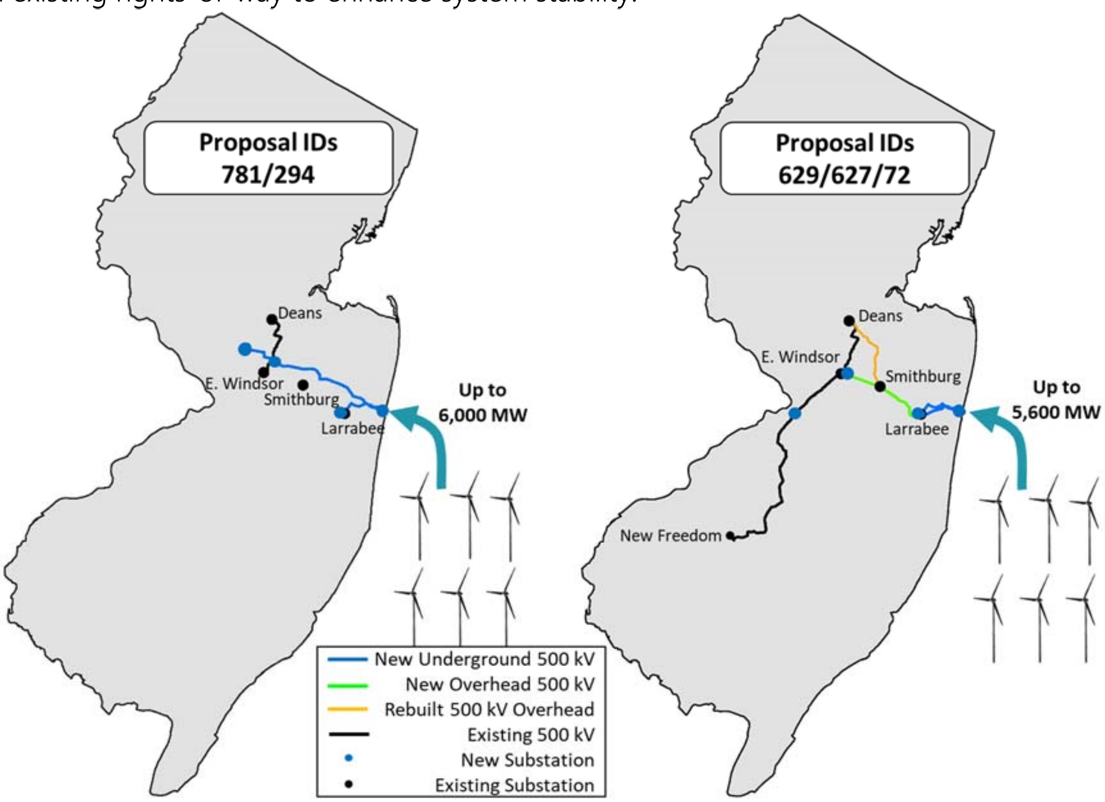


Figure 1: Clean Energy Gateway Option 1B Proposals

Option 2 Proposal

LS Power Grid's Option 2 solution (Proposal ID 594) consists of 345 kV submarine cables connected from the onshore Lighthouse Substation (included with Option 1B) to new offshore substations located proximate to OSW lease areas through a new offshore backbone system. This proposal will facilitate offshore interconnections of 4,000 MW to 6,000 MW of OSW without the need for midpoint reactive power compensation offshore. The blue area in Figure 2 below identifies the system reach with a single 345 kV cable. The new offshore substations provide a new AC point of interconnection for OSW generators in the ocean.

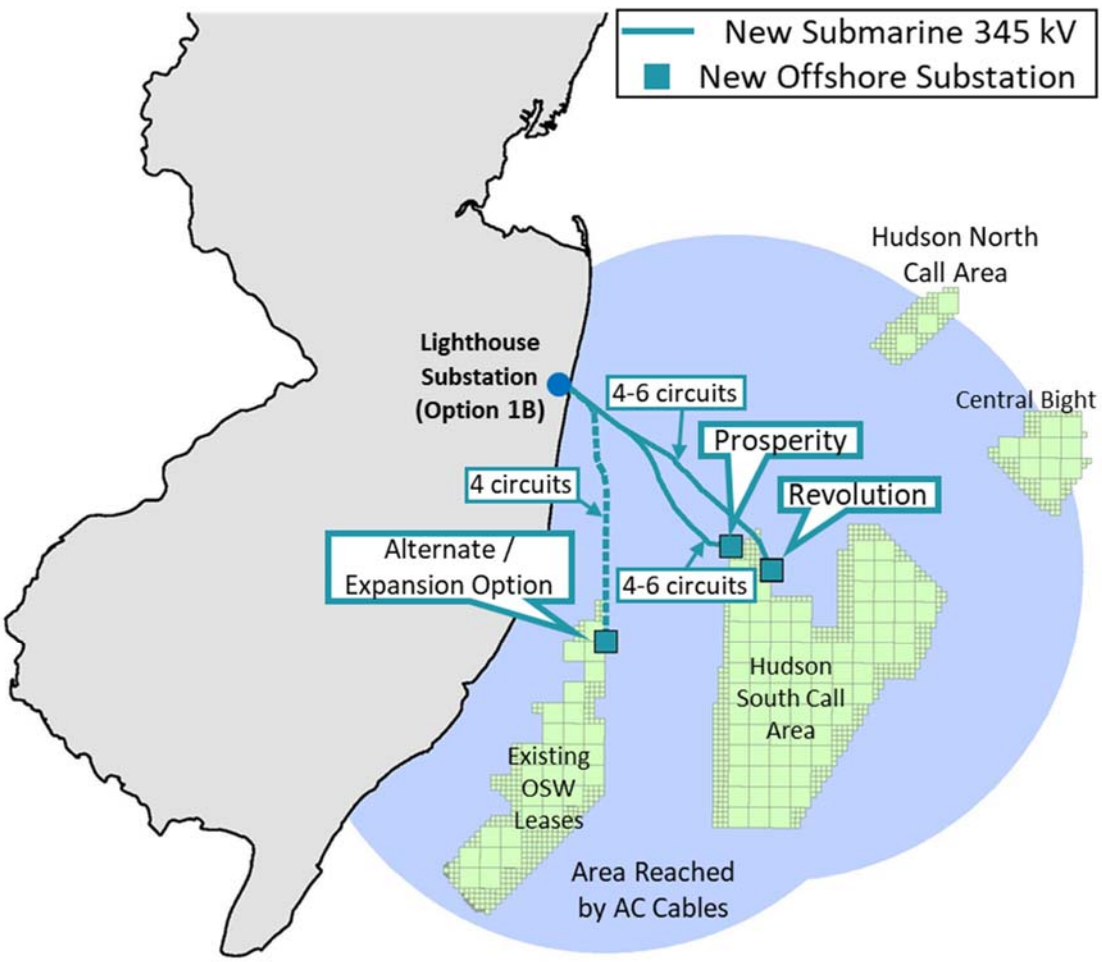


Figure 2: Clean Energy Gateway Option 2 Proposal

Benefits of AC Approach

The Clean Energy Gateway is superior to offshore HVDC alternatives for several reasons:

Clean Energy Gateway Advantage	Discussion
More Reliable	Offshore HVDC converter stations require more frequent outages, increasing OSW generation curtailment
More Resilient	Offshore HVDC converter stations introduce large, single contingencies with long restoration timeframes, increasing OSW generation curtailment
Lower Losses	Offshore HVDC converter stations consume additional power causing increased losses relative to AC for relatively short distances
Lower Operating Costs	Offshore HVDC converter stations rely on power electronic devices with significantly more frequent maintenance requirements (e.g., weekly versus biannual) and with short operating lives (requiring full replacement in year 20)
More Expandable	HVDC circuit breakers are not commercially available limiting future networking opportunities
Lower EMF	AC tri-core cables have a *lower* magnetic field than HVDC alternatives, as further described Technical Appendix Section 1
More Affordable	AC substations and transmission lines are substantially less expensive than HVDC for relatively short distances due to the high cost of offshore HVDC converter stations
Flexibility for the Future	AC solutions rely on technologies that are proven to be highly reliable for use onshore, offshore, networked, and radial. HVDC is proven only in point-to-point configurations and requires technology advancements to provide an offshore meshed/networked solution.

HVDC technology is well suited for specific applications typically connecting two systems (each with load and generation) to provide controllability or transferring large amounts of power across long distances. These circumstances do not apply to New Jersey OSW integration. An OSW HVDC transmission line would be scheduled consistent with the OSW generation being produced and flow power in the same manner as an uncontrolled AC system. The OSW lease areas are accessible with AC cables in a way that is cost-effective[1] with an AC system providing more redundancy to facilitate a lower risk of curtailment due to single outages.

As identified by some speakers at the stakeholder meetings, AC cables do require additional equipment for reactive compensation. LS Power Grid's proposal includes this equipment and its cost is low compared to the cost of offshore HVDC terminals. The overall cost of an AC system, including the cost of all reactive power equipment to control voltage, is significantly lower than the cost of an HVDC system to integrate OSW for New Jersey.

[1] See Technical Appendix Section 2

Cost and Cost Certainty

The Clean Energy Gateway is a lower cost solution due to the natural cost advantages of its design relative to proposed alternatives. LS Power Grid is not cutting any corners, using risky technology, or omitting key elements of the scope to achieve a more affordable solution as suggested by some competing bidders.

Figure 3 provides an estimated cost on a dollar per megawatt basis of the initial injection scenarios being studied by PJM,[2] based on information publicly available including additions for generator interconnections and known onshore upgrades. Other proposals are 30% to 80% more expensive than LS Power Grid, with the LS Power Grid proposals providing savings of over $1 billion.

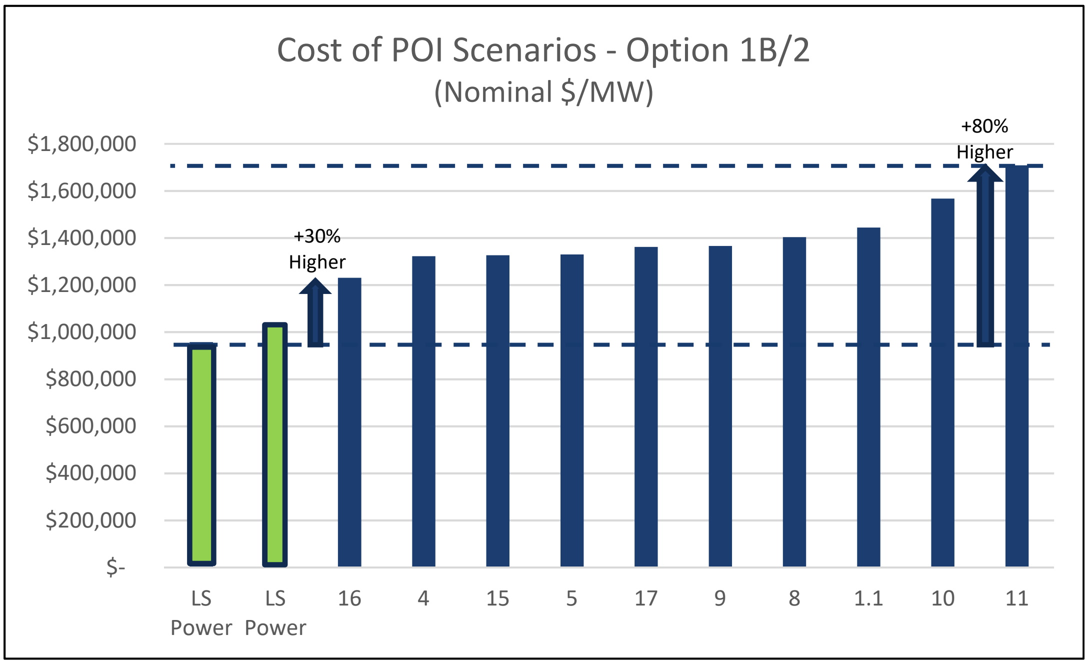


Figure 3: Estimated Capital Cost Comparison

[2] "2021 SAA Proposal Window to Support NJ OSW" presentation to PJM Transmission Expansion Advisory Committee, April 12, 2022, Slide 9

LS Power Grid's inherently low cost is backed by a comprehensive package of cost containment with no risk premium as summarized in Figure 4.

	Capital Cost Cap	Rate of Return on Equity Cap	Equity Percentage Cap	Annual Revenue Requirement Limit
LS Power Grid	●	●	●	●
Company A	●	●	●	◐
Company B	◐	●	●	○
Company C	◐	●	●	○
Company D	◐	○	●	○
Company E	◐	○	○	○
Company F	◐	○	○	○
Company G	◐	◔	◔	◔

● Cost Containment With Limited Exceptions, No Risk Premium
◐ Cost Containment With Exceptions
◔ Cost Containment With Risk Premium
○ No Cost Containment

Figure 4: Cost Containment Comparison

The Clean Energy Gateway will be completed by LS Power, a New Jersey based company, that is the most successful competitive transmission provider in the United States and has delivered every one of its competitive transmission projects on schedule and within its cost commitments. Cost certainty is provided by binding commitments on capital costs and annual revenue requirements. This combination of design, certainty, and value provides the BPU and New Jersey ratepayers with benefits unmatched by other proposals.

II. Minimizing Environmental Impact

The Clean Energy Gateway is designed under the principle of *Avoid, Minimize, and Mitigate*.

- ✓ *Avoid* impacts on the environment, sensitive resources and the public where possible. This includes avoiding known sensitive areas such as the Pinelands and Raritan Bay.
- ✓ *Minimize* impacts on the environment using consolidated corridors, coordinated planning to avoid repeated construction disturbances, minimizing the number of landfalls, and minimizing cable corridor length.
- ✓ *Mitigate* remaining impacts where appropriate, for example, by avoiding construction in shore communities during the tourist season and establishing mitigation funds including community mitigation funds and a Wildlife Mitigation Fund.

LS Power Grid carefully planned the Clean Energy Gateway to minimize environmental impacts and minimize risks. Its proposals include risk identification and mitigation strategies, detailed permitting plans, engagement plans, a fisheries protection plan, threatened and endangered species protection plans, and cultural resource avoidance and mitigation plans.

Consolidated Corridors

The most significant impact the SAA process can have on reducing the environmental impact of transmission for OSW is selecting projects that avoid sensitive environmental areas and consolidate cables to a limited number of corridors. Consolidating corridors reduces the number of shore landings and minimizes the footprint of the transmission system required for OSW delivery. Reducing the number and distance of transmission corridors is much more important than simply reducing the number of cables. The Clean Energy Gateway uses consolidated corridors and construction planning that avoids repeated disturbance and minimizes the impact to ocean floor habitat and sensitive species. A single shore landing location with a coordinated plan for all drilling operations beneath the beach minimizes impacts to beach habitat and marine species.

The centrally located landing site utilized by the Clean Energy Gateway allows for relatively short cables from OSW lease areas to the shore landing, reducing corridor disturbance relative to alternatives. For example, Figure 5 illustrates the corridor miles for PJM Scenario ID 4[3] as compared to the PJM Scenario ID 6 (Clean Energy Gateway) to integrate 4,500 – 5,000 MW of OSW.[4] The Clean Energy Gateway has significantly less corridor miles - 125 corridor miles as compared to 184 corridor miles - resulting in a smaller project footprint and, as a result, lower overall environmental impacts. The Clean Energy Gateway also has a single shore landing location, which further reduces impacts relative to options with multiple shore landing locations.

[3] Ibid

[4] This comparison is based on three recent OSW lease areas with a range of distances from the shore.

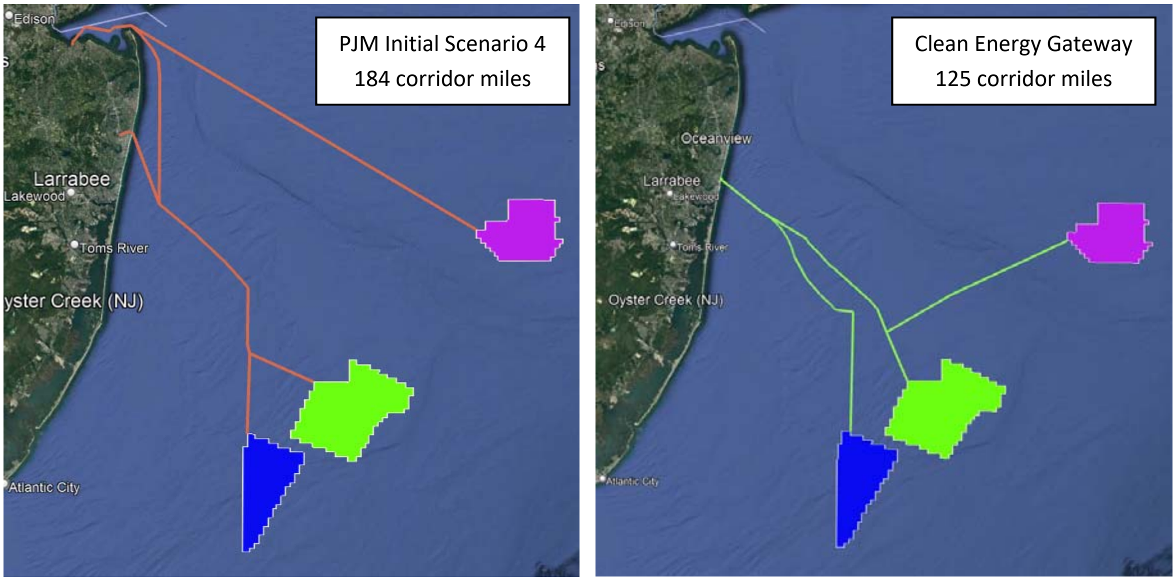


Figure 5: Cable Corridor Distance Comparison

In addition, the Clean Energy Gateway provides a greater opportunity to optimize the cabling internal to each OSW lease area relative to HVDC alternatives. An AC solution allows OSW generators to optimize their collector systems to reduce cost, reduce losses, and reduce curtailment associated with inter-array cabling as identified in Technical Appendix Section 5. In contrast, HVDC alternatives require a single DC collection point within the OSW lease area that would not allow for such optimizations.

Lower EMF Impacts

Contrary to claims of several participants in the stakeholder meetings, AC cables proposed by LS Power Grid have *lower* electromagnetic fields ("EMF") than HVDC alternatives proposed by others. A common misconception is that HVDC cables have lower EMF than AC alternatives. This is not the case. As discussed in more detail in Technical Appendix Section 1, the magnetic field of a tri-core AC cable proposed by LS Power Grid is significantly lower than the magnetic field of the HVDC cable alternatives proposed by others.

Minimizing Onshore Impacts

LS Power Grid's proposals also serve to minimize the onshore environmental impact of OSW transmission in several ways.

In developing the Clean Energy Gateway proposals, considerable attention was given to reducing the impact on New Jersey communities and stakeholders. Particular importance was placed on the shore landing location because it determines the communities impacted by offshore cables, landing locations, and onshore cables. Community stakeholders were engaged along beach communities to understand the impacts of potential landing locations and community cooperation. This engagement led to the determination that the proposed landfall near the location of several existing offshore cable landfalls at state owned property located near Sea Girt would have the lowest impact on beach communities.

LS Power Grid's proposals have a single shore landing location, minimizing the number of areas impacted by landfall. The Clean Energy Gateway provides for the ability to complete all shore area construction in a coordinated manner to avoiding repeated disturbances, reducing impacts to communities.

The LS Power Grid Option 1B (onshore) proposals are entirely within existing rights-of-way, consisting of underground cables in the streets, or in some cases replacement of existing overhead lines within the same right-of-way. Multiple onshore circuits are combined in an underground duct bank to minimize impacts and, where possible, multiple duct banks are combined into a single corridor. This approach facilitates a higher energy transfer per corridor than a HVDC approach. More detail regarding the proposed installation of underground cables in the streets is provided in Technical Appendix Section 3.

LS Power Grid's proposals minimize the scope of onshore upgrades that may be required to integrate OSW, therefore minimizing the overall environmental impacts of onshore construction.

III. Coordination with Wind Plans

The Order identifies project-on-project risk as a potential disadvantage of the SAA process, however, a transmission first approach will minimize project-on-project risk, and the SAA process presents better coordination and lower overall risk for OSW generators, such as the reduction of the risk of the interconnection queue process.

LS Power Grid's proposal goes a step further than other proposals in terms of coordination with OSW generation planning as it:

- ✓ Provides access to all OSW leases areas off the New Jersey coast;
- ✓ Creates certainty of the location and cost of interconnection;
- ✓ Eliminates issues of technology and vendor compatibility due to its use of AC equipment; and
- ✓ Provides the least risk interconnection approach for Solicitation 2 OSW generation, which can connect directly to LS Power Grid's alternative POI at Lighthouse without incremental permitting requirements.

Transmission First

A transmission first approach, which schedules the completion of transmission in advance of the requirements of the OSW generation, is the simplest approach to minimizing project-on-project risk. The incremental cost to place transmission in-service in advance of OSW generation can be mitigated by phasing proposal elements to best match the timing of OSW completion. LS Power Grid's proposals include phasing of in service dates for proposal elements that is coordinated with OSW generation sequencing, and ahead of the dates needed by OSW generators.

A transmission first approach eliminates the significant cost and schedule risks associated with the interconnection queue process. The collective time to complete the studies and subsequently construct the necessary upgrades could be longer than the time to permit and construct the OSW generation. Upgrades constructed under the interconnection queue process do not include cost containment or schedule guarantees provided by the interconnecting transmission owners. As evidenced by prior OSW interconnection requests, the scope of the upgrades for each OSW generator is likely to encompass significant transmission upgrades representing hundreds of millions of dollars. This represents a significant risk for delay, especially given new OSW lease areas have not submitted requests into the queue.

In contrast, LS Power Grid's proposals mitigate project-on-project risk with a schedule guarantee that reduces LS Power Grid's rate of return on equity in the event of schedule delays. This mitigates the cost for ratepayers due to a delay and provides a strong financial incentive for on-time performance. LS Power Grid's proposal reduces risk to ratepayers relative to generators building transmission, and relative to proposals without any schedule guarantees.

Reach to All OSW Lease Areas With Certainty

The Clean Energy Gateway establishes new 345 kV offshore substations proximate to the OSW lease areas that include the necessary reactive compensation equipment to interconnect cables from OSW lease areas. These new 345 kV offshore substations will provide known interconnection points for the OSW generation with comparable access to all OSW lease areas. This eliminates uncertainties associated with transmission interconnection to facilitate robust competition among OSW generation for future solicitations and provide flexibility to New Jersey in its awards to achieve the 7,500 MW OSW goal. OSW generators would know the location of the POI for the procurement and scope of facilities without facing the risk and uncertainties of the interconnection queue, and be able to take this into account in bidding for future procurements resulting in a lower proposed OREC price.[5] In addition, permitting and construction activities for the Clean Energy Gateway can be completed without regard to the specific OSW generators selected for award by New Jersey.

This is superior to the "flexible" approach advertised for offshore HVDC terminals where the offshore location may change based on the OSW generator selected in future procurements. This approach introduces greater project-on-project risk as the transmission cannot be fully permitted and constructed until the OSW generation is awarded. This approach also requires additional coordination between the SAA transmission project and OSW generation causing delays and incremental cost and complexity in permitting, design, and construction. The risk and uncertainty is greater for Option 2 proposals that connect to OSW generation at 66 kV, which would require an HVDC terminal to be centrally located within the OSW lease area. Identifying OSW generation POIs as soon as possible allows for a more orderly and efficient permitting process for the OSW transmission with reduced project-on-project risk.

Benefits of AC Transmission Offshore

In addition to providing lower curtailment risk and lower operating losses, the Clean Energy Gateway provides several benefits relative to a DC approach in terms of coordination with OSW generator plans. Stakeholder Meeting #2 included significant discussion of technology and vendor compatibility between vendors of DC equipment as a barrier to future OSW networking. This is not an issue with AC equipment, as AC equipment for different vendors is commonly networked. This compatibility provides a higher level of "future-proofing" than a DC approach.

DC transmission is also "lumpier" requiring increments of 1,200 MW to 1,500 MW to achieve economies of scale. The Clean Energy Gateway establishes 345 kV AC points of interconnection in the ocean, which provides for delivery of OSW generation in 500 MW increments,[6] providing more flexibility (in addition to reducing the impact of the outage of a single cable as previously discussed). Further, Lighthouse Substation can accept power at other voltages in the event it would be more efficient for certain OSW generators to permit and construct their own radial interconnection. An AC

[5] As identified by Community Offshore Wind at Stakeholder Meeting #2.

[6] While 345 kV cables are becoming a standard offshore, generators would be able to install cables of a different voltage such as 275 kV tri-core cables which would have a capacity of approximately 400 MW each.

delivery system provides more flexibility, giving OSW generators the ability to propose different amount of capacity, and allows for better matching with OSW generation bids.

Another advantage of the Clean Energy Gateway is the ability for future networking with existing breaker technology. In contrast, DC technology would require New Jersey to rely on the future availability of DC breakers to accomplish networking. While DC breakers may appear promising, the technology has been promising for a very long time, having been identified as “five-years away” for over 60 years.[7]

Coordination with Solicitation 2 Projects

The New Jersey BPU has completed two OSW solicitations to date, Solicitation 1 in June 2019 and Solicitation 2 in June 2021. The SAA process contemplates that the 2,658 MW of generation procured in Solicitation 2 could make their own transmission interconnection arrangements or could connect to the SAA projects. The Clean Energy Gateway proposal provides the most flexibility with greatest potential for cost savings and avoidance associated with interconnection of OSW generators selected in BPU Solicitation 2.

The Clean Energy Gateway establishes new points of interconnection offshore and onshore (i.e., Lighthouse Substation) that could be used by Atlantic Shores or Ocean Wind II. These new substations provide additional interconnectivity, are physically closer to the OSW lease areas than existing interconnection alternatives (e.g., Smithburg, Larrabee), and are in the same corridor as prior permitting activities to accommodate the OSW generation schedule. In addition, diverting a portion of Atlantic Shores to Lighthouse Substation to reduce the generation interconnected at Cardiff to 900 MW or less would avoid significant system upgrades. These factors enable interconnection to the Clean Energy Gateway to be lower cost than current alternatives available for both Atlantic Shores and Ocean Wind II.

In the Clean Energy Gateway proposals as well as in comments at the March 22 Stakeholder Meeting #1, LS Power has presented scenarios of how the Clean Energy Gateway can allow New Jersey to exceed its 7,500 MW OSW goal. Figure 6 identifies three scenarios, which vary by the amount of Solicitation 2 capability interconnection to the Clean Energy Gateway. Under Scenario 1, all of Ocean Wind II and 610 MW or more of Atlantic Shores would interconnect to the Clean Energy Gateway onshore substation at Lighthouse. This scenario has the lowest total amount of OSW at 8,150 MW, which is still greater than the current 7,500 MW goal. Scenario 1 likely provides the lowest total cost per MW by avoiding significant onshore upgrades triggered by more than approximately 900 MW of generation interconnected at Cardiff. Scenario 3 assumes none of the Solicitation 2 generation would connect to the Clean Energy Gateway. In this case, the incremental capability of 6,000 MW from the Clean Energy Gateway would be incremental to the past procurements and provide a total

[7] The 1964 National Power Survey published by the Federal Power Commission (predecessor of FERC) describes commercialization of HVDC breakers on the short-term horizon, with “[t]he most pessimistic estimate by the above manufactures of the time required [for commercialization of HVDC breakers] is about five years.” https://books.google.com/books/about/National_Power_Survey_1964.html?id=xgtGAQAAIAAJ

of 9,900 MW of OSW integration. All of these scenarios can be implemented in time to accommodate the schedule of the OSW generators.

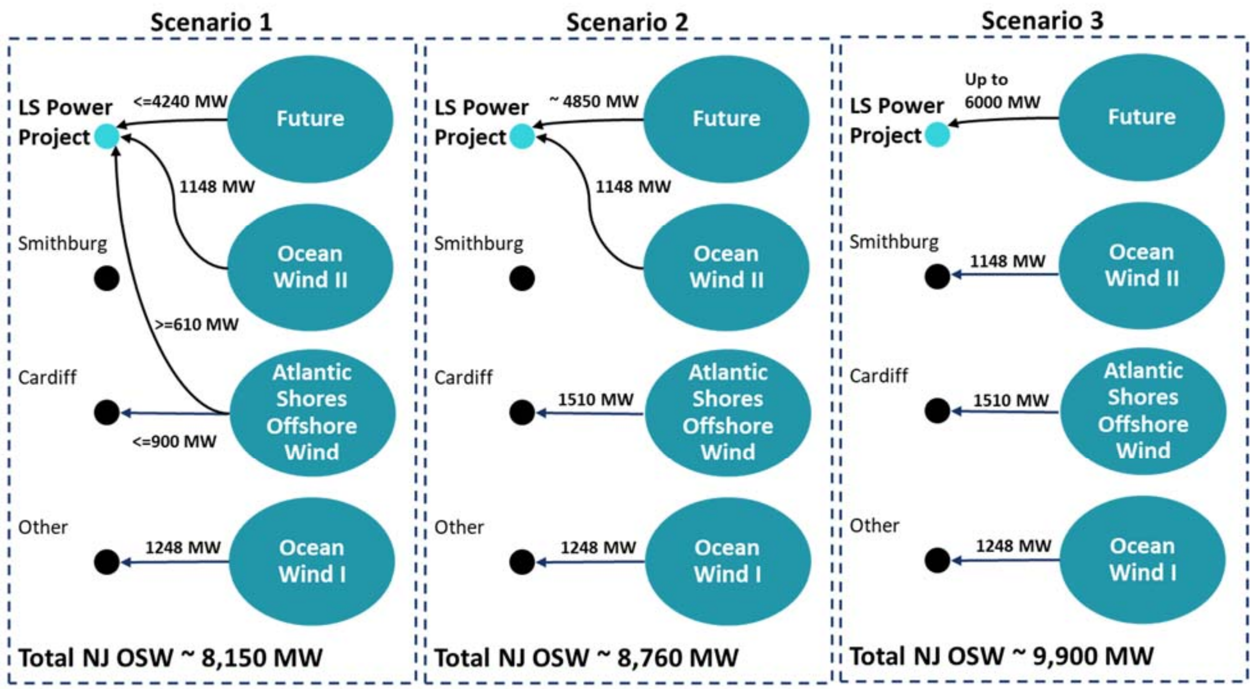


Figure 6: Injection Scenarios With Varying Amounts of Solicitation 2 Generation

IV. Affordability, Cost Containment and Risk Mitigation

LS Power Grid does not sacrifice safety, reliability, or quality in order to provide the most cost-effective solution with the least risk. In developing its proposals, substantial efforts were expended to inform a detailed cost estimate and support the cost containment measures, which protect New Jersey ratepayers from the most significant commercial risks to implement the project. Design measures were incorporated beyond the minimum requirements to increase reliability, provide flexibility, increase certainty, and reduce implementation and operational risks. These efforts will benefit the BPU and PJM by ensuring that the cost estimate is realistic, achievable, and backed by guarantees from a trusted entity with a track record of success.

The Clean Energy Gateway is the most affordable solution with:

- ✓ An all-in capital cost estimated to be 30% to 80% lower than competing alternatives.
- ✓ Lower life cycle costs provided by lower equity returns, reduced levels of equity, and long-lived assets requiring less specialized maintenance.
- ✓ Reduced OSW generation energy losses and curtailment risks.
- ✓ Minimal costs related to interconnection and system upgrades.

The cost savings of the Clean Energy Gateway proposal are backed by strong cost containment. LS Power Grid's proposal includes the following five binding cost containment commitments that protect New Jersey ratepayers:

- ✓ a project cost cap;
- ✓ a rate of return on equity cap;
- ✓ an equity percentage cap;
- ✓ a transmission revenue requirement cap; and
- ✓ a schedule guarantee.

These cost containment measures provide substantial value and protections for New Jersey and ratepayers, including cost certainty for all components of the revenue requirement. These cost containment measures are being provided at no premium to ratepayers.

To effectuate these cost commitment measures, LS Power Grid will file with FERC to incorporate the cost containment provisions into its formula rates and these provisions can be included in the Designated Entity Agreement. These provisions will be enforceable by FERC, or by the BPU or any other stakeholder before FERC.

Binding Project Cost Cap

LS Power Grid proposed a binding project cost cap in each of the Clean Energy Gateway proposals. Transmission ratepayers are typically exposed to all project implementation risks, associated increases in costs, and increased revenue requirements, which are significant for a project of this magnitude. The project cost cap provides assurance to the BPU and to New Jersey that the value of the Clean Energy Gateway will not be eroded by cost increases.

The binding project cost cap does not include any risk premium to ratepayers – if project costs are below the cap, then only the actual costs will be included in the rate base. However, if project costs are above the cap, then ratepayers will only pay rates on a rate base of the project cost cap. LS Power Grid's capped cost-of-service approach also ensures that ratepayers benefit from items like an investment tax credit for transmission infrastructure, if applicable.

Rate of Return on Equity (ROE) Cap

LS Power Grid's proposals included a binding rate of return on equity cap for the life of the project that is significantly lower than typical transmission ROEs. Unlike other proposed ROE structures, this cap is only subject to adjustment downwards and will not increase for the life of the asset. Ratepayers would otherwise be exposed to potential rate increases due to prevailing market conditions for the cost of equity or ROE adders/incentives over time. The ROE cap, combined with the equity percentage cap, can reduce the cost borne by ratepayers by 28%-40% as compared to typical New Jersey based utility revenue requirements as detailed in Technical Appendix Section 4.

Equity Percentage Cap

LS Power Grid's proposals included a binding cap on the actual or hypothetical capital structure used for determining its revenue requirements. The debt/equity ratio is a significant contributor to the cost of capital and the revenue requirement associated with the project. Because the ROE is typically much higher than the cost of debt, a lower percentage of equity will act to lower the weighted average cost of capital.

Transmission Revenue Requirement ("TRR") Cap

LS Power Grid's proposals include a binding TRR cap. The TRR cap includes the total amount of all of the elements that could be charged to ratepayers under cost of service rates including operations and maintenance costs, administrative and general costs, book depreciation, cost of debt, return on and of equity, inventory, as well as income taxes with limited excluded costs.

Guaranteed Completion Date

LS Power Grid will guarantee that the Project will be complete and ready for energization by the guaranteed completion dates. These dates ensure that the Project is completed in a manner that allows OSW from past and future BPU solicitations to connect to the Project without delays.

LS Power Cost Containment Performance

Risk management is essential to ensuring a project stays on schedule and within budget. LS Power Grid has adopted the risk philosophy that mitigates and manages risks in a manner that does not compromise safety, reliability requirements, environmental protection, or reputation. The BPU and

New Jersey benefit from this philosophy through confidence that risks transferred to LS Power Grid will be managed and mitigated in a manner that does not compromise these factors.

This approach has been used on all LS Power transmission projects and is a key contributor to its ability to deliver cost-effective transmission solutions with firm cost commitments. LS Power has extensive experience in assembling and managing multi-disciplinary teams to successfully deliver complex projects across the country. Perhaps more importantly, LS Power has unparalleled experience delivering competitive transmission projects subject to cost containment and schedule guarantees. LS Power has consistently completed extra-high voltage transmission projects at or below original cost estimates and on or ahead of schedule. The majority of these projects were subject to firm cost and schedule commitments. LS Power's disciplined project management approach and extensive diligence have facilitated firm commitments to the benefit of ratepayers, without seeking exceptions for "unforeseeable events".

Project	Region	Description	Final Cost Competitive Scope	Cost Containment	RTO Planning Estimate at Approval ($Year of Occurrence)
Silver Run	PJM	6 miles 230 kV including submarine cable	$149.5 million	$166.3 million	N/A. Proposals ranged $100 million to $1.55 billion
DesertLink	CAISO	60 miles 500 kV	$145.1 million	$145.5 million	$159 million
Republic	MISO	31 miles 345 kV	$56.8 million	$58.1 million	$74 million
Central East Energy Connect	NYISO	125 miles 345 kV	To be determined	$615 million	$819 million

V. Reliability and Other Benefits

LS Power Grid's Clean Energy Gateway proposals provide several other key benefits:

- ✓ *Reliability benefits*, as the Clean Energy Gateway adds AC capacity to the existing system and provides a more reliable, redundant offshore system;
- ✓ *Electricity market efficiency benefits*, including production cost savings and capacity market savings; and
- ✓ *Economic development benefits and community benefits*, including increased employment and tax payments in New Jersey and commitments to fund several local community efforts.

Reliability Benefits

The Clean Energy Gateway ensures reliable delivery of up to 6,000 MW of OSW to New Jersey load. The Project incorporates thoughtful solutions to meet reliability criteria, solve system violations, and enhance grid resiliency. Project components incorporate rigorous design criteria with the ability to withstand extreme weather events to provide high availability.

LS Power Grid's Option 1B proposals add new onshore circuits to the existing AC system. The Clean Energy Gateway provides new connections between western and eastern New Jersey. This allows for delivery of OSW generation to load within New Jersey and delivery of energy to eastern New Jersey load during times of low OSW generation. By providing new circuits to the existing AC system, the Clean Energy Gateway increases reliability through additional redundancy in the event of an outage of system elements. The new AC circuits also reduce loading on the existing system, especially when compared to singular HVDC injections of power. Reducing loading of the existing system reduces system-wide average losses compared to alternatives, which provides cost savings for ratepayers. LS Power Grid's Option 2 proposal provides redundant paths from offshore substations to onshore points of interconnection, increasing reliability of delivery and reducing curtailment of OSW generation.

During the design of the Clean Energy Gateway, particular importance was placed on reliability because of the large scale of the solution and New Jersey's future reliance on OSW. New Jersey can experience many different types of severe weather events including hurricanes, thunderstorms, lightning strikes, and ice storms. Design elements were incorporated to enhance reliability including meeting rigorous design criteria and specific measures to protect the Project against severe weather. For example, all onshore substations will be "storm hardened" and are designed to withstand extreme flood levels and extreme winds.

Electricity Market Efficiency Benefits

LS Power Grid conducted a market efficiency study of its Clean Energy Gateway Option 1B proposals, which identified several electricity market efficiency benefits.

LS Power Grid performed production cost analysis in the PROMOD software of a base case model, a model with power injection at the PJM default points of interconnection, a case with the complete build out of LS Power Grid's underground Option 1B Proposal ID#781, and a case with the complete build out of LS Power Grid's underground/overhead rebuild Option 1B Proposal ID#629. The analysis identified significant load savings[8] from the delivery of OSW generation for New Jersey, over $100 million per year, as well as for other areas within PJM. The analysis also identified significant reductions in emissions of carbon dioxide, sulfur dioxide, and nitrous oxide from electricity generation, with high reductions from the higher levels of delivery from the LS Power Grid proposals.

LS Power Grid performed a load deliverability analysis to assess potential capacity market savings. This analysis identified that Option 1B Proposal#629 would enable 522 MW more incremental OSW capacity than delivery to the PJM default points of interconnection, and Option 1B Proposal #781 would enable 635 MW more incremental OSW capacity than delivery to the PJM default points of interconnection. In addition, the LS Power Grid proposals provide incremental capacity for the Capacity Emergency Transfer Limit (CETL) into the EMAAC region, where all of New Jersey is located and which typically has a higher clearing price for capacity under PJM's base residual auctions. Based on the results of recent auctions, LS Power Grid estimates savings over $70 million per year relative to a case of delivery to the default points of interconnection.

PJM is conducting its own analysis of market efficiency benefits of the submitted proposals, and LS Power Grid anticipates the PJM analysis will identify similar market efficiency benefits in terms of load savings, emission reductions, and capacity market savings.

Economic and Community Benefits

The Clean Energy Gateway will provide substantial benefits to local communities and the state of New Jersey. These benefits include direct economic development, property tax and other tax payments, and indirection economic development including associated with OSW generation. LS Power Grid has committed to union contractors for construction. Property tax payments are estimated to be $20 million per year for the combination of Proposal IDs 629 and 594 and $35 million per year for combination of Proposal IDs 781 and 594.

LS Power Grid's proposal also provides community investment commitments including establishing a community outreach center, a wildlife monitoring fund, workforce development and scholarship programs, a ratepayer assistance program, and an investment in vehicle electrification.

[8] Load savings is a measurement of the total cost paid by load consuming customers for electricity in the PJM wholesale market.

V. Conclusion

The State of New Jersey is well situated with many OSW lease areas located proximate to its coast. The close proximity enables OSW to be integrated with an AC system and avoid having to rely on HVDC technology. This results in a system that is significantly lower cost, more efficient, more reliable, and more expandable while also minimizing impacts to the environment and communities. HVDC technology is not well suited for New Jersey OSW integration as it merely adds cost and complexity with no real purpose or material benefits.

LS Power Grid's Clean Energy Gateway extends and enhances the existing extra-high voltage AC grid to provide New Jersey with value unmatched by other proposals. This facilitates a highly reliable and resilient AC system using commercially available, proven and trusted technologies serving as a backbone that can be easily expanded in the future. This value is demonstrated as the Clean Energy Gateway integrates OSW at the lowest cost per MW and guaranteed for ratepayers through the strongest cost containment and risk mitigation. The Clean Energy Gateway is backed by the strength and proven ability of LS Power to develop, construct, operate and maintain high-voltage transmission infrastructure as promised.

Technical Appendix

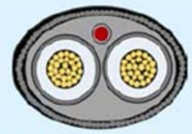
Contents

1. Electromagnetic Fields of AC and HVDC Cables

Contrary to claims of several participants in the stakeholder meetings, AC cables proposed by LS Power Grid have lower electromagnetic fields ("EMF") than HVDC alternatives proposed by others.

First of all, it is important to note that the studies have not found harmful impacts of EMF from submarine cables, including to species sensitive to magnetic fields. The magnetic field of a tri-core AC cable as proposed by LS Power Grid is significantly lower than the magnetic field of the HVDC cable alternatives proposed by others, as identified in the literature. A tri-core AC cable is configured in a delta-configuration, which significantly reduces the magnetic field due to a cancellation effect. A bundle of two HVDC cables has a significantly higher magnetic field, even at the same current and same voltage, than a tri-core AC cable. Technical Appendix Figure 1 below is from a recent Bureau of Ocean Energy Management study[1] related to OSW transmission. The first column related to AC inter-array cables is not relevant to this discussion. The second column identifies the magnetic field of an AC export cable from 138 kV to 400 kV at a current of 700 A to 1265 A to be between 30 milligauss to 165 milligauss measured at the seafloor. LS Power Grid is proposing cables within this range. The third column identifies the magnetic field of a HVDC export cable from 75 kV to 500 kV at a current of 625 A to 1330 to be between 590 milligauss to 1250 milligauss measured at the seafloor, an order of magnitude higher. The HVDC cables proposed by others are within this range.

Table 1. Comparison of offshore undersea power cables. Magnetic fields are calculated between seafloor and 1 m above seafloor for cables buried ~1 - 2 m below seafloor[1]

Power Cable Characteristic	 AC Inter-Array Cable	 AC Export Cable	 DC Export Cables
Cable Voltage (kV)	34.5 to 161	138 to 400	±75 to ±500[2]
Cable Size (mm)	125 to 170	210 to 265	130[4]
Cable Current (A)	700 to 760	700 to 1265	625 to 1330[2]
AC Magnetic Field at seafloor (mG)	20 to 65	30 to 165	0[3]
DC Magnetic Field at seafloor (mG)	0[3]	0[3]	590 to 1250[2]

[1] Figure 5 provides a detailed cable cross section with the components.
[2] DC cable voltages, currents, and magnetic fields from Normandeau et al. [1], Appendix B, Tables B-1 and B-7.
[3] AC power cables are sources of AC magnetic fields but may be sources of very weak DC fields if ground currents flow on the cables or shields. DC power cables are sources of DC magnetic fields, and depending upon the technology, sometimes very weak harmonic AC fields.
[4] per cable rated at ±320 kV; AC cable at similar load lists bundle diameter as 220 mm [24].

Technical Appendix Figure 1: HVDC / AC EMF Comparison

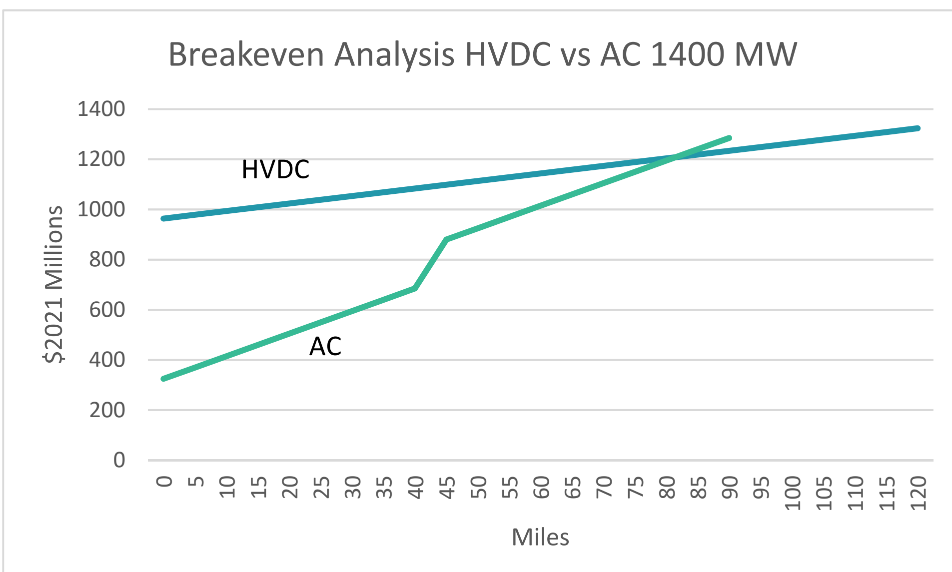
With respect to electric field, the electric field of an AC cable is greater than that of a HVDC cable, but the electric field of both an AC and HVDC cable properly armored and buried is negligible.

[1] Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England. Available at https://espis.boem.gov/final%20reports/BOEM_2019-049.pdf

2. Example Breakeven Analysis of AC vs. HVDC Deployment

The deployment of HVDC technology is limited to cases where the benefits of HVDC outweigh the incremental cost of HVDC equipment. These benefits could be where AC cables are not feasible, where the controllability of HVDC results in other system benefits, or where the distance is such that the savings of HVDC cables offsets the cost of HVDC terminals. HVDC technology is also used to connect two asynchronous systems. None of these circumstances are present in the case of transmission for New Jersey offshore wind. AC cables are feasible. Radial HVDC connections to a single point of interconnection would be controlled to match the OSW generation, operating the same as an AC cable. The benefits of savings from HVDC cables does not offset the cost of the offshore HVDC terminal at the relatively short distances, as shown in the following break-even analysis.

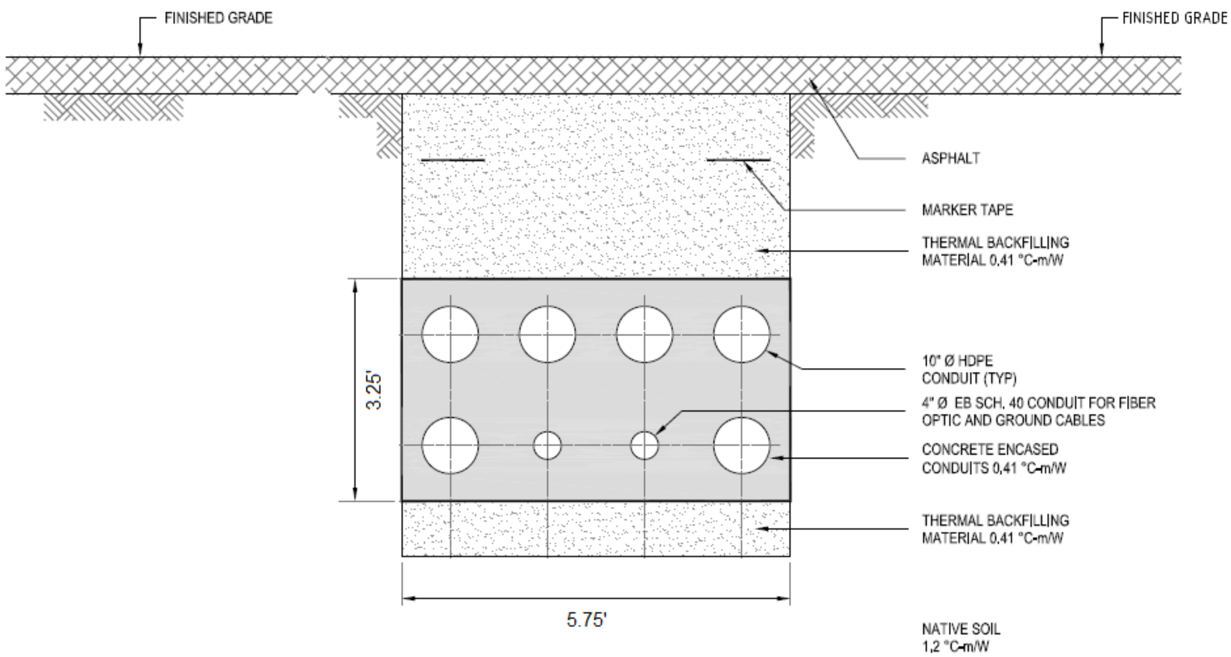
Technical Appendix Figure 2 provides an example breakeven analysis for cost for the use of HVDC transmission for 1400 MW of offshore wind. The assumptions behind this example are 1) HVDC offshore platform and terminal and HVDC onshore terminal total cost of $960 million, 2) HVDC cable installation of $3 million per mile, 3) AC offshore platform and onshore terminal costs of $325 million, 4) AC cable installation of $9 million per mile, 4) AC cable requires $150 million midpoint compensation station at a length of 45 miles or more. HVDC would become more cost effective at a length of approximately 80 miles. Note that the current OSW lease areas are less than 60 miles from the New Jersey coast.



Technical Appendix Figure 2: Example HVDC / AC Cost Breakeven Analysis

3. Profile of Duct Bank for LS Power Onshore Underground Cables

AC cables are routinely installed beneath municipal and state roads. The space requirements and construction techniques for the onshore underground cables proposed by LS Power Grid are typical. First, conduits will be installed underground, encased in concrete. Manholes will be installed approximately every 2,000 feet, and cables pulled through the conduits from manhole to manhole and spliced together. Technical Appendix Figure 3 identifies a proposed duct bank with two circuits with three cables each. The duct bank is 5.75 feet wide and 3.25 feet high, generally requiring only a single lane of traffic to be closed at a time during construction activities. Note that the capability of a duct bank with two onshore AC circuits is approximately 2,200 MW, compared to 1,200 MW to 1,500 MW for an onshore duct bank with a single HVDC circuit.



Technical Appendix Figure 3: Onshore Underground Duct Bank

4. Impact of the Cost of Capital on Ratepayers

The cost of capital is a key determinant in utility cost-of-service rates as it determines the annual payments for financing the upfront cost in terms of debt payments and payments to the equity investors. Reducing the cost of capital is similar to reducing the interest rate on a mortgage or car loan, and can provide very high savings over time.

Different transmission service providers can have significantly different costs of capital due to varying equity layers and return on equity requirements. The table below compares the impact of the cost of capital on the actual costs paid by ratepayers. The first column is representative of what terms might be included in a competitive proposal. The other three columns include values taken from actual formula rates of PJM utilities. The last column includes 100 basis points of ROE adders, since in the absence of an ROE cap, PJM and the BPU should assume the highest possible ROE. The utility capital structures have a cost of capital that is between 28%-40% higher than the cost of capital of the competitive proposal. So even for two projects with the exact same capital cost, there is a potential for significant ratepayer savings every year for the life of the project.

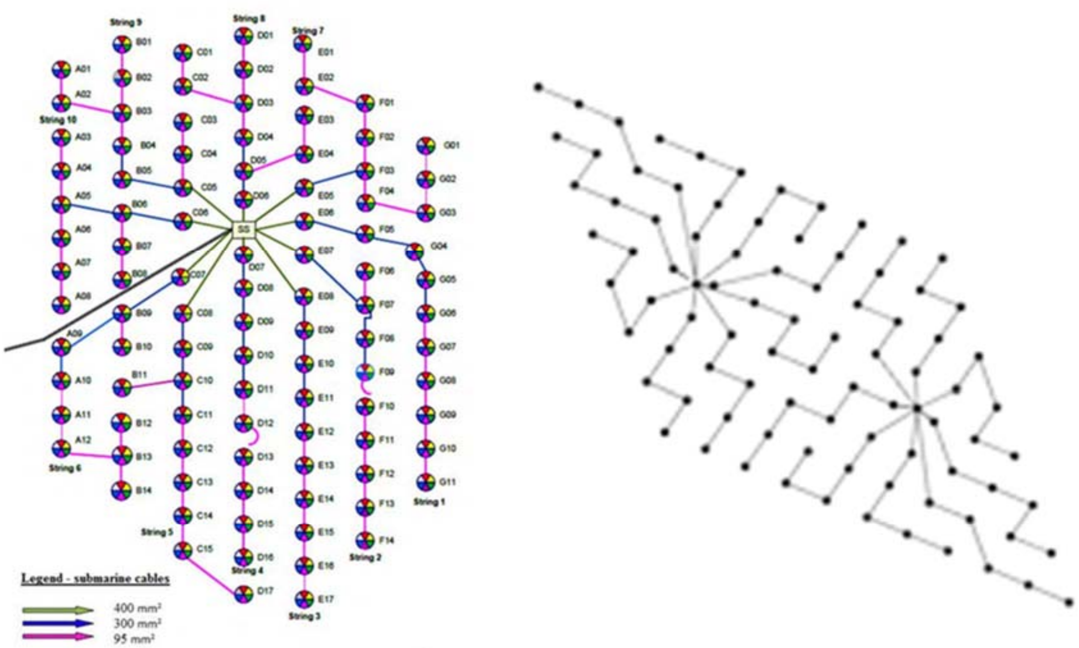
	Competitive Proposal	PJM Regulated Utility 1	PJM Regulated Utility 2	PJM Regulated Utility 3
Rate of Return on Equity	9.0%	10.5%	10.8%	11.4%*
Cost of Debt	3.95%	4.40%	4.80%	3.95%
Equity/Debt Percentages	40.0% / 60.0%	50% / 50.0%	51% / 49.0%	54.6% / 45.4%
Federal/State Income Tax Rates	21.0% / 9.0%	21.0% / 9.0%	21.0% / 9.0%	21.0% / 9.0%
Total Pre-Tax Cost of Capital	7.1%	9.0% +28% higher	9.5% +35% higher	9.9% +40% higher
First Year Capital Recovery for $3 Billion Rate Base	$212 million	$271 million	$285 million	$297 million
Incremental Cost of Utility vs. Competitive Proposal, Year 1		+$59 million higher	+$74 million higher	+$85 million higher
Incremental Cost Over 20 Years		+$985 million	+$1.2 billion	+$1.4 billion

*includes 100 basis point ROE adders

Based on the pre-tax cost of capital identified in the table above, the first year difference in the revenue requirement would range from $59 million to $85 million for $3 billion of facilities. In general, this savings would decrease over time due to the depreciation of rate base. This is not always the case, since a utility with uncapped rates could file for a higher percentage of equity, or a higher rate of return on equity, increasing the cost to ratepayers. Setting aside the risk of higher rates and taking into account depreciation, the total savings over the initial 20 years of operation due to the differences in the cost of capital would be from $985 million to $1.4 billion – relative to an initial capital cost of $3 billion. These savings would continue for the life of the project – up to 60 years or more.

5. Optimization of Offshore Inter-Array Cables

Delivering OSW to shore through AC cables allow for better optimization of the OSW generators' inter-array cable configuration. Technical Appendix Figure 4 illustrates an optimized cable array configuration for two actual European OSW facilities. The configuration on the left is from a single wind collection station, such as will be required by an HVDC approach. As shown, placing a constraint of requiring all OSW generation to be collected to a single point is not optimal. This requires more generators on a single circuit and/or more circuits with higher losses as a result. The configuration on the right is optimized with two collection points. A single collection point could have been used if it were optimal, but without a constraint requiring a single collection point, the OSW generation developer optimized the configuration with two collection stations. A HVDC approach would require collection stations matching the size of the HVDC convertor, proposed by various bidders in sizes of approximately 1200 MW-1500 MW. LS Power Grid's AC approach provides for collection stations in increments of 500 MW each, matching the capacity of a single 345 kV tri-core submarine cable, providing for the ability to optimize the inter-array cable configuration.



100 Wind Turbine Generator Project
Inter-Array Cable Configuration
Single Collection Station

88 Wind Turbine Generator Project
Inter-Array Cable Configuration
Two Collection Stations

Technical Appendix Figure 4: Inter-Array Cable Configuration Comparison