WATT Coalition Comments Urging Inclusion of Grid Enhancing Technologies to Reduce Cost and Increase Pace of Offshore Wind Integration to Meet NY CLCPA Goals

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The WATT (Working for Advanced Transmission Technologies) Coalition is pleased to offer the following comments on the NYSERDA 2022 Offshore Wind Solicitation Draft.

The WATT Coalition is a non-profit organization focused on facilitating the adoption of advanced technologies on the US electric transmission system that improve reliability, lower cost, and accelerate decarbonization, benefiting American citizens and businesses. The WATT coalition is comprised of associate members benefiting from Grid Enhancing Technologies and 7 technology members, offering Advanced Power Flow Control, Dynamic Line Ratings (DLR), and Topology Optimization:

Ampacimon is a global leader in grid monitoring solutions that utilize patented sensors and software to increase the capacity of transmission and distribution assets. Their dynamic line rating systems, with grid monitoring sensors and software, have been deployed worldwide.

Lindsey Manufacturing Company provides innovative and cost saving products to the global electric utility industry. Lindsey is an industry leader in transmission line monitors and software for measuring and forecasting dynamic line ratings and line capacity. They produce a variety of other systems designed to enhance grid resiliency and optimize distribution networks.

LineVision provides utility solutions that leverage advanced sensors and analytics to increase the capacity, flexibility, and reliability of overhead lines. Their non-contact monitoring systems provide real-time situational awareness and anomaly detection, unlock additional capacity on existing lines, and provide condition-based health analysis to optimize asset management and grid reliability.

NewGrid is a software firm that provides transmission topology optimization tools and services. NewGrid's software automatically identifies grid reconfigurations to route power flow around congested or overloaded transmission facilities (it is, in a sense, a "Waze" for the grid), increasing the transfer capability of the grid and delivering savings and increased reliability and resilience.

Smart Wires develops and implements technologies that advance the delivery of electricity around the world. With their technology, electric utilities can maximize transfer capacity on their grids, creating a more flexible and efficient network. Their power flow control technology dynamically controls transmission line reactance to direct power away from overloaded lines onto lines with spare capacity.

WindSim has developed a wind farm design software based on computational fluid dynamics that optimizes wind turbine placement. Using accurate simulations, WindSim software can more realistically capture terrain effects on wind conditions than many traditional technologies. WindSim Power Line (WPL) is a a state-of-the-art forecast solution for overhead line operations and provides transmission owners an enhanced view of the conditions of their transmission lines by modeling wind at high-spatial resolution and computing thermal interactions (using IEEE-738) for every transmission span on which the system is deployed.

Heimdall Power provides cost-efficient dynamic line rating-based solutions to support data-driven decision-making for operations and planning of high-voltage overhead power lines. Their sensors and software optimize power grid utilization by maximizing power line capacity, control, and uptime. Real-time and forecast insights allow for swift detection of issues & predictive maintenance, and increased flexibility through energy flow & bottleneck analysis.

Associate members of the WATT Coalition include Vermont Electric Power Company, EDF Renewables, Invenergy, and Pine Gate Renewables.

Grid Strategies LLC serves as the convener of the WATT Coalition.

The WATT Coalition recognizes that New York has an aggressive offshore wind goal to install 9 GW by 2035 to support Climate Leadership and Community Protection Act (CLCPA) decarbonization targets, and that the onshore electricity grid will require significant development to manage associated interconnections. Historically, utilities, system operators, and regulators assumed the transmission grid was essentially "fixed" in capacity and configuration. This assumption ignores the capabilities offered by advanced transmission technologies which allow physical transmission assets to be actively managed to provide more transmission capacity, reduce grid congestion, provide higher reliability and resilience and improve the integration of renewable generation. By using the Grid Enhancing Technologies (GETs) offered by the WATT Coalition to fully utilize the grid's capacity, New York can dramatically reduce the amount of new asset construction and cost while accelerating progress toward meeting requirements in a non-disruptive and socially-just way.

This response provides input primarily on the Interconnection and Delivery details in Sections 2.1.6, 3.2.6, and 6.4.8:

1. NYSERDA validation of wind integration with GETs
2. Injection point overload mitigation
3. Application for system wide benefits

1. GETs are currently being evaluated by NYSERDA to support wind integration

In 2021 NYSERDA kicked off a funded initiative of several projects to promote the development of a high performing smart electric grid that integrates a diverse supply of renewable energy resources, enhances overall grid performance and resiliency, and enables customers to reduce their energy costs, consumption, and environmental impacts.[1] WATT members LineVision and Smart Wires were both recipients of project funding, indicating NYSERDA and stakeholder support for novel approaches to identify underutilized system capacity and shift power flow to reduce congestion and allow more net power to flow in the existing system.

Modeling GETs in transmission planning is straightforward, WATT recommends that these technologies be prioritized in proposer Interconnection & Delivery plans and that a loading order approach be taken by third-party consultants to resolve constraints. Advanced power flow control injects a voltage waveform in series with the line. For transmission planning purposes, this can be simply modeled as a change in line reactance. Modules for series reactors (increase line reactance) and series capacitors (decrease line reactance) are available in transmission planning software. Smart Wires can provide tools that survey an area of the grid, identify the best locations for advanced power flow control, and iterate through various installation sizes until the constraint is resolved.

Topology optimization software identifies reconfigurations of the transmission grid, implemented by opening or closing existing high-voltage circuit breakers. These reconfigurations can be readily validated, studied and represented in standard transmission planning software.

Dynamic line rating enables transmission operators to allow higher currents on a line than its static rating, depending on ambient conditions like temperature and wind speed. The impact of dynamic line rating is not typically modeled in long term transmission planning, but it is represented in operational models by changing the line current limits.

2. Overloads can be mitigated at or near the generator injection point with GETs

Evidenced by the results from the first NY lease auction, in which six projects totaling 7 GW were selected, the ratings of these NY offshore wind projects are much closer to those of nuclear power facilities than conventional onshore renewable energy.[2] Simply put, the existing onshore electricity grid was not designed to accommodate multiple, nuclear-sized power flow injection points along the coast. So as phased tranches of offshore wind power aim to connect to the onshore network, modeling indicates that circuits near or connected to the injection point typically see an excess share of new power flow, overloading their thermal rating, as referenced in Section 2.1.6 of the Draft Solicitation. However, there are often lower voltage constraints that limit the optimal utilization of these main high-capacity lines. Advanced power flow control deployments can resolve constraints by rerouting power away from newly-overloaded circuits and onto underutilized paths with spare capacity. Such a scheme was used by National Grid Electric Transmission in the UK to increase power transfers from Scottish wind to the London metro area by roughly 1.5 GW.[3] There is also inherent complementarity of

[1] https://www.nyserda.ny.gov/About/Newsroom/2021-Announcements/2021-09-28-NYSERDA-Announces-11-Million-to-Enhance-Electric-Grid-Performance

[2] https://www.doi.gov/pressreleases/biden-harris-administration-sets-offshore-energy-records-437-billionwinning-bids-wind

[3] https://www.smartwires.com/2019/11/26/nget-release/

increasing line capacity with dynamic line rating during periods of peak wind and managing incremental flow changes by rerouting power with topology optimization and adjusting dispatch of installed advanced power flow control units. WATT strongly recommends that NYSERDA direct proposers to incorporate rapid GETs network upgrades in line with the first phase of offshore wind build-out, while longer-term system expansion is evaluated and ultimately constructed.

3. Broader system benefits can be achieved with these flexible technologies

Aside from the injection point constraint mitigations discussed above, GETs implementations provide noticeable incremental benefit due to their flexibility in dispatch and control. Per Sections 3.2.6 and 6.4.8, NYSERDA should direct proposers to think creatively about their interconnection and delivery plans, leveraging GETs for these submissions would likely yield greater benefit to NY ratepayers. The rapid time scales for GETs implementation, often weeks to months, will also allow proposers to achieve higher deliverability sooner than with traditional upgrades. The temporary and redeployable nature of GETs hardware can even provide relief during economically or reliability-challenged outages associated with new generation-driven construction.

Series compensation has also been documented as an effective approach to manage voltage stability challenges on long transmission lines connecting large renewable generation pockets with load centers. The most common issues with fixed series capacitor (FSC) installations are their risk of resonating at sub-synchronous frequencies, known as sub-synchronous oscillations (SSO). The two most common types of SSO are sub-synchronous torsional interaction (SSTI) and sub-synchronous control interaction (SSCI). [4] Advanced Power Flow Control is a proven alternative with negligible sub-synchronous oscillation (SSO) risk, and has been validated by Central Hudson Gas & Electric in advance of a series compensation application. [5] In these devices, the phase-locked loop generates a stepped pulse sinusoidal voltage signal mainly at the fundamental frequency and independently from the line current. This scheme, validated in multiple academic papers and textbooks on flexible alternating current transmission system devices, ensures that there is negligible to no impact to SSO.

Regions across the globe have observed the SSO phenomenon. An SSO event that occurred in 2016 in Latin America caused extensive damage to generation facilities due to SSO interactions, and more specifically sub-synchronous torsional interaction, between the generation facilities and the FSC. Mitigations for SSO are often costly and can include intentionally constraining nearby generation or limiting the power flow control impact of the series compensation. Given the many operational and economic implications of mitigation options, the fastest and most practical solution is to permanently bypass any FSC installation at risk of SSO interactions. However, doing so effectively eliminates the contribution of capacitive reactance to the grid and strands multi-million-dollar investments. Even when initial studies don't show SSO issues, changes to the grid topology and generation in the future could result in conditions for SSO to occur.

Phase Angle Regulators (PARs) are legacy bulk oil-filled devices that have historically been used in New York to manage power flow across borders or seams, for example between New York (NYISO) and

[4] Torsional interaction is the opposing torque forces between the turbine-generator shaft and the electrical grid. Control interactions occur when doubly-fed induction generator controls act to "amplify" sub-synchronous currents entering an induction generator (such as wind turbines). This results in high torsional stress on generator rotor shafts and instability in power electronic control systems.

[5] https://www.epri.com/research/products/000000003002019771

Pennsylvania (PJM). Advanced power flow control is a proven, compelling alternative to PAR (also known as Phase-Shifting Transformer or Quadrature Booster) applications and are even seen as a "more environmentally friendly technology than a conventional quad booster, with a carbon footprint that is approximately ten times less."[6] PARs are inherently challenging to move between locations or voltage classes. Commonly substations are unable to provide enough space for PAR deployments, restricting their application to a limited number of locations. Modular advanced power flow control deployments can be relocated easily and offer more flexible siting than PARs, as they can be installed in smaller footprints, across multiple areas at a single substation or across multiple substations.

Advanced power flow control devices can be manufactured and installed in 6 to 12 months, whereas PAR manufacturing timelines are roughly 48 months, this rapid delivery enables constraint mitigation in line with offshore wind development timelines. PARs operate through manual tap-changes, which can result in additional maintenance and reduced life when operated frequently. Accordingly, PARs are often given a periodic set point (monthly or seasonal) to manage flows over the given period, but this often results in sub-optimal system operation. Advanced power flow control devices utilize power electronics and can change operating points frequently, without increased maintenance or component degradation, enabling optimal operating point selection to maximize system benefits.

Inherently, PARs control power flows on a single circuit, and therefore do not typically offer wide-area control schemes. Conversely, advanced power flow control devices offer real-time, granular control, with software and firmware enabling operators to coordinate between multiple deployments to optimize system power flows. The modular nature of these devices provides additional resiliency against potential component failure, it is consequently straightforward to add extra modules on hot standby whereas PARs are characterized by a single point of failure. NYSERDA should direct proposers to investigate advanced power flow control as a preferred alternative for any PAR or series compensation needs associated with their interconnections, to avoid environmental, cost, time, and SSR/SSCI risks.

4. Conclusion

Investments in GETs have provided large system impact and substantial savings for consumers around the world and will do the same for New York ratepayers via these recommendations to the New York 2022 Offshore Solicitation draft. The WATT Coalition urges NYSERDA staff to prioritize proposer submissions that leverage GETs in their Interconnection & Delivery plans. Advanced power flow control should be recognized as the preferred method for series compensating long, high capacity AC lines.

From overload mitigation to enhanced outage management, GETs provide significant benefits to New York ratepayers by enabling a more flexible, controllable network. Fully utilizing the capacity of the existing network is the most cost-effective means of enabling rapid offshore wind integration in New York and ensures that all ratepayers see the lowest rate impact possible while accruing the benefits of the clean energy transition.

Best Regards,

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[6] https://www.nationalgrid.com/electricity-transmission/document/137561/download (p. 14)

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