Executive Summary of Initial Report on the New York Power Grid Study

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Executive Summary

New York's Climate Leadership and Community Protection Act (CLCPA) requires an unprecedented transformation of the State's electricity grid to achieve 70% renewable generation by 2030, zero-emission electricity by 2040, and an 85% economy-wide reduction in greenhouse gas emissions from 1990 levels by 2050. The CLCPA specifies minimum amounts of certain types of resources, including 6,000 MW of distributed solar resources by 2025, 3,000 MW of storage by 2030, and 9,000 MW of offshore wind (OSW) generation by 2035. Even greater quantities of various types of renewable generation are necessary to achieve the clean energy mandates for 2040 and 2050. Meeting these milestones will require investment in renewable generation, as well as storage, energy efficiency measures, electrification of the transportation and heating sectors, and electric transmission and distribution (T&D) infrastructure.

T&D infrastructure will play a critical role in meeting the State's goals by connecting new renewable resources to the grid and transmitting and delivering energy to consumers. Accordingly, the recently enacted Accelerated Renewable Energy Growth and Community Benefit Act directs the Public Service Commission (PSC) to advance the work of identifying T&D upgrades needed to reliably and cost-effectively integrate the required renewable resources, and to establish planning processes to support cost-effective and timely infrastructure development.

To meet these directives, the PSC, through the Department of Public Service, initiated a set of system studies, collectively referred to as the Power Grid Study (PGS), which is the subject of this Initial Report. The PGS consists of three components, each of which is included in this Report:

- A study conducted by the Joint Utilities[1] on local transmission and distribution (LT&D) needs (Utility Study);

[1] The Joint Utilities include the New York utilities of Central Hudson Gas & Electric Corp. ("Central Hudson"), Consolidated Edison Company of New York, Inc., (ConEd), Long Island Power Authority (LIPA or LIPA/PSEG), Niagara Mohawk Power Corporation d/b/a National Grid (National Grid), New York State Electric & Gas Corporation and Rochester Gas and Electric Corporation (NYSEG and RG&E or AVANGRID), and Orange & Rockland Utilities, Inc. (Orange and Rockland or O&R).

- A study of offshore and onshore bulk-power transmission infrastructure scenarios, and related environmental permitting considerations, to illustrate possible solutions to integrate the mandated 9,000 MW of offshore wind (OSW generation by 2035, sponsored by the New York State Energy Research and Development Authority (NYSERDA) and conducted by DNV-GL, PowerGem, and WSP (OSW Study)
- A state-wide scenario-based study to analyze transmission, generation, and storage options for achieving 70% renewable generation by 2030 and a zero emissions grid by 2040, sponsored by NYSERDA and conducted by Siemens (Zero Emissions Study).

The overall results of the Power Grid Study indicate that:

- Transmission expansion programs already underway have positioned the State well to achieve its **2030** milestones.[2] Additional efforts are likely needed to: (a) accelerate certain LT&D upgrades over the next decade; (b) expand Long Island bulk transmission to facilitate the interconnection of OSW generation and its delivery to the rest of the State (the OSW Study proposes that interconnecting 6,000 MW of wind in New York City and the remaining 3,000 MW on Long Island should be feasible, but capacity beyond this quantity on Long Island will require upgrades); (c) identify feasible and cost-effective OSW interconnection-related substations and local transmission upgrades in the New York City area; and (d) implement carefully-planned storage deployment that is closely coordinated with OSW and land-based renewable generation interconnection needs.
- Integrating 9,000 MW of offshore wind generation by **2035** is projected to be achievable without major onshore bulk transmission upgrades beyond expanding Long Island bulk transmission links and likely local upgrades in New York City, as previously noted. Interconnecting a maximum amount of OSW in the New York City area would be advantageous given the large load and strong bulk transmission system. However, overcoming cable routing limitations in New York Harbor, space constraints in substations on Manhattan, and permitting complexities in both the Harbor and along the Long Island coastline (including approaches to New York City through the Long Island Sound) will require careful planning of OSW transmission cable routes and points of interconnection. Creating the option for a meshed offshore network by linking the offshore substations of several individual OSW plants near each other is valuable

[2] The already-planned projects assumed to be developed include the Western NY Empire State line 345 kV project in Zone A, the AC Transmission Segment A & Segment B 345 kV projects in Zone E and F, and the Northern New York 345 kV projects in Zone D and E (including upgrades from Porter to Edic). Additionally, the Zero Emissions Study assumes a new 1,250 MW high-voltage direct current transmission line delivering dispatchable renewable energy into New York City.

because a meshed configuration can achieve a more reliable and resilient delivery of OSW generation. However, a decision to implement a meshed system can be delayed (and perhaps should be delayed pending federal approval of new wind energy areas), as long as the State ensures that any projects with radial connections are constructed in ways that include the option to integrate the radial lines into a meshed system later.

- Projections for future bulk transmission needs through **2040**—beyond the already-planned projects and an expected new high-voltage direct current line delivering dispatchable renewable energy into New York City—depend to some extent on how the State progresses toward its renewable generation goals, among other factors. For example, changes in the mix and locations of generation development as the State approaches the zero-emission grid milestone may affect congestion costs and the need for new bulk transmission. These may include the downstate congestion relief projects identified in the Zero Emission Study as potentially needed by 2040. However, the study's conclusions about bulk transmission needs rely on particular simulations and assumptions that are more idealized and optimized than is likely achievable. Some of the recent NYISO studies,[3] utilizing different assumptions, suggest that congestion costs may be incurred in an earlier time frame. The State should coordinate with NYISO to revisit these and other relevant study assumptions at regular intervals to ensure that bulk transmission needs are pro-actively identified. The NYISO's economic and public policy planning processes provide an effective mechanism for identifying such needs and developing timely solutions.

Assessment of the Power Grid Needs

The three PGS studies suggest the following potential distribution, local transmission, and bulk transmission needs:

- Through 2030, the need for upgrades to the Utilities' **local transmission and distribution** systems may be limited to the acceleration of LT&D projects that are already in the Utilities' plans to address expected reliability needs and refurbishment of aging assets. On a total state-wide basis, these Phase 1 projects appear to expand the local grid's headroom sufficiently to integrate the land-based renewable resources needed to meet the CLCPA's 2030 requirements, and possibly beyond. Thus, accelerating the utilities' planned reliability upgrades and asset maintenance programs

[3] Examples are the 2019 CARIS Report, 2020 RNA Report, the New York Grid Evolution Study, and the Climate Impact Study prepared by or on behalf of NYISO in 2020.

will capture significant CLCPA benefits—although some Phase 2 projects should be prioritized to support renewable generation development in attractive locations.

- Proposed Phase 1 Utility projects include the following:
  - Utility distribution investments that would add 1,970 MW of headroom interconnection of distributed renewable resources
  - Planned local transmission projects that would add up to 5,710 MW of headroom for renewable resources located in export-constrained upstate generation pockets to on-ramp them onto the bulk transmission
  - Planned Phase 1 local transmission projects that would add 910 MW of headroom to off-ramp generation from the bulk transmission system to downstate load pockets, needed in the short term to allow for the retirement of peaking generation while supporting delivery of renewable generation as the State approaches its zero-emission milestone in 2040

- The Utility Study does not identify specific CLCPA-driven transmission needs for land-based resources beyond those that may be addressed through the acceleration of local Phase 1 projects. However, in case additional renewable generation headroom is needed beyond that provided through Phase 1 projects, the Utilities proposed a number of Phase 2 candidate projects that would be able to further expand headroom for CLCPA benefits.[4]
- Utility Phase 1 projects may not provide enough headroom in some locations with attractive renewable development opportunities. For these specific locations, some Phase 2 CLCPA-driven projects will be necessary and should be prioritized.
- To address already-anticipated challenges associated with integrating 9,000 MW of OSW generation, the Utility Study suggests the following Phase 2 candidate solutions:
  - LIPA proposes to increase export capability from Long Island—a need LIPA submitted in the NYISO public policy transmission planning process—and related upgrades to convert a portion of its local transmission system to bulk-power voltage levels.

[4] The Utilities also proposed a policy framework for the selection, prioritization, benefit-cost analysis, and cost allocation of such CLCPA-driven LT&D projects. The proposed policy framework will be addressed by the PSC in a future order in Case No. 20-E-0197. This Initial Report focuses on the power grid implications of the Utility Study and does not address the Phase 2 policy proposals.

    - ConEd is proposing candidate Phase 2 projects to address reliability needs and space constraints at its New York City substations, with two OSW integration hubs capable of integrating 5,200 MW of additional OSW generation into the City's system.

- The OSW Study indicates additional **transmission from Long Island** (NYISO Zone K) to the mainland (Zones I and J) will be needed by 2035. The study shows this need arises as interconnecting more than 3,000 MW of OSW generation to Long Island would cause increased curtailments. Interconnecting more than 3,000 MW to the Long Island grid may be inevitable as more than 9,000 MW of OSW generation is likely required for achieving the State's zero emission mandate by 2040, or even earlier if constraints in New York City force more of the 9,000 MW to Long Island.
- The OSW Study indicates connecting the off-shore substations of nearby OSW plants to create a **meshed offshore network** can achieve a more reliable and resilient delivery of OSW generation—even given necessary delays to such an approach pending federal approval of new wind energy areas by the Bureau of Ocean Energy Management (BOEM).
- The Zero Emissions Study also projects that additional **bulk transmission from upstate into New York City and Long Island** (from Zone H to Zones I, J, and K) will likely become cost-effective after 2035 as the grid approaches zero emissions, as a means to address high congestion costs associated with the unavailability of fossil-fueled generation options. These congestion-reducing transmission investments would reduce upstate congestion and renewable generation curtailments and allow the downstate (New York City and Long Island) area to reduce its projected reliance on backstop renewable-fueled thermal generation.
- The Zero Emissions and OSW Studies both find that location-optimized **battery storage** will be necessary to cost-effectively address the renewable generation integration and avoid more substantial transmission upgrades. The OSW Study finds that avoiding major transmission upgrades requires the carefully planned colocation of 1,700 MW of battery storage at the substations in the New York City area and Long Island utilized for integrating OSW generation. The Zero Emissions Study optimizes the location-specific deployment of 3,000 MW of battery storage by 2030, of which 1,600 MW would be deployed in New York City and Long Island. The study finds storage needs accelerate rapidly after 2035 as an emission-free grid needs to be achieved by 2040, with approximately 15,000 MW of battery storage projected state-wide by 2040, of which 7,300 MW would be located in New York City and Long Island.

Recommendations for the Future Grid

The Power Grid Study is a first step toward planning the investments in New York's electric system that are needed to meet CLCPA goals. It provides valuable information to the State, utilities, and transmission and renewable generation developers. However, cost-effective transmission development and utilization of the existing grid requires foresight and coordination that will necessitate the continuation of active planning, coordination, and process management. Without them, challenges and costs will likely exceed those identified in the studies. For the State to cost-effectively achieve its CLCPA milestones, this report offers the following recommendations for further consideration by the PSC and State policy makers.

Local Transmission and Distribution

- The PSC should consider implementing an expedited approval process for the proposed **Phase 1 local transmission and distribution projects**. Many of the Phase 1 projects facilitate timely interconnection of renewable generation in constrained upstate generation pockets.
- The Utilities' proposed Phase 2 projects should be assessed further. These projects can be evaluated—along with advanced technology options—based on the utilities' proposed Phase 2 project selection and cost-benefit framework.
  - Some proposed Phase 2 projects should be prioritized as they provide unique opportunities to expand Phase 1 projects and/or address high-interest, high-potential renewable generation pockets.
  - As a next step, the PSC should work with the Utilities and NYSERDA to advance high-priority Phase 2 projects to address headroom constraints in high-interest, high-potential renewable generation development areas, such as the Hornell generation pocket, for which the proposed Phase 1 projects do not create sufficient headroom.
- Significant renewable generation potential also appears to exist in areas of the State that currently do not have access to the existing transmission infrastructure. These areas have not been addressed in the Utility Study or the NYISO CARIS analyses which formed the starting point of the Utility Study. The PSC may want to consider whether several such areas in the NYISO footprint should be developed as local renewable energy zones through the construction of new local transmission infrastructure.
- In future assessments of the CLCPA benefits of LT&D projects, we recommend the Utilities adopt a *common* set of methodologies that more comprehensively identify

renewable integration benefits. The benefits created by projects should be quantified both in terms of renewable capacity and energy, rather than just capacity. Assessments of local transmission projects should include models of neighboring utilities' systems. Assessment of distribution projects should: (1) incorporate detailed modeling of the electrical system upstream and downstream of the distribution substation, (2) account for variability in load and renewable output, (3) address demonstrated DER developer interest through the use of queue data, and (4) include technical issues beyond thermal capacity ratings.

Offshore Wind Transmission

- The planning process to address OSW-related **transmission needs from Long Island** should be initiated. All studies indicate that additional tie-line capacity would be needed by 2035–2040 as renewable requirements expand and emissions limits tighten. Advancing such a project would provide additional value earlier if constraints into New York City force more than 3,000 MW of OSW into Long Island and mitigate curtailments associated with real-world operating conditions not captured in the studies' simulations. Given the decade it may take to plan, permit, and construct such a project, the planning process should start soon. The State should consider utilizing the NYISO Public Policy Transmission Planning Process as it is uniquely suited for developing cost-effective solutions to this need.
- A multi-disciplinary coordination effort should be undertaken to support solutions to route up to 6,000 MW of OSW generation into **New York City** (through the Narrows and inner harbor or the Long Island Sound) to connect to the City's transmission substations.
- The State should consider creating the option to develop a **meshed offshore power grid** that, at some point, could connect OSW plants serving the State with each other and possibly with plants serving needs in New England and New Jersey. This may require that NYSERDA's OSW procurements incorporate offshore substation designs that include—as an option—the capability to be meshed to two neighboring stations. This would create the option, likely at only modest incremental costs, to integrate the State's OSW plants into a more reliable, more valuable offshore transmission grid that could also provide new interconnections with neighboring power markets. Close coordination with BOEM to make more wind energy areas available will foster more competitive OSW procurements and facilitate the potential development of meshed offshore transmission systems. Therefore, the State should advocate for the expeditious development of new wind energy areas that take into consideration state policy needs.

Advanced Technologies

- The Utility Study discusses the potential for advanced transmission technologies, but its recommendations do not go far enough to deploy in a timely fashion, well-tested technologies that could provide CLCPA benefits and reduce costs.
- The State should encourage the Utilities and other transmission owners to expeditiously evaluate and deploy **advanced transmission technologies**—such as dynamic line ratings for which commercial-scale applications, for example, have demonstrated a 20-30% increase of average annual transmission capacity above static ratings (e.g., with a 10% increase during 90% of the year, 25% during 75% of the year, and 50% during 15% of the year), while maintaining or enhancing system reliability.
- Several of the available technologies have advanced well beyond their research and development and pilot program phases and are ready for commercial deployment in the State. Collectively, the Utilities have experience with most of the advanced technologies evaluated in the Utility Study, many of which can be deployed to both the local and bulk-power grid more quickly and cost-effectively than traditional transmission upgrades. They also can be deployed quickly in targeted locations to expand the renewable resource integration capability of both the existing transmission system and proposed new projects.
- Both utility and NYISO transmission planning processes should be improved to recognize the unique advantages that advanced technologies can provide to address CLCPA-driven needs. Cost recovery mechanisms will need to be clarified for storage facilities that can both cost-effectively address a CLCPA transmission need and participate in NYISO wholesale power markets.

Improved and Coordinated Planning Processes

- The State will need to continue to refine its **planning processes** to achieve the necessary coordination of distribution, local transmission, and bulk-power transmission infrastructure and renewable resource investments. The Zero Emissions Study's projected development of more than 9,000 MW of OSW generation, at least 30,000 MW of land-based renewables, and approximately 15,000 MW of storage by 2040 will need to be coordinated closely (both in terms of location and in-service dates) with grid infrastructure investments to achieve the most cost-effective outcomes.

- The State should facilitate additional coordination across the different existing planning processes. Specifically, since some of the local transmission needs may be resolved by upgrading the systems to bulk transmission voltage levels, closer coordination between NYISO and local utility planning will be necessary. For example, LIPA's and ConEd's Phase 2 local transmission proposals to facilitate OSW interconnections will require coordination with bulk transmission planning to achieve cost-effective outcomes. The more integrated and coordinated planning processes should also be designed to recognize the unique advantages that storage and advanced technologies can provide to address CLCPA-driven needs.
- As previously noted, multi-disciplinary planning and coordination efforts should be initiated to support the development of cost-effective options for routing up to 6,000 MW of OSW generation into New York City and its interconnection with the City's substations. Additionally, the State should explore available policy options to support appropriate coordination to ensure the State's offshore wind energy goals are reached. In addition to minimizing disruptions for stakeholders, such coordination may also significantly reduce developer risks, likely yielding a lower-cost outcome for the State.
- To date, **forecasting of renewable generation development** in specific locations has been based on applications for interconnection at the bulk power level through NYISO and at the local T&D level through individual utilities under the PSC's standard interconnection requirements. To improve planning and support procurement efforts, these forecasts of renewable development locations on the bulk and local transmission systems should be improved by including mapping of solar and wind resource potential, regional econometric indicators for new development, environmental constraints, inter-regional energy exchanges, local regulations that impact greenfield development, and interconnection headroom estimates.

Further Studies

- More detailed and consistent studies will be necessary to **quantify existing headroom** in various transmission-constrained areas on the local and bulk transmission systems and to identify high-priority, high-value locations that should be targeted with transmission upgrades. These studies should be based on both a power-flow model that better measures headroom capacity and a production simulation model—ideally aligned with the NYISO's economic planning process assumptions and modeling tools—that can estimate annual curtailments and the extent to which proposed upgrades can reduce these curtailments.

- The State should also coordinate with NYISO further studies of the **operational challenges** not fully analyzed in the OSW and Zero Emissions Studies, aimed at better understanding transmission needs given the likely real-world flexibility challenges, congestion costs, and renewable curtailments. Building on recent NYISO analyses, such studies would focus on the operational implications of factors such as day-ahead renewable generation forecasting errors, real-time renewable generation uncertainties and associated intra-hour system flexibility needs, the impacts of planned and unplanned transmission outages, and system performance under more challenging weather conditions (such as storms, heat waves, and cold snaps).
- Further studies will be required to more completely understand the generation and storage technology options that will be needed after 2035 to cost-effectively reduce emissions to zero by 2040, and the extent of how these technologies will impact grid investment needs. The Zero Emissions Study projects that emissions could be eliminated fully with approximately 20,000 MW of **backstop thermal generation** that is fueled with landfill gas, bio gas, or other renewable natural gas. This option yields high congestion costs, which makes bulk-power transmission upgrades from upstate to downstate cost effective. At this point, however, the projected solution should be seen mostly as a placeholder until more clarity exists about available future technologies, such as green hydrogen and long-duration storage.