New York State Great Lakes Wind Energy Feasibility Study: Interconnection

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New York State Great Lakes Wind Energy Feasibility Study: Interconnection

Final Report

Prepared for:

New York State Energy Research and Development Authority

Albany, NY

Prepared by:

Pterra Consulting

Albany, NY

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Abstract

The Great Lakes Wind Feasibility Study investigates the feasibility of adding wind generated renewable energy projects to the New York State waters of Lake Erie and Lake Ontario. The study examines myriad issues, including environmental, maritime, economic, and social implications of wind energy areas in these bodies of freshwater and the potential contributions of these projects to the State's renewable energy portfolio and decarbonization goals under the New York State Climate Act.

The study, which was prepared in response to the New York Public Service Commission Order Case 15-E-0302, presents research conducted over an 18-month period. Twelve technical reports were produced in describing the key investigations while the overall feasibility study presents a summary and synthesis of all twelve relevant topics. This technical report offers the data modeling and scientific research collected to support and ascertain Great Lakes Wind feasibility to New York State.

To further inform the study in 2021, NYSERDA conducted four public webinars and a dedicated public feedback session via webinar, to collect verbal and written comments. Continuous communication with stakeholders was available through greatlakeswind@nyserda.ny.gov NYSERDA's dedicated study email address. Additionally, NYSERDA and circulated print advertisements in the counties adjacent to both Lake Erie and Lake Ontario as to collect and incorporate stakeholder input to the various topics covered by the feasibility study.

Keywords

Great Lakes Wind, Lake Erie, Lake Ontario, interconnection, headroom, solo headroom, total headroom, simple transmission upgrades, transmission constraints

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Acronyms and Abbreviations

70x30	Shorthand for the requirement of New York State's Climate Leadership and Community Protection Act (CLCPA) for a minimum of 70% of New York's end-use electrical energy requirements to be generated by renewable energy systems in 2030.
CARIS	Congestion Assessment and Resource Integration Study. A biennial study conducted by NYISO.
CPNY	Clean Path NY project. One of two projects awarded under Tier 4.
GLW	Great Lakes Wind
Headroom	The projected capability of the grid to support additional renewable energy generation. Based on the definition in NYS PSC Case 20-E-00197, "Staff Straw Proposal for Conducting Headroom Assessments," filed March 16, 2021.
MW	megawatts
NREL	National Renewable Energy Laboratory
NYBPS	New York Bulk Power System. The transmission grid of New York State.
NYISO	New York Independent System Operator. The entity responsible for interconnections to the NYBPS.
NYSERDA	New York State Energy Research and Development Authority

POI	Point of Interconnection. The location where Great Lakes wind generation delivers power to the land-based electric grid. For this study, all POIs correspond to existing New York substations.
Power Grid Study	Initial Report on the New York Power Grid Study," NY Department of Public Service, NYSERDA, the Brattle Group and Pterra Consulting, January 19, 2021.
SCRD	A function of the TARA software (product of PowerGEM) which adjusts generation dispatch to eliminate normal (n-0) and contingency (n-1) overloads. SCRD uses a cost function that applies the same cost per MW for all generators, regardless of fuel type, to obtain a secure dispatch.
Simple transmission upgrades	Simple upgrades assume that building a new line or transformer parallel to and of the same voltage level and rating as the constrained facility is sufficient to relieve a constraint. In practice, solutions to transmission constraints may start from this form of simple upgrade to other options such as reconductoring the line, adding a new line on a different right-of-way and/or connecting to different substations, uprating the voltage, rebuilding the line and non-wire and new technology solutions.
Simultaneous headroom	The total headroom available from multiple POIs considered together.
Solo headroom	Solo headroom measures the MW capacity that can be supported by the grid at each POI on the assumption that no other new interconnections are being added, i.e., the power flow model held static except for the interconnection of the GLW at a POI.
Tier 4	NYSERDA's Tier 4 solicitation, part of New York State's Clean Energy Standard intended to increase the penetration of renewable energy into New York City.
Zero Emissions Study	An alternate study which assumed lower renewable buildout than the 2019 CARIS. Included as appendix E of the Power Grid Study.

Executive Summary

Pterra Consulting and the Brattle Group (Study Team) were tasked to conduct a feasibility assessment for potential interconnections of Great Lakes Wind (GLW) generation with the New York Bulk Power System (NYBPS). To perform the assessment, The Study Team developed power flow models to represent the NYBPS in 2030 with an assumed renewable generation buildout.

To provide a measure of interconnection capacity, the capacity headroom definition and calculation method described in recent New York State Public Service Commission orders were selected. Potential points of interconnection (POIs) on the existing NYBPS located within 20 miles of the Lake Erie or Lake Ontario shoreline were initially selected for analysis. These were filtered down to a few representative POIs for more detailed analysis.

For Lake Erie GLW, the available POIs showed combined capacity headroom of 270 megawatts (MW) without transmission upgrades. Applying a set of simple transmission upgrades[1] costing some $68.8 million (M) [2] can increase the Lake Erie total headroom capacity by 60 MW to 330 MW.

For Lake Ontario GLW, several POIs in Monroe and Oswego counties showed solo[3] headroom capacity in the range of 850 to 1100 MW without the need for transmission upgrades. At most, there is a total[4] headroom capacity for up to 1140 MW for the Lake Ontario POIs. The total headroom capacity may be increased by140 MW by implementing simple upgrades costing some $236.6m. The Jefferson County POIs showed no solo headroom capacity. Simple transmission upgrades costing at least $164.5 million may open about 50 MW of headroom capacity.

1 Introduction

1.1 Background

Pterra Consulting and the Brattle Group (Study Team) were engaged by NYSERDA to conduct a feasibility assessment for potential interconnections of Great Lakes Wind (GLW) generation with the New York Bulk Power System (NYBPS). The objective of this assessment is to identify critical information that may inform the general feasibility of GLW energy from an interconnection perspective. The information developed in the assessment would then serve as guidance to the overall GLW Feasibility Study concerning locations of the GLW collector stations, electrical connections between the GLW collector stations and points of interconnection on the NYBPS, and any needed transmission upgrades to support the interconnection and approximate costs of the upgrades.

The Study Team was tasked to utilize available NYBPS models in the form of power flows as developed by others such as the New York Independent System Operator (NYISO) and to augment such models with the latest information on future renewable generation and load development.

1.2 Objectives

The objectives of the interconnection feasibility study are:

- To develop a preliminary understanding of the feasibility of interconnection of GLW resources to the NYBPS.
- Identify critical information that may inform the general feasibility of GLW energy from an interconnection perspective.
- Provide guidance to NREL on determining Points of Interconnection (POI) on the NYBPS, including any needed transmission upgrades.

1.3 Approach

The assessment leverages results of the Power Grid Study[5] and other existing power flow and energy deliverability analyses such as the NYISO Congestion Assessment and Resource Integration Study (CARIS).[6]

Power flow models developed by the NYISO served as the initial basis for assessment. These models were augmented with projected renewable development out to the year 2030. Potential points of interconnection (POI) to the land-based NYBPS, as reflected in the power flow models, were selected for evaluation based on distance from each lakeshore and voltage level. The available capacity headroom was then determined for each of the POIs. The term "headroom," as used in this report, means the projected capability of the grid to support additional renewable energy generation.[7] Applied to the present analysis, headroom represents the potential capability for GLW to interconnect; however, it also represents the capacity that is available to any other generation resource that may want to interconnect at the same POI. The nature of the NYISO market for new generation is competitive and GLW is expected to compete with other resource development model analysis to utilize the available headroom.

The selection of POIs was narrowed down by region and the maximum simultaneous headroom was determined for the combined interconnection of all GLW.

2 Modeling and Analysis

2.1 Representing 2030 Grid Conditions

The initial NYBPS models used for the study were power flow cases obtained from NYISO. These power flow cases were part of the NYISO's 2019 FERC 715 filing. The specific cases selected for study are summarized in Table 1.

Table 1. NYISO Power Flow Cases Selected for Initial Assessment

Study Year	Description	Designation
2025	Summer Peak 50-50 Case	25S
2025	Spring Light Load	25SLL
2025-26	Winter Peak load	25W
2030	Summer Peak 50-50 Case	30S

For an initial set of POIs, direct connections to existing substations rated 115 kilovolts (kV)and above that were within 25 miles of either the Lake Erie or Lake Ontario New York shorelines were considered. The list of POIs is included in appendix A.

An initial measurement for "solo" headroom was applied to each of the selected POIs. Solo headroom measures the megawatt capacity that can be supported by the grid at each POI on the assumption that no other new interconnections are being added, i.e., the power flow model is held static except for the interconnection of the GLW at a POI. Solo headroom at each POI was calculated for each of the power flow cases shown in Table 1.

The analysis showed that the most constrained condition for GLW interconnection occurs in the 2030 summer peak model. Subsequent analysis was conducted based on the 2030 summer peak model only.

Note that the 2030 summer peak model provided by NYISO as part of the 2019 FERC 715 filing differs from the 2030 model applied in the 2019 CARIS Report. Essentially, the CARIS model sought to meet the so-called "70 x 30 target"[8] by adding approximately 30 GW of utility-scale renewable generation resources throughout the NYBPS. The Power Grid Study, on the other hand, noted that the CARIS buildout was much higher than other projections such as those of the Zero Emissions Study.[9]

For the GLW interconnection feasibility assessment, a modified renewable buildout was developed. The Study Team reviewed data from the NYISO interconnection queue of June 2021 and developed a projected buildout that uses interconnection applications submitted to NYISO and following closely the models developed in the Power Grid Study, specifically Table 4-1 of the Zero Emission Study.[10] While the Zero Emissions Study specified the total buildout in terms of technology, the NYISO interconnection queue was used to allocate the buildout by NYISO Load Zone. The resulting buildout distribution is summarized in Table 2.

Table 2. Projected Renewable Generation Buildout in Megawatts based on 2021 NYISO Queue and Total Buildout for 2030 in the Zero Emissions Study

NYISO Zone	Existing Renewable*	Added OSW	Added LBW	Added UPV	Total Added
A	2497		1620	1120	2740
B	620		220	130	350
C	3421		1710	700	2410
D	1564		1250	0	1250
E	831		1420	440	1860
F	1265			910	910
G	88			510	510
H	0				0
I	0				0
J	0	3000			3000
K	24	3000			3000
NYCA	10312	6000	6220	3810	16030

OSW	offshore wind
LBW	land-based wind
UPV	utility-scale photovoltaic
NYCA	New York Control Area
*	Includes nuclear, hydro, wind and solar

A modified 2030 summer peak model was developed starting from NYISO case 30S and adding the renewable buildout shown in Table 2. In addition, the Tier 4 awards[11] were added to the transmission model. Specifically, the Clean Path NY (CPNY) Project would draw on wind, solar, and hydro generation from Upstate New York, including potential interconnections from GLW, to deliver renewable power to New York City. Furthermore, existing thermal generators with no application or schedule for retirement were assumed to remain in service.

The large number of new generation sources introduced by the buildout and the addition of Clean Path New York (CPNY) required that the power flow model's generation schedule be revised to balance total generation with the load and to secure the system by eliminating thermal overloads under normal and contingency conditions. This was accomplished using a non-economic security-constrained[12] generation dispatch.

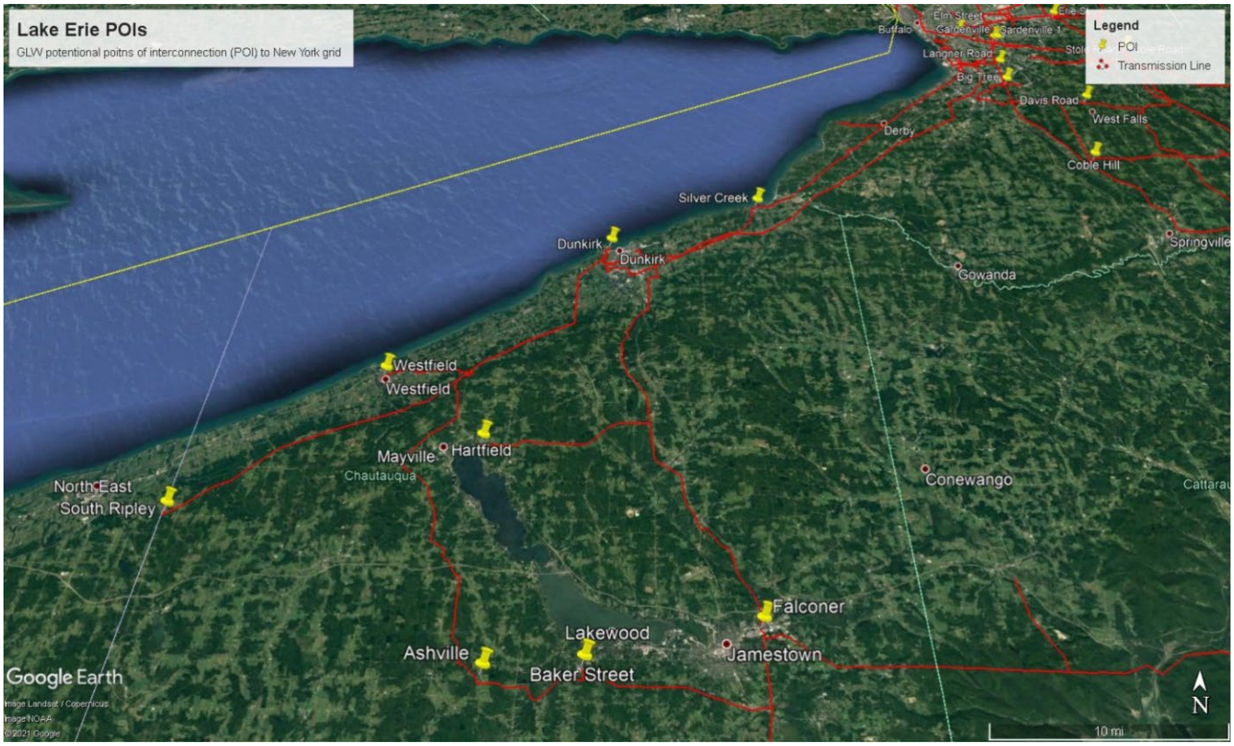
The revised 2030 summer peak power flow model is then used to recalculate the solo headroom capacities for POIs along the Great Lakes shoreline and the total (or simultaneous headroom) for GLW at each of Lake Erie and Lake Ontario as discussed in the subsequent sections.

2.2 Lake Erie Points of Interconnection and Headroom Capacity

Lake Erie abuts the New York counties of Erie in the north and Chautauqua in the south. The existing New York Bulk Power System (NYBPS) has facilities near the shoreline in both counties. A geographic map of potential points of interconnection (POI) for Lake Erie GLW is shown in Figure 1.

For the analysis of headroom capacity, two POIs were selected for each of the bordering counties from among the POIs considered in appendix A.

Figure 1. Geographic Map of Potential Points of Interconnection to the New York Bulk Power System Facilities for Lake Erie Wind Generation



Solo headroom analysis was applied to the selected Lake Erie POIs[13] using the modified 2030 power flow model. (Note that the modified power flow already includes representation of renewable energy projects proposed for interconnection to the NYBPS as of the June 2021 NYISO interconnection queue. The list of these renewable energy projects is shown in appendix B.) The results of the headroom analysis for Erie Lake GLW POIs are shown in Table 3.

Table 3. Solo Headroom Capacity for Selected GLW POIs Along Lake Erie Shoreline Based on Modified 2030 Power Flow

POI	County	Capacity Headroom (MW)
Dunkirk 230	Chautauqua	240
Ashville 115	Chautauqua	180
Stolle Rd 230	Erie	140
Elm St 230	Erie	270

The results of the solo headroom analysis indicate that there is headroom capacity for at least a 270 Megawatts (MW) Great Lakes Wind (GLW) farm on Lake Erie. It is important to note the assumption in solo headroom is that there are no other competing new generation sources (such as solar, wind, storage, and conventional resources. Furthermore, the following exclusions noted in the Straw Proposal are applicable here:

- Capacity headroom values are not the same as installed capacity or nameplate rating. An additional calculation is needed to convert the optimal transfer values to the nameplate rating of a specific resource technology. Depending on the quality of the wind available on the lake, the ratio of the nameplate to headroom capacity can vary from 1.0 to 2.0.
- Other system conditions can impact the capacity headroom, including the continued operation of nuclear units in Upstate New York, variations in the assumed buildout of renewable generation and construction of transmission upgrades by 2030.
- Capacity headroom is also subject to constraints from other reliability and operating constraints such as overlapping contingencies, voltage criteria violations, grid stability, and short circuit withstand levels.

To determine the total simultaneous headroom capacity that can be interconnected at multiple POIs from wind generation on Lake Erie, a separate headroom calculation was conducted. Given the four potential POIs listed in Table 3, an optimal transfer simulation determined the maximum capacity headroom that can be developed from the combination of POIs. The resulting calculation is shown in Table 4.

Table 4. Simultaneous Headroom Capacities in Megawatts (MW) without Transmission Upgrades for GLW POIs Along Lake Erie Shoreline

POI	County	Simultaneous Headroom Capacity (MW)
Dunkirk 230	Chautauqua	0
Ashville 115	Chautauqua	0
Stolle Rd 230	Erie	0
Elm St 230	Erie	270
Total		270

The results of Table 4 show that the total capacity headroom for Lake Erie wind generation is limited to 270 MW. Once the 270 MW capacity headroom at the Elm Street POI is utilized, there is no additional capacity. This implies that the four POIs utilize common transmission routes toward load centers and once any one of the POIs utilizes the headroom capacity on those routes, the other POIs will have no headroom capacity remaining. These congested routes may be addressed in various ways including upgrading the affected facilities, developing alternate routes, applying non-economic generation re-dispatch, implementing non-wires solutions, and integrating advanced technology, among others.

To provide a cost basis for increasing headroom capacity, the cost of simple upgrades[14] was considered. The resulting increases in headroom capacity with the associated costs (based on the conceptual cost per mile of a simple upgrade) are summarized in Table 5.

Table 5. Simultaneous Headroom Capacity Gained with Simple Transmission Upgrades for Total Lake Erie Wind Generation

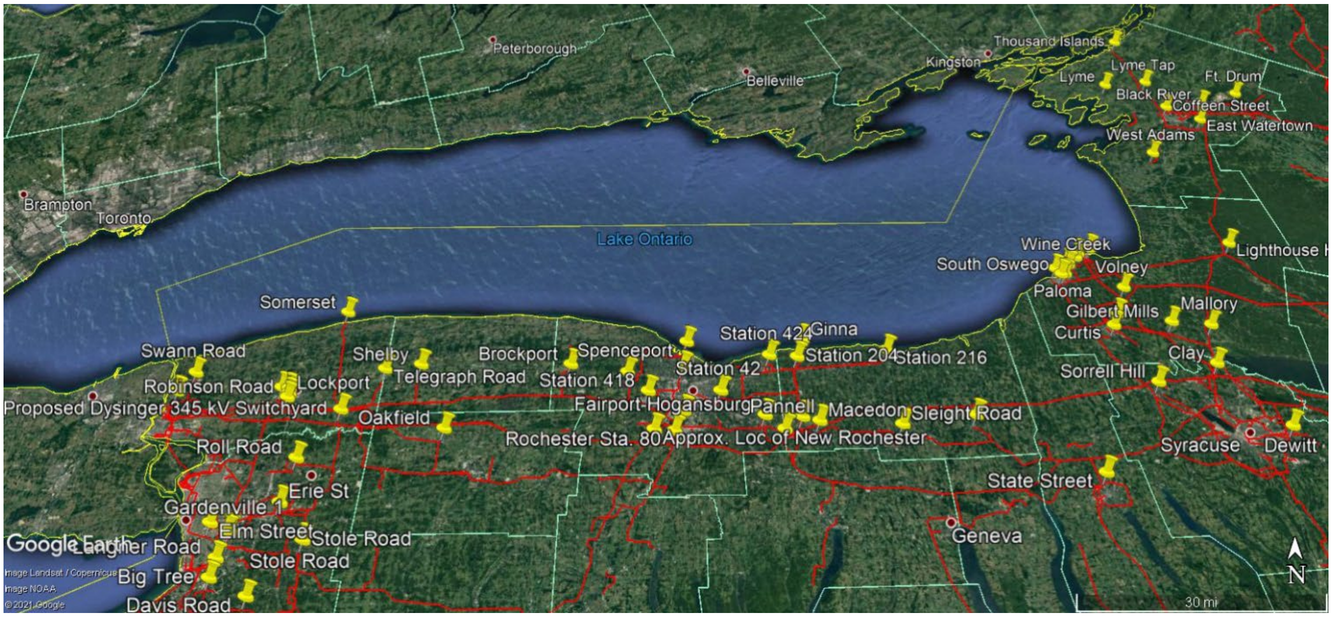
Simple Transmission Upgrade	Simultaneous Headroom Capacity (MW)	Conceptual Cost of Transmission Upgrades ($m)
None	270	0
Wethersfield-Stony Creek 230 kV	280	22.3
South Perry-Wethersfield 230 kV	320	36.0
High Sheldon-Stony Creek 230 kV	330	10.5
Total		68.8

Table 5 shows that a set of simple transmission upgrades costing $68.8 m can increase the Lake Erie headroom capacity by 60 MW.

2.3 Lake Ontario Points of Interconnection and Headroom Capacity

New York State has a longer shoreline along Lake Ontario compared to Lake Erie. Several New York State counties border the lake, including Niagara, Orleans, Monroe, Wayne, Cayuga, Oswego and Jefferson. The existing State transmission grid and potential POIs along this shoreline are shown in Figure 2.

Figure 2. Geographic Map of Potential Points of Interconnection to the New York Bulk Power System Facilities for Lake Ontario Wind Generation



Based on the location of accessible POIs along the shoreline, four counties were selected. For each county, two POIs were identified which had the highest solo headroom[15] capacity in each county. The solo headroom capacities for the selected POIs are shown in Table 6.

Table 6. Solo Headroom Capacity without Transmission Upgrades for Selected Great Lakes Wind Points of Interconnection [POIs) Along Lake Ontario Shoreline

POI	County	Capacity Headroom (MW)
Somerset 345	Niagara	450
Robinson Rd 230	Niagara	40
Pannell 345	Monroe	1000
Rochester 345	Monroe	850
Clay 345	Oswego/Onondaga	1100
Oswego 345	Oswego	1100
Fort Drum 115	Jefferson	0
West Adams 115	Jefferson	0

Note that the high headroom capacities at Pannell, Rochester, Clay, and Oswego substations are solo measurements, i.e., each of the capacities assumes no other GLW interconnection elsewhere in the vicinity and no other competing new generation sources. To determine the total simultaneous capacity that can be interconnected at multiple POIs, a separate headroom calculation was conducted for the POIs with the highest solo headroom capacities (Pannell, Rochester, Clay, and Oswego).

The results of these calculations are summarized in Table 7.

Table 7. Simultaneous Headroom Capacities in Megawatts without Transmission Upgrades for GLW POIs Along Lake Ontario Shoreline

Scenario	Pannell 345	Rochester 345	Clay 345	Oswego 345	Total
1	0	0	930	210	1140
2	1000	0	0	0	1000
3	0	850	0	30	880
4	0	0	1100	0	1100
5	0	0	0	1100	1100

If 1000 MW of GLW is interconnected at Pannell (scenario 2), the other POIs will have zero headroom as the injection of power at Pannell utilizes the transmission capacity for the other POIs. Hence, the total GLW that can be interconnected in this scenario is 1000 MW. Similarly, large amounts of GLW interconnected at Rochester (scenario 3), Clay (scenario 4) or Oswego (scenario 5) reduce the available capacity for other POIs. The optimal scenario (scenario 1) is to interconnect 930 MW at Clay and 210 MW at Oswego for a total of 1140 MW. The optimal scenario produces the highest total interconnection of GLW. Any other combination of interconnections will lead to fewer total GLW MW interconnected.

While there are significant amounts of solo headroom capacity in the Monroe and Oswego County POIs, and about half the capacity available in Niagara County POIs, the POIs in Jefferson County show limited capacity without transmission upgrades. The associated conceptual cost estimates to apply simple transmission upgrades to increase headroom at the Fort Drum POI in Jefferson County are summarized in Table 8.

Table 8. Solo Headroom Capacity Gained with Simple Transmission Upgrades for the Fort Drum POI in Jefferson County

Simple Transmission Upgrade	Solo Headroom Capacity (MW)	Conceptual Cost of Transmission Upgrades ($m)
None	0	0
Marcy 345/115 kV transformer	10	9.0
Ft. Drum-Taylorville-Boonville-Porter 115 kV	60	155.3
Total		164.3

The Ft. Drum solo headroom capacity can be increased from 0 to 60 MW with simple upgrades costing $164.5 million. A similar increase in headroom capacity for the West Adams POI can be achieved for an additional simple upgrade of the West Adams-Coffeen-Black River line at a cost of $39.2M in addition to the Fort Drum upgrade costs.

While the total headroom capacity for Lake Ontario wind generation is 1,140 MW. This capacity may be further increased by transmission upgrades. Applying simple upgrades to address the constrained routes and estimating the cost of each simple upgrade shows that an increase of 140 MW can be achieved for an upgrade cost of $236.6M. The upgrades considered and associated cost estimates are summarized in Table 9.

Table 9. Simultaneous Headroom Capacity Gained with Simple Transmission Upgrades for Total Lake Ontario Wind Generation

Simple Transmission Upgrade	Simultaneous Headroom Capacity (MW)	Conceptual Cost of Transmission Upgrades ($m)
None	1140	0
Fraser-Oakdale 345 kV	1260	204.8
Coddington-Montour Falls 115 kV	1270	22.9
Coddington-Etna 115 kV	1280	8.9
Total		236.6

3 Conclusions

The study team, Pterra Consulting and the Brattle Group, were tasked to conduct a feasibility assessment for potential interconnections of Great Lakes Wind (GLW) generation with the New York Bulk Power System (NYBPS). To perform the assessment, the study team developed power flow models to represent the NYBPS in 2030 with an assumed renewable generation buildout.

To provide a measure of interconnection capacity, the capacity headroom definition and calculation method described in recent New York State Public Service Commission orders were selected. Potential points of interconnection on the existing NYBPS located within 20 miles of the Lake Erie or Lake Ontario shoreline were initially selected for analysis. These were filtered down to a few representative POIs for more detailed analysis.

For Lake Erie GLW, the available POIs showed combined capacity headroom of 270 MW without transmission upgrades. Applying a set of simple transmission upgrades[16] costing some $68.8m[17] can increase the Lake Erie total headroom capacity by 60 MW to 330 MW.

For Lake Ontario GLW, several POIs in Monroe and Oswego counties showed solo[18] headroom capacity in the range of 850 to 1100 MW without the need for transmission upgrades. At most, there is a total[19] headroom capacity of up to 1140 MW for the Lake Ontario POIs. The total headroom capacity may be increased by140 MW by implementing simple upgrades costing some $236.6m. The Jefferson County POIs showed no solo headroom capacity. Simple transmission upgrades costing at least $164.5 million may open about 50 MW of headroom capacity.

3.1 Important Notes About Headroom and Interconnection

Applied to the present analysis, headroom represents the potential capability for GLW to interconnect; however, it also represents the capacity that is available to any other generation resource that may want to interconnect at the same POI. The nature of the NYISO market for new generation is competitive and GLW is expected to compete with other resource development modeling analysis to utilize the available headroom.

Capacity headroom values are not the same as installed capacity or nameplate rating. An additional calculation is needed to convert the optimal transfer values to the nameplate rating of a specific resource technology. Depending on the quality of the wind available on the lake, the ratio of the nameplate to headroom capacity can vary from 1.0 to 2.0.

Other system conditions can impact the capacity headroom, including the continued operation of nuclear units in Upstate New York, variations in the assumed buildout of renewable generation and construction of transmission upgrades by 2030.

Capacity headroom is also subject to constraints from other reliability and operating constraints such as overlapping contingencies, voltage criteria violations, grid stability, and short circuit withstand levels.

In an actual interconnection study, the model used may be different based on system conditions deemed to have been changed by NYISO at that time. Headroom capacity is only one component that prospective interconnections to the NYBPS need to address. Other reliability issues relating to transient voltage, stability, short circuit, deliverability, transfer capability and higher-level contingencies would also need to be considered.

Appendix A: List of Potential Points of Interconnection to Existing Substations Rated 115 Kilovolts and Higher

The POIs are categorized in terms of straight-line distance from the shoreline as follows:

- Level 1 POIs—those which are located within 5 miles of the shoreline.
- Level 2 POIs—those which are located within 5–15 miles of the shoreline.
- Level 3 POIs—those which are located within 15–25 miles of the shoreline.

Table A-1. Potential Points of Interconnection

Substation	Voltage	Area	Zone	POI Category	Approximate Distance from the Shoreline (mi)
Somerset	345	West	NYSEG WE	Level 1	0.54
Stole Road	345	West	NYSEG WE	Level 2	14.95
Gardenville	230	West	NYSEG WE	Level 2	5.77
Robinson Road	230	West	NYSEG WE	Level 2	14.91
Stole Road	230	West	NYSEG WE	Level 2	14.95
Big Tree	115	West	NYSEG WE	Level 1	4.01
Erie	115	West	NYSEG WE	Level 2	12.14
Gardenville	115	West	NYSEG WE	Level 2	5.23
Hinman	115	West	NYSEG WE	Level 2	12.21
Robinson Road	115	West	NYSEG WE	Level 2	14.91
Roll Road	115	West	NYSEG WE	Level 3	24.01
Stole Road	115	West	NYSEG WE	Level 2	14.95
Macedon	115	Central	NYSEG CE	Level 2	14.30
Sleight Road	115	Central	NYSEG CE	Level 2	14.55
Silver Creek	115	West	NYSEG WE	Level 1	0.12
Davis Road	115	West	NYSEG WE	Level 2	10.40
Langner Road	115	West	NYSEG WE	Level 1	3.98
Lockport Energy Associates Units 1 & 2	115	West	NYSEG WE	Level 2	11.75
Lockport Energy Associates Units 3 & 4	115	West	NYSEG WE	Level 2	11.75
Dysinger	345	West	NGRD WES	Level 3	18.00
Dunkirk	230	West	NGRD WES	Level 1	0.00
South Ripley	230	West	NGRD WES	Level 2	5.02

Table A-1 continued

Substation	Voltage	Area	Zone	POI Category	Approximate Distance from the Shoreline (mi)
Ashville	115	West	NGRD WES	Level 3	19.70
Baker Street	115	West	NGRD WES	Level 3	21.77
Falconer	115	West	NGRD WES	Level 3	24.51
Hartfield	115	West	NGRD WES	Level 2	8.27
Elm Street	230	West	NGRD WES	Level 1	2.92
Lockport	115	West	NGRD WES	Level 2	13.28
Mountain	115	West	NGRD WES	Level 2	8.24
Swann Road	115	West	NGRD WES	Level 2	5.45
Coble Hill Line 151	115	West	NGRD WES	Level 2	12.87
Coble Hill Line 152	115	West	NGRD WES	Level 2	12.87
Shelby	115	Genesee	NGRD GNS	Level 2	11.52
Brockport	115	Genesee	NGRD GNS	Level 2	10.55
Mortimer	115	Genesee	NGRD GNS	Level 2	10.55
Oakfield Tap	115	Genesee	NGRD GNS	Level 3	21.68
Telegraph Road	115	Genesee	NGRD GNS	Level 2	12.38
Clay	345	Central	NGRD CEN	Level 3	24.05
Oswego	345	Central	NGRD CEN	Level 1	0.00
Scriba	345	Central	NGRD CEN	Level 1	0.71
Volney	345	Central	NGRD CEN	Level 2	9.19
Independence	345	Central	NGRD CEN	Level 1	0.34
Alcan	115	Central	NGRD CEN	Level 1	0.74
Bristol Hill	115	Central	NGRD CEN	Level 2	13.15
Clay	115	Central	NGRD CEN	Level 3	24.05
Curtis Street	115	Central	NGRD CEN	Level 2	12.96
Gilbert Mills	115	Central	NGRD CEN	Level 2	14.61
Hammerhill	115	Central	NGRD CEN	Level 1	0.00
Wine Creek	115	Central	NGRD CEN	Level 1	0.56
Hogansburg 1	115	Central	NGRD CEN	Level 2	12.70
Hogansburg 2	115	Central	NGRD CEN	Level 2	12.70
Lighthouse Hill	115	Central	NGRD CEN	Level 2	13.80
Mallory	115	Central	NGRD CEN	Level 3	17.50
Oswego Unit 3&4	115	Central	NGRD CEN	Level 1	0.00
Paloma	115	Central	NGRD CEN	Level 1	1.98
South Oswego	115	Central	NGRD CEN	Level 1	1.80
Scriba	115	Central	NGRD CEN	Level 1	0.71

Table A-1 continued

Substation	Voltage	Area	Zone	POI Category	Approximate Distance from the Shoreline (mi)
Sorrell Hill	115	Central	NGRD CEN	Level 3	23.55
Black River	115	Mohawk	NGRD MVN	Level 3	15.57
Coffeen Street	115	Mohawk	NGRD MVN	Level 2	12.96
East Watertown	115	Mohawk	NGRD MVN	Level 2	14.19
Fort Drum 2	115	Mohawk	NGRD MVN	Level 3	22.13
Fort Drum 2	115	Mohawk	NGRD MVN	Level 3	22.13
Thousand Islands	115	Mohawk	NGRD MVN	Level 1	0.90
West Adams	115	Mohawk	NGRD MVN	Level 2	5.99
Lyme Tap	115	Mohawk	NGRD MVN	Level 2	9.12
Lyme	115	Mohawk	NGRD MVN	Level 1	3.30
Spenceport	115	Genesee	RG&E	Level 2	10.03
Westfield	115	West	NGRD WES	Level 1	1.03
Rochester Station 80	345	Genesee	RG&E	Level 2	13.97
Pannell	345	Genesee	RG&E	Level 3	16.02
Clyde/Station 199	115	Central	RG&E	Level 2	14.43
Station 216	115	Genesee	RG&E	Level 1	2.83
Station 82 Bus 1	115	Genesee	RG&E	Level 2	10.55
Station 418	115	Genesee	RG&E	Level 2	12.71
Ginna	115	Genesee	RG&E	Level 1	0.61
Pannell	115	Genesee	RG&E	Level 3	16.02
Quaker	115	Genesee	RG&E	Level 2	13.73
Station 204	115	Genesee	RG&E	Level 1	3.51
Station 42	115	Genesee	RG&E	Level 2	6.25
Station 82 Bus 2	115	Genesee	RG&E	Level 2	10.55
Station 48	115	Genesee	RG&E	Level 1	4.34
Station 7 Bus 2	115	Genesee	RG&E	Level 1	0.50
Station 424	115	Genesee	RG&E	Level 1	2.77
New Rochester	345	Genesee	RG&E	Level 3	18.78
New Rochester	115	Genesee	RG&E	Level 3	18.78

Appendix B: List of Renewable Energy Projects from the June 2021 NYISO Interconnection Represented in the Modified 2030 Power Flow Model

B-1 Lake Erie Projects

Queue Pos.	Project Name	SP (MW)	WP (MW)	Type/ Fuel	County	Interconnection Point
0505	Ball Hill Wind	100	100	W	Chautauqua	Dunkirk - Gardenville 230kV
0759	KCE NY 6	20	20	ES	Erie	Gardenville - Bethlehem Steel Wind 115kV
0783	South Ripley Solar	270	270	CR	Chautauqua	South Ripley 230kV
0787	Levy Grid, LLC	150	150	ES	Erie	Gardenville 115kV
0804	KCE NY 10	20	20	ES	Erie	Erie 34.5kV
0858	Genesee Road Solar Energy Center	350	350	S	Erie	Stolle Rd - Five Mile Rd 345kV
0878	Pirates Island	100	100	ES	Erie	Huntley - Gardenville 115kV
0945	Niagara Grid I	20	20	ES	Erie	Huntley - Praxair 115kV
0951	Cayuga Grid, LLC	100	100	ES	Erie	Gardenville 115kV
1043	SL Portland Solar	19.8	19.8	S	Chautauqua	Dunkirk - Falconer 115kV
1098	Kingbird Solar	20	20	S	Chautauqua	Dunkirk - Silver Creek 115 kV
1151	York Run Solar	90	90	S	Chautauqua	Falcon 115 kV

* The column labeled 'SP' refers to the maximum summer megawatt electrical output. The column labeled 'WP' refers to the maximum winter megawatt electrical output.

** Type / Fuel. Key: W=Wind, S=Solar, ES=Energy Storage, CR+PV+Storage.

B-2 Lake Ontario Projects

Queue Pos.	Project Name	SP (MW)	WP (MW)	Type/ Fuel	County	Interconnection Point
0571	Heritage Wind	200.1	200.1	W	Genesee	Lockport - Mortimer 115kV
0574	Mad River Wind	450	450	W	Jefferson-Oswego	Volney - Marcy 345kV
0584	Dog Corners Solar	20	20	S	Cayuga	Aurora 34.5kV
0590	Scipio Solar	18	18	S	Cayuga	Scipio 34.5kV
0704	Bear Ridge Solar	100	100	S	Niagara	Mountain- Lockport 115kV
0709	Alder Creek Solar	165	165	S	Oneida	Chases Lake - Porter 230kV
0721	Excelsior Energy Center	280	280	S	Genesee	Dysinger - New Rockester 345 kV
0774	Tracy Solar Energy Centre	119	119	S	Jefferson	Thousand Island - Lyme 115kV
0811	Cider Solar	500	500	S	Genesee	Dysinger - New Rochester 345kV
0843	NY37 Solar	20	20	S	Jefferson	Coffeen St - West Adams 115kV
0852	Niagara Dolomite Solar	180	180	S	Niagara	Robinson Rd - Stolle Rd 230kV
0859	Ridge View Solar Energy Center	350	350	S	Niagara	Kintigh - Dysinger 345kV
0864	NY38 Solar	120	120	S	Jefferson	Coffeen St - East Watertown 115kV
0871	Verona Solar Energy Center I	250	250	S	Oneida	Clay - Edic 345kV
0873	Verona Solar Energy Center II	250	250	S	Oneida	Clay - Edic 345kV
0879	Holley Road Solar	19.9	19.9	S	Orleans	Lockport - Mortimer 115kV
0882	Riverside Solar	100	100	S	Jefferson	Lyme 115kV
0883	Garnet Energy Center	200	200	S	Cayuga	Pannell - Clay 345kV
0913	SunEast Manchester Solar LLC	20	20	S	Wayne	Hooks Rd - Elbridge 115kV
0935	SunEast Oriskany Solar LLC	20	20	S	Oneida	Brothertown-Oriskany Falls 46kV
0950	Orleans Solar	200	200	S	Orleans	Lockport - Mortimer 115kV
0993	Empire Energy Storage	10	10	ES	Monroe	Station 55 - Station 73 34.5kV
0995	Alabama Solar Park LLC	130	130	S	Genesee	Lockport - Batavia 115kV
1000	SunEast Flat Stone Solar LLC	20	20	S	Oneida	Oneida - Rome 115kV

Table B-2 continued

Queue Pos.	Project Name	SP (MW)	WP (MW)	Type/ Fuel	County	Interconnection Point
1051	Transit Solar Project	20	20	S	Genesee	Batavia - Golah 115kV
1059	Jaton	16.2	16.2	S	Oswego	South Oswego - Clay 115 kV
1062	Tubolino 2	19.8	19.8	S	Jefferson	West Adams - Coffeen St 115 kV
1063	Morrow Farms LLC	19.8	19.8	S	Jefferson	Thousand Island - Coffeen St 115 kV
1064	K. High	19.8	19.8	S	Wayne	Station 218 - Station 181 34.5kV
1077	Rutland Center Solar	110	110	S	Jefferson	Middle Rd 115kV
1079	Somerset Solar	207	207	S	Niagara	Kintigh 345 kV
1088	Harvest Hills Solar	200	200	S	Cayuga	Wright Avenue - Cayuga 115kV
1090	Westmorland Solar	20	20	S	Oneida	Yahnundasis - Clinton 46kV
1103	Thousand Island Solar	110	110	S	Jefferson	Coffeen St - Thousand Island 115KV
1104	Brockport BESS	20	20	ES	Monroe	Brockport - Albion 34.5kV
1109	Worth Wind	92	92	W	Jefferson	Lighthouse Hill - E. Watertown 115kV
1134	Tracy Storage	5	5	ES	Jefferson	Thousand Island - Coffeen St 115 kV
1136	Honey Ridge Solar	140.6	140.6	CR	Jefferson	Black River 115kV
1148	Agricola Wind Project	97	97	W	Cayuga	Milliken - Wright Ave 115 kV
1161	Garnett Battery Storage	20	20	ES	Cayuga	Pannel - Clay 345 KV
1162	Ontario Valley Solar	312.9	312.9	CR	Jefferson	Lyme - Thousand Island 115 kV
1169	Excelsior Battery Storage	20	20	ES	Genesee	Dysinger - New Rochester 345kV
1178	NY115 - Newport Solar	130	130	S	Oneida	Porter - Deerfield 115kV
1191	Gunns Corners Solar	100	100	CR	Jefferson	Lyme - Thousand Island 115 kV

Type / Fuel. Key: W=Wind, S=Solar, ES=Energy Storage, CR+PV+Storage.

Endnotes

1 Simple upgrades assume that building a new line or transformer parallel to and of the same voltage level and rating as the constrained facility is sufficient to relieve the constraint. In practice, solutions to transmission constraints may start from this form of simple upgrade to other options such as reconductoring the line, adding a new line on a different right-of-way and/or connecting to different substations, uprating the voltage, rebuilding the line and non-wire and new technology solutions.

2 Applying a conceptual cost per mile of the simple upgrade.

3 Solo headroom measures the MW capacity that can be supported by the grid at each POI on the assumption that there are no other new interconnections being added, i.e., the power flow model being held static except for the interconnection of the GLW at a POI.

4 Total headroom is the MW capacity for the combination of all POIs accessible from either Lake Erie or Lake Ontario.

5 "Initial Report on the New York Power Grid Study," NY Department of Public Service, NYSERDA, the Brattle Group and Pterra Consulting, January 19, 2021.

6 "2019 CARIS Report," NYISO, July 2020.

7 Based on the definition in NYS PSC Case 20-E-00197, "Staff Straw Proposal for Conducting Headroom Assessments," filed March 16, 2021 (the "Straw Proposal").

8 "70x30" is shorthand for the requirement of New York State's Climate Leadership and Community Protection Act (CLCPA) for a minimum of 70% of New York's end-use electrical energy requirements to be generated by renewable energy systems in 2030.

9 The Zero Emissions Study is included as appendix E to the Power Grid Study.

10 Power Grid Study, p. E-24.

11 NYSERDA's Tier 4 solicitation is part of New York State's Clean Energy Standard and was intended to increase the penetration of renewable energy into New York City. Two projects were selected for contract awards. These are the Clean Path NY (CPNY) and Champlain Hudson Power Express (CHPE) Projects.

12 This used a function of the TARA software (product of PowerGEM) known as SCRD (security-constrained redispatch). The function adjusts generation dispatch to eliminate normal (n-0) and contingency (n-1) overloads. SCRD uses a cost function that applies the same cost per MW for all generators, regardless of fuel type, to obtain a secure dispatch.

13 An earlier analysis considered a larger number of potential POIs in each county, but two POIs for each county with the highest headroom were selected for the purposes of the further analysis presented herein.

14 Simple upgrades assume that building a new line or transformer parallel to and of the same voltage level and rating as the constrained facility is sufficient to relieve the constraint. In practice, solutions to transmission constraints may start from this form of simple upgrade to other options such as reconductoring the line, adding a new line on a different right-of-way and/or connecting to different substations, uprating the voltage, rebuilding the line and non-wire and new technology solutions.

15 The headroom capacity is based on the modified 2030 summer peak power flow model which includes representation of renewable energy projects proposed for interconnection to the NYBPS as of the June 2021 NYISO interconnection queue. The list of these renewable energy projects is shown in appendix B.

16 Simple upgrades assume that building a new line or transformer parallel to and of the same voltage level and rating as the constrained facility is sufficient to relieve the constraint. In practice, solutions to transmission constraints may start from this form of simple upgrade to other options such as reconductoring the line, adding a new line on a different right-of-way and/or connecting to different substations, uprating the voltage, rebuilding the line and non-wire and new technology solutions.

17 Applying a conceptual cost per mile of the simple upgrade.

18 Solo headroom measures the MW capacity that can be supported by the grid at each POI on the assumption that there are no other new interconnections being added, i.e., the power flow model being held static except for the interconnection of the GLW at a POI.

19 Total headroom is the MW capacity for the combination of all POIs accessible from either Lake Erie or Lake Ontario.

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New York State Energy Research and Development Authority

17 Columbia Circle
Albany, NY 12203-6399

toll free: 866-NYSERDA
local: 518-862-1090
fax: 518-862-1091

info@nyserda.ny.gov
nyserda.ny.gov

NEW YORK STATE | NYSERDA

State of New York
Kathy Hochul, Governor

New York State Energy Research and Development Authority
Richard L. Kauffman, Chair | Doreen M. Harris, President and CEO