Transmission Planning for the Clean Energy Transition

System Conditions and Dispatch Assumptions

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Presentation Overview

- Review of Previous PAC Presentations
- Pilot Study Conditions
- Pilot Study Key Assumptions
- Feedback & Next Steps

REVIEW OF PREVIOUS PAC PRESENTATIONS

New Challenges in Transmission Planning

- By 2030, New England's power system is expected to have much higher levels of clean energy integration than today
  - Approximately 7,800 MW of distributed photovoltaic (PV) resources
  - 3,100 MW of offshore wind with contracts signed or under negotiation
  - New HVDC interconnection to Quebec
  - Increased development of battery energy storage
- These trends will require changes in New England's transmission planning studies
  - Different system conditions to be studied, including mid-day minimum load conditions
  - New approaches to data collection
- Topic introduced in a September 24, 2020 PAC presentation, pilot study proposal introduced in a November 19, 2020 PAC presentation

Pilot Study Overview

- ISO-NE proposes a "pilot" study of the conditions described in the September PAC presentation to quantify the trade-offs between transmission cost and reliability under infrequent conditions
- This pilot study will look at the year 2030 and will *not* be a Needs Assessment, Solutions Study, or competitive transmission RFP
  - Purpose is to test out assumptions, and quantify the tradeoffs between transmission investment and system flexibility
  - Reliability concerns found would not be addressed in a Solutions Study or competitive RFP as a result of this study
  - Any transmission solutions identified would be roughly representative only, and costs would be rough order-of-magnitude estimates
  - Results of the pilot study would inform decisions on assumptions to be used in future Needs Assessments
- DER data collection efforts will proceed in parallel with the pilot study, with the study using the best assumptions possible in the absence of actual data

Feedback from Previous PAC Presentations

- Many stakeholders provided comments during and after the September and November PAC presentations
- Selected feedback related to the pilot study
  - Can the ISO provide more clarity on the objectives of the pilot study?
  - Can these study conditions also be applied to interconnection studies?
  - How often do the various levels of load, solar production, and wind production occur?
  - Can these conditions be addressed via operator action?
  - How will these new assumptions align with the probabilistic generator dispatch method used currently?

Some Responses to Stakeholder Feedback

- The pilot study has two major objectives:
  - Exploration of reliability concerns to quantify trade-offs between system reliability/flexibility and transmission cost
  - Development of new assumptions for use in planning studies
- Frequency/Probability of Proposed Study Conditions
  - Answering this question requires defining a tolerance around the proposed point to be studied, in order to choose what historical points are "close" to the proposed study conditions
  - Rather than define this tolerance, historical data is available on the ISO-NE website; this data can be analyzed by stakeholders
  - When reliability concerns are found in the pilot study, ISO-NE will determine the critical system conditions causing the concern, and quantify the likelihood of these conditions where possible

Some Responses to Stakeholder Feedback

- Treatment of Generator Outages
  - ISO-NE previously proposed taking a “system-wide” view of New England’s power system, rather than stressing any particular area
    - This approach will work well for minimum load cases, where many (or most) synchronous generators will be offline
  - Many concerns that may occur at minimum load are likely to appear in these cases
    - Low inertia, low short-circuit strength
    - Intra- and inter-area transient stability
    - High transmission system voltage
  - Peak load concerns are more likely to be driven by generator outages
    - Following suggestions at previous PAC meetings, ISO-NE will create variations on the peak load cases with various generator outages to better address peak load concerns driven by generator outage conditions
- Other feedback will be addressed as the pilot study continues

PILOT STUDY CONDITIONS

Pilot Study Scope

- Four different load levels will be examined: two Summer peak load scenarios and two Spring minimum load scenarios
- These four scenarios will be expanded into six base cases, three peak load and three minimum load, to examine different levels of renewables as well as other key assumptions
- Steady-state analysis will be performed on all six base cases
- Stability analysis will primarily be performed on select cases where renewable generation is high
- These cases will help the ISO to gather information about how these assumptions affect the system broadly, laying the ground work for future study work to look at specific assumptions/areas in more detail

Proposed Pilot Study Assumptions: Load & Solar

- All values based on 2020 CELT report. Solar nameplate of 7,878 MW is based on capacity expected by June 2030.
- Solar numbers updated from November presentation to be correct numbers for 2030 (previous numbers were for 2029)

Condition to Study	Power Consumption	Solar Output	Forecasted Net Load in 2030
Spring/Fall Weekend Nighttime (minimum consumption)	8,000 MW	0% x 7,878 MW = 0 MW	8,000 – 0 = **8,000 MW**
Spring/Fall Weekend Mid-Day (minimum net load)	12,000 MW	90% x 7,878 MW = 7,090 MW	12,000 – 7,090 = **4,910 MW**
Summer Weekday Mid-Day (maximum consumption)	100% of 90/10 forecast = 27,462 MW	40% x 7,878 MW = 3,151 MW	27,462 – 3,151 = **24,311 MW**
Summer Weekday Evening (maximum net load)	95% of 90/10 forecast = 26,089 MW	10% x 7,878 MW = 788 MW	26,089 – 788 = **25,301 MW**

Proposed Pilot Study Assumptions: Wind

- Studies will examine the end of the output range that is conservative for the condition studied
  - High wind generation when low inertia may be a concern
  - Low wind generation where load serving may be a concern

Condition to Study	Onshore Wind Generation	Offshore Wind Generation
Spring Weekend Nighttime (minimum consumption)	5% (steady-state) 65% (stability)	15% (steady-state) 90% (stability)
Spring Weekend Mid-Day (minimum net load)	55%	60%
Summer Weekday Mid-Day (maximum consumption)	5% (steady-state) 30% (stability)	5% (steady-state) 90% (stability)
Summer Weekday Evening (maximum net load)	5%	5%

PILOT STUDY KEY ASSUMPTIONS

Minimum Load Pilot Study Base Cases

- Proposed minimum load conditions have been adapted into three base cases

Base Case	Net Load Level	Wind Level	Solar Level	Study Type
Spring Weekend Nighttime Minimum (High Renewables)	8,000 MW	65% Onshore 90% Offshore	0%	Steady-State and Stability
Spring Weekend Nighttime Minimum (Low Renewables)	8,000 MW	5% Onshore 15% Offshore	0%	Steady-State only*
Spring Weekend Mid-Day Minimum	4,910 MW	55% Onshore 60% Offshore	90%	Steady-State and Stability

*Limited stability analysis may be performed on this case

Peak Load Pilot Study Base Cases

- Proposed peak load conditions have been adapted into three base cases
- Variations on Summer weekday evening case will be used to test generation outages

Base Case	Net Load Level	Wind Level	Solar Level	Study Type
Summer Weekday Mid-Day Peak (High Renewables)	22,341 MW	30% Onshore 90% Offshore	65%	Steady-State and Stability
Summer Weekday Mid-Day Peak (Low Renewables)	24,311 MW	5% Onshore 5% Offshore	40%	Steady-State only*
Summer Weekday Evening	25,301 MW	5% Onshore 5% Offshore	10%	Steady-State and Stability

*Limited stability analysis may be performed on this case

Primary Reasons for Studying Each Case

Case	Rationale
Spring Weekend Nighttime Minimum (High Renewables)	• High exports from SEMA/RI and Maine • Low generation in other parts of New England may lead to high voltage
Spring Weekend Nighttime Minimum (Low Renewables)	• Low transfers and minimum online generation • Greatest exposure to system-wide high voltage
Spring Weekend Mid-Day Minimum	• Greatest exposure to loss of DER caused by transmission system faults • Few online synchronous generators (low inertia) could cause area-wide stability concerns
Summer Weekday Mid-Day Peak (High Renewables)	• Transient voltage and fault recovery concerns may result from a combination of high load and high inverter-based generation
Summer Weekday Mid-Day Peak (Low Renewables)	• Highest load in areas with low solar penetration • Greatest exposure to thermal and voltage concerns in areas with low solar penetration
Summer Weekday Evening	• Highest net load served by transmission system • Greatest exposure to thermal and voltage concerns in areas with higher solar penetration

Future Transmission and Generation Included

- All PPA-approved transmission projects through May 1, 2020
- All future generation projects with Forward Capacity Market commitments, or with financially binding contracts in place or under negotiation, including the following:
  - Vineyard Wind (800 MW interconnecting at Barnstable 115 kV)
  - Revolution Wind (704 MW interconnecting at Davisville 115 kV)
  - Mayflower Wind (804 MW interconnecting at Bourne 345 kV)
  - Park City Wind (790 MW interconnecting at West Barnstable 345 kV)
  - Three Corners Solar (112 MW interconnecting at Albion Road 115 kV)
  - ISO-NE is interested in including any other resources with contracts signed or pending; please notify ISO-NE via pacmatters@iso-ne.com
- All known generation retirements and permanent delists through 2030, including Mystic

Hydro Assumptions for Minimum Load Cases

- 70% of nameplate assumed for run-of-river, based on analysis of historical springtime data
- Ponding hydro assumed offline, in order to store energy for peak hours
- Hydroelectric pumped storage assumed offline
  - More conservative: no pumping load results in less generation online
  - No guarantee that space will be available in upper reservoirs for water pumped both at night and mid-day

Base Case	Run-of-River Hydro	Ponding Hydro	Pumped Hydro
Spring Weekend Nighttime Minimum (High Renewables)	70%	0%	Offline
Spring Weekend Nighttime Minimum (Low Renewables)	70%	0%	Offline
Spring Weekend Mid-Day Minimum	70%	0%	Offline

Hydro Assumptions for Peak Load Cases

- Assumed pumped storage generating 100% for evening peak
  - In today's studies, some pumped storage units kept offline to provide reserves
  - In the evening peak case, fast-start simple-cycle gas units are available to provide reserves in place of pumped storage

Base Case	Run-of-River Hydro	Ponding Hydro	Pumped Hydro
Summer Weekday Mid-Day Peak (High Renewables)	No change from current Needs Assessment process	No change from current Needs Assessment process	No change from current Needs Assessment process
Summer Weekday Mid-Day Peak (Low Renewables)	No change from current Needs Assessment process	No change from current Needs Assessment process	No change from current Needs Assessment process
Summer Weekday Evening	No change from current Needs Assessment process	No change from current Needs Assessment process	100% of units generating

Inter-Area Transfer Assumptions for Minimum Load Cases

Base Case	NECEC	Phase II**	Highgate**	NB-NE	NE-NY
Spring Weekend Nighttime Minimum (High Renewables)	1200 MW*	0 MW	0 MW	0 MW	0 MW
Spring Weekend Nighttime Minimum (Low Renewables)	1200 MW*	0 MW	0 MW	0 MW	0 MW
Spring Weekend Mid-Day Minimum	1200 MW*	0 MW	0 MW	0 MW	0 MW

*NECEC may be reduced to avoid exceeding internal transfer limits such as Maine-New Hampshire

**Assumed 0 MW due to lessened need for imported power under minimum load conditions

Inter-Area Transfer Assumptions for Peak Load Cases

Base Case	NECEC	Phase II	Highgate	NB-NE	NE-NY
Summer Weekday Mid-Day Peak (High Renewables)	1200 MW*	1500 MW	225 MW**	700 MW	0 MW
Summer Weekday Mid-Day Peak (Low Renewables)	1200 MW*	1500 MW	225 MW**	700 MW	0 MW
Summer Weekday Evening	1200 MW*	1500 MW	225 MW**	700 MW	0 MW

*NECEC may be reduced to avoid exceeding internal transfer limits such as Maine-New Hampshire

**Measured at the Canadian-U.S. border

Pseudo-Economic Dispatch for Remaining Generation

- A "pseudo-economic" dispatch will be used to dispatch any remaining generation required to meet the desired load levels according to a typical dispatch order
- Generation will be dispatched in the following order:
  - Nuclear
  - Biomass
  - Natural gas combined-cycle
  - Natural gas simple-cycle
  - Coal
  - Oil
  - Diesels, aero-derivatives, and other fast-start generation

Other Assumptions for Pilot Study Cases

- Spring cases assume one nuclear unit outaged for refueling and maintenance (will assume Millstone 2 out of service)
- Internal interfaces will not be set to their limits or any particular target value, but will be determined by a pseudo-economic generation dispatch (as long as interface limits are not exceeded)
- Generation dispatches will be chosen to ensure that the daily peak load can still be met without infeasible changes in generation between the mid-day minimum and the evening peak

Frequency/Probability of Reliability Concerns

- Any reliability concerns found in the pilot study will be analyzed to determine the main factor driving the concern
  - For example: is the concern driven by high solar production? Low offshore wind output? Low net load?
- Variations on the original cases will be created and studied to determine the "critical point" at which the concern arises
  - For example: a concern may arise whenever solar power output is above 85% of nameplate capacity
- Using historical data and upcoming stochastic data from DNV GL, the "critical point" will be converted into an estimate of exposure, in terms of hours per year where possible
  - For example: solar power output is above 85% of nameplate for 30 hours per year, on average

FEEDBACK & NEXT STEPS

Feedback and Next Steps

- Feedback on the pilot study proposal may be submitted to pacmatters@iso-ne.com by January 8, 2021 (allowing extra time in addition to normal 15 calendar days for holidays)
- Please submit additional resources with signed or pending contracts to ISO-NE (via pacmatters@iso-ne.com) by January 8, 2021 (allowing extra time in addition to normal 15 calendar days for holidays)
- Next Steps:
  - Finalize pilot study base cases and review with PAC
  - Perform steady-state and stability analysis on pilot study cases
  - Review findings of these studies with PAC
  - In parallel with the pilot study, outreach to distribution providers regarding DER data collection
  - Further discussion on open questions, and on the pilot study results and tradeoffs on future Needs Assessment assumptions, at future PAC meetings