JANUARY 21, 2021 | WEBEX

Transmission Planning for the Clean Energy Transition

Pilot Study Base Cases

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Presentation Overview

- Review of Pilot Study Assumptions
- Responses to Feedback
- Likelihood of Study Conditions
- Pilot Study Base Case Details
- Feedback & Next Steps

REVIEW OF PILOT STUDY ASSUMPTIONS

Review of Previous PAC Presentations

- 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
- ISO-NE proposed a "pilot" study of the conditions described in previous PAC presentations to quantify the trade-offs between transmission cost, reliability, and emissions under a variety of possible system conditions
- Topic introduced in a September 24, 2020 PAC presentation, pilot study proposal introduced in a November 19, 2020 PAC presentation, pilot study assumptions introduced in a December 16, 2020 PAC presentation

Review of Pilot Study Base Case Assumptions

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
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

Review of Pilot Study Base Case Assumptions

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
Summer Weekday Mid-Day Peak (High Renewables)	No Change*	No Change*	No Change*
Summer Weekday Mid-Day Peak (Low Renewables)	No Change*	No Change*	No Change*
Summer Weekday Evening	No Change*	No Change*	100% of units generating

* Compared to the current Needs Assessment process

Review of Pilot Study Base Case Assumptions

Base Case	NECEC	Phase II	Highgate**	NB-NE	NE-NY
Spring Weekend Nighttime Minimum (High Renewables)	1,090 MW	0 MW	0 MW	0 MW	0 MW
Spring Weekend Nighttime Minimum (Low Renewables)	1,090 MW	0 MW	0 MW	0 MW	0 MW
Spring Weekend Mid-Day Minimum	0 MW*	0 MW	225 MW	0 MW	0 MW
Summer Weekday Mid-Day Peak (High Renewables)	1,090 MW	1,500 MW	225 MW	700 MW	0 MW
Summer Weekday Mid-Day Peak (Low Renewables)	1,090 MW	1,500 MW	225 MW	700 MW	0 MW
Summer Weekday Evening Peak	1,090 MW	1,500 MW	225 MW	700 MW	0 MW

* NECEC set to 0 MW due to excess New England generation in this case

** Highgate (measured at the Canadian-U.S. border) set to 225 MW for cases between the hours of 8 AM and 11 PM, set to 0 MW for all other hours per Highgate contract

Note: NECEC was updated from 1,200 MW in the December presentation to 1,090 MW after reviewing the contract again

Review of Pilot Study Base Case Assumptions

- 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
- Spring cases assume one nuclear unit outage 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

RESPONSES TO FEEDBACK

Responses to Feedback

- ISO-NE may pursue winter peak cases at a later date if forecasts show that they could introduce potential new reliability concerns
- ISO-NE is currently investigating the application of low-inertia conditions to neighboring areas for minimum load cases
  - Recent work through the EIPC Frequency Response Working Group (FRWG) examined an interconnection-wide low-inertia system condition in order to examine the adequacy of governor response
  - The FRWG work chose a dispatch based on actual conditions from a set time in 2018; matching this dispatch exactly in a 2030 base case may not be feasible or accurate
  - ISO-NE will continue investigating the best way to account for lower inertia in neighboring areas

LIKELIHOOD OF STUDY CONDITIONS

Quantifying the Likelihood of Study Conditions

- Multiple stakeholders have submitted comments and questions regarding the likelihood of the chosen study conditions
- In response to this feedback, ISO-NE has examined historical hourly data on the PAC website*, covering 2000 to 2019, to estimate the likelihood of the three minimum load study conditions
- Estimates of likelihood of peak load study conditions are still in progress

*https://www.iso-ne.com/static-assets/documents/2020/09/2020_iso_ne_variable_energy_resource_ver_data_series_2000_2019_rev3.zip

Quantifying the Likelihood of Study Conditions

- The likelihood of study conditions can be expressed in terms of "expected hours per year"
  - On average, during how many hours per year were conditions observed to be similar to the proposed study conditions?
  - Conditions observed less than one hour per year will have a fractional number of hours per year
- As a baseline for comparison, 90/10 peak load, by definition, is expected to occur in one hour every ten years (0.1 hours per year)
- Since 2010, nighttime and mid-day minimum loads (including effects of EE) have been trending downward; nearly all hours matching these study conditions have occurred since 2010
  - Downward trend is likely a result of energy efficiency investments
  - These conditions may become more common in future years than they were between 2000 and 2019

Quantifying the Likelihood of Study Conditions

Base Case	Load Level (Gross Load – EE)	Wind Level	Solar Level	Simultaneous Occurrence
Spring Weekend Nighttime Minimum (High Renewables)	8,000 MW (7,000-9,000 MW)* 17 hours/year	65% Onshore (60%-100%)* 90% Offshore (85%-100%)* 885 hours/year	0% 4416 hours/year	1.7 hours/year (34 hours in 20 years)
Spring Weekend Nighttime Minimum (Low Renewables)	8,000 MW (7,000-9,000 MW)* 17 hours/year	5% Onshore (0%-10%)* 15% Offshore (0%-20%)* 539 hours/year	0% 4416 hours/year	1.1 hours/year (22 hours in 20 years)
Spring Weekend Mid-Day Minimum	12,000 MW (11,000-13,000 MW)* 1589 hours/year	55% Onshore (50-100%)* 60% Offshore (55-100%)* 1593 hours/year	90% (80-100%)* 97 hours/year	0.3 hours/year (6 hours in 20 years)

* Historical hours were identified by using ranges around the proposed study conditions as shown.

PILOT STUDY BASE CASE DETAILS

Generation by Resource Type for Min Load Cases

Resource Type	Spring Weekend Nighttime Minimum (High Renewables)	Spring Weekend Nighttime Minimum (Low Renewables)	Spring Weekend Mid-Day Minimum
Non-DER Solar	0 MW	0 MW	529 MW
Onshore Wind	824 MW	64 MW	333 MW
Offshore Wind	2,931 MW	488 MW	933 MW
Hydro	371 MW	371 MW	371 MW
Pumped Hydro	0 MW	0 MW	0 MW
Nuclear	2,612 MW	2,612 MW	2,612 MW
Biomass	361 MW	844 MW	0 MW
Combined-Cycle Gas	0 MW	2,666 MW	0 MW
Simple-Cycle Gas	0 MW	0 MW	0 MW
Diesel	0 MW	0 MW	0 MW
Coal	0 MW	0 MW	0 MW
Oil	0 MW	0 MW	0 MW

Generation by Resource Type for Peak Load Cases

Resource Type	Summer Weekday Mid-Day Peak (High Renewables)	Summer Weekday Mid-Day Peak (Low Renewables)	Summer Weekday Evening Peak
Non-DER Solar	382	235 MW	58 MW
Onshore Wind	380 MW	63 MW	63 MW
Offshore Wind	2,931 MW	163 MW	163 MW
Hydro	397 MW	397 MW	397 MW
Pumped Hydro	923 MW	923 MW	1,844 MW
Nuclear	3,555 MW	3,555 MW	3,555 MW
Biomass	928 MW	928 MW	928 MW
Combined-Cycle Gas	9,907 MW	14,710 MW	14,789 MW
Simple-Cycle Gas	0 MW	522 MW	522 MW
Diesel	0 MW	0 MW	0 MW
Coal	0 MW	0 MW	0 MW
Oil	0 MW	0 MW	0MW

Interface Flows for Minimum Load Cases

Interface	Spring Weekend Nighttime Minimum (High Renewables)	Spring Weekend Nighttime Minimum (Low Renewables)	Spring Weekend Mid-Day Minimum
Orrington South	195 MW	3 MW	47 MW
Surowiec South	1,072 MW	934 MW	-56 MW
ME-NH	888 MW	751 MW	-142 MW
North-South	1,785 MW	1,474 MW	1,047 MW
Boston Import	1,638 MW	1,638 MW	1,845 MW
SEMA/RI Export	1,294 MW	-103 MW	554 MW
East-West	1,130 MW	-418 MW	-896 MW

Interface Flows for Peak Load Cases

Interface	Summer Weekday Mid-Day Peak (High Renewables)	Summer Weekday Mid-Day Peak (Low Renewables)	Summer Weekday Evening Peak
Orrington South	601 MW	1,046 MW	1,047 MW
Surowiec South	1,301 MW	1,765 MW	1,683 MW
ME-NH	702 MW	1,688 MW	1,584 MW
North-South	694 MW	2,173 MW	1,979 MW
Boston Import	4,526 MW	4,539 MW	4,442 MW
SEMA/RI Export	1,937 MW	95 MW	-266 MW
East-West	-1,438 MW	-1,688 MW	-2,064 MW

Possible Sensitivities for the Spring Mid-Day Minimum Case

- In the Spring Mid-Day Minimum case there are approximately 1,385 MW of surplus renewable generation left after curtailing imports and biomass
- In the base case, this is resolved by curtailing both onshore and offshore wind to keep NE-NY flows at 0 MW
- For informational purposes, sensitivities will be performed to explore alternatives to curtailing this wind output, which may include:
  - Utilizing storage (existing pumped hydro/batteries)
  - Curtailing solar instead of wind

Treatment of Generator Outages

- To ensure that the conclusions of the pilot study are transferable to future Needs Assessments, variations on the summer weekday evening peak case will be created to examine generator outages
- Variations on this case will attempt to match generator outage assumptions from past Needs Assessments, in order to examine the effects of changes in load and renewable assumptions on system needs

FEEDBACK & NEXT STEPS

Feedback and Next Steps

- Feedback on the pilot study base cases may be submitted to pacmatters@iso-ne.com by February 5, 2021
- Next Steps:
  - 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