Capacity Value Summary

Zachary T Smith

Manager, Capacity Market Design

ICAPWG

December 18th, 2018

Agenda

- Background
- Summary of Stakeholder Comments on GE Study
- Assumptions
- Other Studies
- 5 MW Extrapolation
- Other Stakeholder Concerns
- Appendix

Background

Purpose of today's meeting

- Review stakeholder feedback on concerns regarding Capacity Value Study
- Provide NYISO analysis in response to feedback to assess capacity value at a 5 MW block size
- We will not be discussing the capacity market design proposal in today's meeting or the results from the additional analysis being conducted by GE

Definitions

- **Capacity Value**
  - How much perfect capacity of a particular resource is necessary to provide an equivalent reliability benefit in a given location
  - Capacity Value is independent of transmission constraints
  - Capacity Value for a traditional generator can be approximated by UCAP
- **Reliability Benefit**
  - The impact that a unit has on a reliability metric, such as Daily Loss of Load Expectation
- **NYCA-wide Reliability Value**
  - The amount of perfect capacity spread throughout NYCA proportional to existing capacity which would provide an equivalent reliability benefit
  - NYCA-wide Reliability Value incorporates the impact of transmission congestion
- **Capacity Margin**
  - The difference between the total amount of resources on the system and the system load [MW]
    - Capacity Margin [MW] = total amount of resources [MW] – system load [MW]

Definitions cont.

- **Resource with daily energy duration limitations**
  - A resource that has a limitation that may impact its ability to continuously inject megawatts at its full Installed Capacity rating for a 24 hour period
  - Examples:
    - ELRs, SCR, ESRs, DER (homogeneous load reduction or heterogeneous aggregations)

Definitions cont.

- **An Energy Limited Resource (ELR) is an energy supplier that is unable to operate at a level that represents its ICAP obligation for all hours of the day, but can operate at that level for at least four consecutive hours each day**
  - Some ELRs are limited by something other than technical parameters and physical operating characteristics (*e.g.*, regulatory restrictions)
  - Some ELRs are limited by technical parameters are physical operating characteristics
- **ELRs may differ from other resources types with daily energy duration limitations**
  - ELR daily limitation may not be binding every day but may be situational

Definitions cont.

- **NYISO's MST defines an Energy Limited Resource as:**
  - "A resource, that, due to environmental restrictions on operations, cyclical requirements, such as the need to recharge or refill, or other non-economic reasons, is unable to operate continuously on a daily basis, but is able to operate at least four consecutive hours each day. Energy Limited Resources must register their Energy limiting characteristics with, and justify them to, the ISO consistent with ISO procedures"
  - Examples include, but are not limited to a hydro unit that is subject to recharge periods or a generator with NOx/SOx restrictions on run times
- **Attachment M of the ICAP Manual Attachments describes the process for a unit to register as an ELR**
  - The unit must provide a detailed explanation of why it is unable to run at its ICAP MW for 24 hours a day with supporting data

NEW YORK INDEPENDENT SYSTEM OPERATOR

Definitions cont.

- **ELR treatment in the GE Capacity Value Study:**
  - To date the GE MARS modeling done for the NYSRC's IRM study and other NYISO studies does not model the existing ELR resources with their daily energy duration limitations
  - Rather, the model treats these resources as having availability based solely on their EFORd/transition rates, similar to other generation resources

GE MARS clarification

- **GE MARS modeling for different types of resources**
  - Availability based
    - Transition rates based off EFORd
  - Performance based
    - Historic performance (limited to intermittent resources such as wind, solar, run of river hydro and land fill gas resources, and SCRs)

Summary of Stakeholder Comments on GE Study

NEW YORK INDEPENDENT SYSTEM OPERATOR

DRAFT – FOR DISCUSSION PURPOSES ONLY

Summary of Stakeholder Comments on GE Study

- Concerns with the load shapes that were used in the study (i.e. out of date, conservative, penetration of renewables)
- Concerns that the system was modeled At Criterion
  - Other options include at Level of Excess and As Found
- Concerns surrounding limitations of the GE MARS tool (i.e. perfect foresight) as well as the limitations in the post processing methodology (e.g. can only dispatch resources in full capacity blocks or in 50 MW blocks, does not evaluate start-up times)
  - More detail in following slides

Summary of Stakeholder Comments on GE Study

- Questions on methodology and whether NYISO would consider an ELCC study approach
- Will NYISO consider additional analysis (either through GE or external consultant)?
  - For example, will the NYISO consider location of resources in analysis?

Capacity Value Study: Assumptions

NEW YORK INDEPENDENT SYSTEM OPERATOR

Assumptions

Assumptions in the Capacity Value Study that may be biasing the results one way or the other

- **Potentially overestimate the Capacity Value of resources with duration limitations**
  - Perfect foresight in scheduling resources to need
  - Scheduling resources after EOPs
- **Potentially underestimate the Capacity Value of resources with duration limitations**
  - Block size decrease
  - Durations are scheduled in consecutive hours

NEW YORK INDEPENDENT SYSTEM OPERATOR

5 MW Extrapolation

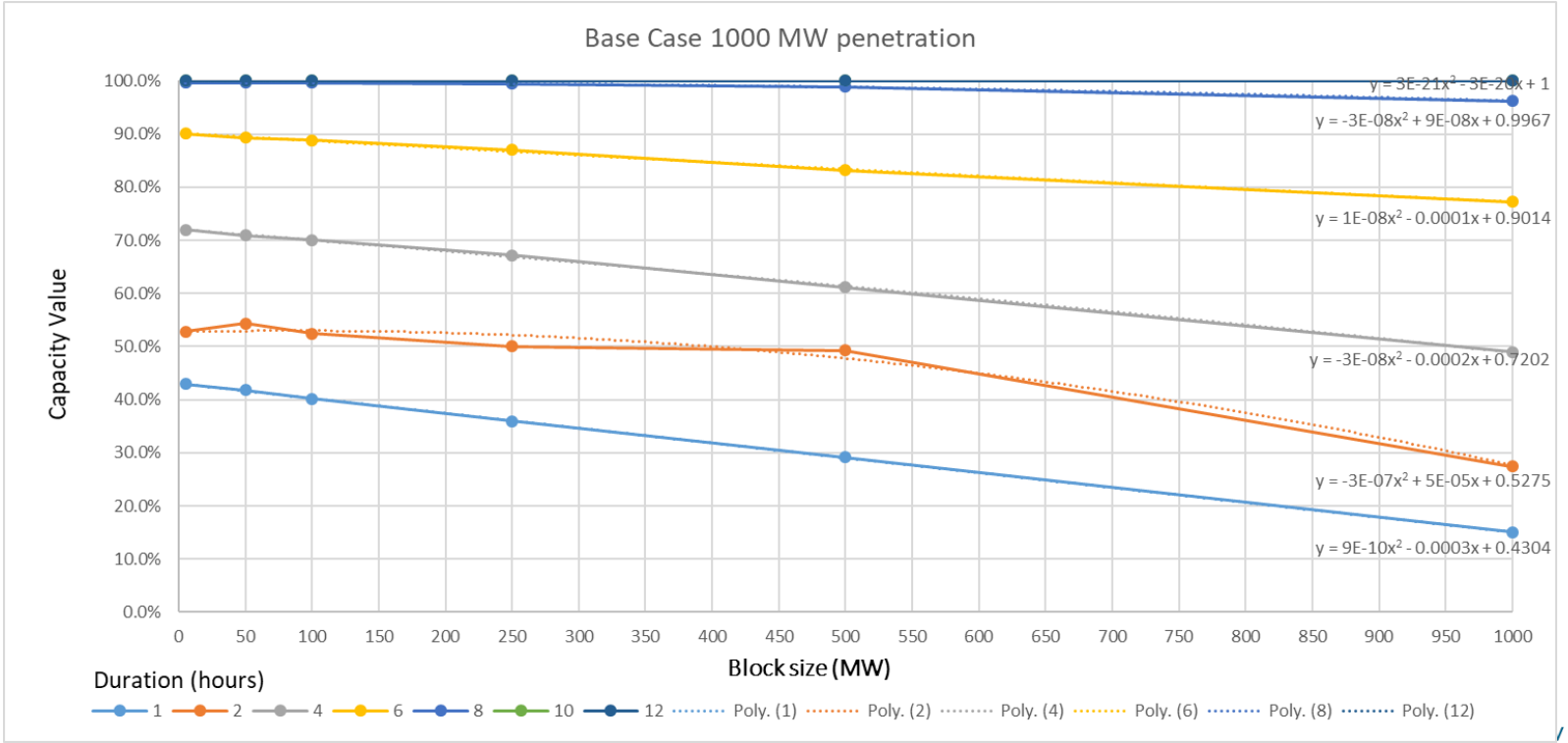
5 MW Extrapolation

- **The NYISO received a suggestion to plot the GE results using a different sensitivity**
  - Rather than plot Capacity Value vs. Duration, recommended to plot **Capacity Value vs. Block size**
  - The smallest block size we have in data in 50 MW, so the NYISO plotted the existing data and extrapolated the data using a polynomial trend line to approximate the Capacity Value of the 5 MW block size

Cases

- The NYISO conducted this analysis for two cases: the Base Case at 1000 MW penetration and High Wind – High Solar Case at 1000 MW penetration
- Note that the NYISO is <u>not advocating</u> for these capacity values
  - This analysis was conducted to be responsive to stakeholder feedback to evaluate capacity value of these duration limited resources at a 5 MW block sizes in order to further stakeholder discussion and consideration

Base Case



NEW YORK INDEPENDENT SYSTEM OPERATOR

DRAFT – FOR DISCUSSION PURPOSES ONLY

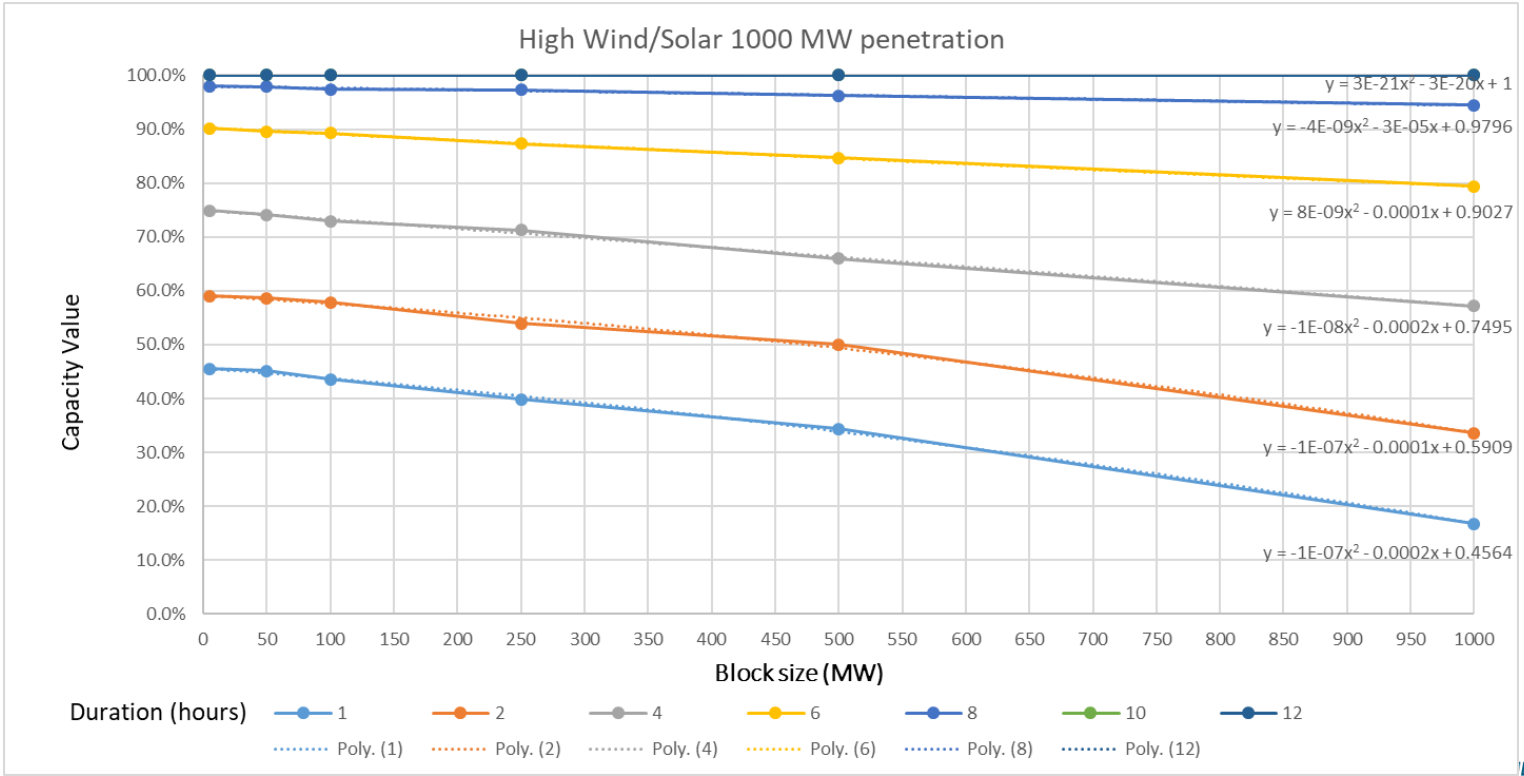
Base Case Capacity Values

Hour Duration

MW 1000 MW Penetration	1	2	4	6	8	10	12
5	42.9%	52.8%	71.9%	90.1%	99.7%	100%	100%
50	41.8%	54.4%	70.9%	89.3%	99.7%	100%	100%
100	40.1%	52.4%	70.0%	88.8%	99.7%	100%	100%
250	36.0%	50.1%	67.2%	87.0%	99.4%	100%	100%
500	29.1%	49.3%	61.1%	83.2%	98.8%	100%	100%
1000	15.0%	27.4%	48.9%	77.2%	96.2%	100%	100%

NEW YORK INDEPENDENT SYSTEM OPERATOR

High Wind – High Solar



High Wind – High Solar Capacity Values

Hour duration

MW	1000 MW penetration	1	2	4	6	8	10	12
	5	45.5%	59.0%	74.9%	90.2%	97.9%	100%	100%
	50	45.1%	58.7%	74.1%	89.6%	97.9%	100%	100%
	100	43.6%	57.9%	73.0%	89.3%	97.4%	100%	100%
	250	39.8%	54.0%	71.3%	87.3%	97.3%	100%	100%
	500	34.3%	50.1%	65.9%	84.7%	96.3%	100%	100%
	1000	16.7%	33.6%	57.2%	79.4%	94.4%	100%	100%

Conclusions

- The analysis to extrapolate the capacity values at 5 MW block sizes shows that there is a small incremental value in dispatching resources in smaller block sizes, and that the capacity value of resources levels off

Next Steps

- Continue discussions at January 8th, 2019 ICAPWG

Feedback/Questions?

- Email additional feedback to: ztsmith@nyiso.com and deckels@nyiso.com

Appendix

Response to Stakeholder Comments on GE Study

- **Concerns with the load shapes that were used in the study (i.e. out of date, conservative, penetration of renewables)**
  - The NYISO dedicated the 12/6 ICAPWG to explaining the modeling tool, load shapes, and assumptions used in its Capacity Value Study
  - The load shapes used in the study are the same load shapes that are used in the IRM Study each year
  - The historic load shapes are scaled up to the peak load of the year being studied
  - Grid scale renewables are modeled as supply and will not affect load shapes
    - Uncertainty due to Behind the Meter Solar is captured in the Load Forecast Uncertainty

Response to Stakeholder Comments on GE Study

- **Concerns that the system was modeled At Criterion (rather than at Level of Excess or As Found)**
  - The NYISO felt it was appropriate to conduct the study At Criterion to align our reliability criteria used to set the requirements for the Capacity Market
  - To understand the sensitivity of the results to the resource levels modeled in the base case, the NYISO has asked GE to perform two sensitivities at the Level of Excess for comparison
  - See following slide for more information

Percent Values for different scenarios

Excess percent above requirements

Base Case		
Location	As Found %	Level of Excess %
G-J	8.6%	1.5%
LI	9.7%	3.8%
NYC	13.7%	2.4%
NYCA	7.0%	0.6%

High Wind - High Solar	
Location	Level of Excess %
G-J	1.5%
LI	3.9%
NYC	2.3%
NYCA	0.5%

Response to Stakeholder Comments on GE Study

- **Concerns surrounding limitations of the GE MARS tool (i.e. perfect foresight) as well as the limitations in the post processing methodology (e.g. can only dispatch resources in full capacity blocks or in 50 MW blocks, does not evaluate start-up times)**
  - The NYISO explained the GE MARS tool and the post processing method at the 12/6 ICAPWG
  - NYISO Capacity Market does not currently value start-up time and the NYISO does not believe that the Capacity Market is the appropriate place to value start-up time
  - Additional explanations are included on slide 15 of today's presentation to better address these concerns

Response to Stakeholder Comments on GE Study

- **Questions on methodology and whether NYISO would consider an ELCC study approach**
  - The Capacity Value Study methodology as well as the differences between Capacity Value Study and ELCC Study were discussed at 12/6 ICAPWG
  - The NYISO explained at the 12/6 ICAPWG why it believes that the Capacity Value Study was an appropriate approach for this analysis

Response to Stakeholder Comments on GE Study

- **Will NYISO consider additional analysis (either through GE or external consultant)?**
  - The NYISO is open to considering additional analysis, either through GE or an external consultant
  - The NYISO asked GE to perform two sensitivities at the Level of Excess for comparison
    - Results of these sensitivities will be brought to a future ICAPWG

Previous Discussions

- **Previous discussions on the Capacity Value from this year:**
  - February 2nd 2018 ICAPWG
    - https://www.nyiso.com/documents/20142/1395087/Capacity%20Value%20of%20Resources%20with%20Energy%20Limitations.pdf/29fe19c1-9567-4457-3dce-6c74cb5284d4
  - April 26th 2018 ICAPWG
    - https://www.nyiso.com/documents/20142/2545489/04232018%20Capacity%20Value%20of%20Resources%20with%20Energy%20Limitations.pdf/865c64e1-75b6-0eeb-43e6-b818ff7d356a
  - July 24th 2018 ICAPWG
    - https://www.nyiso.com/documents/20142/2547799/Capacity%20Value%20of%20Resources%20with%20Energy%20Limitations.pdf/27519226-afb5-a440-fcac-669e38a8c2ec
  - October 9th 2018 ICAPWG
    - https://www.nyiso.com/documents/20142/3698135/Expanding%20Capacity%20Eligibility%20clean.pdf/08985712-1a61-5bff-f12e-05570bd0af90
  - November 29th 2018 ICAPWG
    - https://www.nyiso.com/documents/20142/3758748/DER%20Capacity%20Market%20Updates%20and%20Schedule.pdf/2ea38d70-2616-53fb-17c9-2888e79becf3
  - December 6th 2018 ICAPWG
    - https://www.nyiso.com/documents/20142/3832196/Capacity%20Value%20Study%20Summary.pdf/e43f7c7b-cada-04be-05b2-95c1d9e1f007

Other sources for information

- In 2012, the NYISO with the NYSRC performed an analysis on SCR's contribution to Resource Adequacy
  - http://www.nysrc.org/pdf/MeetingMaterial/ICSMeetingMaterial/ICS_Agenda135/2012%20SCR%20Study%20Report%20for%20ICS%20-final-05-01-12.pdf
- IN 2014, NYISO initiated an effort to increase the duration requirement from 4 to 6 hours for the SCR program
  - https://www.nyiso.com/documents/20142/1403273/SCR%20Performance%20Obligations%20_ICAPWG072114.pdf/c4114ded-c70d-b067-baab-cc536a844664

Other sources for information

- **Sources referenced at the 12/6 ICAPWG for further information**
  - Modeling Multiple Load Shapes in Resource Adequacy Studies (2013)
    - http://nysrc.org/pdf/Reports/IRM%20White%20Papers/Multiple%20Load%20Shape%20%205_29_13%20Final.pdf
  - Load Forecast Uncertainty Models for the 2018 IRM Study (2017)
    - https://www.nyiso.com/documents/20142/1408371/2018_IRM_LFU_Models.pdf/a9354a55-3e5f-2b26-7ccd-62fb22a09de4

Other studies referenced by stakeholders

- **IEEE – Estimating the Capacity Value of Concentrating Solar Power Plants with Thermal Energy Storage: A Case Study of the Southwestern United States (2012)**
  - Case study estimates the capacity value of CSP plants at three sites in the southwestern U.S. (California, Nevada, and New Mexico)
    - Analysis uses historical data from 1998-2005
    - Study does not analyze capacity value as a function of resource penetration
  - Capacity value is measured through ELCC Study – determine the value of resources added to the system
    - Looks at the capacity value of concentrating solar power (CSP) development, specifically: CSP with thermal energy storage
- **The results of this study are not comparable to GE's Capacity Value Study because the study looks at resources:**
  - Specific to one type of resource (concentrating solar with thermal energy storage)
  - Located in the southwestern U.S.
    - The system conditions in the southwestern U.S. may not be comparable to those in NYS

NEW YORK INDEPENDENT SYSTEM OPERATOR

Other studies referenced by stakeholders

- **IEEE – A Dynamic Programming Approach to Estimate the Capacity Value of Energy Storage (2014)**
  - Case study estimates the capacity value of storage in five utility systems: Pacific Gas and Electric (PG&E), Southern California Edison (SCE), NV Energy (NE), Public Service Company of New Mexico (PNM), and FirstEnergy (FE)
    - Analysis uses historical data from 1998-2005
    - Study does not analyze capacity value as a function of resource penetration
  - Capacity value is measured through ELCC Study – determine the value of resources (in this case energy storage) added to the system
    - Capacity value is highly sensitive to storage dispatch decisions, which are determined by energy prices
- **Even though the approach of the study varies from the GE Capacity Value Study, the value results are comparable (1-10 hour durations equal to ~40-90% Capacity Values)**
  - This study is not clear on the assumptions used to derive their conclusions
- **The results of this study are not comparable to GE's Capacity Value Study because the study looks at resources:**
  - Specific to one type of resource (energy storage)
  - Based on energy prices
  - Located in the southwestern U.S.
    - The system conditions in the southwestern U.S. may not be comparable to those in NYS

Other studies referenced by stakeholders

- **ICF – Unlocking the Hidden (Capacity) Value in Energy Storage (2016)**
  - Case study models ERCOT's grid using ICF's Stochastic Resource Assessment Model
    - Modeled a future year (2018) using projected generation/load data
    - Study does not analyze capacity value as a function of resource penetration
  - Recommends measuring the capacity value of resource (in this case energy storage) through ELCC or ideal-generator method (IGM)
    - Calculate the capacity value of resource by evaluating the improvement in LOLE assuming that it is available for hour(s) (corresponding to resource's duration)
  - Concluded that a 1 hour 100 MW energy storage system can provide 46 MW of firm capacity, and a 4 hour 100 MW energy storage system can provide 99 MW of firm capacity
- **The results of this study are not comparable to GE's Capacity Value Study because the study looks at resources:**
  - Specific to one type of resource (energy storage)
  - Located in the southern U.S.
    - The system conditions in the southern U.S. may not be comparable to those in NYS

Other methodologies NYISO has reviewed

- NREL
  - Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning (IVGTF1-2): Additional Discussion (2011)
    - Recommends ELCC approach for Resource Adequacy Planning
    - Suggests alternative reliability metrics that ELCC can be based on:
      - LOLP/LOLE – daily
      - LOLH (hourly LOLP)
      - EUE – expected unserved energy
  - The method chosen for performing the study was to accommodate the specific question that CPUC was trying to answer

Other methodologies NYISO has reviewed

- **Energy and Environmental Economics**
  - Capacity and Flexibility Needs under Higher Renewables (2015)
    - Suggests that there is a planning problem regarding resource adequacy
    - Refers to RECAP approach used in modeling ELCC
  - E3/Calpine ELCC Modeling (2016)
    - ELCC Study used to determine the value of resources added to the system
  - The method chosen for performing the study was to accommodate the specific question that CPUC was trying to answer
- **CAISO**
  - Calpine/E3 ELCC Proposal: Overview and Answers to Stakeholder Questions (2017)
    - ELCC Study used to determine the value of resources added to the system
  - The method chosen for performing the study was to accommodate the specific question that CPUC was trying to answer

Other methodologies NYISO has reviewed

- **CAISO**
  - Effective Load Carrying Capacity and Qualifying Capacity Calculation Methodology for Wind and Solar Resources (2014)
    - CPUC Staff Proposal to conduct ELCC for wind and solar resources to determine the value of the resources
  - Potential Energy Division Staff Proposal: Adoption of Simplified ELCC Methodology (2015)
    - Suggests different approaches to incorporate ELCC values
      - e.g. simplified ELCC methods, monthly ELCC values, hybrid approach
  - Energy Division Revised Proposal Monthly LOLE and Monthly ELCC (2017)
    - ELCC Study used to determine the value of resources added to the system, specifically wind and solar

The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefits to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policy makers, stakeholders and investors in the power system

www.nyiso.com

NEW YORK INDEPENDENT SYSTEM OPERATOR