Wind and Solar Intermittent Power Resources (IPR) Participation Model

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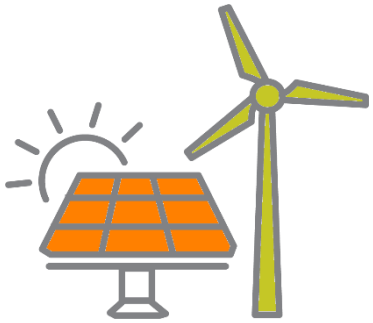


E-Learning Module

Disclaimer:

The information provided in this presentation is intended to highlight the salient features of wholesale wind and solar participation in the NYISO markets.

It is assumed that the learner has some fundamental understanding of how NYISO's wholesale markets function.

Please refer to the Online Learning and Course Materials section on the Market Training webpage on the NYISO website for learning opportunities.

https://www.nyiso.com/training

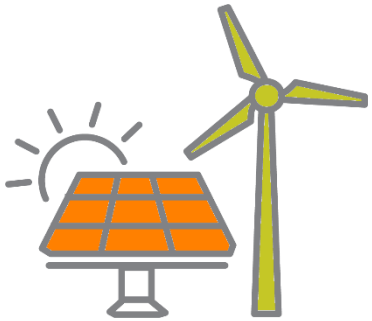
Presentation Outline

- Introduction to Wind and Solar IPR Participation
- Energy Market Participation
- Energy Market Settlements
- Installed Capacity Market Participation
- Additional Documentation Resources

Introduction to Wind and Solar IPR Participation

Intermittent Power Resources (IPR) - Defined

- An Intermittent Power Resource or IPR is a resource:
  - That is renewable;
  - Whose fuel cannot be stored by the facility owner or operator; and
  - That has variability that is beyond the control of the facility owner or operator
- A wind farm: Collection of Wind turbines with its electrical output metered at the point of interconnection with the NYCA Transmission System
- A wholesale Solar resource or Solar farm: Collection of solar installations with its electrical output metered at the point of interconnection with the NYCA Transmission System



Wind and Solar Resource Participation

- This presentation will introduce to the learners, how wind and solar resources participate in the NYISO-administered wholesale markets
- Salient features of Wind and Solar IPR participation:
  - Wind and Solar IPRs submit flexible Day-Ahead and Real-Time offers to indicate their willingness to generate at various price levels
    - May be able to set the market clearing prices when they are marginal
  - They also receive, and are expected to respond to, NYISO economic curtailment signals when prices are below their offer
    - Wind and Solar IPRs must be able to respond to economic curtailment signals from the NYISO (via their Transmission Owner)

IPR Participation in NYISO Markets

Energy Market

Wind and Solar IPRs can participate in the:

- Day-Ahead Energy Market and
- Real-Time Energy Market

Installed Capacity Market

Wind and Solar IPRS can qualify to provide capacity and participate in the Installed Capacity Market

Energy Market Participation

Energy Market Participation

- Participation Requirements
  - Provision of Meteorological data
- Forecasting
  - Day Ahead Market
  - Real-Time Market
- Bidding
  - Day-Ahead Market
  - Real-Time Market
- Scheduling
  - Day-Ahead Market
  - Real-Time Market
- Energy Market Settlements

Participation Requirements

- To qualify for wholesale market participation Wind and Solar IPRs must:
  - Meet a minimum offer size requirement of 1 MW
  - Comply with all metering requirements
    - Meters must:
      - Be approved by Metering Authority
      - Provide revenue-grade hourly metering information
      - Provide six-second telemetry
      - Comply with minimum acceptable accuracy standards
  - Account for energy consumed as Station Power
    - Wind and Solar IPRs will be subject to existing Station Power registration requirements
  - Must be able to respond to economic curtailment signals from the NYISO (via their Transmission Owner)

Participation Requirements

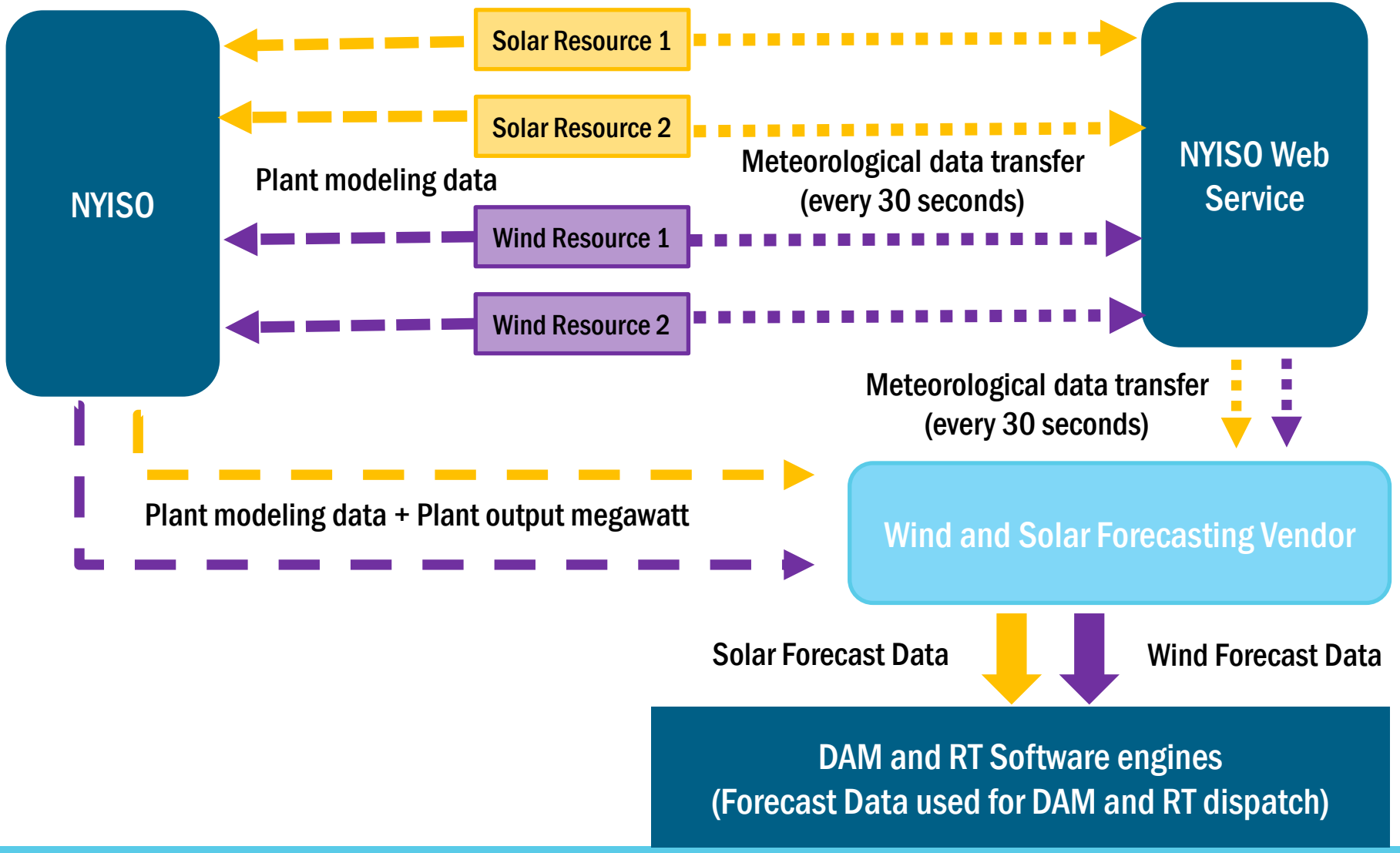
- As part of the registration process, Wind and Solar IPR plant operators are required to supply data to the NYISO, including:
  - Static plant data*
  - Site-specific meteorological data*
    - Wind Resources: All resources
    - Solar resources: 20 MW and higher
  - Maximum plant availability, and
  - 2 year look ahead outage schedule
- Detailed instructions for providing this information are contained within the NYISO Registration Package
- IPR plant operators should notify the NYISO of any changes to this static data

*Please refer to UG 09, Wind and Solar Plant Operator Data User's Guide for more details

Provision of Meteorological Data for Wind and Solar Forecasts

- The NYISO forecast vendor models each plant's site using plant-specific data mentioned in the previous slide
- The IPR plant provides real-time meteorological data to NYISO systems at a 30-second frequency
- Consolidated data from all Wind IPRs and Solar IPRs is then communicated to the NYISO forecast vendor
- This data, coupled with recent plant output megawatt data (provided by the NYISO to the forecast vendor), is used to estimate a Wind power forecast and a Solar power forecast to be used in the NYISO Day-Ahead Market and Real-Time Market solutions

NYISO's Centralized Forecasting Program



Wind and Solar Forecasts: Day-Ahead and Real-Time

Day-Ahead Forecasts

- Are produced twice a day – 4 a.m. and 4 p.m.
- Forecasts beginning HB 0 of the next day to HB 23 of 2 days ahead
  - Are an input to the reliability pass of the SCUC
- Day-Ahead forecasts are based on hourly averages
- Wind and Solar power forecasts are input to SCUC regardless of whether the specific generators provided a bid or not

Real-Time Forecasts

- Are produced every 15 minutes
- Forecasts produced for every 15-minute interval for an 8-hour look ahead
  - Are an input to the RTC and RTD
- Schedules for the Wind and Solar generators are a blended value between persistence (actual) and forecasts
  - Blended rates will weigh heavily on persistence in the short time horizon and more heavily on forecasts further out

Wind and Solar IPRs: Registration Parameters

- MP Administrators are required to provide the following parameters during Registration :

Parameter	Definition	Unit of Measure
Physical Upper Operating Limit (UOL)	Maximum Output capability of the resource	MW
Physical Lower Operating Limit (LOL)	Zero for Wind and Solar IPRs	MW
Response Rate	Represents how quickly the Resource can respond to dispatch instructions from the NYISO to inject onto (must be at least 6.7% of nameplate/minute and will only apply to ramp down resources)	MW/min.

Bidding and Scheduling

Bid Parameters

- Resources will submit the following bid parameters with economic offers:

Parameter	Definition	Unit of Measure
Normal Upper Operating Limit (UOLN)	Maximum Output capability of the resource under Normal conditions	MW
Emergency Upper Operating Limit (UOLE)	Maximum Output Capability of the resource under Emergency conditions	MW
Lower Operating Limit (LOL)	Zero for Wind and Solar Resources	MW
Incremental Bid Curve	Series of monotonically increasing steps reflecting economic willingness to run and produce MWs	$/MW
Market Choice	Identifies which market, Day Ahead or Real Time, the bid parameters apply to	DAM RT
Unit Operation Modes	Parameters that indicate that the IPR should be evaluated based on Economic parameters	ISO-Committed Flexible

Day-Ahead Market Bidding

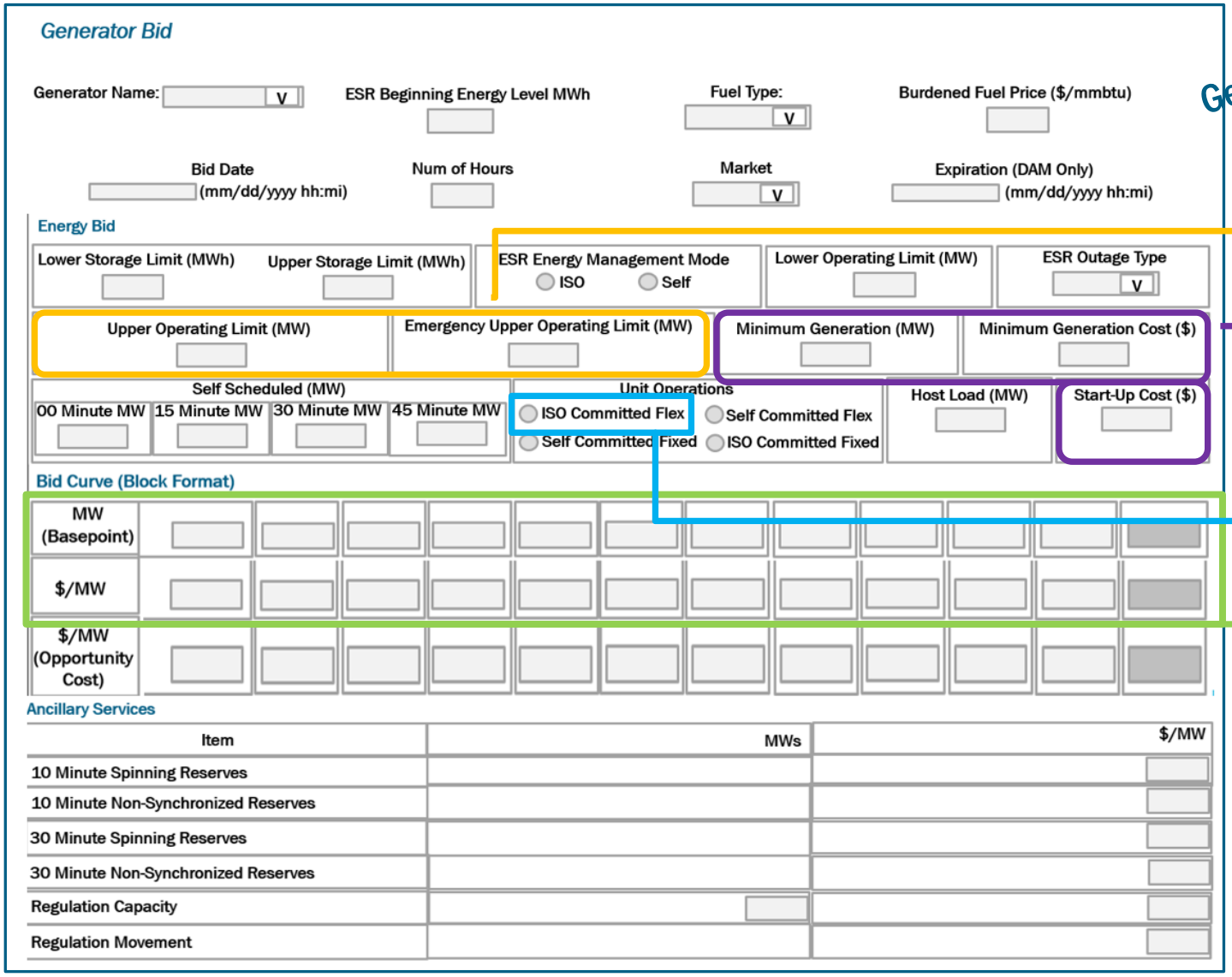
- If Wind or Solar IPRs choose to bid into the Day-Ahead Market, they must:
  - Bid as ISO-Committed Flex units
  - Enter a Minimum Generation MW of 0 MW
  - Enter a Minimum Generation Cost of $0.00
  - Enter a Startup Cost of $0.00
  - Enter the appropriate Bid Upper Operating Limits (Normal and Emergency)
  - Enter an Incremental Cost Curve reflecting the economic willingness for the resource to run

Real-Time Market Bidding

- To be scheduled in the Real-Time Market, the Real-Time bid for a Wind or Solar IPR must:
  - Bid as ISO-Committed Flex units
  - Enter a Minimum Generation MW of 0 MW
  - Enter a Minimum Generation Cost of $0.00
  - Enter a Startup Cost of $0.00
  - Enter the appropriate Bid Upper Operating Limits (Normal and Emergency)
    - The UOLn or UOLe provided with the bid will only used in the formula for determining any Over-generation charge
    - It will not be used to determine the upper limit of the Wind or Solar resource's dispatch range
      - For determining the upper limit of a Wind resource's dispatch range in real-time, the NYISO will use the Wind Energy Forecast
      - For determining the upper limit of a Solar resource's dispatch range in real-time, the NYISO will use the Solar Energy Forecast
  - Enter an Incremental Cost curve reflecting the economic willingness for the resource to run

Energy Market Bid Page

Mock-Up
Generator Bid Screen



Enter appropriate UOLn and UOLe

Enter Zero for Min Gen MW and Min Gen Cost

Must Bid as ISO-Committed Flex

Incremental Cost curve reflecting the economic willingness for the resource to run

Day-Ahead Market Scheduling

- A Wind or Solar IPR may provide Day-Ahead economic offers, but are not required to do so
- Wind and Solar IPRs participating in the Day-Ahead Market are treated no differently than any other resource in the Day-Ahead Market

Real-Time Scheduling

- Wind and Solar IPRs provide real-time economic offers that indicate the price below which they are no longer willing to generate
  - Using their (up to) 11-point Incremental cost curve
- The RTS optimizes for the most economic dispatch and may select a resource to reduce its output
- If the Wind or Solar IPR is not economic to operate at its forecasted output level, a basepoint is created, which reflects the resource's desire to be limited
  - This basepoint takes into account the resource's stated response rate
- The resource must limit its output to the level (or below) specified in the basepoint within the next five minutes

Real-Time Scheduling, cont.

- To determine the Wind or Solar IPRs real-time schedule, RTS uses:
  - Resource's economic offer,
  - Resource's last known energy output
  - Resource's Forecasted Energy Output
- Basepoint instructions are sent electronically from the NYISO to the Transmission Owners (TO)
  - TOs communicate these instructions to the resources
- When the resource is selected economically to limit its output:
  - A separate Output Limit flag is included in these instructions
- NYISO communicates when the Wind or Solar resource is subject to limitations, and when it is not

Energy Market Financial Settlements

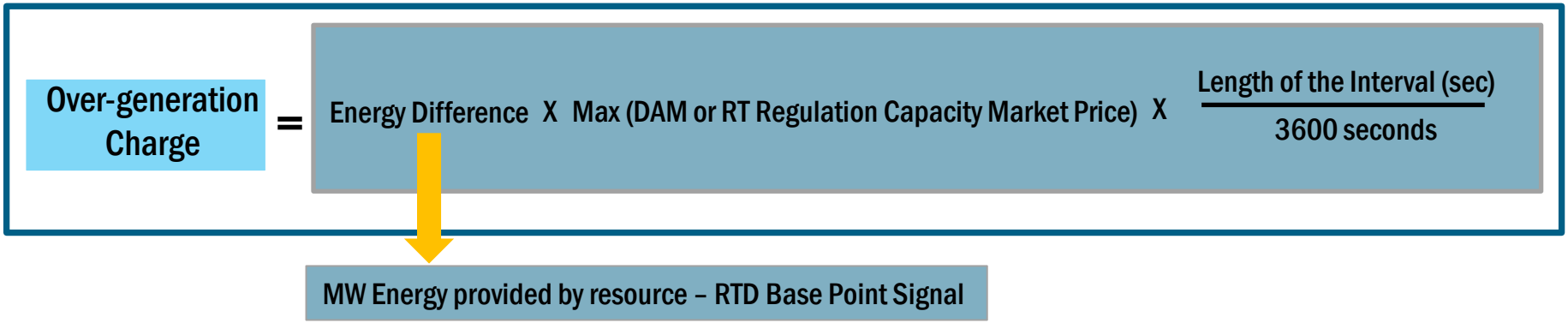
Energy Market Settlements

- Day-Ahead Market Settlement:
  - Applied to Wind or Solar IPRs with accepted Day-Ahead schedules
  - Calculated at an hourly level using DAM LBMP at the gen bus level
- Real-Time Market Settlement or Balancing Market Settlement:
  - Accounts for energy variations in the Wind or Solar resource's Real-Time Dispatch from its Day-Ahead schedule
  - Calculated at RTD interval level (nominal 5-minute level)
    - When output is not limited - payment for all energy produced
    - When output is limited – payment at lesser of actual output or its schedule plus 3% of its UOL

Over-generation Charge for Wind and Solar IPRs

New York ISO

- Wind and Solar IPRs may be assessed an over-generation charge when they are subject to an output limit, and do not limit their output down to their communicated basepoint or below
- For every RT interval that the resource over generates beyond the economically curtailed basepoint:



- The Energy Difference will be zero if:
  - It is a negative number, or
  - If it falls within the 3% of Normal UOL or Emergency UOL for the resource

Energy Market Settlements

- Compensable over-generation
  - When there is NO Wind and Solar Output Limit in effect: All energy injected by the resource in excess of real-time schedules
  - When an output limit is in effect: Three percent (3%) of the resource's Normal or Emergency Upper Operating Limit (UOL)
- Persistent under-generation charge:
  - Wind and Solar IPRs are exempt from persistent under-generation charges
- Day-Ahead Margin Assurance (DAMAP) payment
  - Wind and Solar IPRs are NOT eligible for DAMAP payments

Other Charges

- Monthly Intermittent Power Resource Forecasting Charge for Wind and Solar Resources:
  - $500 + ($6.20 X Nameplate Capacity MW)
- Power Supplier Rate Schedule 1 Charge:
  - Intended to recover a portion of NYISO's operating costs and FERC fees
  - Details on calculation of OATT Rate Schedule 1 charges in Attachment M, Accounting and Billing Manual

Additional Resources

- Market Services Tariff (MST)
- Open Access Transmission Tariff (OATT)
- Accounting and Billing Manual
- Market Participants User's Guide (MPUG)
- Transmission and Dispatch Manual
- UG 09: Wind and Solar Plant Operator User's Guide
- TB 154: Wind and Solar Resource Bidding, Scheduling, Dispatch, and Settlement
- Intermittent Power Resources FAQ
- Market Training Course Materials: MT 201 NYMOC

Installed Capacity Market Participation

Installed Capacity (ICAP) Market Participation

- ICAP Market Rules
  - ICAP Market Qualification Rules
  - ICAP Market Eligibility and Participation Rules
  - Production Factors for Solar Resources
  - Obligations and Other ICAP Market Rules
  - ICAP Market Mitigation

ICAP Market Qualifications for Wind and Solar IPRs

- To qualify for wholesale ICAP Market participation Wind and Solar IPRs must:
  - Satisfy all registration requirements as per tariff rules
  - Complete an effective Interconnection Agreement that allows wholesale market participation as per tariff rules and ISO procedures
  - Have a minimum injection capability of 1 MW
  - Submit Outage Schedules two years forward from the anticipated date of first offer into the capacity market
- Wind and Solar IPRs electrically located outside of the New York Control Area are not eligible to qualify as Installed Capacity Suppliers
- Under current rules, Wind and Solar resources are not eligible to participate as Installed Capacity Suppliers with Energy Duration Limitations (EDL)

DMNC equivalent

- Wind and Solar Resources are not required to perform DMNC tests
  - Instead required to provide a DMNC Equivalent value

DMNC Equivalent value = (Combined Nameplate Capacity of all units in the station) − Station Service Load

- The sum of the DMNC values of all units under a single PTID cannot be greater than the DMNC equivalent value of the PTID taken as a single unit
- Each such individual unit is assigned a rating by distributing the combined Capacity among the units comprising the PTID

Adjusted ICAP and UCAP

- Adjusted ICAP for Wind and Solar IPRs: The amount of ICAP a Wind or Solar resource has available, taking into account the Resource's applicable Duration Adjustment Factor*

Adjusted ICAP = ICAP X Duration Adjustment Factor

ICAP = Nameplate Capacity

- UCAP for Wind and Solar IPRs: The amount of capacity it can reliably provide during system peak load hours

UCAP = Adjusted ICAP X Production Factor

- Production Factor for a Wind and Solar IPR for a specific Capability Period: Based on historical generating data during peak load hours of previous like capability season

* Duration Adjustment Factor for Wind and Solar IPRs = 100%

Production Factor Calculation

- Existing Wind and Solar IPRs:
  - Production Factor for a Wind or Solar IPR for a particular Capability Period based on its operating data for the Prior Equivalent Capability Period during applicable Peak Load Windows
    - Summer: Output during Hours 13:00-18:59 June, July, August
    - Winter: Output during Hours 16:00-21:59 Dec, Jan, Feb

$$\text{Production Factor for every hour in Peak load Window} = \frac{\text{Amount of Energy delivered to the NYCA transmission system by resource for specific hour}}{\text{Nameplate Capacity of Wind or Solar resource}} \times \text{Hourly weighting \%}$$

* Hourly weighting percentages for each hour in the Peak Load Windows of Summer and Winter Capability Period months can be found in section 3.4, Attachment J, ICAP Manual

Production Factor Calculation

- New Intermittent Resources:
  - New Wind and Solar IPRs and resources without historical operating data, initial Unforced Capacity will be determined using the factors defined in Section 4.5 of the ICAP Manual
    - UCAP = Nameplate Capacity * Applicable UCAP %

ICAP Market Obligations

Outage Scheduling

- Wind and Solar IPRs are required to follow the same outage scheduling process as all other Generators
  - Outage Schedules two years forward from the anticipated date of first offer into the capacity market, submitted through the Outage Management System (OMS)
  - Planned outages should be reported at least 2 operating days in advance to ensure that the NYISO Day-Ahead Market runs get forecasts reflecting the plant availability
  - Unplanned outages should be reported as soon as practicable
- The NYISO Outage Scheduling Manual outlines the procedures to report plant availability and outages

Reporting GADS Data

- Wind and Solar resources must submit their reportable operating data via the NYISO GADS portal every month
- GADS data will not be the basis of determining UCAP for Wind and Solar Resources
  - UCAP for Wind and Solar Resources will be based on their Production Factor calculated from actual operating data from the prior like Capability Period
  - New Wind and Solar resources and resources without historical operating data, initial UCAP will be determined using the factors defined in Section 4.5 of the ICAP Manual

Selling Capacity as an ICAP Supplier

- Wind and Solar IPRs may sell capacity as an ICAP Supplier through:
  - NYISO Auctions
    - Capability Period or Strip Auction
    - Monthly Auction
    - Spot Market Auction
  - Bilateral transactions
  - In accordance with current rules, similar to all other generators

Certification

- Wind and Solar IPRs that have sold capacity as a supplier in NYISO auctions, or have sold capacity in Bilateral Transactions must follow all current Certification rules and obligations for an ICAP Supplier
- Exact timelines and deadlines for Certification obligations are identified in the ICAP Event Calendar

Determining ICE of the UCAP Supplied

- ICE is the Installed Capacity Equivalent of the amount of Unforced Capacity that the Solar resources supplies in a specified month
- For every month that the resource receives UCAP supplier payments:

$$\text{Installed Capacity Equivalent Of UCAP Supplied (ICE)} = \frac{\text{UCAP Supplied for given month}}{\text{Production Factor} * \text{Duration Adjustment Factor}}$$

- Wind and Solar IPRs will NOT be subject to daily Bid/Schedule/Notify obligations in the Day-Ahead Market

Penalties and Sanctions

- Wind and Solar resources will be subject to penalties/shortfall charges for:
  - Over sale of capacity

ICAP Settlements

- Capacity payments based on UCAP MWs awarded in an auction and the applicable auction clearing price ($/kW-month)
  - Convert MWs to kW by multiplying by 1000
  - Then multiply by auction clearing price
  - This monthly capacity payment is then allocated to the weekly invoice accordingly

ICAP Market Mitigation

Supply Side Mitigation

- Wind and Solar IPRs in Zone J and the G-J Locality (MCZs) will be subject to existing Supply Side Mitigation measures (*i.e.*, the Pivotal Supplier rules)
  - Must identify all "Affiliated Entities" each month based on the criteria in the Market Services Tariff, Attachment H
  - The ICAP Event Calendar specifies the deadlines for identifying Affiliated Entities
  - Will have a "must offer" obligation if their MW are under the control of a Pivotal Supplier

Buyer-Side Mitigation

- Buyer Side Mitigation rules apply for resources present in the Mitigated Capacity Zones (New York City and Zones G-J)
  - Buyer Side Mitigation (BSM) is to prevent uneconomic entry from artificially suppressing Installed Capacity prices
- Wind and Solar IPRs will not be subject to review by the NYISO under BSM rules or otherwise be subject to an Offer floor
  - A wind or solar Intermittent Power Resource is considered an Excluded Facility as it is qualified to satisfy the goals specified in the New York State Climate Leadership and Community Protection Act (CLCPA)
  - Please refer to MST Section 23.2 for a full definition of Excluded Facilities

* Please refer to MST, Attachment H, Section 23.4.5.7.13 for more details

Additional Resources

- Market Services Tariff (MST)
- Open Access Transmission tariff (OATT)
- Installed Capacity Manual
- Attachment J, Unforced Capacity for Installed Capacity Suppliers, ICAP Manual
- Attachment K, Reportable Operating Data, ICAP Manual
- Outage Scheduling Manual
- MST Attachment H, Section 23.4.5 Installed Capacity Market Mitigation Measures
- Market Training Course Materials, Intermediate ICAP Course – MT 305

Presentation Summary

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Questions?

For any future assistance, please contact NYISO Stakeholder Services at stakeholder_services@nyiso.com or by phone at (518) 356-6060