Challenges of Integrating Renewable and Distributed Resources into Transmission Planning

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National Council on Electricity Policy (NCEP):

September 13, 2018

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DRAFT – FOR DISCUSSION PURPOSES ONLY

Introduction

- Renewables and Distributed Resources covers a variety of types and sizes of resources that are connected on either the distribution or bulk systems, so they are governed by different market rules, tariffs, and regulatory oversight.
- As a result, they have to be dealt with differently in planning the Transmission system.
- Resources connected to the bulk systems will be studied for interconnection using a new streamlined study process and will be modeled as discrete resources at their point of interconnection
- Resources connected to the distribution system will be handled by the distribution provider and will be aggregated for modeling in planning studies
- NYISO's Planning processes were addressed in 2016 at a previous seminar and the next slide provides a high level review of the processes

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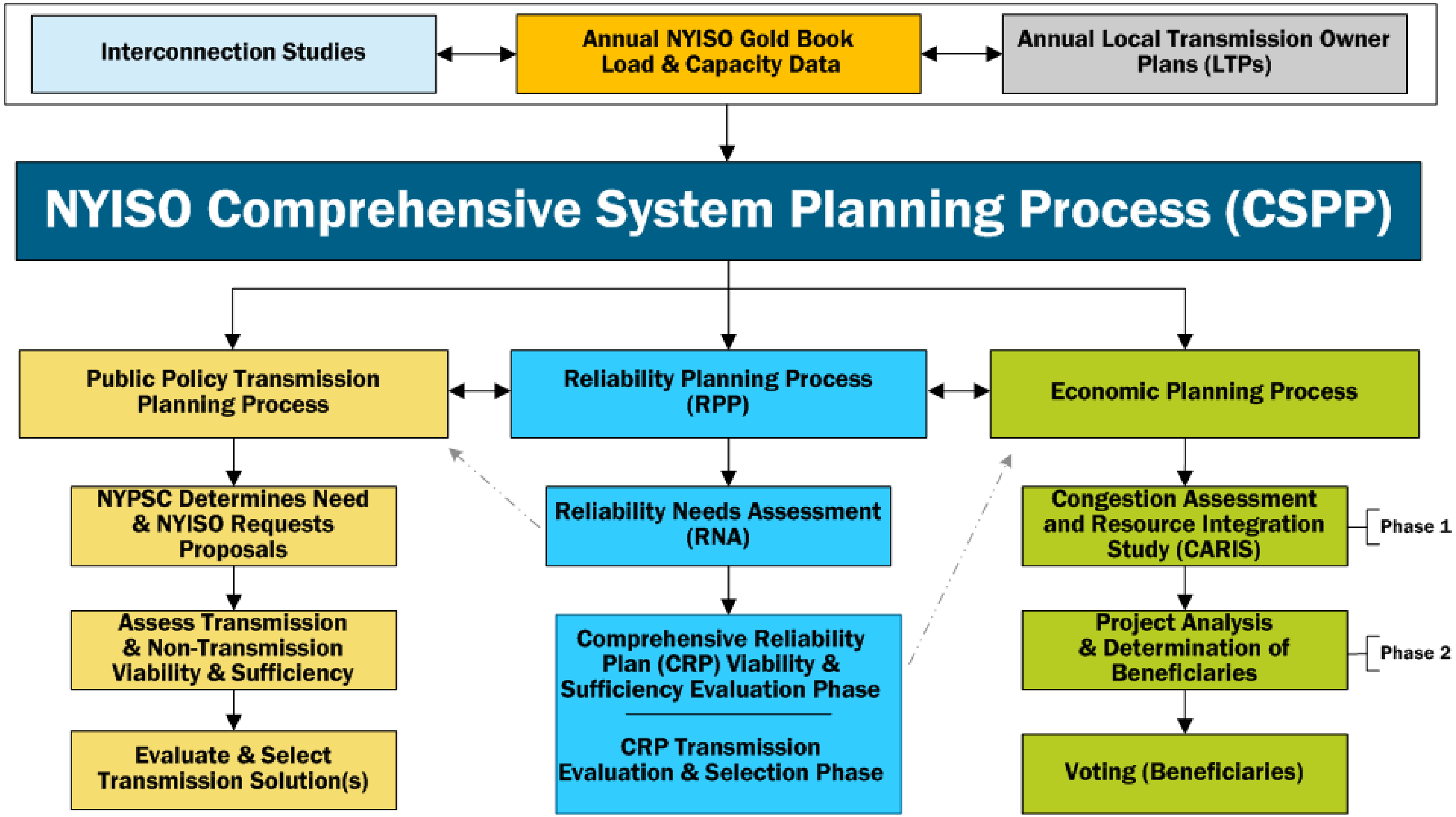

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Overview

- Most renewable and distributed resources are wind and solar
- Most of the existing resources are connected to the bulk system or are proposing to connect to the bulk system are located in upstate NY as can be seen on the next slide
- In that the resources connected to the bulk system are following the existing interconnection and planning processes, this presentation is focused on Distributed Energy Resources (DER)
  - What are DERs?
  - DER Type Definitions
  - DER Classifications
  - Data Requirements
  - Visibility by the ISO/RTOs
  - Forecasting Load
  - System Modeling & Security
  - Interconnection Processes
  - Measurement & Verification

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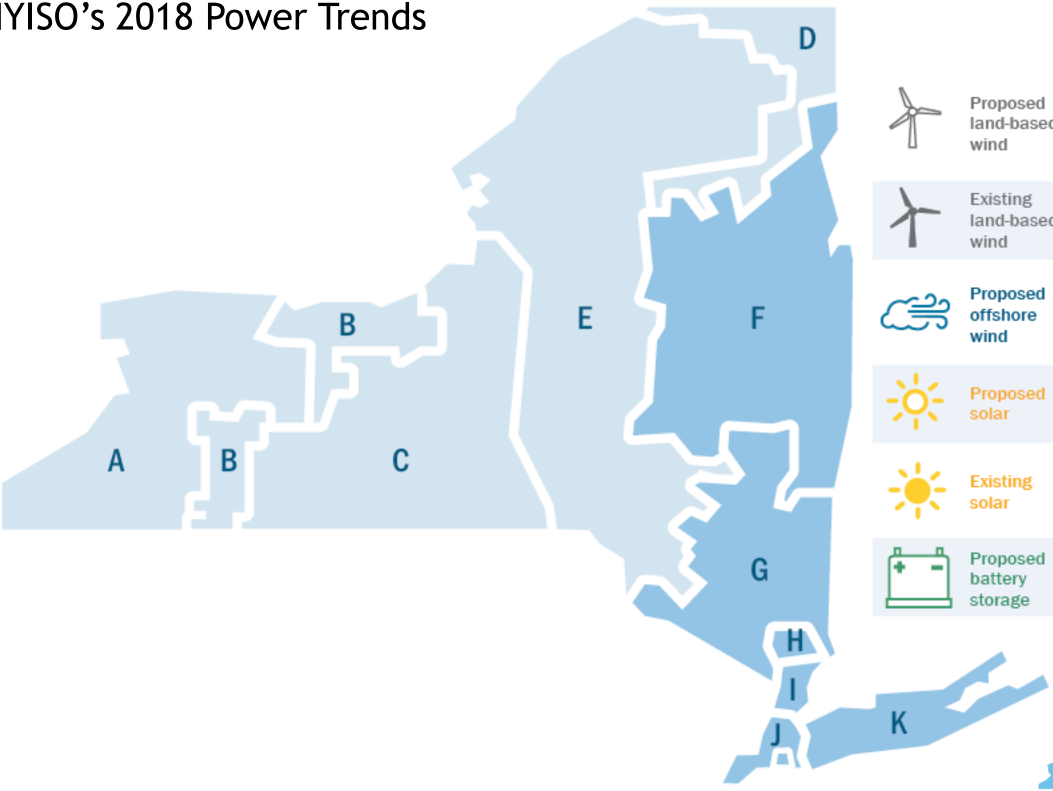
Wind, Solar & Storage

as projected in NYISO's 2018 Power Trends

Existing and Proposed Wind, Solar, and Storage Capacity in New York State (MW)



	UPSTATE (Zones A-E)	DOWNSTATE (Zones F-K)
Proposed land-based wind	4,264	120
Existing land-based wind	1,828	0
Proposed offshore wind	0	96
Proposed solar	1,058	904
Existing solar	0	32
Proposed battery storage	195	240

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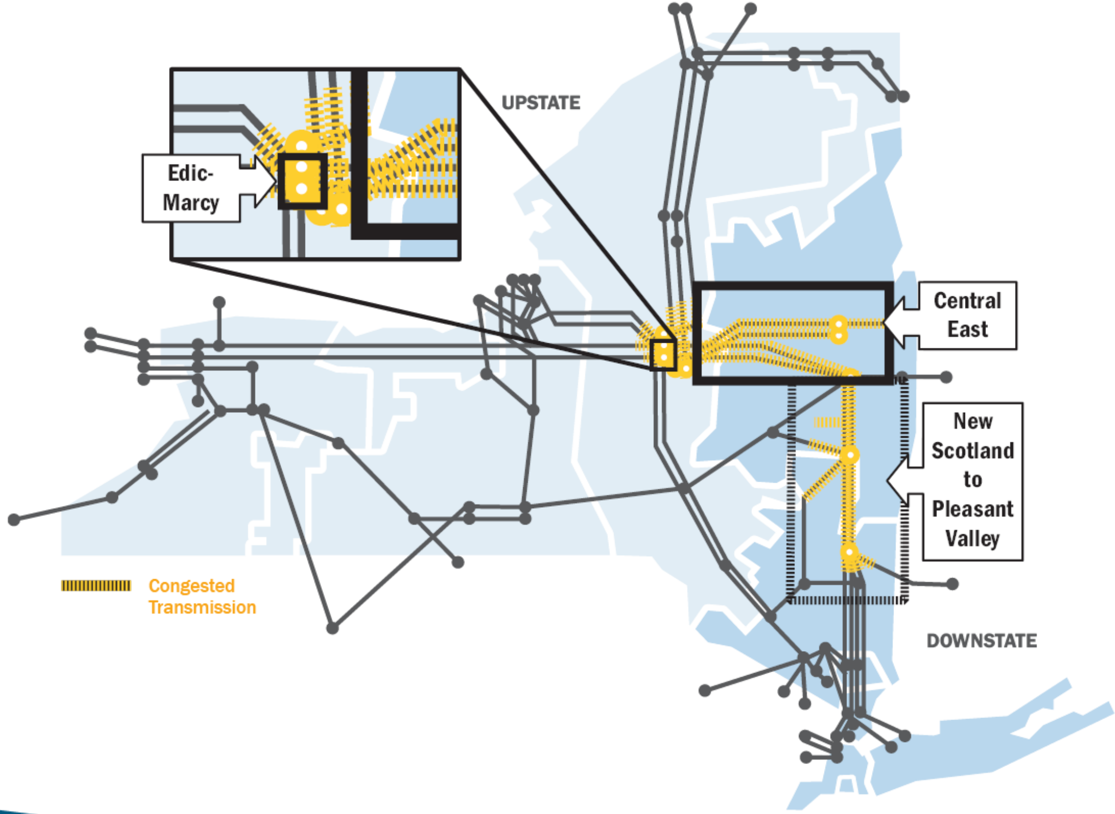
Transmission Congestion



The most congested elements of NY's transmission system include:

- All or parts of the high-voltage transmission path from Oneida County through Capital Region (Central East)
- South to the Lower Hudson Valley (New Scotland — Pleasant Valley)
- The 230-kilovolt system in Western New York (Western 230kV).

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What Are DER Resources?

- Definitions may vary across regions, which makes common understanding and practice more difficult
- Resources may be connected to either the wholesale bulk system or to the retail distribution system
- For DER connected to the distribution system, DERs also include resources that:
  - Produce electricity and are not otherwise included in the formal NERC definition of the BES
  - Are located solely within the boundary of any distribution provider and is a non-BES resource

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DER Type Definitions

- **Distributed Generation (DG)**
  - Any non-BES generating unit or multiple generating units at a single location owned and/or operated by 1) the distribution utility, or 2) a merchant entity
- **Behind the Meter Generation (BTMG)**
  - A generating unit or multiple generating units at a single location (regardless of ownership), of any nameplate size, on the customer's side of the retail meter that serve all or part of the customer's retail load with electric energy. All electrical equipment from and including the generation set up to the metering point is considered to be behind the meter. This definition does not include BTMG resources that are directly interconnected to BES transmission.
- **Energy Storage Facility (ES)**
  - An energy storage device or multiple devices at a single location (regardless of ownership), on either the utility side of the customer's side of the retail meter. May be any of various technology types, including electric vehicle charging stations.
- **DER Aggregation (DERA)**
  - A virtual resource formed by aggregating multiple DG, BTMG, or ES devices at different points of interconnection on the distribution system. The BES may model a DERA as a single resource at its 'virtual' point of interconnection at a particular T-D interface even though individual DER comprising the DERA may be located at multiple T-D interfaces.
- **Micro-grid (MG)**
  - An aggregation of multiple DER types behind the customer meter at a single point of interconnection that has the capability to island. May range in size and complexity from a single 'smart' building to a larger system such as a university campus or industrial/commercial park.
- **Cogeneration**
  - Production of electricity from steam, heat, or other forms of energy produced as a by-product of another process.
- **Emergency, Standby, or Back-up Generation (BUG)**
  - A generating unit, regardless of size, that serves in times of emergency at locations and by providing the customer or distribution system needs. This definition only applies to resources on the utility side of the customer retail meter.

https://www.nerc.com/comm/Other/essntlrlbltysrvcstskfrcDL/Distributed_Energy_Resources_Report.pdf

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DER Classifications

- The information required by the RTOs is different based on where the DER is located and how it will be modeled
  - Utility-Scale DER: DER directly (or closely) connected to the distribution bus or connected through a dedicated, non-load serving feeder. These resources are specifically three-phase interconnections. Their gross nameplate rating is generally in the range of 0.5 to 20 MW with varying control complexity.
  - Retail-Scale DER: DER that offsets residential, commercial, or industrial customer load. R-DER represents the truly distributed resources throughout the distribution system whose controls are generally reflective of IEEE 1547. These resources may be aggregated single-phase and three-phase resources.
- NERC recommends that Planning Coordinators develop thresholds for appropriate modeling of U-DER and R-DER in planning models because it affects interconnection, metering, billing, operations, and modeling

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Data Requirements (U-DER)

- U-DER
  - Type of generating resource (e.g., wind, solar, battery, etc)
  - Distribution bus nominal voltage where the U-DER is connected
  - Feeder characteristics for connecting U-DER to distribution bus (if applicable)
  - T-D interface transformer
  - Capacity of each U-DER resource
  - Forced outage information
  - Control modes – voltage, frequency, active-reactive priority
  - Dynamics models

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Data Requirements (R-DER)

- R-DER
  - Aggregate capacity of R-DER for each feeder or load as represented in the model
  - De-rating factors to account for forced outage rates
  - Vintage of IEEE 1547 (e.g., 2003) or other relevant interconnection standard requirements that specify DER performance
  - As available, aggregate information characterizing the distribution circuits where R-DER are connected.

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Visibility of DERs by the ISO/RTOs

- Wholesale generators connection to the bulk system have an obligation to provide data to NYISO through:
  - ISO Agreement
  - Market Administration and Control Area Services Tariff provides for:
    - Access to Complete and Accurate Data
    - Provision of Data By Market Participants
  - Open Access Transmission Tariff, which obligates Developers to deliver information to the connecting Transmission Owner
- Most DERs are not connected to the bulk system and it may be difficult to obtain and maintain data
  - ISOs/RTOs are dependent on Transmission and Distribution Owners to obtain, maintain, and communicate accurate plant, interconnection, and performance records for DERs

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Forecasting Load

- Load forecasting must be developed independent of DERs
- Avoid netting of DER with loads:
  - Forecast total load absent R-DER and U-DER as much as possible
    - Model R-DER and U-DER as resources as much as possible
    - Behind-the-meter DER may not be metered
      - If behind-the-meter DER is not metered, then it presumes that there is no obligation to serve the load or provide its reserves and it can’t be modeled
      - If behind-the-meter is metered, then it should be modeled as a resource
- If DER is modeled independent from the load, it can still be aggregated

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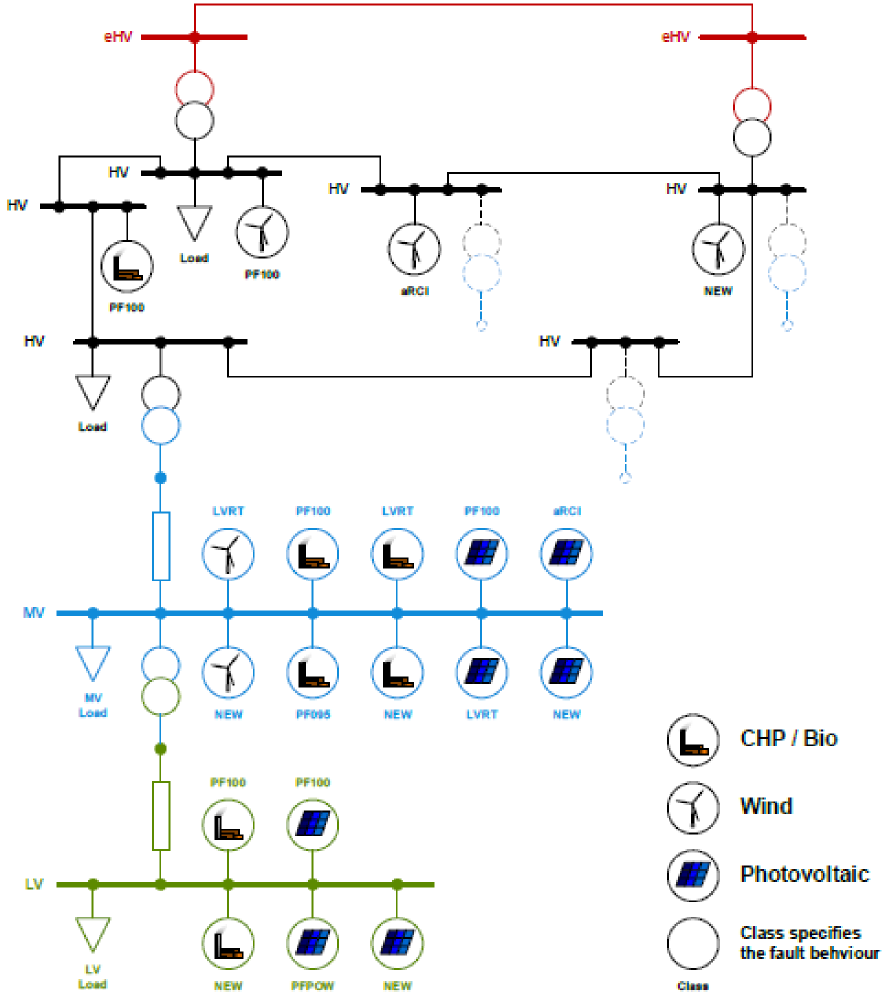
System Modeling & Security

- All components of the system must be represented in the models, either directly or in an aggregated way, with sufficient fidelity to provide meaningful and accurate simulation results



Recommended Practices for Modeling DER

- Ideal situation
  - Explicitly model utility and retail scale DER (U-DER and R-DER, respectively)
  - Explicit modeling of U/R-DER in provides a solid framework for ensuring these resources are accounted for thermal and dynamics models
- Practical situation
  - Full detail often won’t be worth the additional effort
  - Aggregation is going to be required, but:
    - Using accurate equivalent models is going to be difficult because small resource owners won’t understand the data they need to provide
    - The data will be changing constantly due to lack of standardized designs and steady addition/modification/removal of resources
  - Engineering judgment is required to model detailed information when necessary and to make reasonable aggregated models

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Recommended Practices for Modeling DER (Cont.)

- NERC recommends a “modular approach” to model development to ensure better accuracy in representations of resources for various studies.
- Considerations to the modular approach could consider:
  - Differentiation of DER types to derive meaningful dispatch scenarios
  - Differentiation of DER per interconnection requirements performance to represent the fundamentally different steady-state and dynamic behavior among future and legacy DER
  - Differentiation of DER per technology type (e.g., inverter-coupled vs. directly-coupled synchronous generator DER) to accurately represent the technology-specific dynamic behavior.

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Recommended Practices for Modeling DER (Cont.)

- Thresholds for aggregating DER or distinctly modeling DER need to be determined.
  - Example: WECC Requirements
    - Modeling of any single DER with a capacity of greater than or equal to 10 MVA, and
    - Modeling of multiple DER at any load bus where their aggregated capacity at the 66/69 kV substation level is ≥ 20 MVA with a single-unit behind a single equivalent (distribution) impedance.

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Interconnection Processes

- Currently, NYISO's visibility of plants depends on which interconnection process a plant goes through
- Plants from all 3 processes are often in close electrical proximity of each other
  - NYISO Small Generator Interconnection Process (SGIP):
    - For plants connecting to transmission, sub transmission, or FERC-jurisdictional distribution and intends to sell into NYISO market.
    - Typical size 2-20 MW
    - Metering required and NYISO operations have dispatch control over plant
    - Models provided during interconnection study

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Interconnection Processes (Cont.)

- NYS Department of Public Service Standard Interconnection Request (SIR):
  - For plants connecting to sub-transmission or distribution and do not intent to sell into NYISO market.
  - Typical size: from residential rooftop up to 5MW
  - Monitoring and control requirements determined by size (described in later slide)
- Transmission Owner Process:
  - Each TO has an interconnection process for projects that don't fall into the other 2 categories.
  - Typical size: from 5 MW up to 20MW
  - Monitoring and control requirements determined by TO

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Model Validation & Verification

- Power flow models will need to be validated against actual operating conditions based on metered data
  - Actual data will be needed to assess performance of system with DER
  - Actual data will guide baseline and contingency assessments
- Forensic analysis of disturbances will be required to verify proper dynamic performance of models
- This may require costly metering and telecommunications equipment, which may be resisted by developers, consumers and states

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Questions?

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- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policymakers, stakeholders and investors in the bulk power system

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