New York ISO
Independent System Operator

Offshore Wind Profile Development – Follow Up

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ICAP/MIWG/PRLWG Meeting

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Background

- **Early 2021, the NYISO updated the initial Unforced Capacity percentage ("UCAP%") for wind resources during the first year of operation in Section 4.5 of the ICAP Manual.**
  - The initial UCAP% for Land-based Wind was updated using the 5-year average (2014-2019) of UCAP % with actual historical production data for all existing wind resources
  - For offshore wind, stakeholders agreed to wait for the updated NREL data to be released early 2021
- **In April 2021, NREL released an updated 20-year wind dataset (2000-2020). However, the new release only included the meteorology data, without power profiles**
  - Users are also expected to develop power conversion assumptions to produce simulated power profiles
- **Therefore, the NYISO has engaged the consultant DNV to develop the 20-year simulated historical offshore wind power profiles**

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Project Status

- The project was kicked off in July
- DNV has been running the model to translate meteorological data into power profiles.
  - Proper loss considerations are expected to be captured through the process
- The following slides provide high level description on the model and underlying methodologies

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Offshore Wind Profile Modeling Methodology

Christopher Hayes, Senior Meteorologist

Renewable Profile Modeling

Relevant Expertise

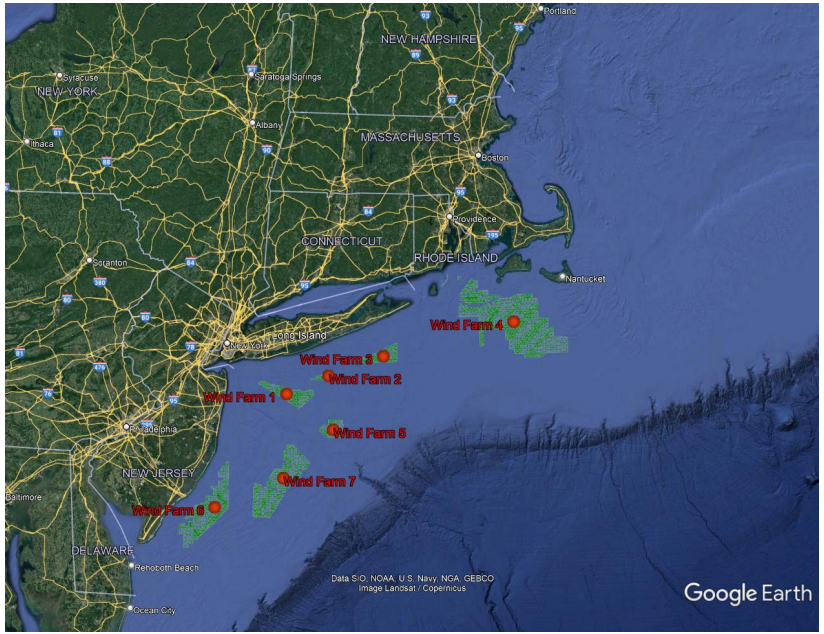
Across the Northeastern U.S. DNV has conducted mesoscale modeling studies covering all offshore BOEM lease areas near New York and has recently completed extensive mesoscale wind, solar and load modeling for the ISO-NE offshore wind integration planning advisory committee.

DNV has conducted more than 50 GW of offshore owner's engineer and due diligence services, more than 30 GW of offshore energy yield studies and more than 170 GW of onshore energy yield assessments in the U.S. Our energy assessment reports are trusted and relied upon for most of the project-financed projects in the U.S.

DNV manages and maintains data from the NY Bight floating lidar assessment campaign for the New York State Energy Research and Development Authority (NYSERDA)

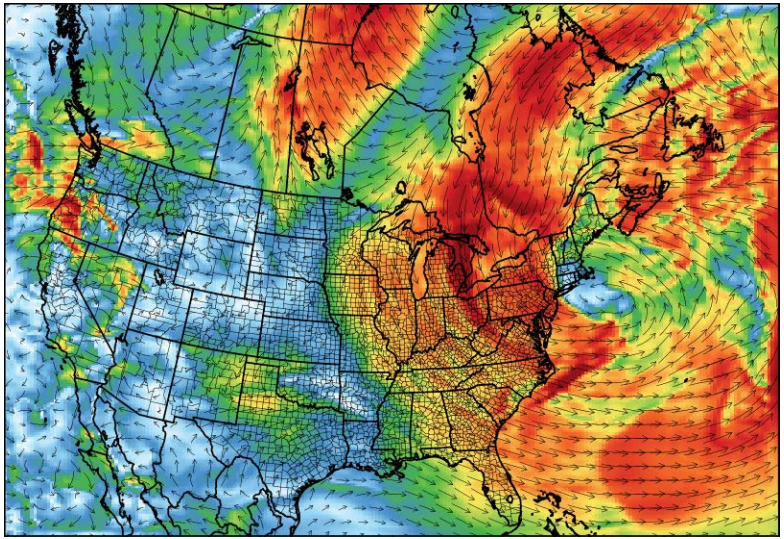
Project Description

- NYISO has requested DNV produce at least 3 hourly OSW power profiles covering the period 2000 through 2021 for the chosen sub-areas.
  - New York City Harbor
  - Long Island Shore
  - Long Island East End
- DNV has chosen to model the generation at 7 nearby potential development areas, including 5 BOEM lease areas and 2 planning areas.
  - Will be aggregated to the 3 chosen sub-areas
  - 1 nautical-mile turbine spacing
  - Generic Offshore Turbine
  - Assumed complete buildout for each development area (~34 GW).
- Mesoscale weather modeling
  - Covers entire offshore area
- Power modeling
  - DNV WindFarmer



Weather Model

- DNV Wind Mapping System
  - The Weather Research and Forecasting (WRF) model, a state-of-the-art community mesoscale model that has been thoroughly documented in the open-peer reviewed literature.
  - A well-validated, published ensemble downscaling technique based upon the "analog method"
  - 2 km (horizontal) resolution - hourly
  - Calibrated with floating LiDAR measurements
- Inputs
  - NASA's Modern Era Retrospective-analysis for Research and Applications Version 2 (MERRA-2)
  - Global 500 m resolution land use, surface aerodynamic roughness and terrain elevation data, based upon the latest validated land cover and digital terrain elevation database
  - Daily global 25 km analyses of lake and sea-surface temperatures
  - 3-hourly global 25 km analyses of soil temperature and soil moisture, snow cover and snow depth
  - Spectral nudging to preserve consistency between the large-scale state of WRF and the driving global reanalysis

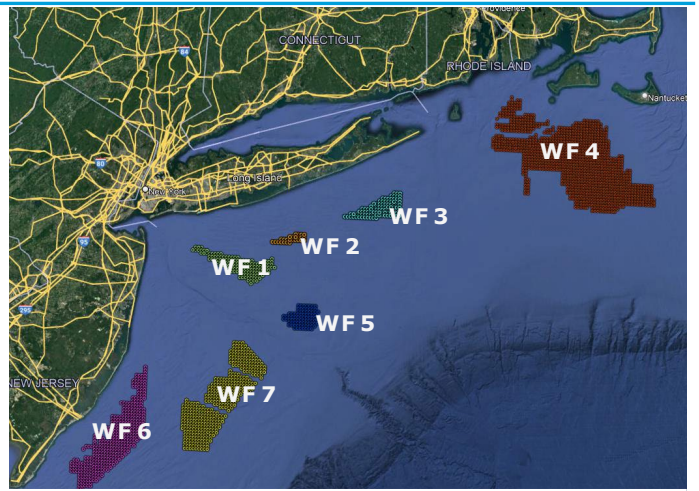


Wind Power Modeling

- Wind Turbine
  - Generic 15 MW offshore turbine
  - 236 m rotor diameter
  - 150 m hub height
  - Representative of turbines in next 3 to 5 years

- Turbine Layouts
  - 7 "Wind Farms" representing potential development areas
  - 1 nautical-mile spacing
  - Gridded to fill out each BOEM lease area or planning area.
  - Aggregated to 3 sub-areas

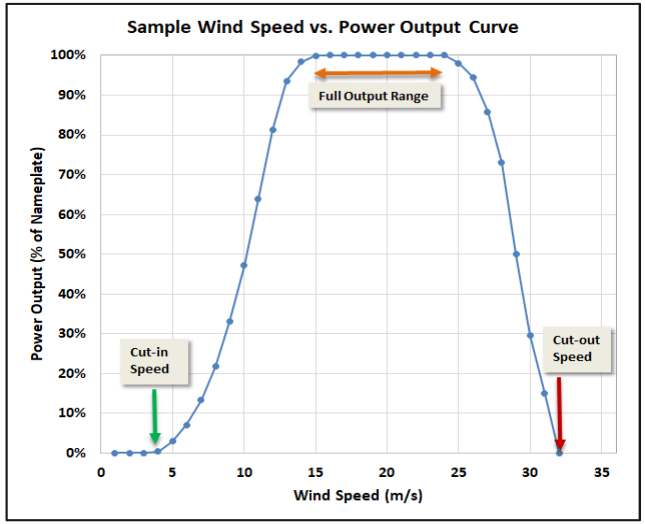
- DNV WindFarmer
  - Simulates energy production based on the distribution of the wind speed and wind direction at the wind farm
  - Accounts for surface roughness, turbine rotor diameter and thrust curves, high wind speed hysteresis, air density, turbulence, turbine wake interactions

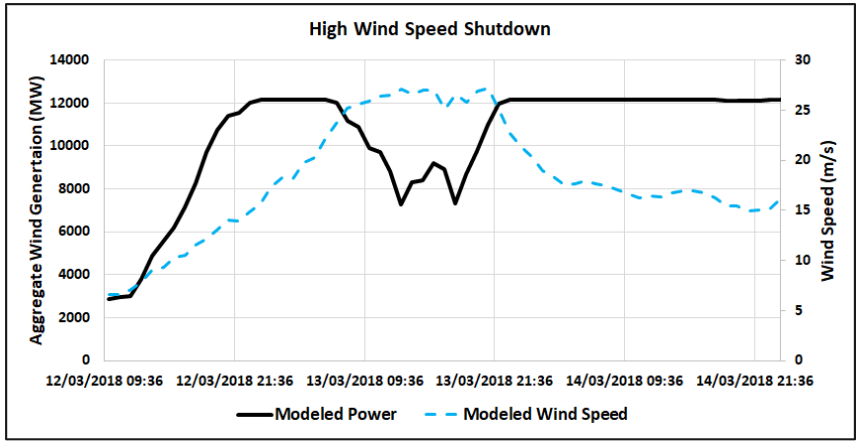


Wind Plant Name	Capacity (MW)	Turbine Count
Wind Farm 1	2,100	140
Wind Farm 2	390	26
Wind Farm 3	1,530	102
Wind Farm 4	16,095	1073
Wind Farm 5	1,260	84
Wind Farm 6	6,075	405
Wind Farm 7	6,615	441

Wind Turbine Power Curve Basics

Wind Speed (m/s)	Percent of Nameplate Power
0	0.0%
1	0.0%
2	0.0%
3	0.4%
4	3.0%
5	7.1%
6	13.3%
7	21.8%
8	33.1%
9	47.2%
10	63.9%
11	81.3%
12	93.6%
13	98.4%
14	100.0%
15	100.0%
16	100.0%
17	100.0%
18	100.0%
19	100.0%
20	100.0%
21	100.0%
22	100.0%
23	100.0%
24	98.0%
25	94.6%
26	85.8%
27	73.0%
28	50.0%
29	29.6%
30	15.0%
31	0.0%





Loss Modeling

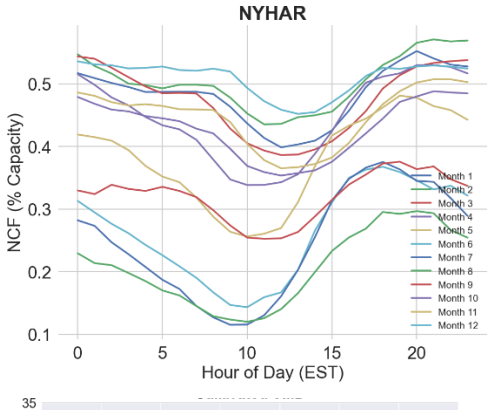
- Wake Losses
  - Wake loss is the effect on the energy production of the wind farm from the changes in wind speed caused by the impact of the turbines on each other
  - Eddy viscosity combined with DNV Large Wind Farm Wake model
  - Internal and External (nearby wind farm)
- Blockage
  - Loss to account for a resistance, or blockage, on the wind flow created by the turbines deflecting some of the flow above and around the wind farm
  - Primarily based on the turbine hub height, rotor diameter, and spacing
- Availability
  - Stochastically modeled on time series basis
  - Groups of turbines become unavailable for several consecutive timesteps (hours/days) until they come back online
  - These downtime events are applied randomly throughout the time series
- Other Losses
  - Electrical efficiency / Line losses: Wind Farm -> Offshore SubStation -> Onshore POI
  - Turbine performance losses (degradation, hysteresis)
  - Environmental losses (icing, temperature shutdown/derating)

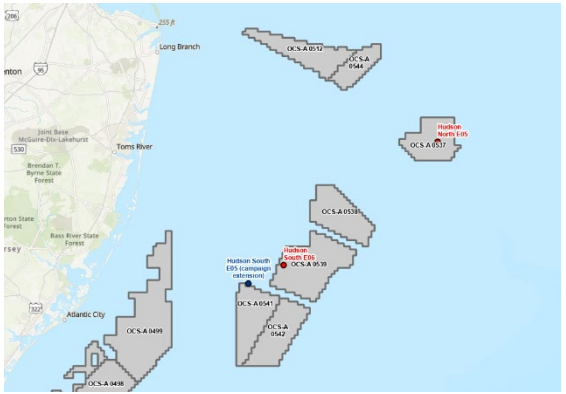
Loss Modeling (continued)

- Losses not considered:
  - Bird/Avian Curtailment
  - Grid / Economic Curtailment
  - Grid Congestion
  - Transmission and project downtime due to extreme weather events (hurricanes)

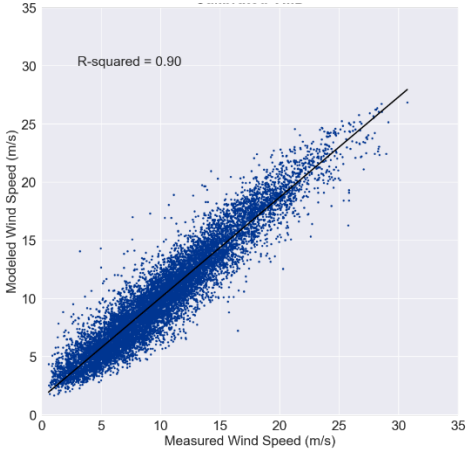
Validation

- Benchmarking to GE Power and ISO-NE (NCF) Profiles
  - Diurnal and seasonal profile shapes
  - Average Net Capacity Factor (NCF)
  - Ramp rates
  - Frequency distribution of hourly power production
  - Annual duration curves
  - Annual loss factor comparison





- Weather data comparison to NYSERDA Floating LiDAR observations
  - Correlations
  - Diurnal and seasonal profile shapes
  - Wind speed ramp rate distributions
  - MAE and RMSE of modeled data by time of day / year



Project Timeline

- **The NYISO expects the final presentation of the offshore wind power profiles is expected early Q4 this year**
  - The NYISO intends to make the hourly offshore wind power profiles publicly available once the project is completed
  - Updates to the offshore wind initial UCAP% in the ICAP Manual Section 4.5 will be coordinated with the Capacity Accreditation project

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Questions?

Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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