# Scope of Work for Stochastic Time Series Modeling for ISO-NE

Steven Judd, PE

PRINCIPAL ENGINEER | SYSTEM PLANNING

# Purpose

- Review the scope of work for the Stochastic Time Series Modeling project and get feedback from stakeholders on potential analysis to complete with new data set.

- Note: Most of the language and images for this presentation were taken from the DNV GL scope of work and were used with their consent.

# Background

- During 2019 it became apparent to ISO-NE that a new consistent dataset of offshore wind was needed to serve as inputs to multiple studies across the organization
  - 2019 Economic Studies
  - Transmission Planning Study Assumptions
  - Energy Security Analysis
- We hired DNV GL at the end of 2019 to use the weather modeling software and develop a historical dataset of all existing wind plants and future offshore wind plants from 2012-2018. This work was presented to PAC in February 2020 with two presentations
  - ISO-NE presentation and DNV GL presentation
- In early 2020, DNV GL updated the data set with an additional year of historical data and recalibrated the models to create an updated data set from 2012-2019
- Both datasets along with documentation are posted on the ISO website
  - 2019 ISO-NE Wind Dataset (2012-2018) Rev.2
  - 2020 ISO-NE Wind Dataset (2012-2019) Rev.2

# Project Overview

- The DNV GL Stochastic Engine will be used to model at 1,000 realistically plausible historical time series of hourly wind generation, behind the meter (BTM) solar PV generation, and load in order to fully capture the range of meteorological conditions that can occur across the ISO-NE service area and quantify the potential variability in the wind and solar resource and any associated risks of underproduction or rare weather events.
- Statistical and probabilistic modeling will be performed on the resulting dataset to determine the likelihood of various events, including large wind ramp events, high wind shutdown extended weather events that may cause resource scarcity such as cold temperatures and low wind generation, and coincident periods of load with low and high solar and wind generation.

# PHASE 1

*Historical Data Time Series Creation*

# Scope of Work

- Phase 1a – Extension of Existing Wind and Power Time Series
  - The DNV GL Wind Mapping System (WMS) will be used to update the mesoscale wind flow results from the previous work.
  - It will be run at a horizontal resolution of 5 km and a temporal resolution of 1 hour for the period 2000 through 2011.
  - The new time series data will be appended to the previously modeled data in order to extend the modeled wind speed time series to cover the period 2000 through 2019 (20 years).
  - Following the update of the mesoscale wind speed data, DNV GL will perform power time series modeling. The power time series modeling will continue to incorporate the wind-to-power conversion models from the previous work.

# Scope of Work, cont.

- Phase 1b – Solar Generation Time Series
  - Normalized behind the meter (BTM) solar power time series will be created for the 8 ISO-NE Load Zones. The time series for each Load Zone will represent the potential BTM solar PV generating capacity for the entire zone.
  - Solar irradiance data for the 2000-2019 period will be generated using DNV GL's SunSpot system.
  - Time series of irradiance data will be generated for approximately 5 cities/locations in each of the 8 designated ISO-NE Load Zones.
  - Representative system information for each city will include azimuth angle, tilt angle, AC capacity, tracker type, module and inverter type. The solar production time series will include soiling, temperature, electrical and performance losses.
  - The solar power time series will be normalized by their capacities and aggregated for each load zone so that the resulting time series will represent the normalized BTM solar generation for the region.
  - Behind the meter solar measurements provided by ISO-NE will be used to calibrate or bias correct the modeled data if necessary.

# Scope of Work, cont.

- Phase 1c – Historical Load Data
  - DNV GL will include hourly time series of historical power demand data for each load zone, as well as system level load (provided by ISO-NE) for use with the stochastic engine.
  - DNV GL will utilize the estimated hourly solar generation, also provided by ISO-NE, to remove the load reduction caused by the behind the meter solar generation to produce a gross load time series for each load zone. Gross load is defined here to be net of energy efficiency.
  - DNV GL will make use of an analog ensemble model to extend the load time series from 2003 back to 2000, so that it extends the same 20-year period as the wind and solar data.

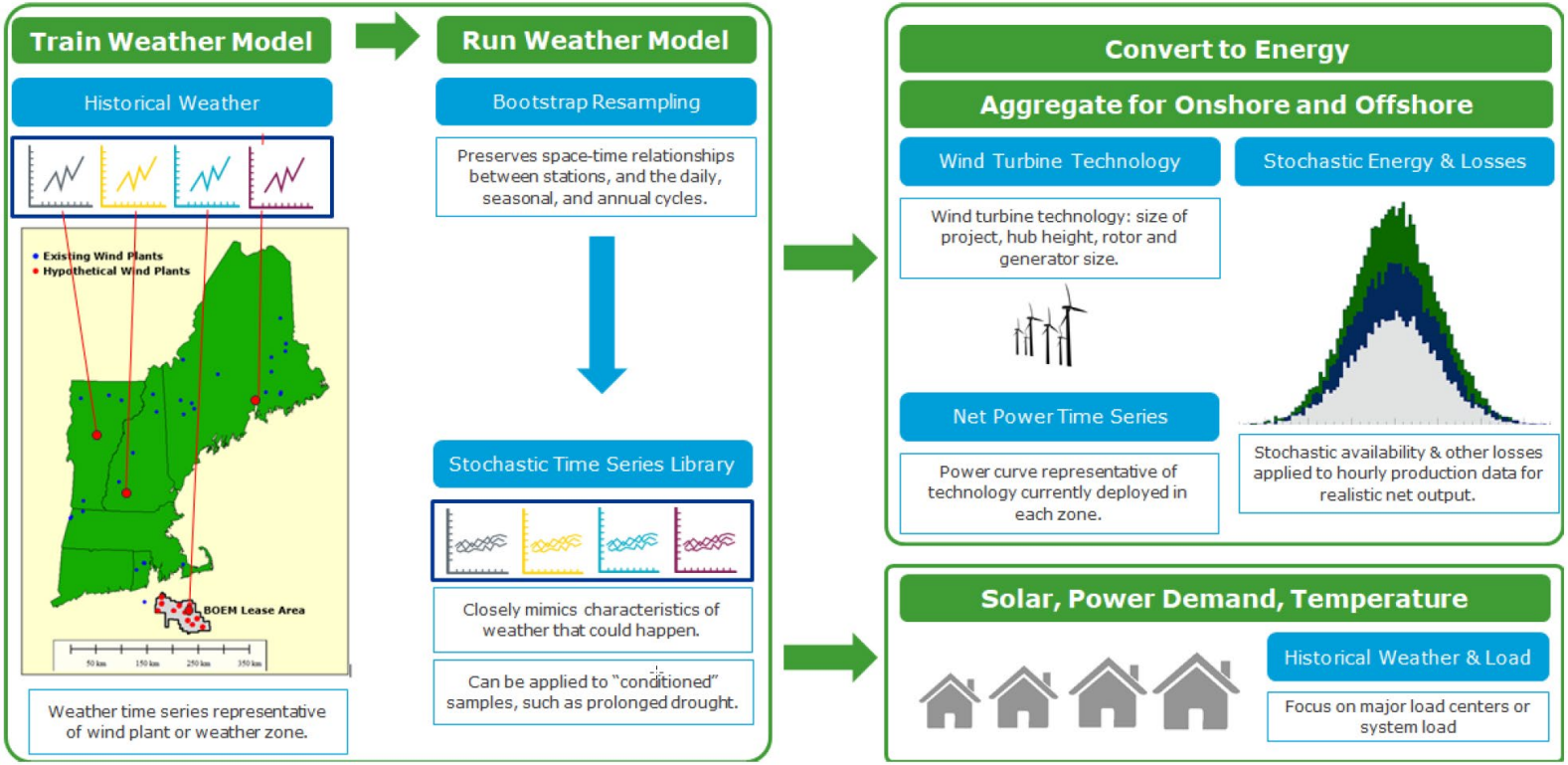
# PHASE 2

*Stochastic Engine*

# Stochastic Engine

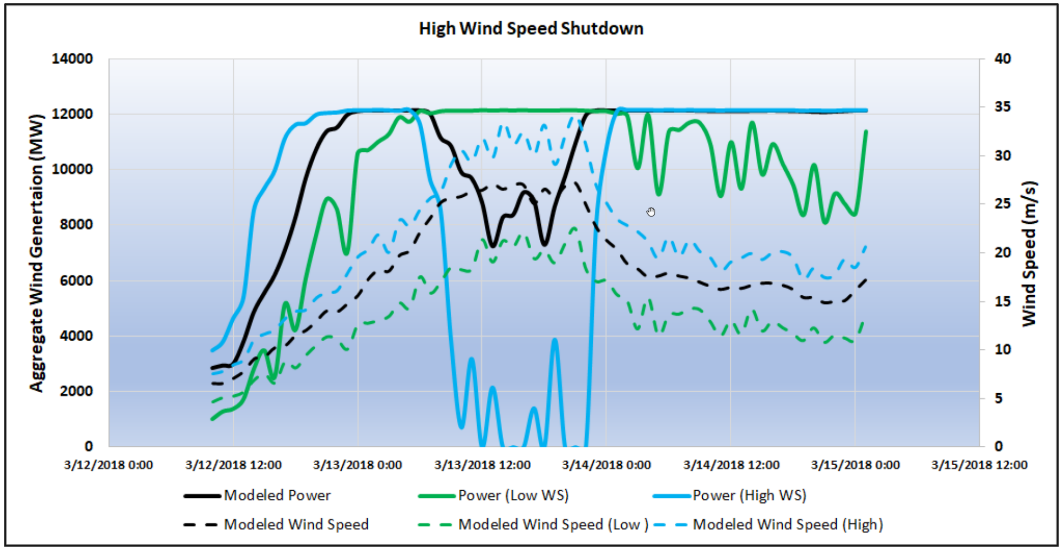
- The Stochastic Engine is a tool developed by DNV GL to statistically tackle time-series-based problems at scale. It can resample any time series (wind speed, irradiance, price, load) into parallel, plausible scenarios while preserving all the relationships within the data and between the signals.
- The weather-to-generation models, created in Phase 1, will then simulate the expected power production for each weather scenario, creating at least 20,000-years worth (1,000 20-year simulations) of hourly time series of power output for each wind plant, zonal solar, and zonal load time series.
- Each time series will preserve the correlations from year-to-year, month-to-month, temperature-to-load, and zone-to-zone.

# Stochastic Engine, cont.



# Stochastic Engine, cont.

- Relatively small changes in wind speeds can have large impacts on expected power production, particularly during instances of high wind speed shutdown. By stochastically modeling the wind speed data and associated power time series data, we can attempt to determine the frequency of these shutdown events and what impact they may have to aggregate wind generation profiles.



# PHASE 3

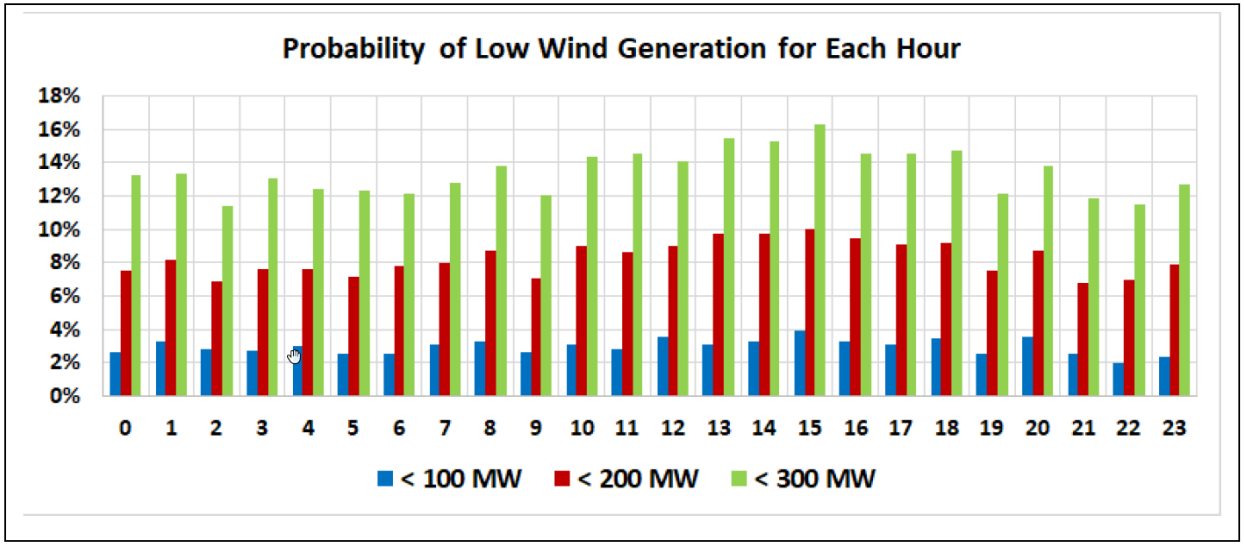
*Probabilistic Modeling*

# Probabilistic Modeling

- With 1,000 20-year time series datasets, probabilistic analysis can occur to determine the likelihood of certain types of events
  - Examining the probability of wind/solar generation being above or below a certain threshold during weather events such as hot or cold spells
  - Quantifying the frequency and duration of instances of turbine shutdown due to high wind speed events
- What type of analysis do stakeholders think would be valuable with the new data set?
- Some proposed examples suggested by DNV GL are on the following slides

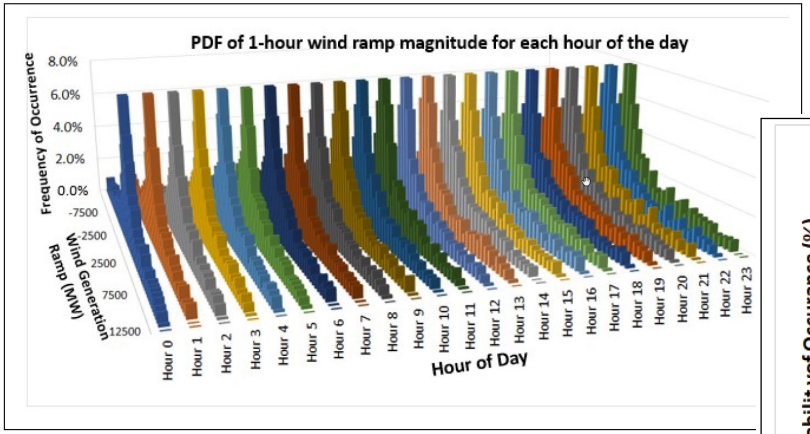
# Probabilistic Modeling, cont.

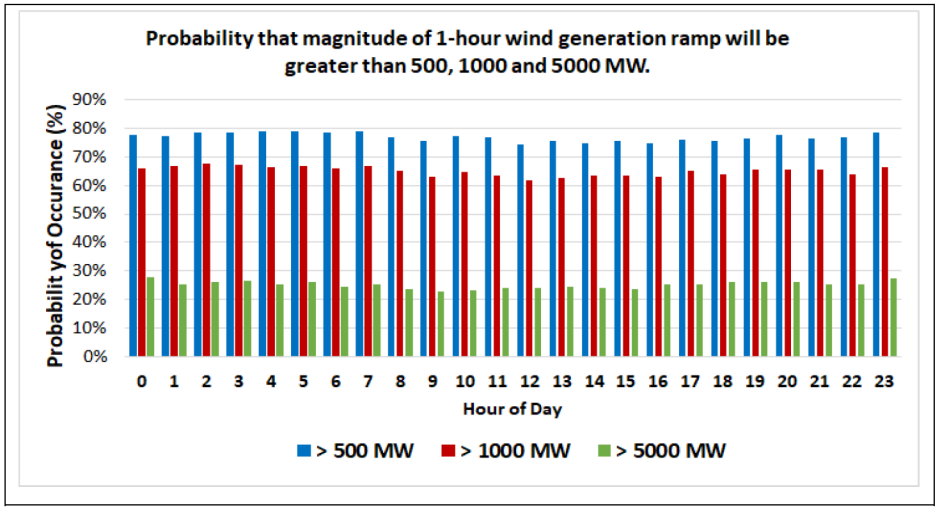
- The probability that aggregate offshore wind generation will be below a range of specified capacity values for each hour of the day



# Probabilistic Modeling, cont.

- The probability that aggregate wind generation will change by a specified capacity for each hour of the day



# Probabilistic Modeling, cont.

- Other possible ideas for analysis…
  - The probability that high wind speed shutdown will occur during each hour of the day and/or when winds exceed a certain threshold
  - The probability that that the magnitude of any high wind speed shutdown, when it occurs, will be greater than a specified capacity
  - The frequency of extended periods of very cold or hot temperatures (determined by heating or cooling degree day or average temperature) and the probability that aggregate wind generation will be below a range of specified capacities.
  - Representative 8760 time series data for a P10, P25, P50, P75, P90 and P99 wind generation year.

# PROJECT SCHEDULE

# Project Schedule

- ISO-NE kicked off the project with DNV GL at the beginning of June
- Phase 1 data is expected in mid-July
- Phase 2 data is expected early-mid August
- Phase 3 analysis is expected by late August / early September

# Stakeholder Feedback

- We would like to know your thoughts on what type of analysis we should conduct with this new dataset?
  - Submit comments and suggestions to pacmatters@iso-ne.com by July 31st
- Some suggestions could be incorporated into this project and some could occur internally after the project is completed with DNV GL using the new datasets
- The ISO also plans to publish the historical time series model data for wind, solar, and load for 2000-2019 similar to previous wind datasets published earlier this year

# Questions