# Multiple Wind Shape Probabilistic Modeling with GE MARS for the Installed Reserve Margin Study

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## *Preface*

Wind by its very nature is an intermittent generation resource. While the cost of construction of new wind farms is still fairly high when compared to other types of generation, its operational costs are relatively small. In addition, wind is fairly abundant and renewable. Energy from wind and solar generation is a benefit to electricity consumers from both a straightforward economic and societal perspective (*i.e.*, less pollution than conventional generation).

Integrating wind and solar generation into a bulk power electric system is problematic from a system planner's and system operator's perspective. Planners and operators need to determine the amount of resources needed to meet the electric system's peak load; however, intermittent generation may or may not be available during peak system hours. The availability of wind unit energy during summer peak hours has varied from about 10% to 20% with these values doubling for winter peak hours. Such availability is in sharp contrast to nuclear generation availability, which approaches 95% during summer peak hours. From a "peak hour" perspective, it would take about six wind generation farms of 1,000 MW to replace one nuclear unit of the same size (1,000 MW). Integrating intermittent resources into a bulk power electric system substantially increases its installed reserve margin requirements.

## *Introduction*

New York has been modeling wind as an hourly load modifier since 2003. This means that each wind farm is modeled with an hourly MW wind shape profile over the course of the year (*i.e.*, 8760 hours). Up until 2013, the wind farms' hourly output was based on a series of wind readings taken over 33 sites across New York State. When a new wind project was sited, the project was modeled based upon the nearest set of wind readings by locations or the closet hourly profile, scaling the MW output for each hour to reach the maximum output of that project. This method had several drawbacks. First, the data was outdated. AWS Truepower conducted the original wind readings over the period from 2004 to 2006. Second, turbine technology dramatically changed—*i.e.*, hub heights have increased, turbine blades are much longer, and capacity factors have increased—and the data was no longer representative of the new technology's capability.

Starting with reliability studies for years 2014 and beyond, actual hourly production data output for each wind unit from the previous year was used to create the hourly wind profiles. While a significant improvement over using simulated data, this method also had its drawbacks. Since wind is highly variable, there can be significant differences in wind performance from one year to the next that can substantially impact the Installed Reserve Margin (IRM). This was noted in the wind profiles of 2013 versus 2014.

In 2015, General Electric (GE) introduced new functionality in its GE MARS software to allow for the use of multiple wind profiles for each wind unit.

## *Objective*

The first objective is to test the new GE MARS Multiple Wind Shape (MWS) functionality to determine if any anomalies are created in the code that would affect current MARS results. The second objective is to test the new functionality to determine if the resulting reserve margin better represents the wind model. It is expected that the new functionality will smooth out large swings in the reserve margin from year to year based on the performance of the wind units.

## *Testing*

The 2016 IRM study base case (17.4%) was used for all MARS runs in this analysis. Production data from NYISO's Decision Support System (DSS) was used to create the yearly wind shapes for each unit. If a unit did not have a full five years of historic data, a zonal average profile based on all units in the respective zone was created and used where there was missing data. The profile was then scaled to the appropriate nameplate capacity rating. The five yearly wind shape profiles were each run independently in Single Wind Shape (SWS) mode using the IRM 2016 Base Case MARS version. These were then rerun using the new MARS version without implementing the MWS functionality. Lastly, the case was run with the MWS functionality turned on.

## *Results*

The results of the MARS analysis are shown in Table 1. A comparison of the MARS runs using the SWS functionality versus the MWS functionality demonstrates that the new MWS functionality did not create any anomalies. The margins ranged from a low of 16.4% to a high of 17.4%. These are shown in Table 1 and Figure 1.

The data and results clearly demonstrate that using only the previous year wind data exposes the IRM to dramatic year to year variation. In going from using the 2013 shape to using the 2014 shape, nearly a 1% drop occurred in the IRM. Then, in going from using the 2014 shape to using a 2015 shape, a 0.8% increase was demonstrated.

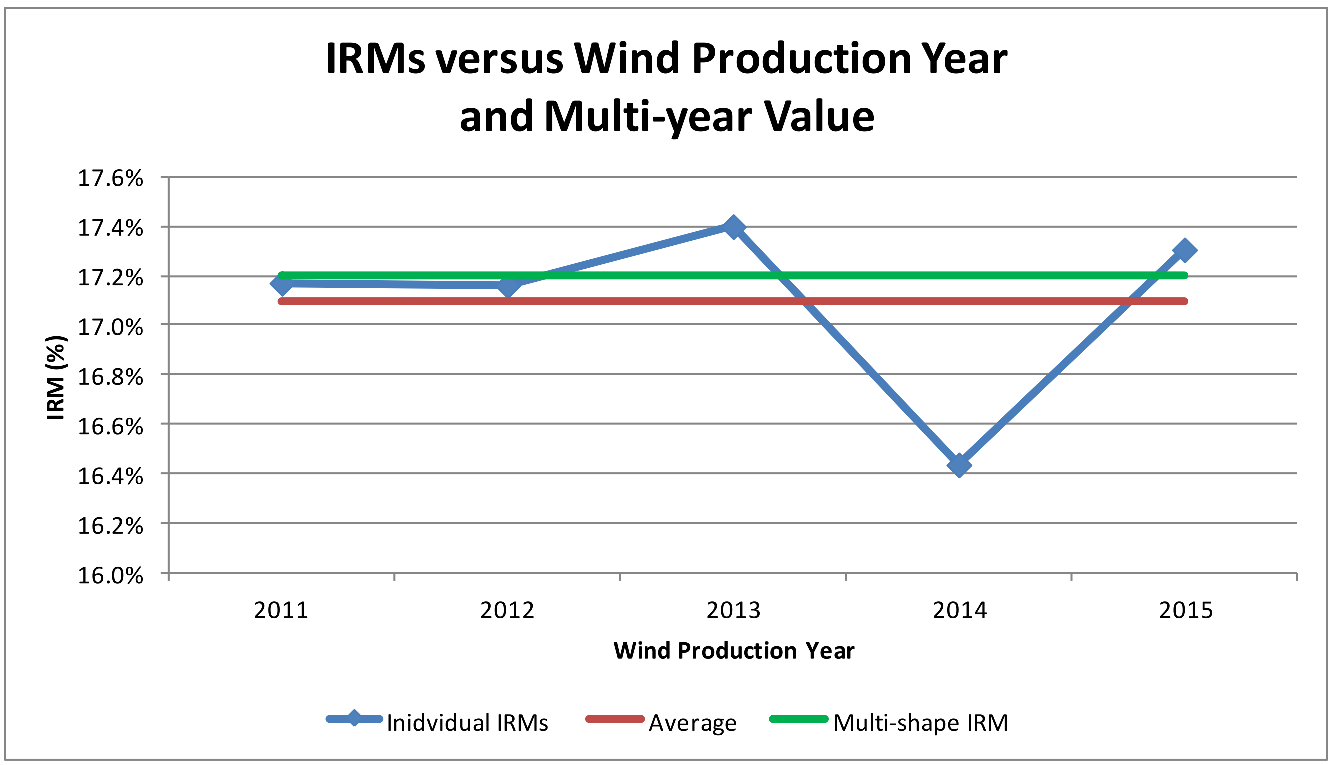
Finally, Figure 1 shows a simple average of the five wind shapes. Note that the Multi-year value is higher than the average value. This is due to the smoothing that occurs during an averaging process whereby there are no longer days where the average wind output would be zero, as would occur in reality.

Table 1

| Wind Production Year | Starting LOLEs* | Inidvidual IRMs |
|---|---|---|
| **2011** | 0.097 | 17.17% |
| **2012** | 0.096 | 17.16% |
| **2013** | 0.100 | 17.40% |
| **2014** | 0.087 | 16.44% |
| **2015** | 0.099 | 17.31% |
| **Average:** | 0.096 | 17.10% |
| **Muli-Year Result:** | 0.100 | 17.21% |

*IRMs are the result of adjusting the LOLEs to 0.100 days/year.

Figure 1



## *Conclusion*

The new functionality introduced no anomalies into the GE MARS analysis. It also performed as expected, smoothing out the large yearly variation that would result from using solely the prior year wind performance data in the reserve margin calculation. In addition, the analysis showed that random selection of wind shapes results in a more realistic IRM value than an average shape could produce. Based on the foregoing, NYISO recommends that the new GE MARS Multiple Wind Shape functionality, using the five previous years of wind production data, be used in the IRM study's base case assumption.