Memorandum

To: Electric Reliability Council of Texas (ERCOT)

Attn: Pete Warnken

From: Mikel Shakarjian, Sr. Project Manager

Katherine Rojowsky, Research Scientist

Date: June 20, 2017

Subject: Simulated Wind Generation Profiles 2016

AWS Truepower (AWST) was contracted to provide historical site-specific hourly wind generation profiles for the year 2016. This work is predated by the 2012 study entitled *Simulation of Wind Generation Patterns for the ERCOT Service Area (AWS Truepower, 2012),*[1] which provided hourly wind generation profiles simulated using meteorological data output from the Mesoscale Atmospheric Simulation system (MASS). An update to this 2012 work was provided on March 27, 2015,[2] which used the Weather Research and Forecasting (WRF) model to simulate the meteorological data for hourly wind generation profiles for the years 1997-2013. Subsequent generation profiles for the year 2014 were provided on July 15, 2015[3] and June 3, 2016.[4] This memo provides an overview of the methodology used to simulate the most recent hourly wind generation time series for the ERCOT service area and a description of the data delivered. The 2016 profiles were created following the methods outlined in AWST (2015), which are briefly summarized below.

The WRF model was used to simulate one year of historical meteorological conditions over the ERCOT region, and these data were converted to power generation time series at 228 previously selected sites using an AWST proprietary algorithm. Model output from individual 9-km grid cells were then aggregated to represent conditions over each site. The site-specific wind speeds were adjusted using observations from validation towers to correct for model bias. Additional adjustments were made to the aggregated wind speed output to account for wake losses, wind speed gusts, and other effects. The most appropriate IEC class turbine power curve was selected and used to convert wind speed to power output at the individual sites. Modeled wind speeds at 80 m were used for IEC Class I and II sites, while wind speeds at 100 m were used at Class III sites and offshore. An in-depth explanation of the methods used to develop the power time series can be found in AWST (2012).

The final power production data sets underwent a rigorous validation process to ensure the results were consistent with actual meteorological and power generation observations, as well as previous efforts. Results show that the dynamic behavior of wind generation at actual wind plants is captured on both a diurnal and monthly basis. The frequency distribution of hourly step changes in power output was evaluated to ensure that the model captures the variability of actual wind farms. The modeled variability compares well with the observed values at both individual and aggregates of wind plant sites (Figure 1).

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[1] http://www.ercot.com/content/committees/other/lts/keydocs/2013/AWS_Truepower_ERCOT_Wind_Patterns_report.pdf
[2] AWS Truepower, LLC, "Simulation of Wind Generation Patterns for the ERCOT Service Area", Report to ERCOT, March 2015.
[3] AWS Truepower, LLC, "Simulated Wind Generation Profiles 2014", Report to ERCOT, July 2015.
[4] AWS Truepower, LLC, "Simulated Wind Generation Profiles 2015", Report to ERCOT, June 2016.

The aggregated power of all sites for the year 2016 shows a consistency in the mean diurnal profile of power output when compared to previous efforts (Figure 2), despite interannual variability in the magnitude of generated power.

This work produced historical hourly wind generation profiles at 228 sites for the year 2016. These data were aggregated by site location (onshore or offshore) and delivered in text file format. A sample of the power output at each site (Figure 3) shows that the MW output generation time series have been provided in local time (Central Standard Time, CST) with the name and capacity of individual sites listed in the header of each column.
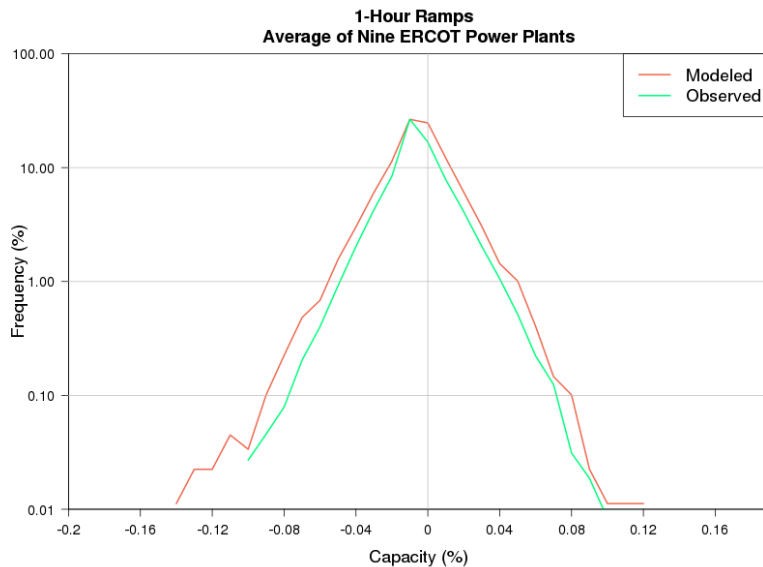

Figure 1. The 60-minute changes in power output modeled for 2016 compared to observed data at nine ERCOT facilities (measured on a logarithmic scale).
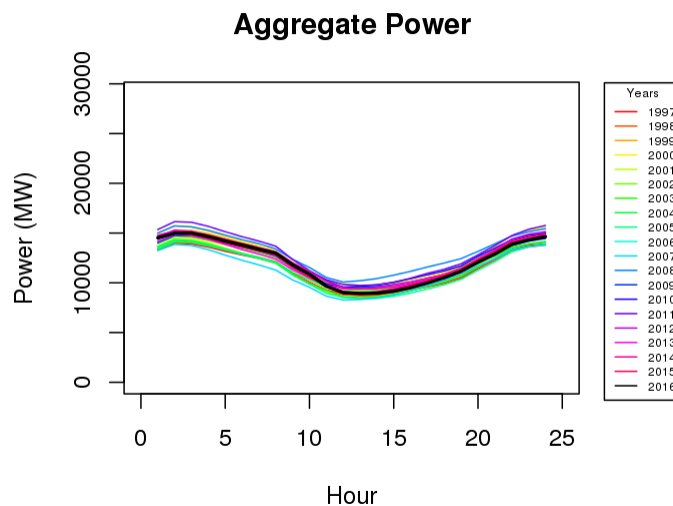

Figure 2. Average diurnal power profile for the years 1997-2016 using the WRF model (aggregate of all sites). Note that the profile for the year 2016 is highlighted in black.

YYYYMMDD	HHMM(CST)	SITE_00001:capacity= 112.5	SITE_00002:capacity= 77.2
20151231	1800	18.7	26.2
20151231	1900	15.3	26.5
20151231	2000	15	23.2
20151231	2100	11.9	20.5
20151231	2200	18.6	17.2
20151231	2300	16.7	19.7
20160101	0	16.6	25.1
20160101	100	19.9	21
20160101	200	27.9	20.4
20160101	300	23.3	20.8
20160101	400	24.7	28.7
20160101	500	32.1	18.7

Figure 3. Data format for 2016 hourly wind generation profiles