Whitepaper

Texan Roulette

Increasing Wind Capacity Raises the Stakes in ERCOT

By Pat Milligan, Dinesh Madan and Vinay Gupta, ICF

Executive Summary

The ERCOT market is now more dependent on random weather than ever. While it was always the case with ERCOT's real-time scarcity construct that hot weather was crucial to drive a high real-time peak demand and potential scarcity pricing, ERCOT now also has more wind capacity than any other U.S. grid, totaling 16.4 GW in August 2016 for a system with realized peak demand of 71.2 GW. ERCOT reports list nearly 5 GW of further wind supply with interconnection rights as early as next year.

This capacity is likely over-counted in the calculation of reserve margin. Officially, ERCOT, in its planning documents, uses a historical average peak contribution during the top 20 load hours for crediting wind capacity. As it stands in 2016, that average is 12% for inland wind and 55% for coastal wind, for a capacity weighted-average of about 17%. This has been relatively uncontroversial; CAISO gave 16% credit in August, and MISO gave 15% credit. However, this level of contribution is based on an average, rather than a reliability standard, and obscures the significant odds of much lower or higher output during peak hours. Table 1 shows the distribution of historical ERCOT-wide wind output at all-hours, August, and August during 3-6 pm when peak demand is likely.

EXHIBIT 1: OUTPUT AS % OF ERCOT INSTALLED CAPACITY (2007-2015 HOURLY AVERAGE)

Percentile	All Hours	August	August 3-6 pmhrs.	August Peak: MW output[1]
.99	76.1%	66.9%	60.6%	9,915 MW
.9	59.4%	46.6%	31.9%	5,219 MW
.5	28.9%	20.5%	14.0%	2,291 MW
.1	5.9%	4.7%	4.6%	753 MW
.01	0.7%	0.6%	1.2%	196 MW

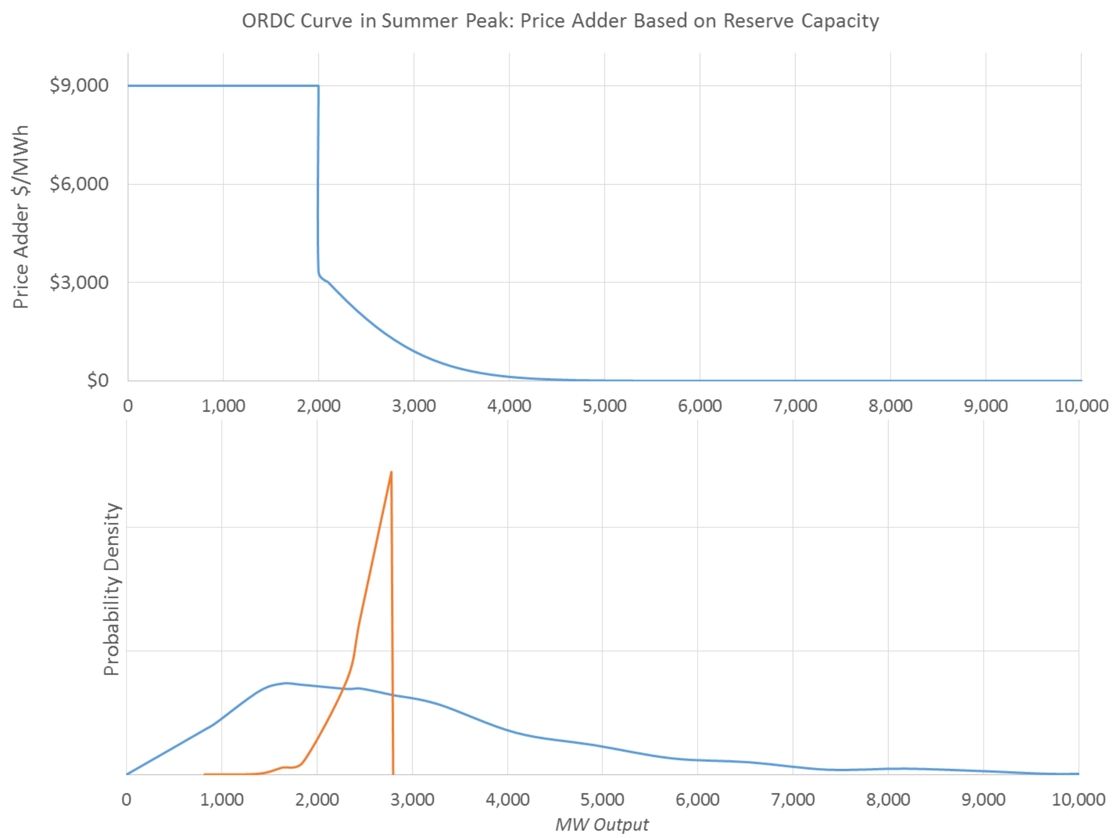
Source: ICF using ERCOT data

While other grids have to grapple with wind variability for planning purposes, ERCOT is additionally at the mercy of wind conditions to generate adequate payouts for thermal units. In spite of record peak demand in 2016 on August 8th, 10th, and 11th exceeding forecast levels, real-time power prices over the week remained low, averaging only $30/MWh and peaking at $130/MWh. In addition, realized scarcity premiums embedded in the ERCOT power price year-to-date is only about $11/kW. This was largely explained by high wind output at the peak hour in 2016 (30% of capacity), the luckiest peak-hour outcome to date. In 2012, despite only having 10 GW of wind on the grid and a peak demand that was very close to forecast, wind output at peak of only 3% helped bring the peak power price up to $1,500/MWh.

[1] Considering 16,362 MW of installed capacity in August 2016. One counter-argument could be that recent wind capacity expansions and new turbine technology make historical averages obsolete, however, even during August 2015 there were multiple days with just ~5% total output at the 4pm hour.

To illustrate just how sensitive the situation is, consider the graphs below. The first graph shows the Operating Reserve Demand Curve (ORDC), which determines the scarcity price based on available surplus capacity to the grid. As shown, at around 2,000-3,000 MW of reserves, the ORDC becomes extremely sensitive to small differences in capacity. At this level, a difference of 1,000 MW of online reserves can make a difference of $8,000/MWh in price.

EXHIBIT 2: ORDC PRICE CURVE AND COMPARISON OF WIND AND THERMAL CAPACITY OUTPUT



Source: ICF using ERCOT data

The second graph compares the probabilistic output of wind on the grid during August peak vs gas-fired combined cycle (CC) of the same reserve capacity.[2] Note that the X-axis in both graphs are the same. The range of wind outcomes can mean the difference between zero scarcity pricing (map 5,000 MW wind output to the ORDC) or the price cap at $9,000/MWh (map 1,000 MW wind output to the ORDC). Consider that a range of 1,000 MW captures over 99% of

[2] 16,362 MW wind online as of August 2016: 16,362 * 17% credit = 2,781 MW of thermal to provide the same reserve capacity. The variability shown in CC output is calculated based on a 5% forced outage rate applied across 6 hypothetical CCs of 464 MW each.

possible outcomes with the thermal units, yet the same range for wind captures just 29% of possible outcomes.

EXHIBIT 3: PRICE ADDER PROBABILITY COMPARISON: WIND VS GAS CC AS SURPLUS ONLINE CAPACITY

Price Adder $/MWh	Wind	Gas CC
>$1,000	38%	>1%
~$1,000 - ~$3,300	29%	99%
$9,000	33%	>1%

Source: ICF using ERCOT data

For further context, it is now the case that variability in wind MW is greater than variability in load. Over the past 10 years, the second-worst outcome for demand was an under-forecast of peak by about 1.7 GW. However, the chance of wind output being 1.7 GW below planning levels is at least 16% during August 3-6 pm hours. Therefore, wind is now the greater unpredictable variable factor (16% chance of low wind vs 10% chance of high demand). Further, the combination of low wind and high load can mean a combined difference of (-4,000) to +6,000 MW.

The effects of this extreme variability are evident when loss-of-load modeling software is used to predict scarcity price outcomes. Exhibit 4 below is illustrative – if expectation scarcity is at a given level x, e.g. $30/kW-yr for a reserve margin of 16-17%, the combination of low wind and high demand can raise actual realized scarcity several times over. Recent years' experience of low prices is also plotted.

EXHIBIT 4: INDICATIVE TOTAL SCARCITY BY SCENARIO

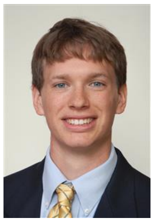
	Low Wind	Average Wind	High Wind
High Demand	2-4x or higher	1-2x	~0.5x
Forecasted Demand	1-2x	x	Very low
Low Demand	~x	~0.5x	Near zero

2016
2015
2014

Source: ICF

With such ever-increasing dependence on highly variable random factors (not even to mention the upcoming wild card that is solar), ERCOT continues to look less and less like a predictable market for capacity and increasingly like a market open to surprise outcomes. Low gas prices, which have compressed the otherwise more stable energy margins for baseload units, means that the entire fleet of dispatchable generators is now dependent on the rolls and turns of hourly scarcity in order to break even. Furthermore, because of the extreme nonlinearity of the ORDC, good years can outweigh bad ones. Behind the appearance of higher reserve margins is an increasing amount of over-counted, highly variable capacity, and the market will catch up to the average sooner or later. Further, the added variability from wind increases the chance that market outcomes will be misinterpreted and there will be over-retirement of capacity during periods of low scarcity, increasing the potential for wider swings between feast and famine.

About the Authors



Patrick Milligan, is an associate with ICF's Commercial Energy division with experience modeling supply and demand in wholesale power, generator asset valuation and financial projection in a variety of markets in the United States, Mexico and Canada.

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For more information, contact:

Shanthi Muthiah
Shanthi.Muthiah@icf.com +1.703.934.3881

Patrick Milligan
Pat.Milligan@icf.com +1.703.225.5856

Dinesh Madan
Dinesh.Madan@icf.com +1.703.713.8846