



# **Trading Opportunities in Volatile Energy Markets**

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# Agenda

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- **Volatility in Physical Energy Markets**
  - General market trends
  - Impact of renewable generation on price volatility
  - Wind forecast driven market risks & opportunities
- **Volatility in Financial Futures Markets**
  - Weather driven front month volatility
  - “Back of the curve” volatility

# **Price volatility in the physical market is increasingly influenced by renewable generation**

## **Volatility in the Physical Energy Markets**

- **Volatility, typically in terms of pricing, is caused by deviations from market expectations either due to fundamental causes or actions driven by trader decision**
  - Supply shortage due to planned and unplanned generation outages and wind generation forecast miss
  - Demand side deviation due to load forecast miss
  - Transmission and congestion constraints drive volatility due to network outages, capacity limitations, topography changes and etc.
  - Trader induced volatility contributes to an overbought or sold market due to perceived scarcity and risk
- **Increasingly renewables have introduced volatility of their own and influenced pricing in both the day ahead and real time markets**
- **The challenge and opportunity for quantitative traders is to model market behaviors based on understanding of fundamentals and identify trading signals from non-random patterns in pricing**

# ERCOT day ahead and real time prices volatility has increasingly been influence by wind generation



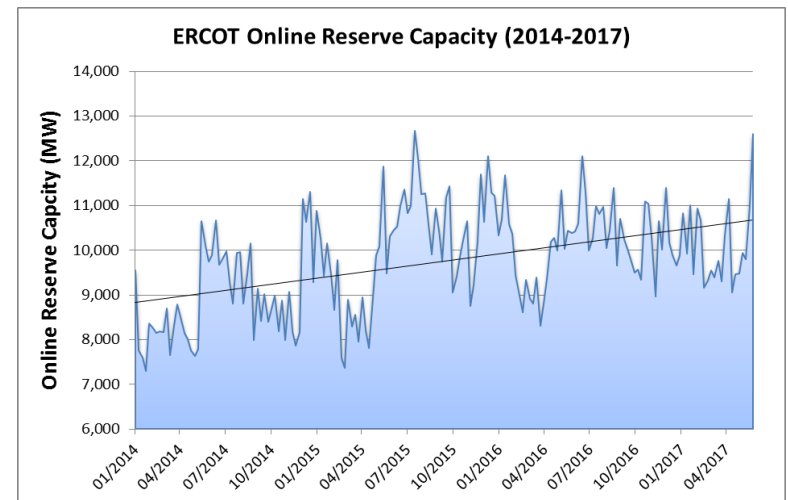
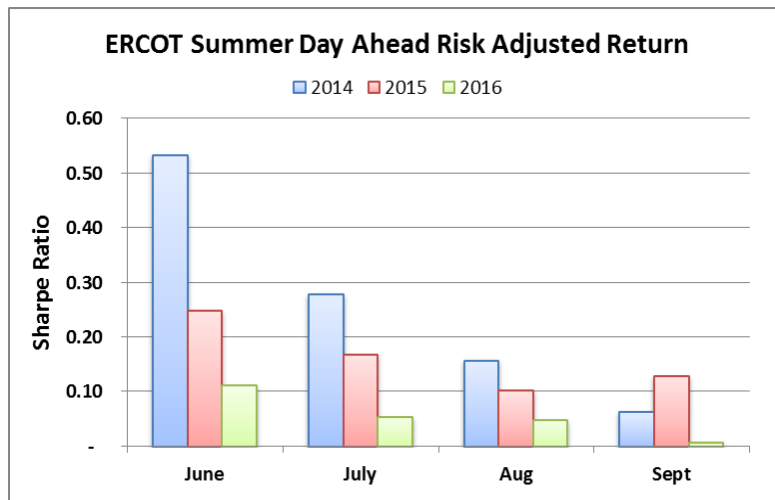
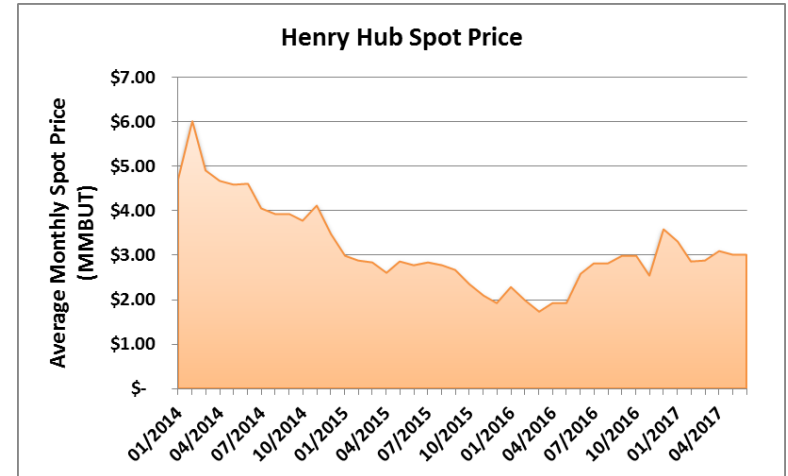
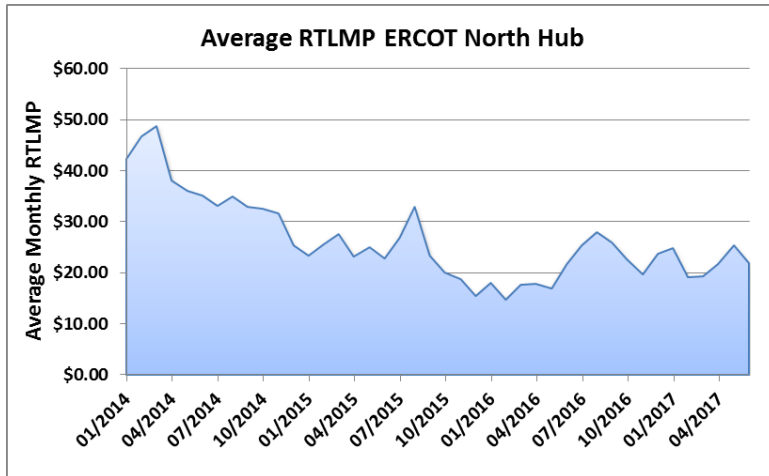
## Market Trends in ERCOT

- **Growth in wind generation and the shale boom has changed the risk profile of cash trades in ERCOT**
  - Texas is the largest user of natural gas for electric power generation in the U.S. and consumed 1539 bcf of gas in 2016<sup>1</sup>
  - Average RTLMP has decreased almost 50% over the last 3 years due primarily to increases in shale gas production but also growing influence of wind generation
  - Wind capacity is now at ~20GW in a 70 GW system. Over forecasted wind generation continues to affect real-time prices but with increasing severity as capacity grows
  - Day ahead premiums have been eroding as ERCOT reserves have increased since 2011, despite an increase in the price cap from \$3000/MWh to a Texas sized \$9000/MWh in today's market.
  - “Fear premium” on the day ahead seems to be declining. Historically after a real-time price spike, the day ahead price used to be more over bought as a result of scarcity pricing.
  - Recent months have seen an increased prevalence of low to negative pricing especially in the West Hub.

(1) [https://www.eia.gov/dnav/ng/ng\\_cons\\_sum\\_dcu\\_STX\\_a.htm](https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_STX_a.htm)

# Increasingly bearish market environment in ERCOT presents challenges for cash trading in ERCOT

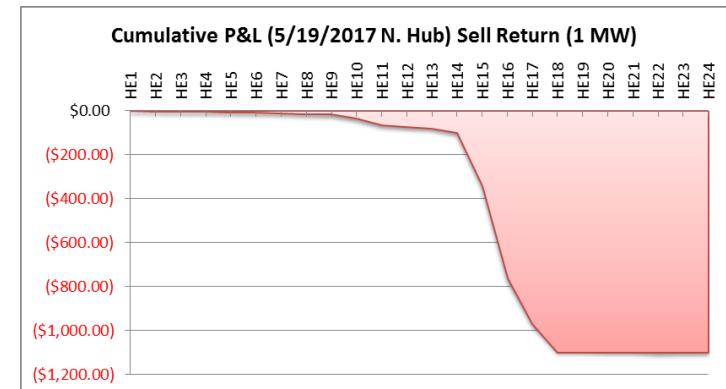
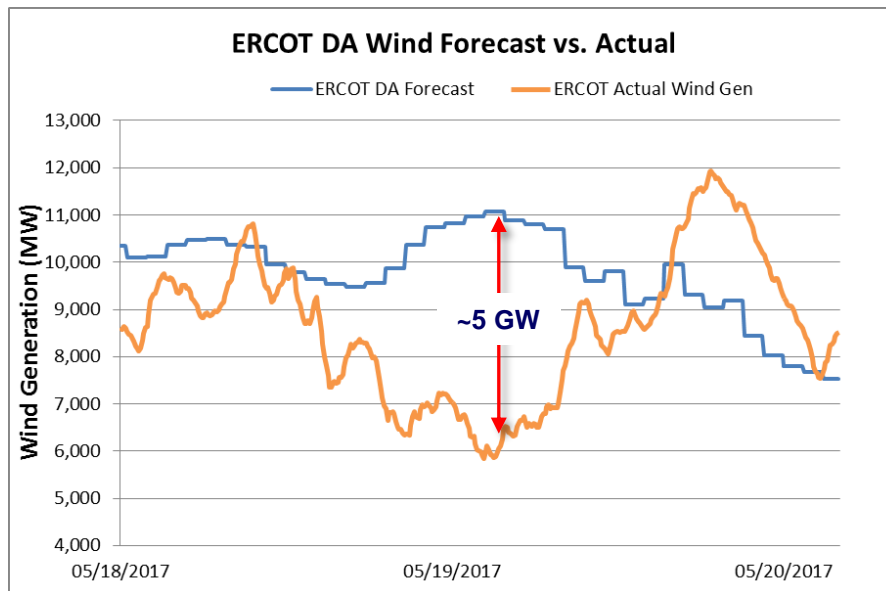
## ERCOT Trends



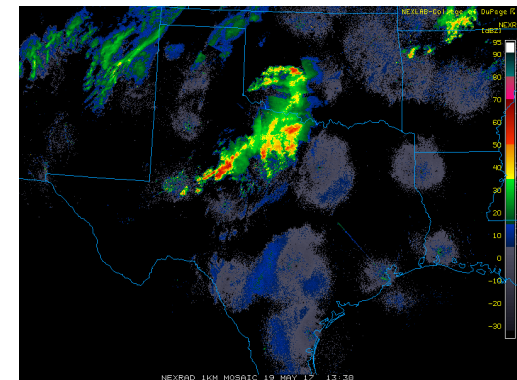
**Over forecasted wind generation caused by convection in the real time creates losses for producers/sellers**

## Convection driven wind ramps

- Wind forecast misses such as on May 19, 2017 creates pain for short term cash traders
- Unforeseen convection on the day ahead missed the wind ramp resulting in real time prices spiking to ~\$450 during peak afternoon hours.



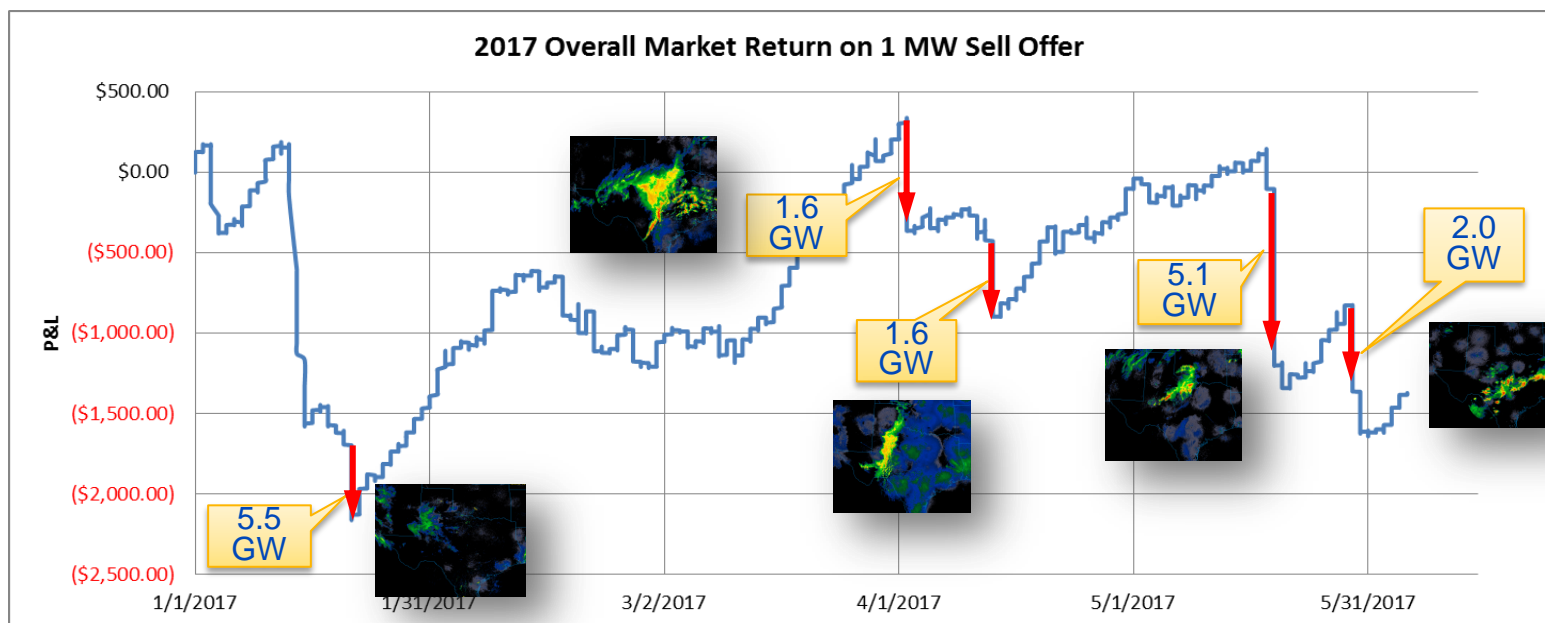
## Thunderstorms on 5/19 shut down the wind



# Avoiding convective forecast errors on the day ahead provides a edge in the day ahead market

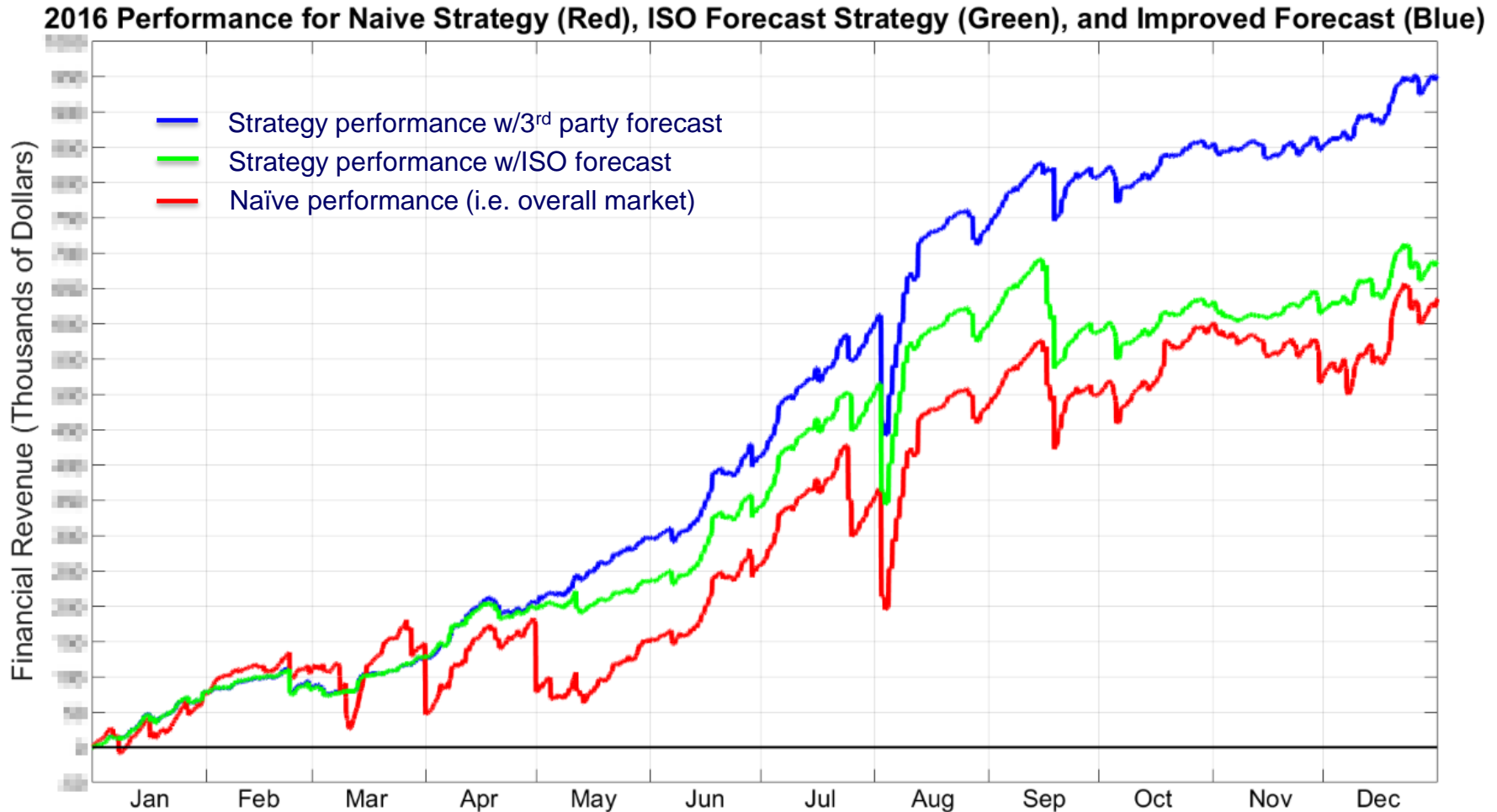
## Effect of convection driven forecast error

- Back test of a hypothetical strategy in 2017 shows five large draw downs coinciding with wind being over forecasted on the day ahead
- Further analysis indicates convection in the real time contributing to wind under production relative to forecast from day ahead
- Cumulative affect on trading profits equal \$3218/MWh on a 1 MW offer turning a losing strategy into a winner



**Backtest of 2016 sell strategy revealed potential for ~35% improvement in P&L with increased forecast accuracy**

## Summer 2016 Backtest w/Improved WPFX



# Negative to low pricing environment driven by high system wind creates trading opportunities

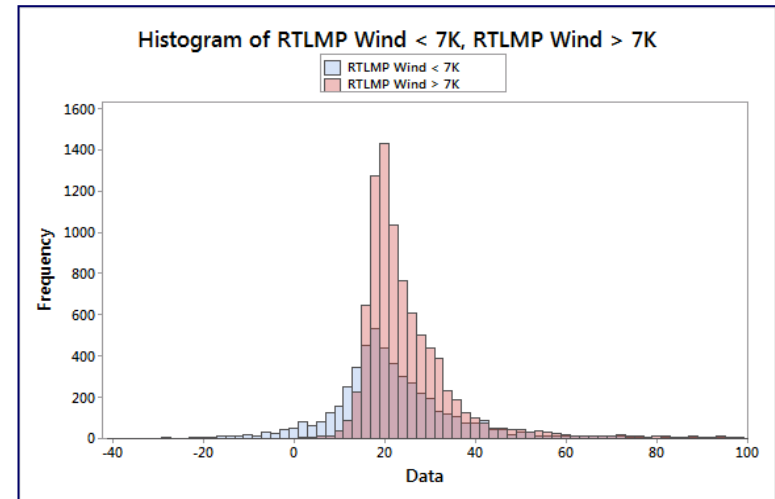
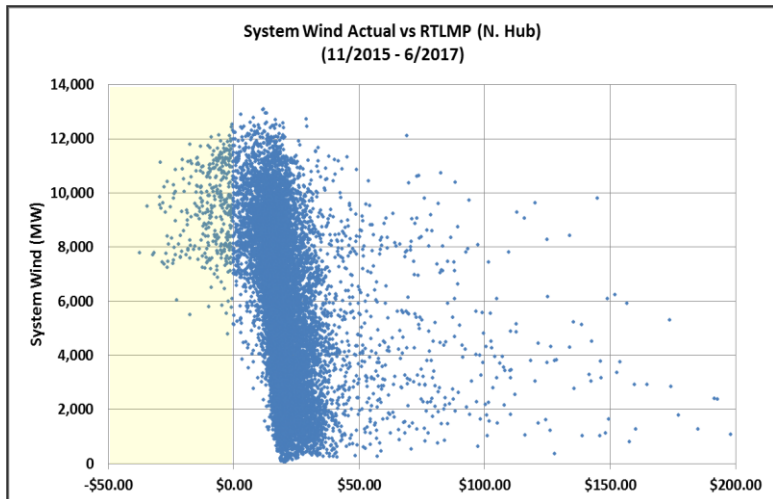
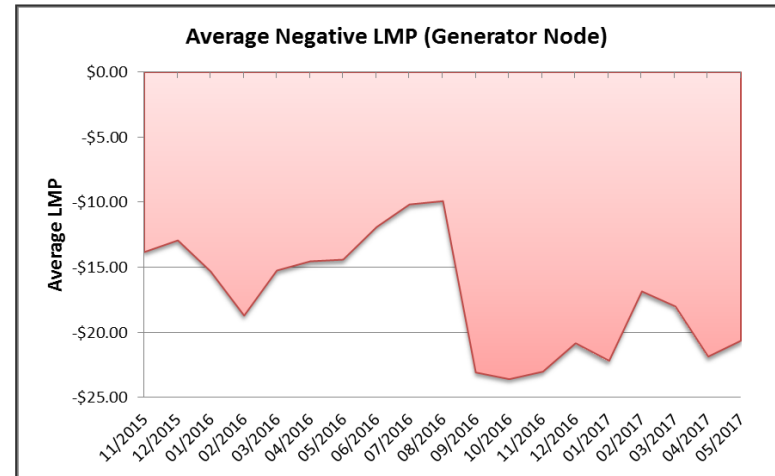
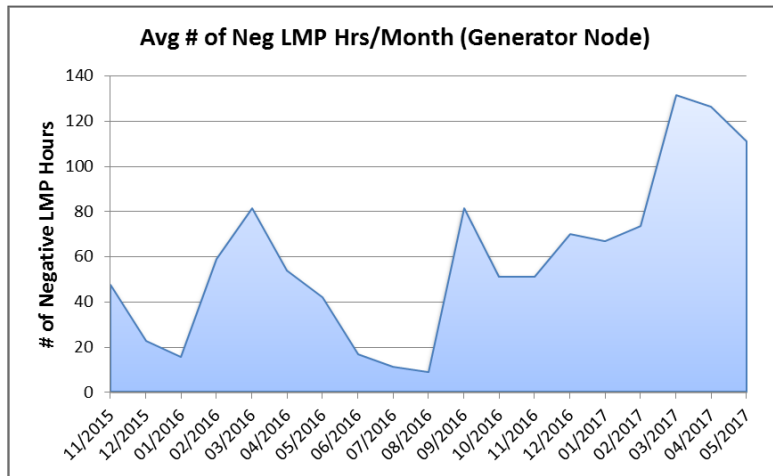


## Market Trends in Southwest Power Pool

- Wind generators can offer to sell day ahead energy at negative prices up to their PTC price (i.e.  $>-\$23/\text{MWh}$ )
- In the real time, wind generators can offer negative prices up to their PTC and/or PPA price to be dispatched
- When high system winds are forecasted on the day ahead, wind generators are competing to sell their energy on the day ahead market to avoid exposure to potentially lower real time prices. Markets can at times be oversold putting downward pressure on day ahead prices
- The MW's that are not picked up on the day ahead are then forced to liquidate at real time prices which can often be negative.
- Occurrences of negative LMP in the real time have been observed with greater magnitude and frequency over time

# Negative to low pricing environment driven by high system wind creates trading opportunities

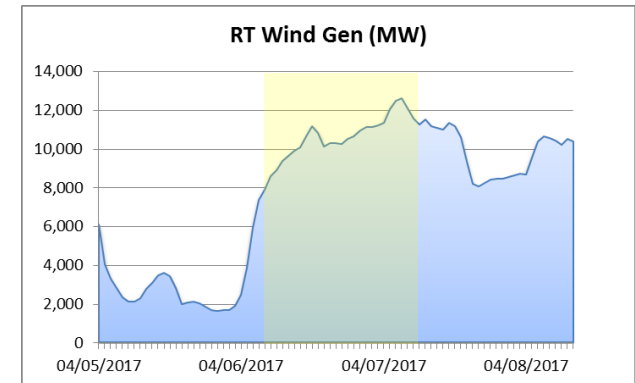
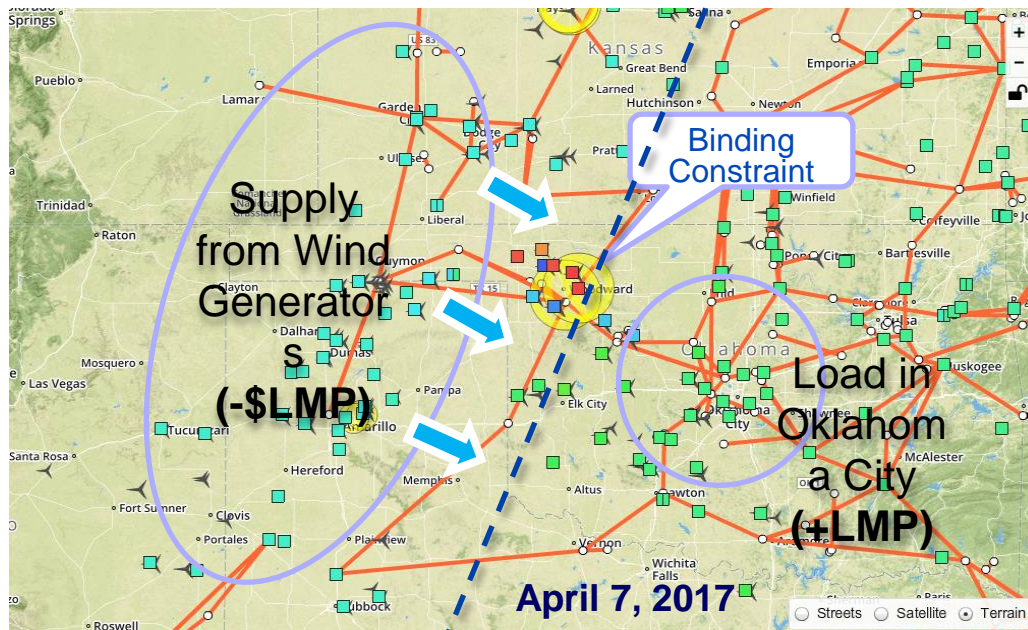
## High Wind Regime in Southwest Power Pool



# Wind driven congestion can offer basis trading opportunities

## Wind driven congestion

- High system winds compounded by specific transmission topography can create wind driven congestion in localized areas in the real time
- Prices can react in opposite directions depending on the particular side of the congestion
- Binding constraints act as a demarcation between supply and load acting as a choke point to power flow



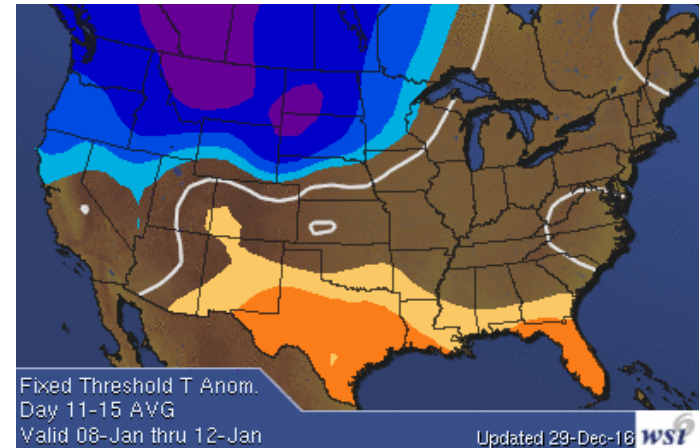
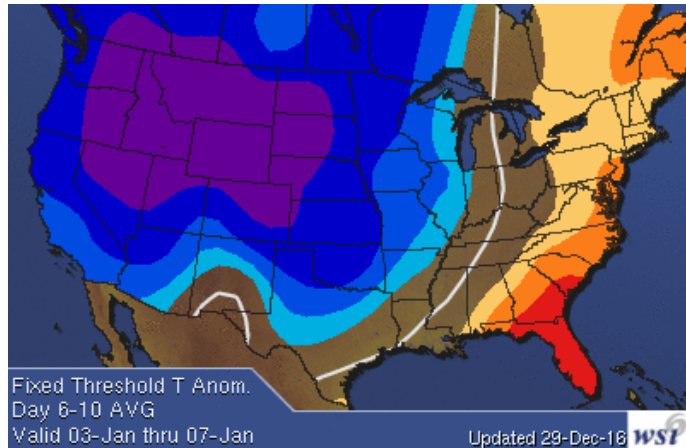
# Volatility in forward markets

## Volatility in the Energy Futures Market

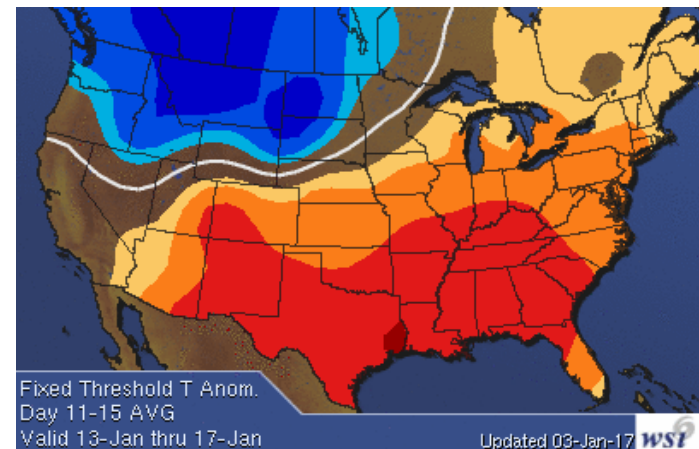
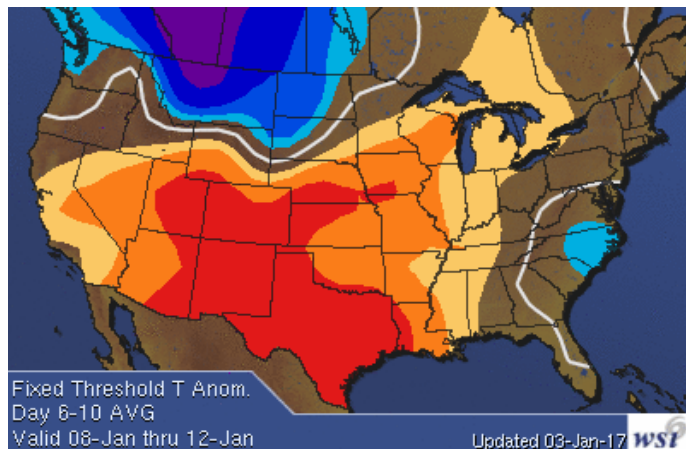
- **Electric energy futures are traded for hedging and speculative purposes and offers a fixed \$/MWh product for a given delivery month out to 5 years**
- **Futures are typically priced in monthly on and off peak strips**
  - On Peak: 5 x 16 (Mon – Fri from HE8 – 23)
  - Off Peak: 7 x 8 (Mon – Sun from HE1 – 7; 24)
  - Off Peak: 5 x 8 (Mon – Fri from HE1 – 7; 24)
- **Front months (1 – 3 month) volatility typically driven by expectations of weather which is a proxy for demand**
- **Futures prices are also influenced by cash performance of near term trades**
- **Back of the curve is typically driven by producer hedging**
  - Producers sell forward generation in the out months to hedge revenue
  - Fundamentals such as expectations of fuel costs, heat rate and renewable penetration for each market
  - Volatility driven by repositioning of hedges

# Example of changing weather forecast on market expectations

## Forecast of Prompt month Jan 2017 on December 29, 2016



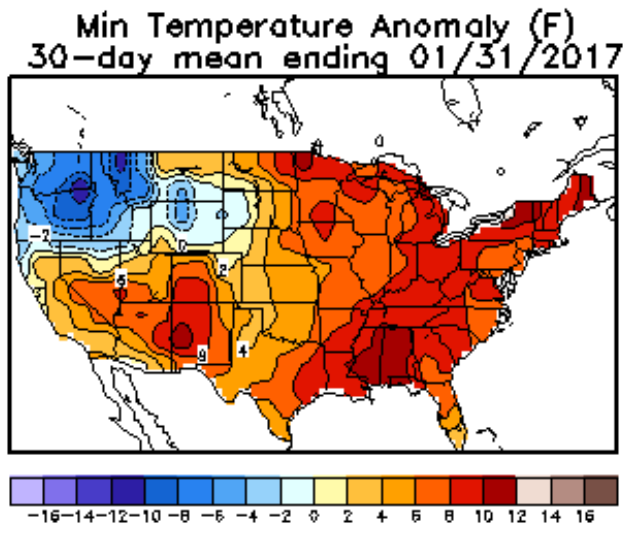
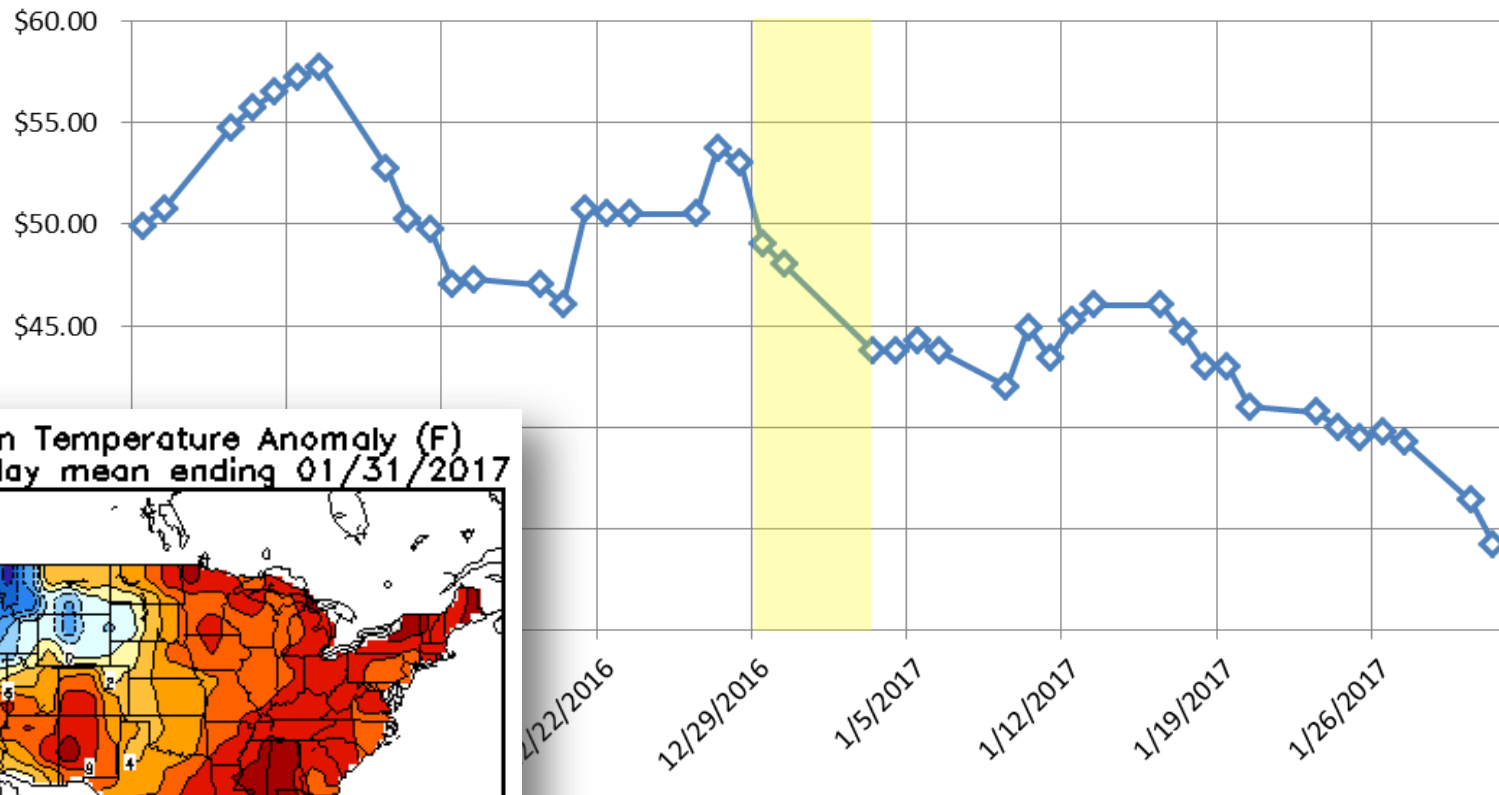
## Forecast of Bal-Month Jan 2017 on Jan 3, 2016



# Bearish reaction due to warmer forecast for the start of Jan 2017 sends overall futures prices down

## Price action on changing market expectations

PJM Western Hub Feb 2017 On Peak



# Summary

## Summary

- Physical market volatility influenced by near term fundamentals
- Changing market environment shaped increasingly by renewable generation
- Growing importance of system wind forecast to provide a trading edge in markets with increased wind penetration
- Where physical markets trade on real time fundamentals futures markets trade on perceptions and expectations
- Forward markets in front months react to numerical model runs based on the 6-10 and 11-15 day temperature anomalies
- Maturation in the energy markets with low cost fuels (i.e. gas and wind) contributing to lower energy prices. The “easy money” is gone and the advantage goes to those that can identify and profit from these ever changing markets