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NEBRASKA WIND & THE SPP MARKETPLACE

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October 2014

Operating and Proposed Wind Farms in Nebraska

September 2014

Disclaimer: Information comes from many public sources. Author does not guarantee accuracy of information.

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SPP INTEGRATED MARKETED

- Started March 1, 2014
- Has two markets
  - Day Ahead (DA)
  - Real Time (RT)
- Day Ahead (DA)
  - Settled Financially
  - Less Volatile
  - Generally averages a higher price
- Real Time (RT)
  - Settled at the difference between DA Awards and RT Actuals
  - Very Volatile at times
  - SPP Market Charges
- Congestion and Market Prices
  - Where the windfarm is located at does make a difference
- Wind Forecasting
  - Very important
  - Wind Forecasters state 15% to 20% error is good
    - Load Forecast it is 2% to 4%
  - DA forecasting and length of time from forecast to actual has a impact

DAY AHEAD PRICES VS REAL TIME PRICES

Numbers from March 1, 2014 to September 30, 2014				
DA Price (Hours) below Offer	DA Price (Hours) Below $0	Lowest (hour) DA Price	RT Price below Offer (Number of Hours)	Lowest RT Price (Hourly Average)
7	7	($7.95)	284	($234.14)
0	9	($8.57)	72	($228.52)
0	8	($9.29)	55	($259.87)
0	5	($9.15)	55	($259.87)
6	6	($10.80)	231	($263.66)
0	2	($1.43)	40	($217.87)

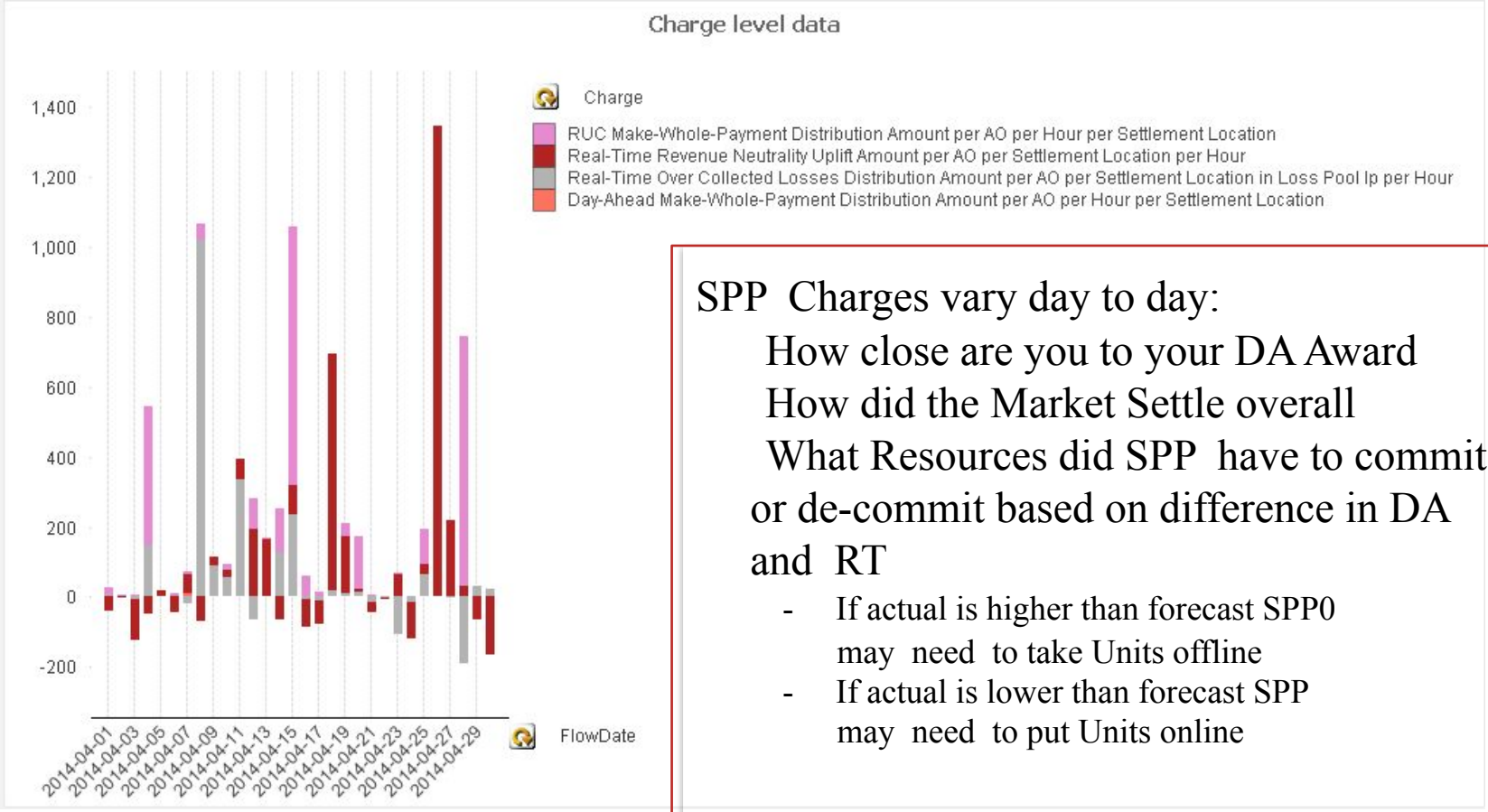
Windfarm #1 and Windfarm 5 do not receive Production Tax Credits

SPP IM MARKET REAL TIME VOLATILITY

- DA is a Hourly Financial Market
  - All Cleared Mws and Prices are hourly
- Real Time (RT) is a five minute Market
  - All Deployments are every Five Minutes
  - All Prices are every Five Minutes
  - Can see volatile prices in 5 minute market
    - Actual RT LMP Prices for he24 at AWEF on September 30th
    - Priced every 5 minutes
    - Positive and negative prices throughout hour
    - Many more 5 minute prices are negative than the hourly numbers from previous Slide

HE 24 at AWEF on September 30th - Five minute Market Real Time LMP Prices													Average for hour
Time	0	5	10	15	20	25	30	35	40	45	50	55	60 minutes
Mw	12.6	12.5	12.5	13.9	16	16.5	15.9	16.2	15.7	15.8	16.2	16.9	15.06
RT Price	($34.85)	$8.64	($28.97)	$17.09	$18.31	$18.80	$19.53	$16.77	$19.14	$21.52	($28.92)	$8.51	$4.63

SPP CHARGES



SPP Charges vary day to day:

How close are you to your DA Award

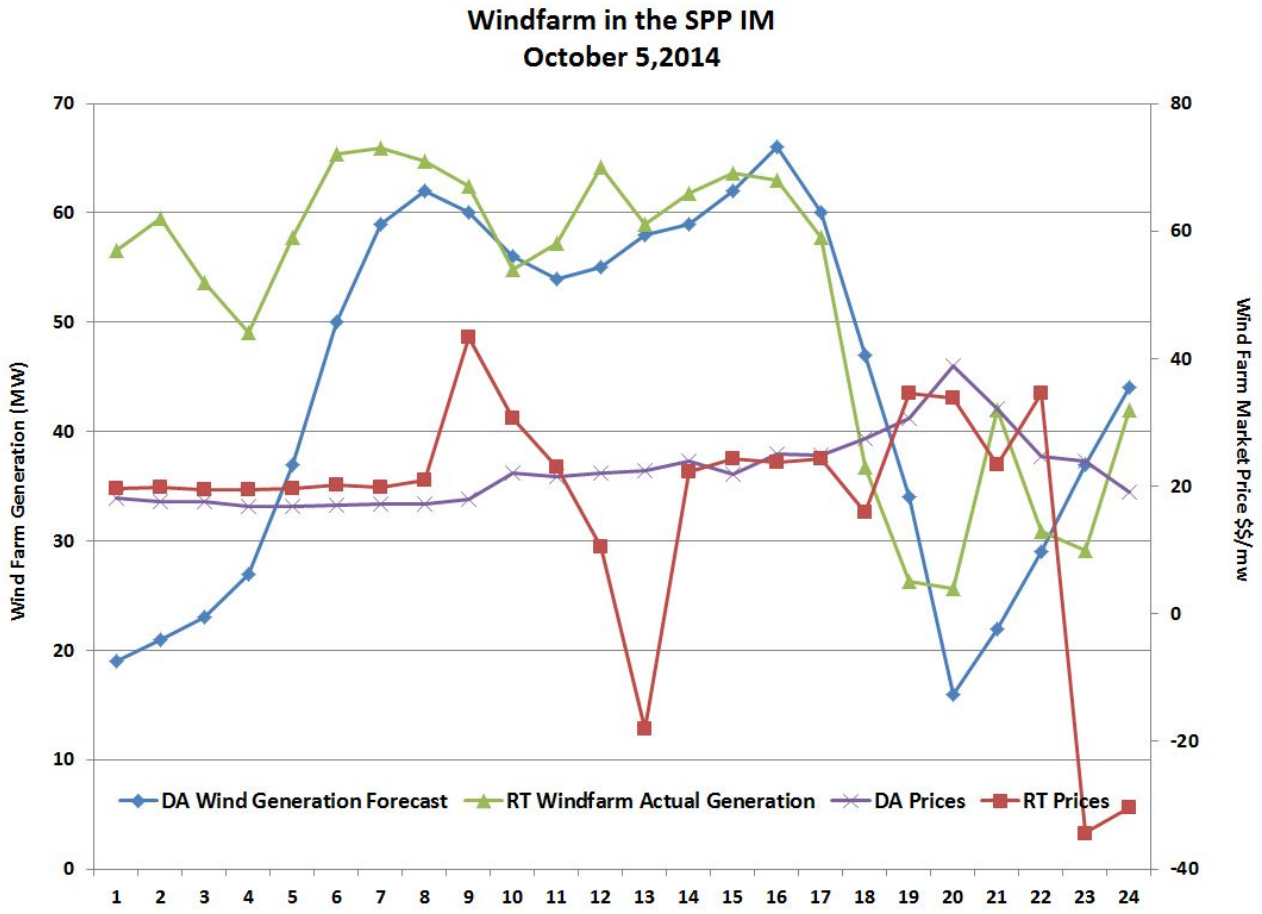
How did the Market Settle overall

What Resources did SPP have to commit or de-commit based on difference in DA and RT

- If actual is higher than forecast SPP0 may need to take Units offline
- If actual is lower than forecast SPP may need to put Units online

WIND GENERATION IMPACTS TO NPPD

- With SPP the Balancing Authority (BA) NPPD follows Directives from SPP for reliability needs
  - Additional Resources that can move may be needed to manage intermediate resources
  - Ancillary Market provides a pricing mechanism for SPP to acquire needed resources for Operational Reserves
    - Includes Reg Up, Reg Dn, Spinning, and Supplemental
- Wind Generation impacts NPPD's from different locations
  - Nebraska
  - SPP
  - MISO
  - WAPA (joining SPP on October 1, 2015)
- Risk for Transmission Flowgate Congestion is highest when wind output is high during low load periods
  - High Volatile Prices
  - One five minute pricing period impacts
  - Spring and Fall Maintenance periods have a impact as well



Example of DA Forecast vs Actual and DA Prices vs RT Prices

- Shows the forecast error
- Shows how volatile the prices can be
- Prices tend to follow forecasting error

RESEARCH ITEMS FOR A RTO MARKET

- **Investigate ways to factor in economic impact of Wind Generation**
  - Reduce financial and operational risks for resources needed for Reliability
    - Need other Resources to manage Intermediate Resources
    - This would include Quick Start Units, multiple start Units, Units with Ramping capabilities, etc.
  - Forecasting for Wind Generation and Load needs to improve
  - Better look ahead tools for Operators of RTO's
- **Moving projects from Non-Dispatchable Variable Energy Resources (NDVER) to Dispatchable Variable Energy Resources (DVER)**
  - Are projects capable?
    - PURPA Qualified Units (QF's)
  - What are the potential costs and benefits?
  - How can the RTO models be improved to manage Wind Generation to show the benefit
- **Improvement in Generator Studies to determine what transmission is needed for Generators**
  - Some sites are price takers and have no Transmission Scheduled

Thank You