



ROTOR EQUIVALENT WIND SPEED VALIDATION STUDY

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EDF VALIDATION DATA SETS

- ❖ Presentation will review validation efforts focused on two sites:
 - Site 1: Central US, Lidar + Met power curve test
 - Site 2: Southern US, Lidar + Met power curve test
- ❖ At present we are unable to make these data sets available as EDF does not maintain 100% ownership of the projects.



SITE 1: CENTRAL US

7 months of lidar data next to a power curve test setup

SITE 1

- ❖ Lidar sited next to permanent met tower and 2 operating turbines
 - 7 months of concurrent measurements: May 2013 – Nov 2013
- ❖ 7 lidar measurement heights across rotor swept area
- ❖ EDF compared the turbine production estimated from:
 - Observed hub height wind speed at permanent met tower
 - Adjusted hub height wind speed from REWS method

| | T52 | T53 |
|--|------|------|
| Change in expected turbine production after applying REWS correction | 0.0% | 0.0% |



SITE 2: SOUTHERN US

7 months of lidar data next to a power curve test setup

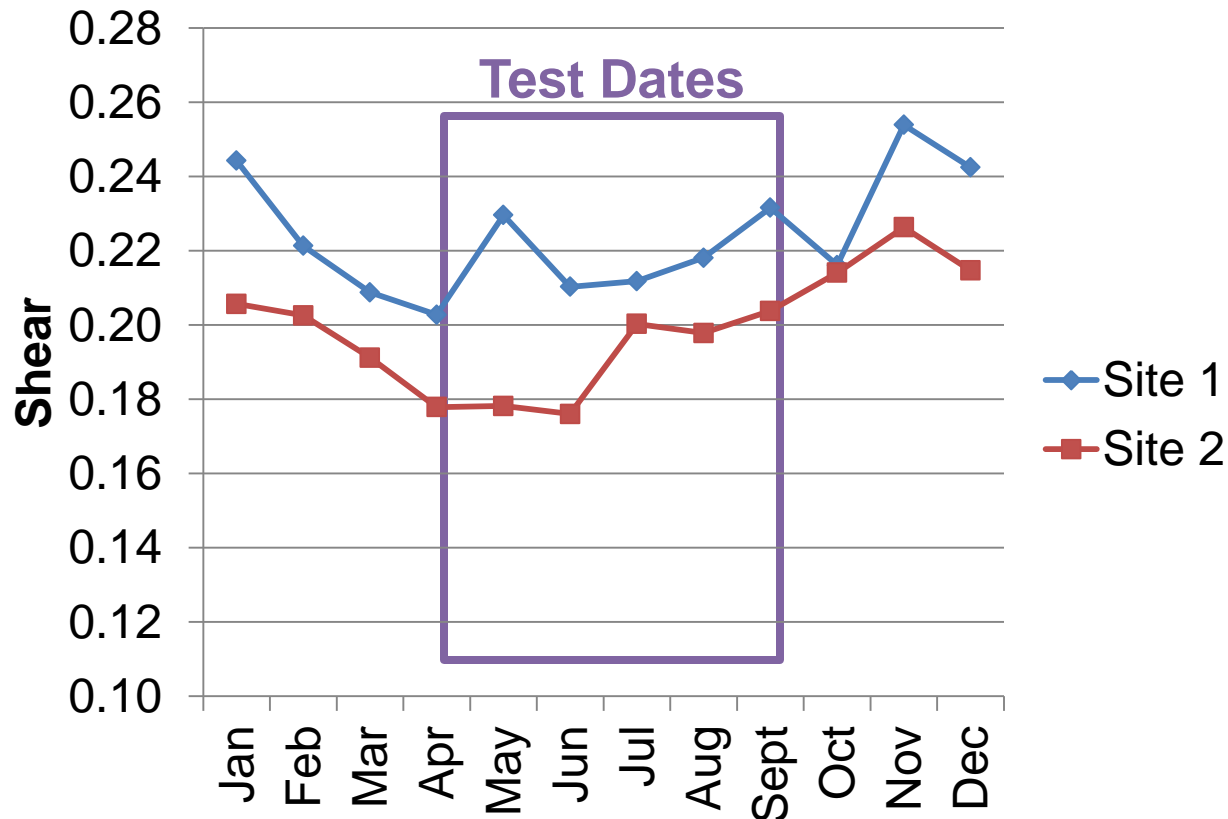
SITE 2

- ❖ Lidar sited next to permanent met tower and 2 operating turbines
 - 7 months of concurrent measurements: May 2013 – Nov 2013
- ❖ 10 lidar measurement heights across rotor swept area
- ❖ EDF compared the turbine production estimated from:
 - Observed hub height wind speed at permanent met tower
 - Adjusted hub height wind speed from REWS method

| | T37 | T38 |
|--|-------|-------|
| Change in expected turbine production after applying REWS correction | -0.7% | -0.7% |

MONTHLY SHEAR PROFILES

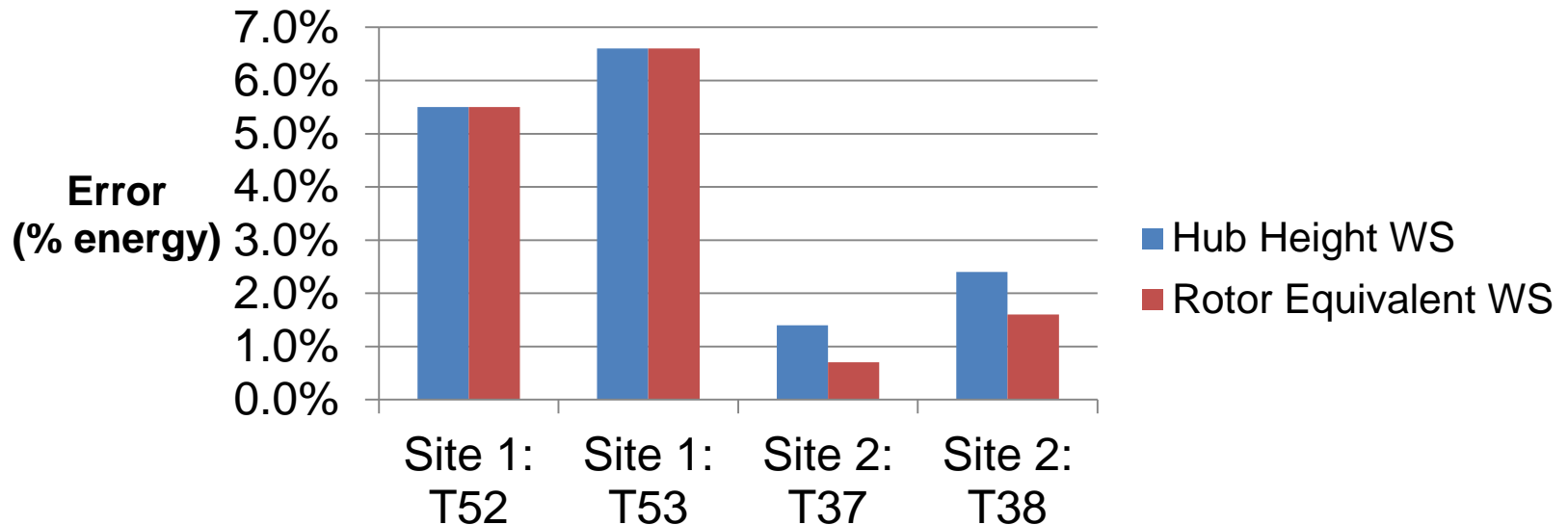
- ❖ Why did REWS adjustment impact results at Site 2 but not Site 1?



REWS: AN IMPROVEMENT?

- ❖ Is there evidence that the Rotor Equivalent Wind Speed method is an improvement over hub height wind speed measurements alone?

Modelled vs. Observed Production



POWER CURVE TESTS

- ❖ EDF performed internal power curve tests (PCT) at Site 1 and 2
- ❖ Independent engineers (IE) previously completed test at both sites
- ❖ Concurrent wind speed data collected at met towers and lidars
 - All required IEC filters were applied to data
 - Appropriate bins were filled
- ❖ Production data collected at neighboring turbines
 - Power data binned in 0.5 m/s bins
 - Data interpolated and extended when necessary
- ❖ Site specific frequency distributions from IE PCTs applied to:
 - Warranted power curve
 - Measured power curves
- ❖ Power Curve Efficiency = Measured MWh / Warranted MWh

POWER CURVE LOSS: JUSTIFIED?

- ❖ Is the power curve loss applied by consultants reasonable?
- ❖ What can be said about IEC power curve test uncertainty?
- ❖ Do stand alone remote sensing devices offer accurate enough results for power curve tests?

| Site | Official PCT | IEC PC Loss | EDF PCT | PCT + REWS | Lidar only PCT |
|-------------|-------------------|-------------|-------------------|------------|----------------|
| 2 | 95.6% | 97.3% | 93.6% | 93.6% | 90.6% |
| | 95.2% | | 93.2% | 93.3% | |
| Test Dates: | 02/2013 – 05/2013 | | 05/2013 – 11/2013 | | |
| 1 | 100.1% | 98.0% | 98.4% | 98.7% | 95.6% |
| | - | | 98.3% | 98.6% | |
| Test Dates: | 12/2012 – 07/2013 | | 05/2013 – 11/2013 | | |

~2%

~2%

CONCLUSIONS AND QUESTIONS

- ❖ With only a few new data points to draw from, it appears that REWS does make a positive improvement in our understanding of the energy produced by a turbine
 - But the improvement seems to fall well within the test uncertainty to begin with
- ❖ EDF was unable to present TI normalization results at this time
 - Hopefully after the current consensus analysis review
- ❖ What other ways can these methods can be quantifiably validated?