



2016 Deepwater Wind's Turbines at Block Island, R.I. (by M. Dwyer)

Wind Energy Power Output

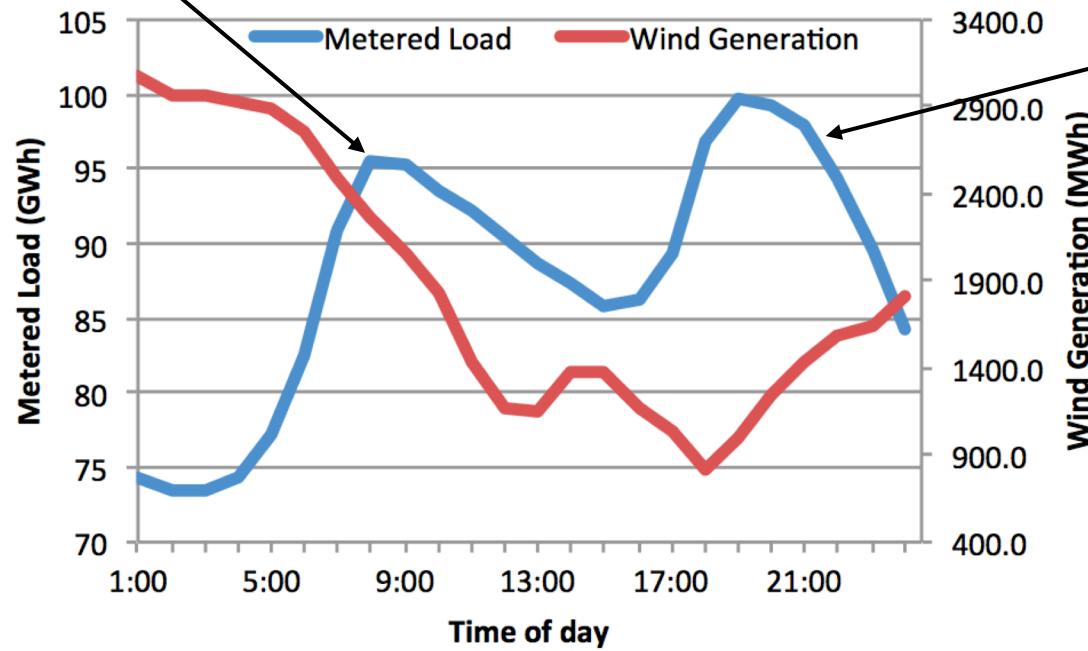
- Wind energy power output depends on wind speed
- Variable power source → uncertainty in the production
- There is wind forecast
- Can we predict wind power from wind speed?
- Why do we need to forecast the wind?



Power System Challenges



Load vs. Generation PJM
on 01/03/2011



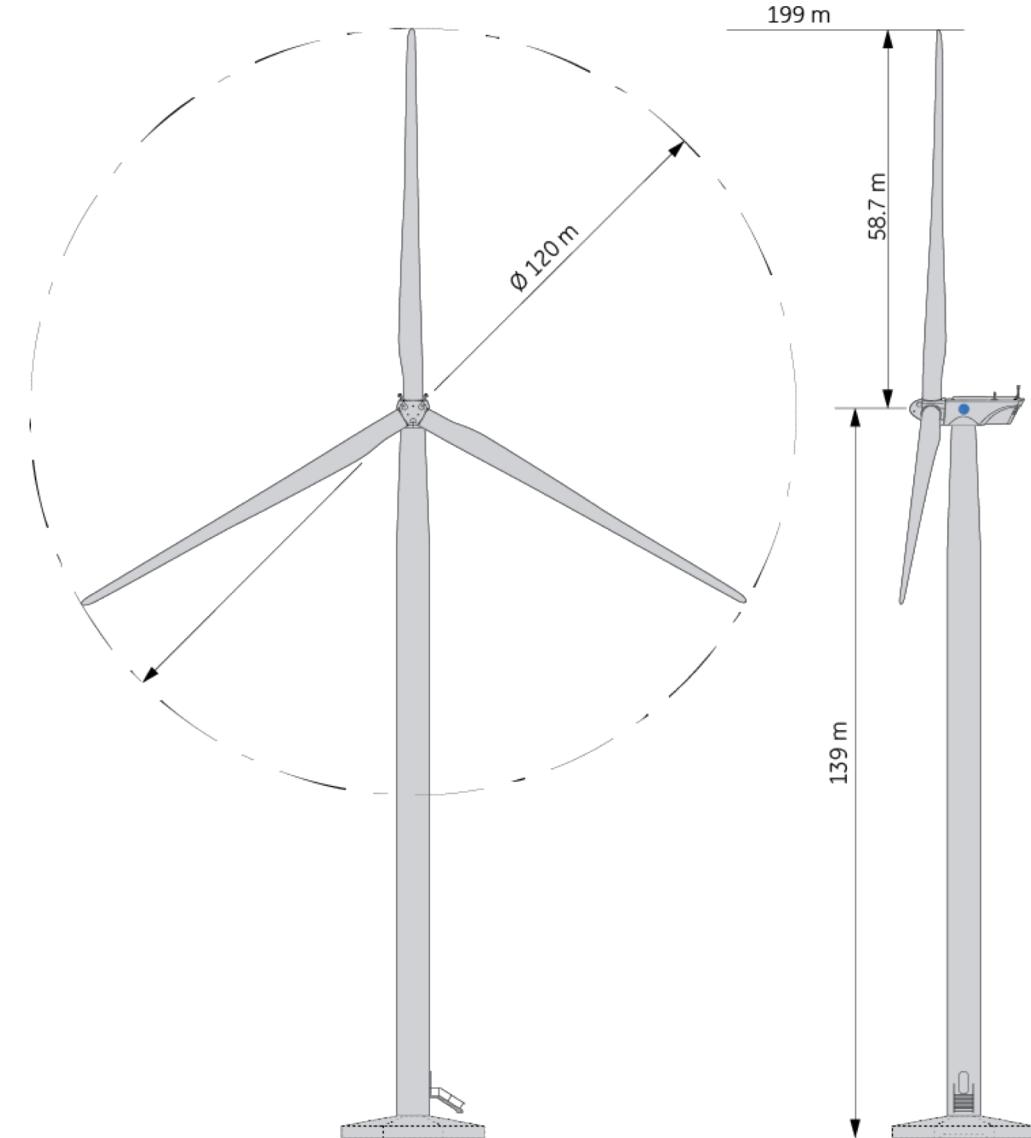
Source: regional transmission organization (RTO) PJM

Wind Turbine Theory

Wind turbine power output is a strong function with wind speed.

Blades sweep through rotor disk.

The power output is a function of the kinetic energy flux through the rotor disk and the efficiency of the design.



Technical Drawing of GE 2.75-120 wind turbine
Source: <https://www.ge.com/renewableenergy/wind-energy/turbines/275-120>

Wind Turbine Theory

Power = $\frac{1}{2} CpAV^3$, where:

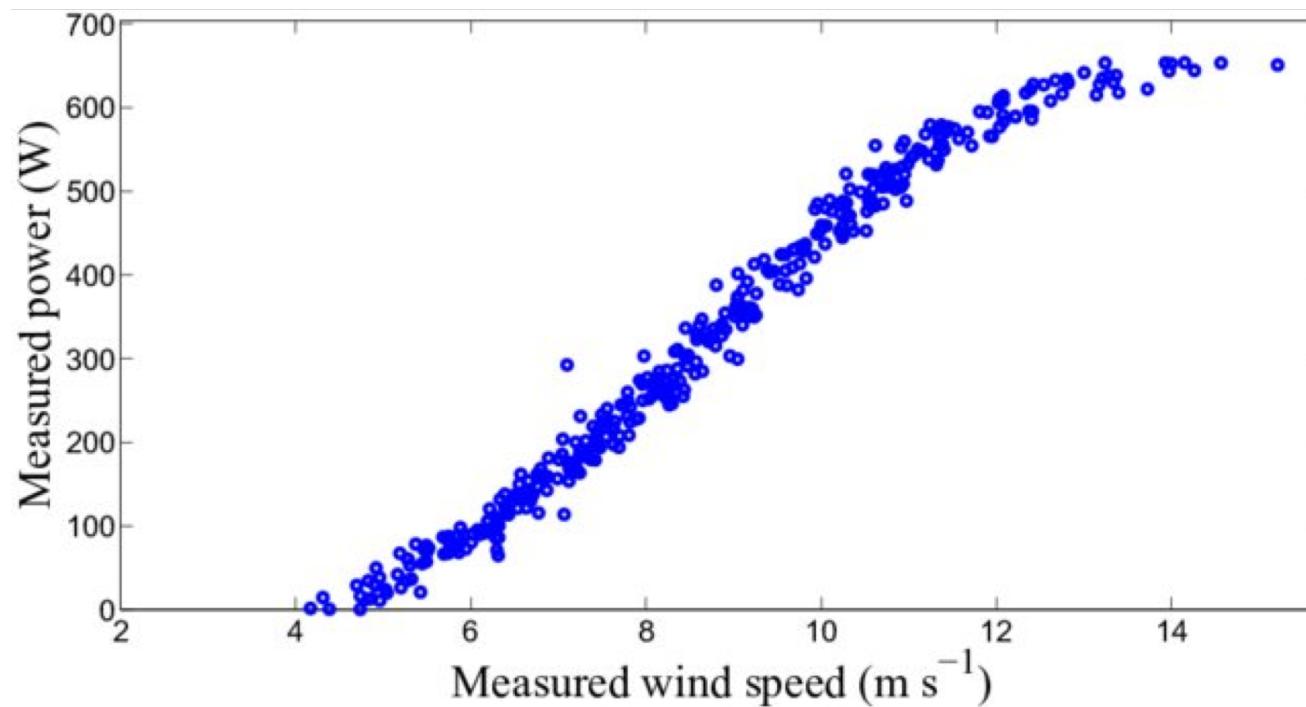
p = air density, C = coefficient of performance, A = rotor area, V = wind speed

Real wind turbine performance is a function of aerodynamics.

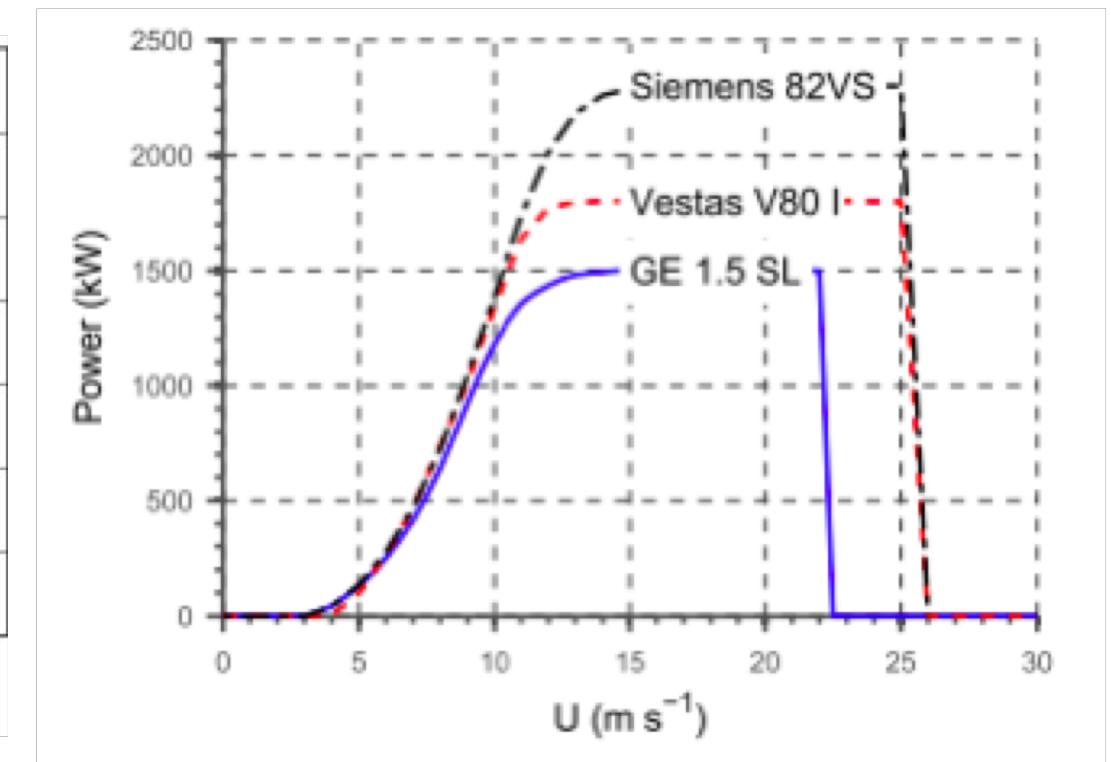
Power output is limited at generator rated power after the rated wind speed.

Wind turbine manufacturers measure their turbine's power curve.

Wind Turbine Performance



Measured power curve for a wind turbine
Source: [10.1016/j.renene.2015.10.014](https://doi.org/10.1016/j.renene.2015.10.014)
(Men et. al. 2016)



Power curves for different turbines
Source: Idaho National Laboratory (Seifert 2007)

Wind Data

Source: <http://www.sotaventogalicia.com/en/real-time-data/historical>



Wind Data

Galician Wind Farm for information, training and research.

Technical information:

- Number of wind turbines: 24
- Different models: 9
- Power rating of the wind farm: 17.56 MW
- Average annual generation: 33,364 MWh
- Prevailing winds: on the east-west axis
- Average wind speed at the site: 6.41 m/s

Overview

- Wind power forecasting through Machine Learning

