Storm 1.8 kW Prototype Wind Turbine Subcontractor Design Review

Small Wind Turbine Project

Principal Investigator: David Calley

Technical Monitor: Jim Green

Southwest Windpower

"Renewable Energy Made Simple"

Design Goals

Wide market appeal using the following design objectives

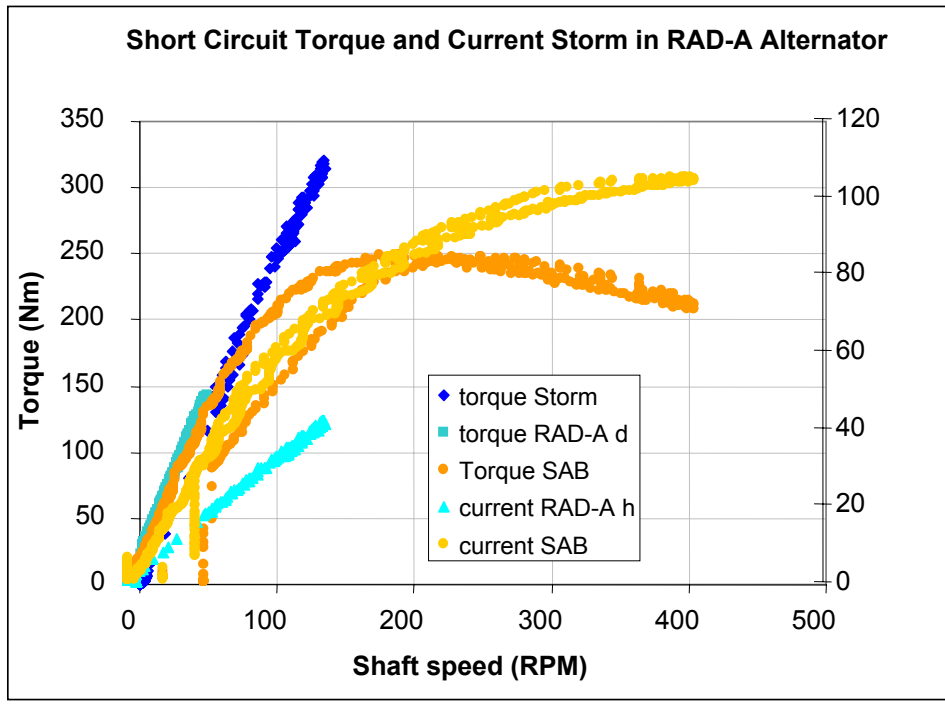
1. *Efficient low wind speed performance*
   - *Over 5000 kwh/year @ 5.4 m/s*
2. *Dramatically reduced installed system cost*
   - *High volume "appliance"manufacturing design*
   - *Under $3,000 installed cost*
   - *COE under national average without subsidy (5.4 m/s)*
3. *Quiet*
   - *Not noticed noise in urban environments*
4. *Conform to standard local zoning restrictions*
5. *Inoffensive, pleasant appearance*
6. *Very high volume manufacturing*

Monopole tower

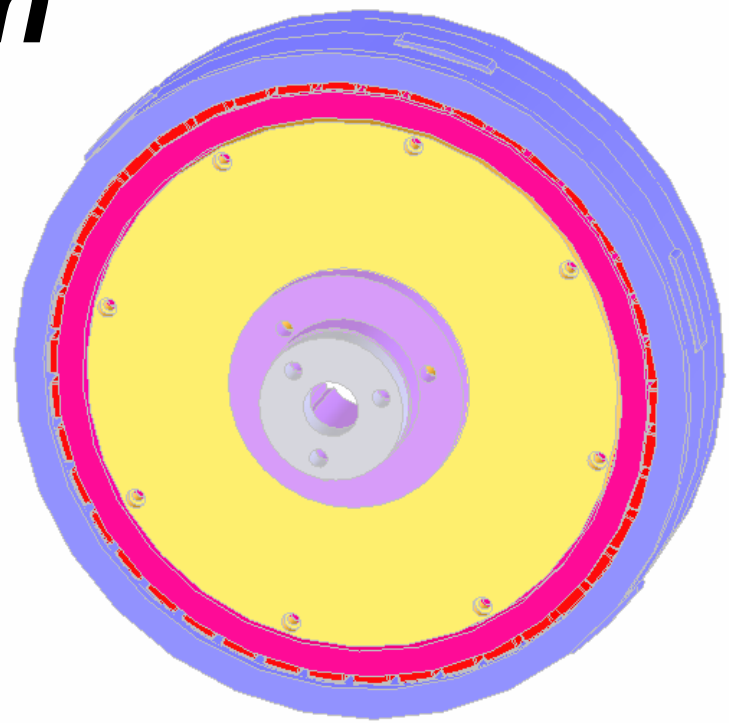
- *Tapered thin-wall steel pole*
- *10.6 meter hub height*
- *Small footprint*
- *Aesthetic and unobtrusive*
- *Well developed manufacturing and distribution*
- *Designed to fit into standard local zoning restrictions*
- *Quick and low cost installation*

Alternator Design Goals

- *Near zero startup torque*
- *High maximum (stall) torque*
- *High Efficiency*
- *Low Noise*
- *Ease of Manufacture*



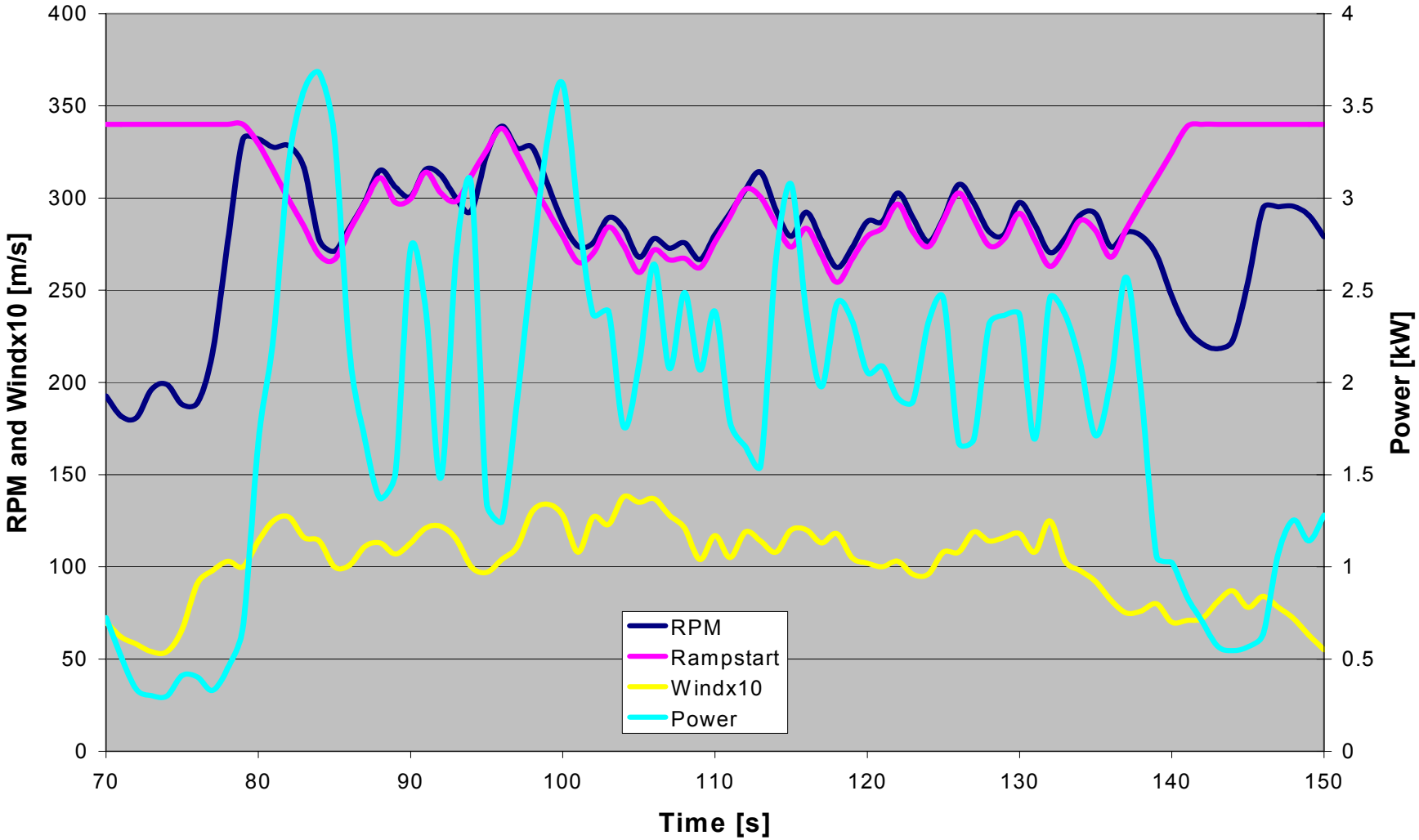
Storm Alternator Design



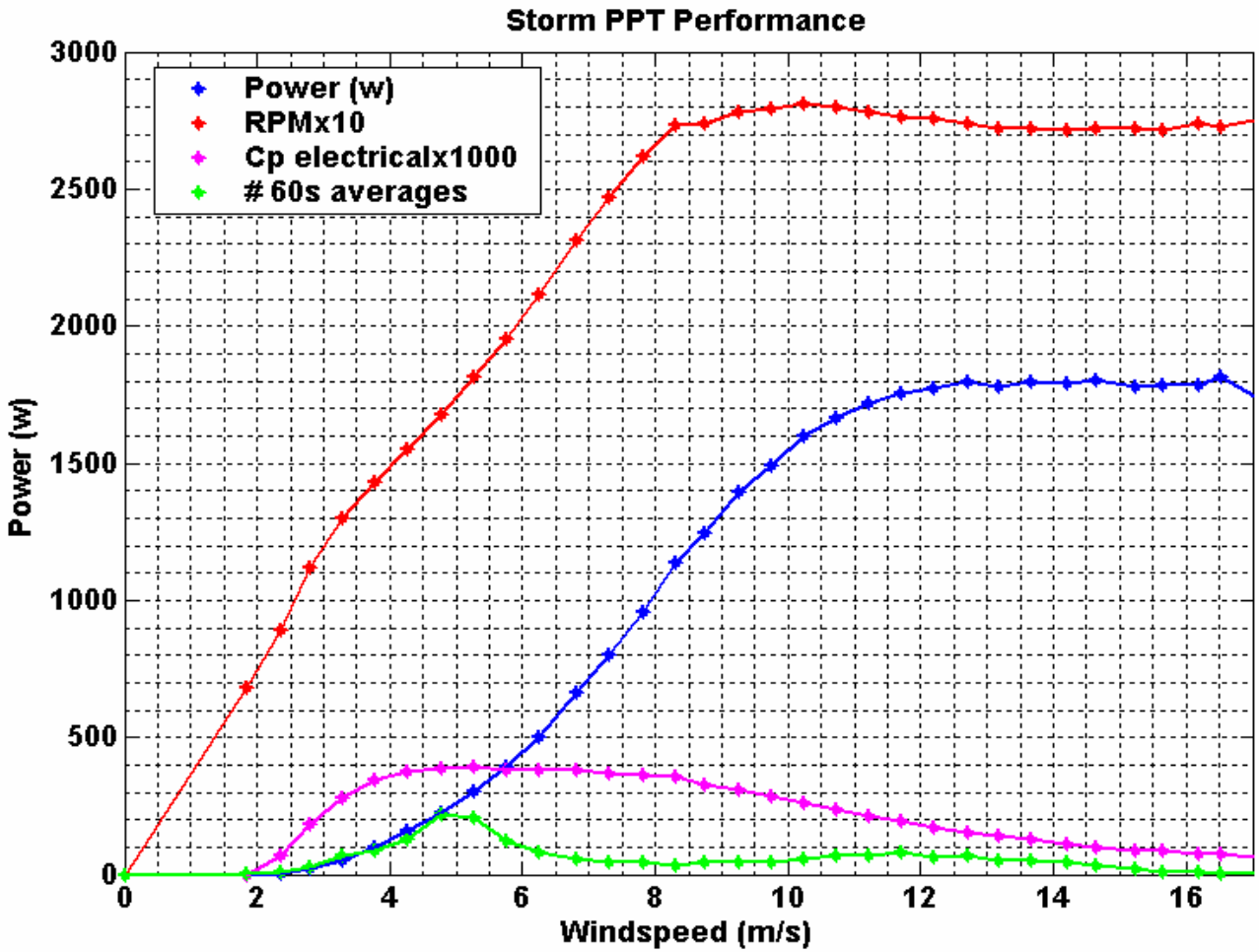
- *Configuration developed just for Storm,*
  - *Practical to produce in high volume*
  - *Essentially no starting torque*
  - *very high stall torque*
  - *Good efficiency*
  - *Slotless,*
  - *Encapsulated*

- *Vital Statistics:*
  - *Bore dimensions Ø358 mm by 62 mm stack length*
  - *42 pole rotor, 8mm thick magnets, 40 MGOe*
  - *Torque -so far too high for us to test*
  - *Voltage ~200 open circuit*

Stall control

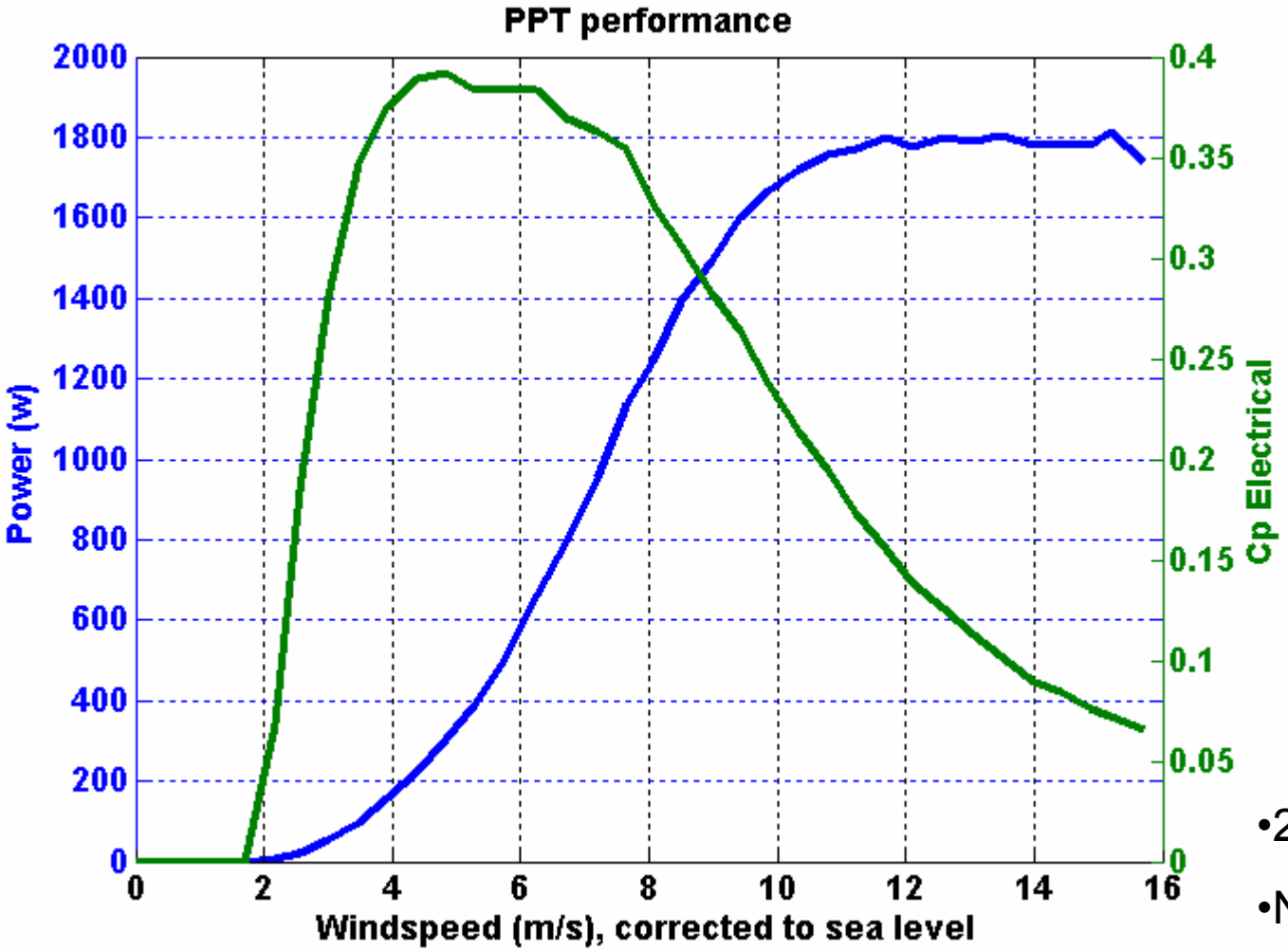


Power, efficiency and rpm



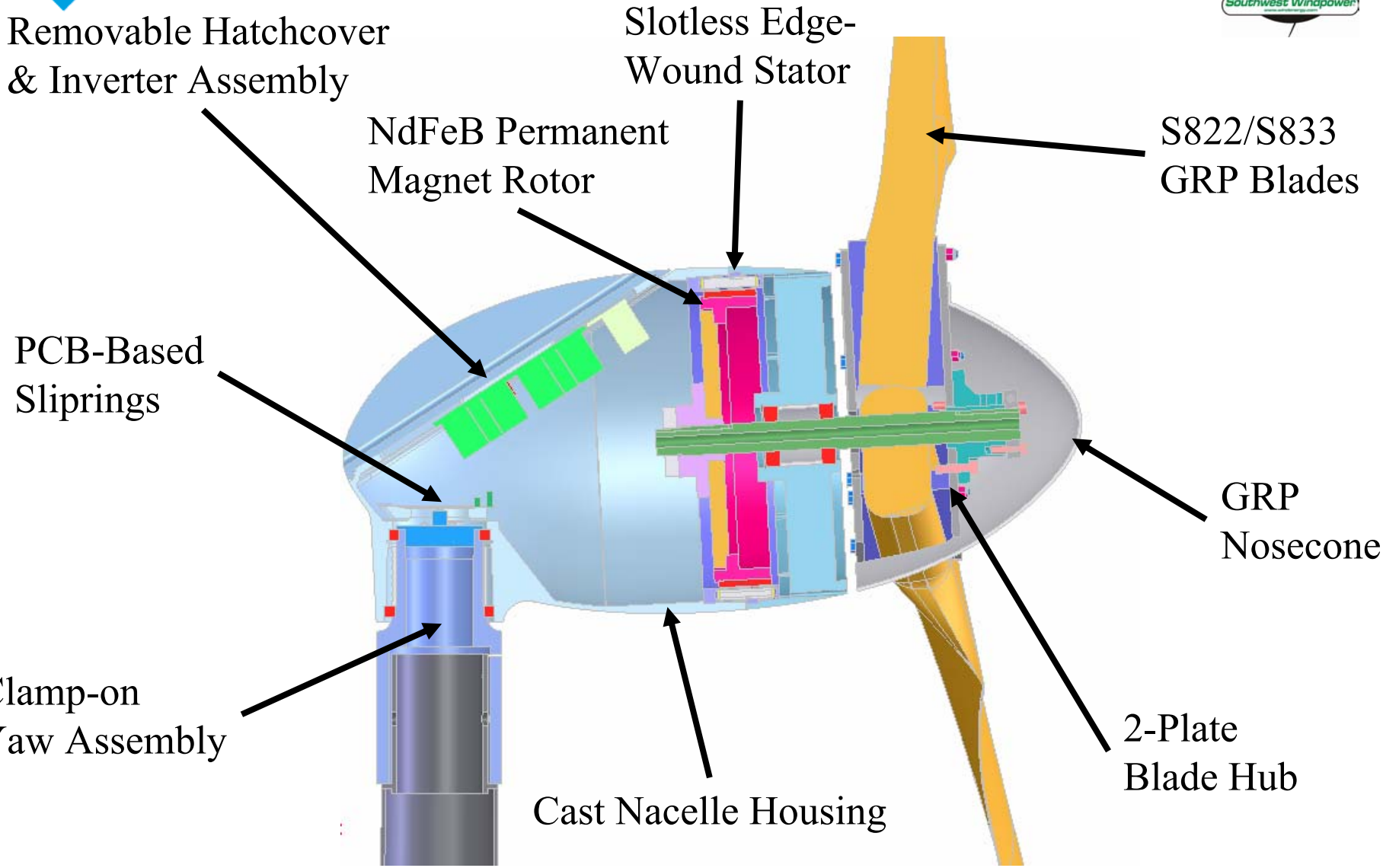
Uncorrected data at 6,800 ft

Corrected Data



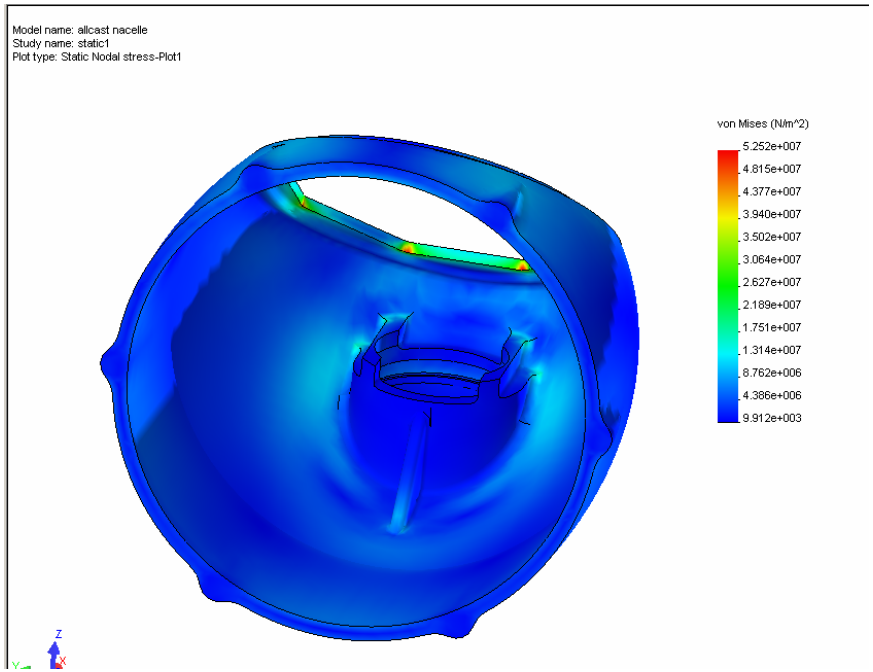
- 275 PRM max
- Near .4 net electrical Cp
- 145 m/sax tip speed
- Flat power at 1800 rpm

Construction



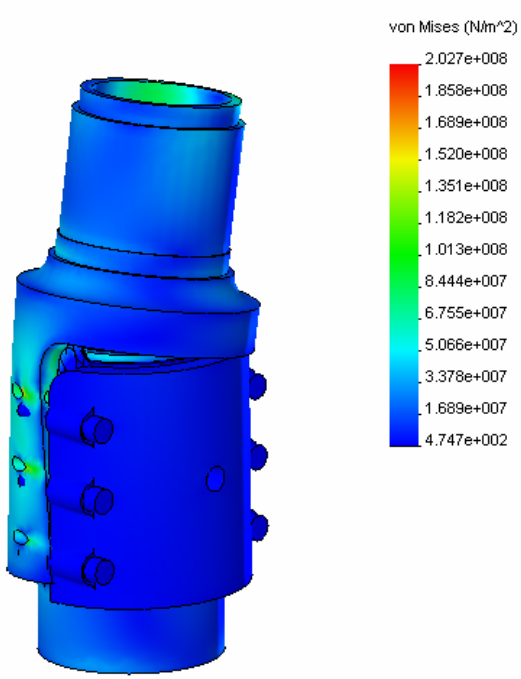
Nacelle

- *Designed for Die cast aluminum*
- *Excellent heat flow*
- *EMI shielding*
- *Sealed*



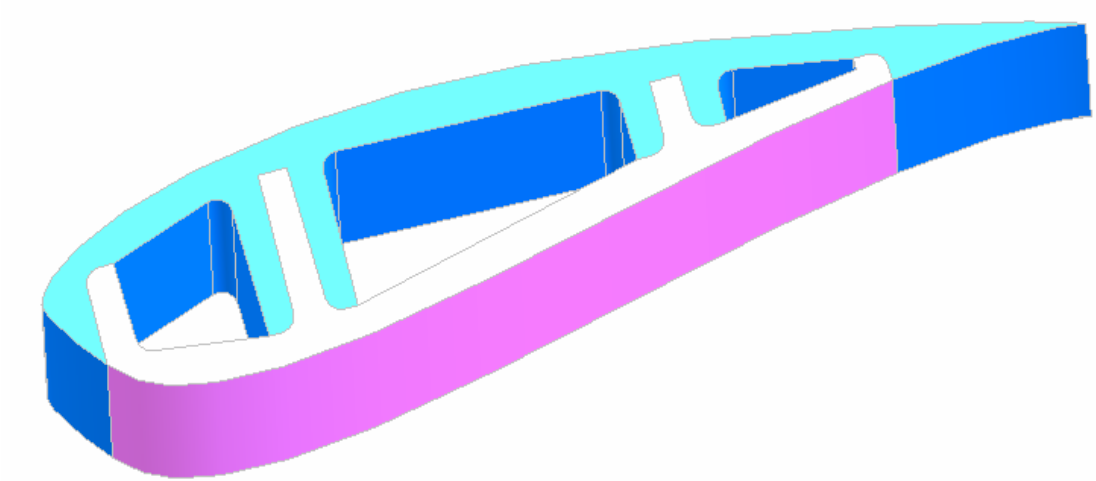
Yaw Assembly

- *Production design likely different*
- *Universal "AIR" style clamp*
- *Molded high volume production design*
- *Integrated sliprings*

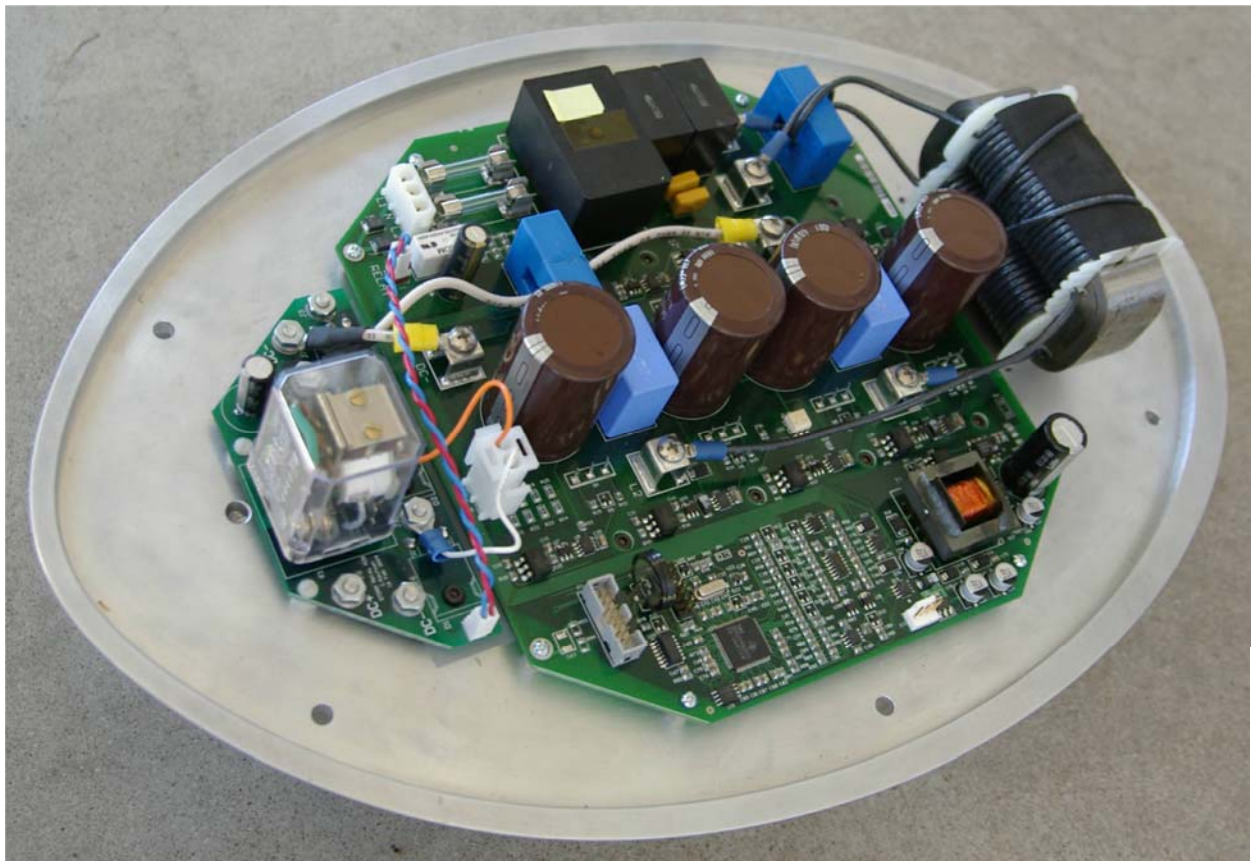


Blades

- *S822, S823 NREL airfoils*
- *Low noise and high performance*
- *Consistent quality, high volume production*
- *Prototype test units of fiberglass, production will be injection molded*
- *Multi-part injection mold blade*



Inverter



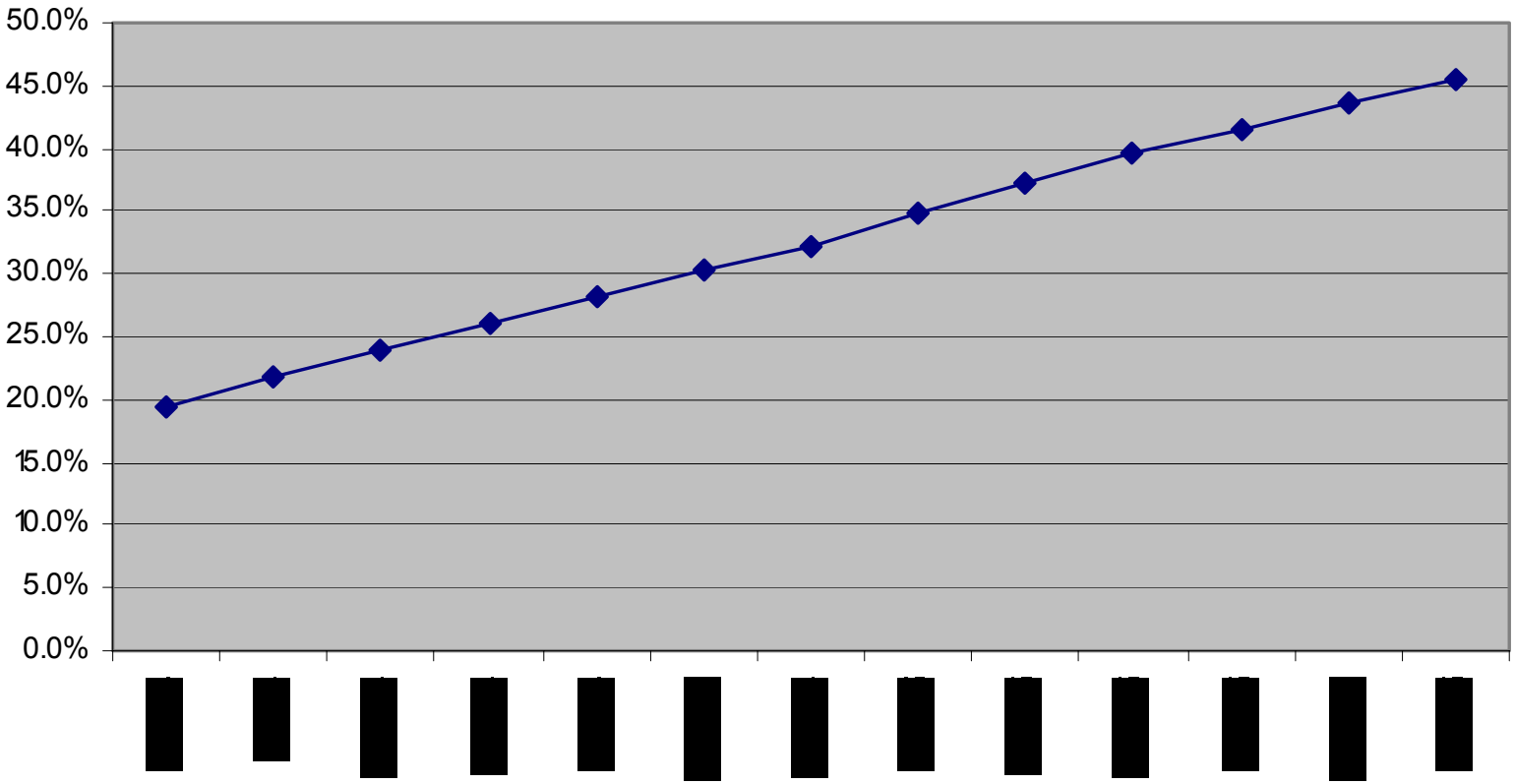
A few achievements of Storm development program

- *Stall control fully realized (originally developed for AIR-X)*
  - *No added cost*
  - *Quiet high wind speed operation*
  - *Leveling of power curve at desired level*
- *Rotor Cp of 0.46 on a small wind turbine*
- *COE looks competitive with conventional sources (new for a small wind turbine)*
- *Slotless, high efficiency wind turbine alternator*
- *Integrated Inverter*

Primary contract goals remaining

- *Inverter testing on prototype in field tests*
- *DF-20 and Certification*
- *Optimizing control algorithm in region 2*
- *Tower cost work*
- *Final manufacturing designs*
- *Manufacturing tooling*

Project cost share to finish project



Conclusion

- Much work remains to finish testing and final designs
- Much work remains to tool and begin production
- We plan to begin production shipments in 2005
- Deeply grateful for NREL's support and for the dedicated staff at Southwest Windpower

Work for Peace…