Introducing the Black Island HR1 Wind Turbine

Polar Technology Conference 2015
Denver, CO

March 24, 2015

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National Renewable Energy Laboratory PIX database
National Renewable Energy Laboratory staff

The HR3 Legend

Black Island, Antarctica

- One of the harshest wind turbine sites in the world

  Routine cat-5 hurricane winds

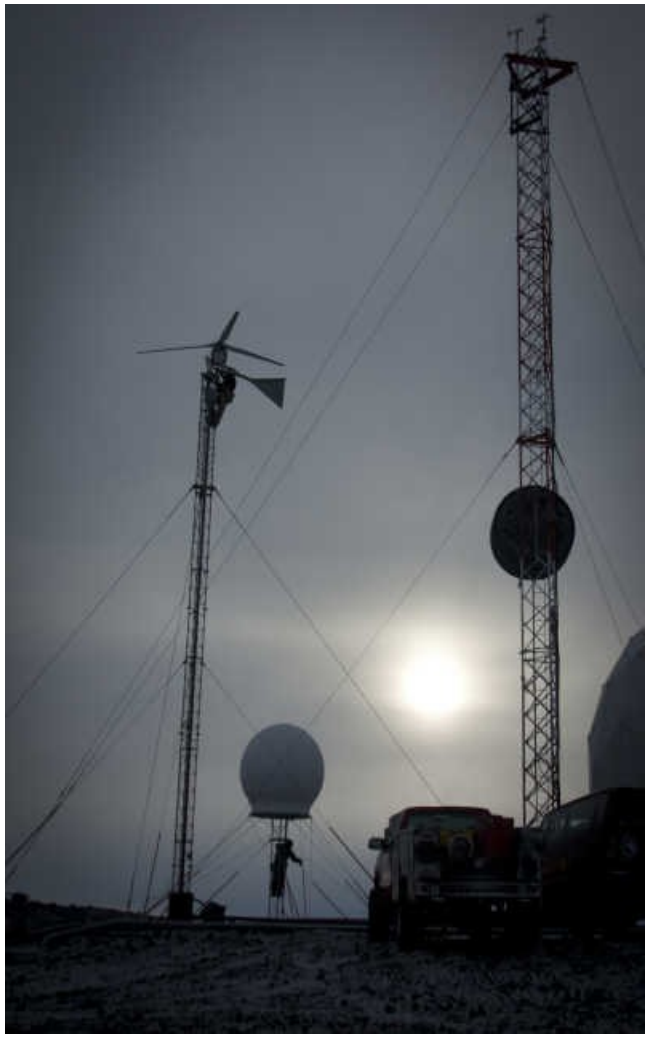
  197 mph maximum speed

  57 C° below zero

  Marine conditions

  Super-critical loads

The HR3 wind turbines at Black Island —running reliably for 27 years.



Black Island Wind Turbines LLC—Our Story

Formed in early 2012 by three wind energy veterans to reintroduce the HR-series of high-reliability turbines.

Purchased IP, drawings, tooling, vendor contacts, customer contacts, parts in 2011.

Phase I: technology updating and value-engineering.

Phase II: Engineering new technologies for far greater reliability and maintainability.

First customer contract– March 2012.

Developing a suite of HR*x*-series 1-10kW machines

Black Island's Management Team

Pat Quinlan, CEO

Former Associate Director of the U-Massachusetts Wind Energy Center.

•Former Senior Analyst at the National Renewable Energy Lab

- Former wind systems field engineer in California.
- Science Fellow in Congress for Chair of House Science Committee, and Technology Fellow in White House for President's Science Advisor.
- M.Sc., Mechanical Engineering, U-Wisconsin Solar Energy laboratory
- Professional Engineer, licensed in CA.

Bill Stein, CTO

Former Senior Research Fellow U-Massachusetts Wind Energy Center.

•Expert electrical systems engineer, CTO of Etesian Technologies LLC.

- Former chief technology officer at Astral Wilcon, small turbine manufacturer.
- Instrumentation engineer at Natural Power, and Yankee Environmental Systems.
- Formerly at MIT Fusion Energy Lab.
- Patents awarded and pending.
- M.Sc., Mechanical Engineering, U-Mass Wind Energy laboratory.

MassCEC Announces Winners of 2014 InnovateMass Program

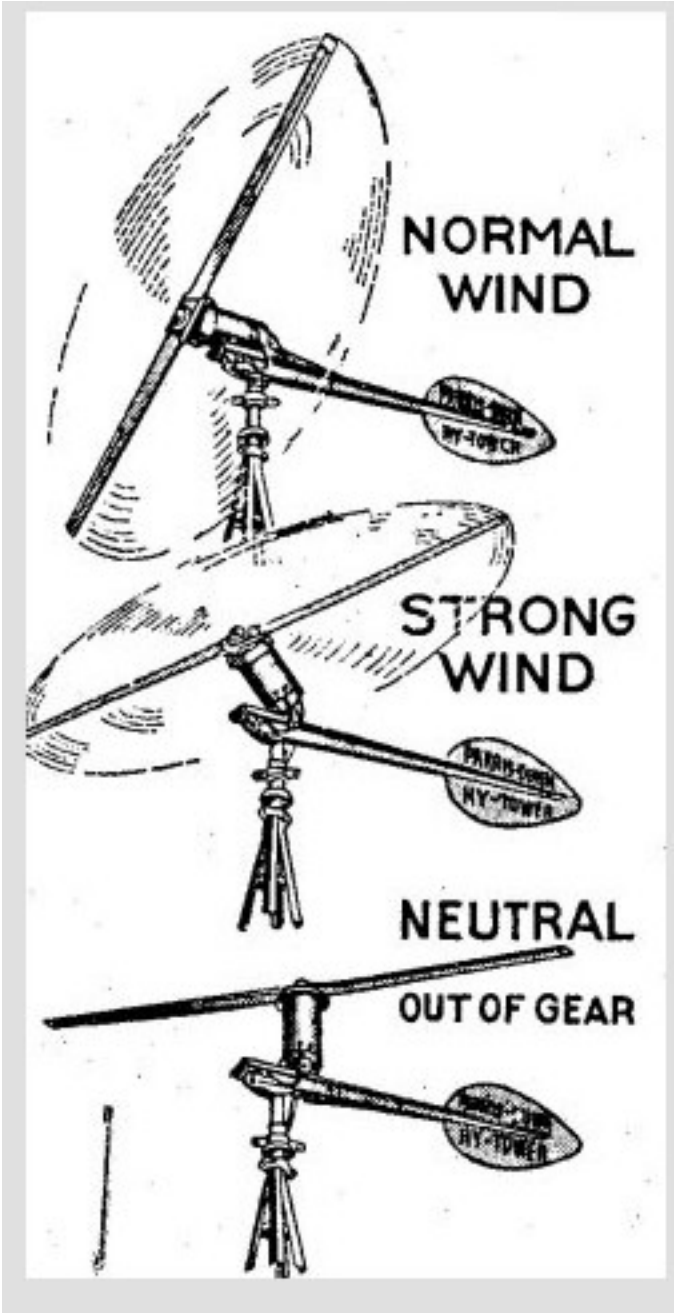
Media Inquiries
Catherine Williams (617) 315-9386 cwilliams@masscec.com
Matt Kakley (617) 315-9339 mkakley@masscec.com
Funding for new energy technologies draws $1.2M in additional investments

Apr 7, 2014 – BOSTON

Amherst-based Black Island Wind Turbines (with Applied Dynamics Corporation) – $150,000 (with a $75,000 match) to finalize the design of a highly-reliable small wind turbine for use in remote locations, military applications and areas that experience extremely high winds.

Design Principles

- Design survival wind speed - 200 mph - retain HR3 architecture
- Increase maintenance interval
- Simplify maintenance
- Where possible COTS components


NORMAL
WIND
STRONG
WIND
NEUTRAL
OUT OF GEAR

HR3 / HR1 Comparison Overview

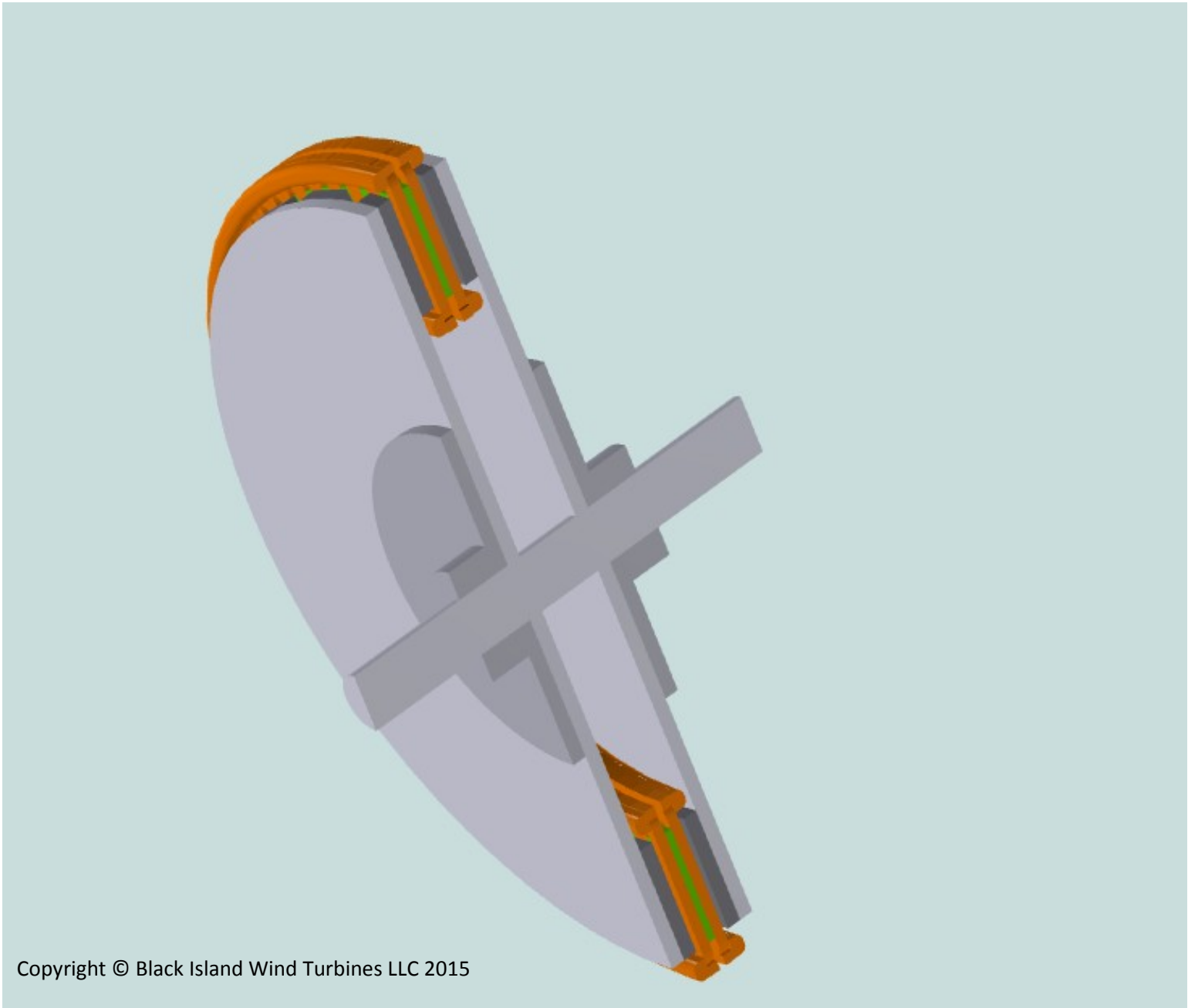
Specification	HR3	HR1
Rated Power	3 KW	1 KW
Annual Energy KW-h	6000 @ 13.7 mph	2260 @13.7 mph
Weight	785 Lbs	195 Lbs
Diameter	17.2 feet	9.7 feet
Generator Type	Wound Rotor Synchronous	PM Synchronous No Slip Rings !
Blade material	Laminated wood	Laminated wood
Control	Passive Pitch	Passive Pitch

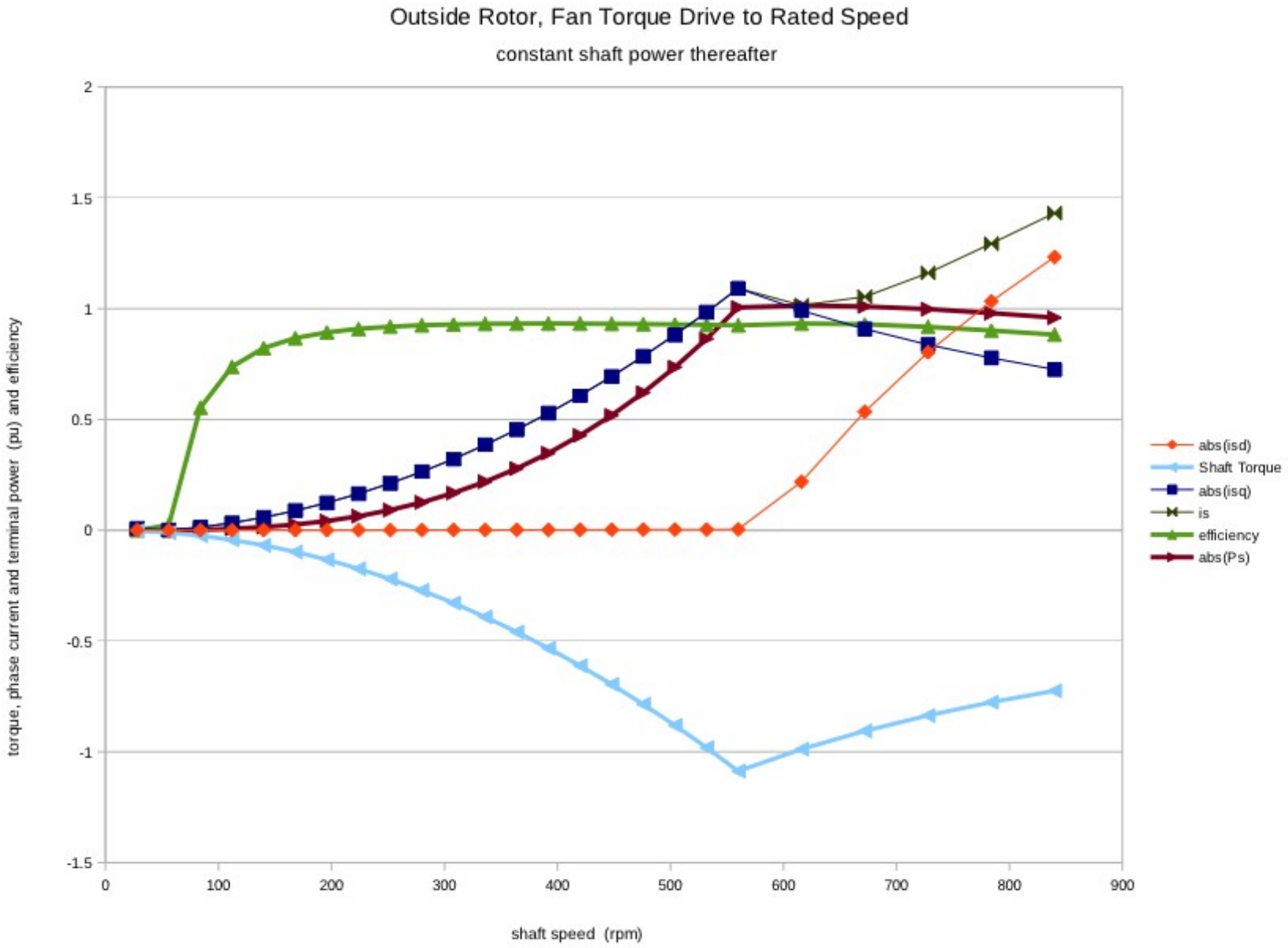
3D Turbine Model

Blade Features

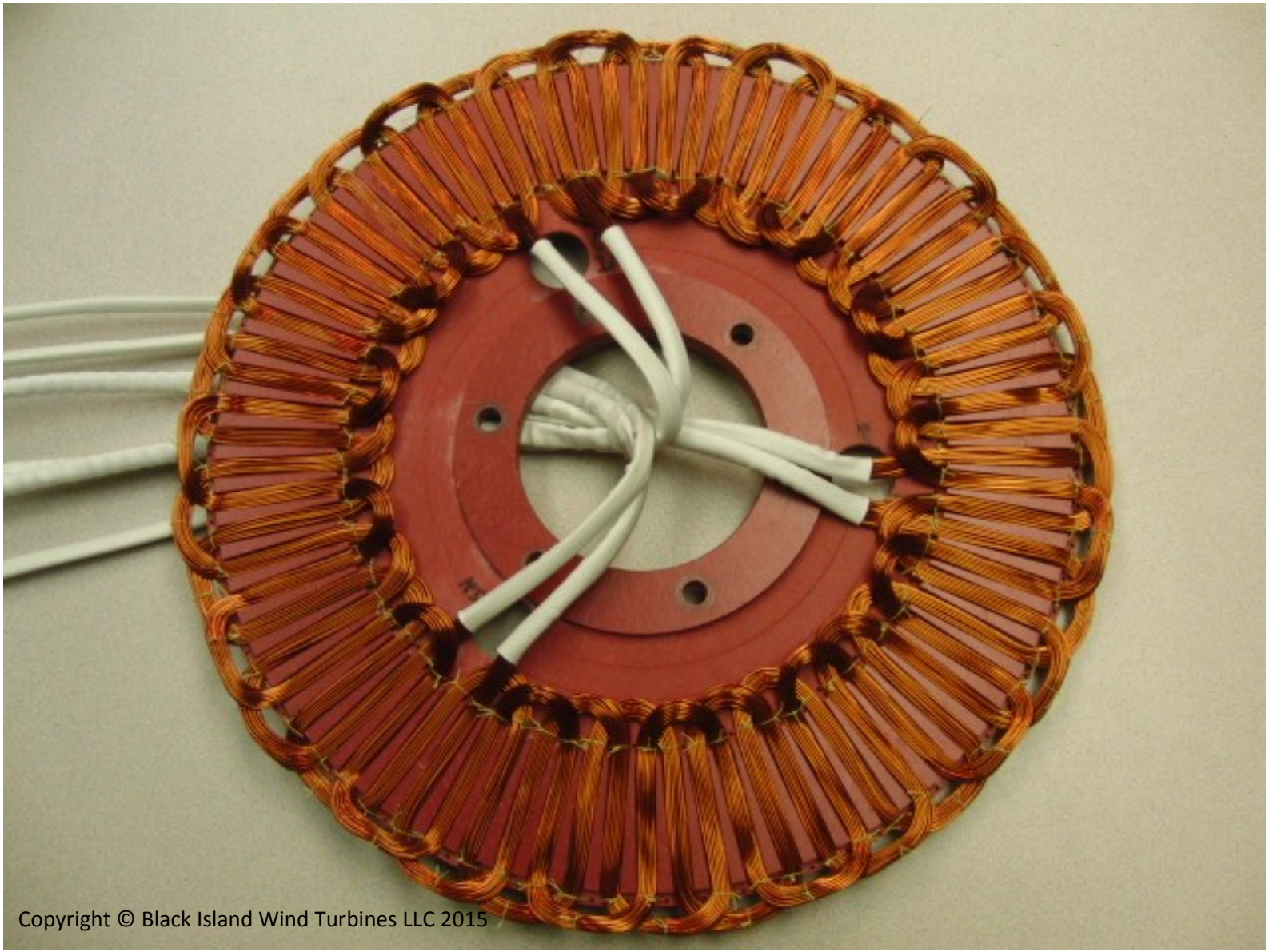
Same Manufacturing Technology as HR3 Blades
Optimum Aerodynamic Twist and Taper
Laminated Birch
6 lbs

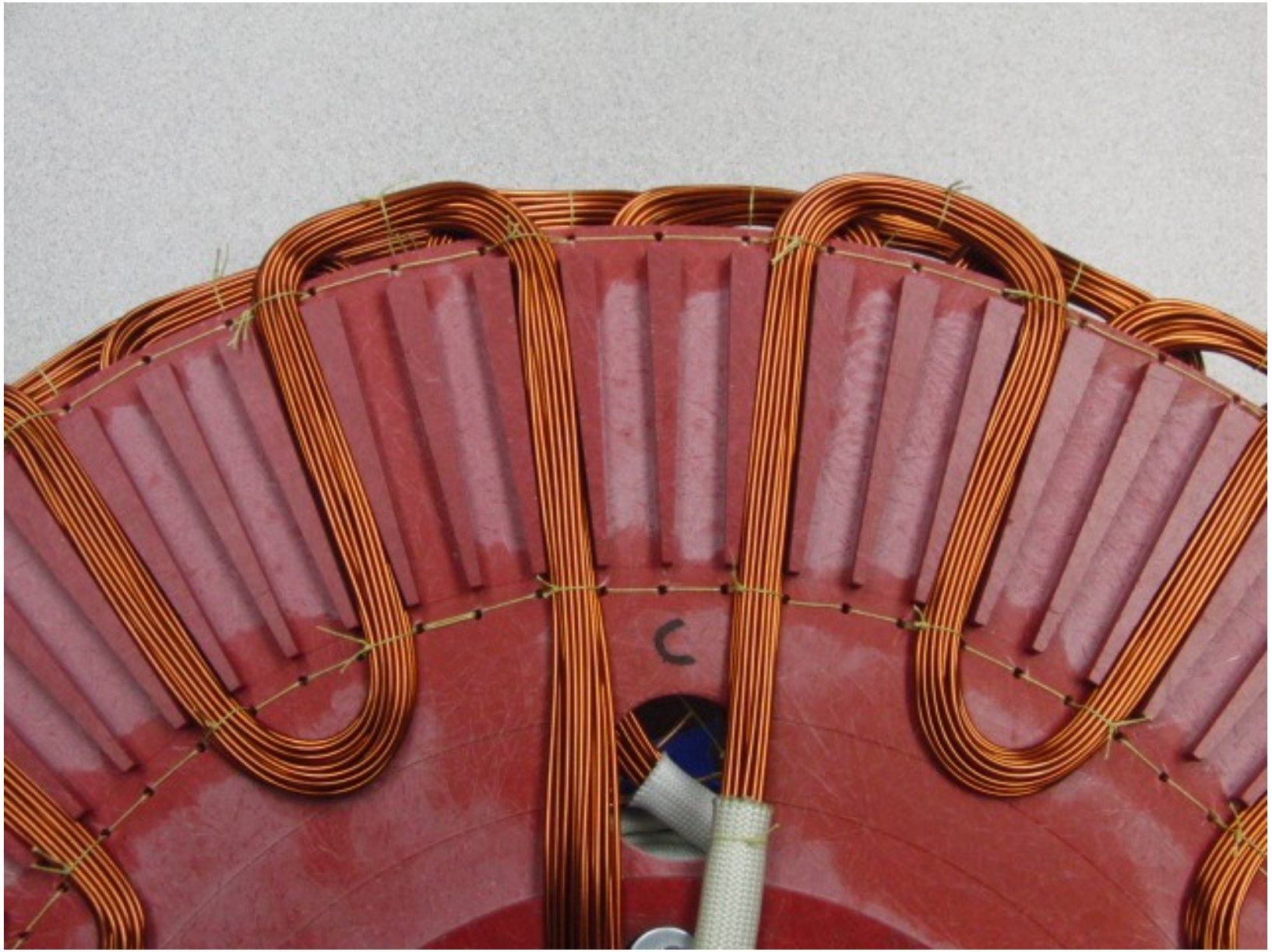
Generator Model Section View




Outside Rotor, Fan Torque Drive to Rated Speed
constant shaft power thereafter
torque, phase current and terminal power (pu) and efficiency
shaft speed (rpm)
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
100
200
300
400
500
600
700
800
900
abs(isd)
Shaft Torque
abs(isq)
is
efficiency
abs(Ps)

Generator Stator Winding





In Conclusion - Greatest invention since … well ever !

Key Features
- Preserved best features of the HR3
- Light Weight 200 Lbs
- Elimination of Generator Slip Rings

- Contract for 1 kW turbine commenced in July 2014
- Prototype construction about 75 % complete
- Anticipate truck testing to begin in late April
- In early discussions for siting of the prototype
- Need to locate a test site for longer term testing

Contact Information:
Bill Stein Black Island Wind Turbines LLC bill.stein@bi-wind.com

Raising a wind turbine – the fun way!