

BRI Cyclo-Turbine™ Power Generator

Boschma Research, Inc.*



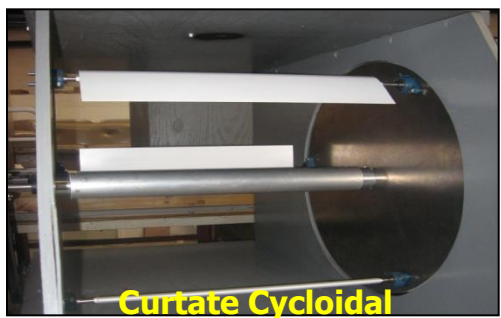
Pi-Pitch Turbine in Final Assembly



First Prototype



BRI Research Vessel



Curtate Cycloidal



BRI Wind Tunnel



Thrust Vector Test

*BRI is a Service Disabled Veteran Owned Small Business with facilities at Brownsboro, Alabama



Boschma Research, Inc. (BRI)

Founded in 2008 to exploit the efficiency advantages of Cycloidal Motion

Heavily armed Engineering team with SOLID WORKS in their holsters

Vast experience by team of technicians recently released from Turkish jails!

Supported by Investors, Contracts and Grants



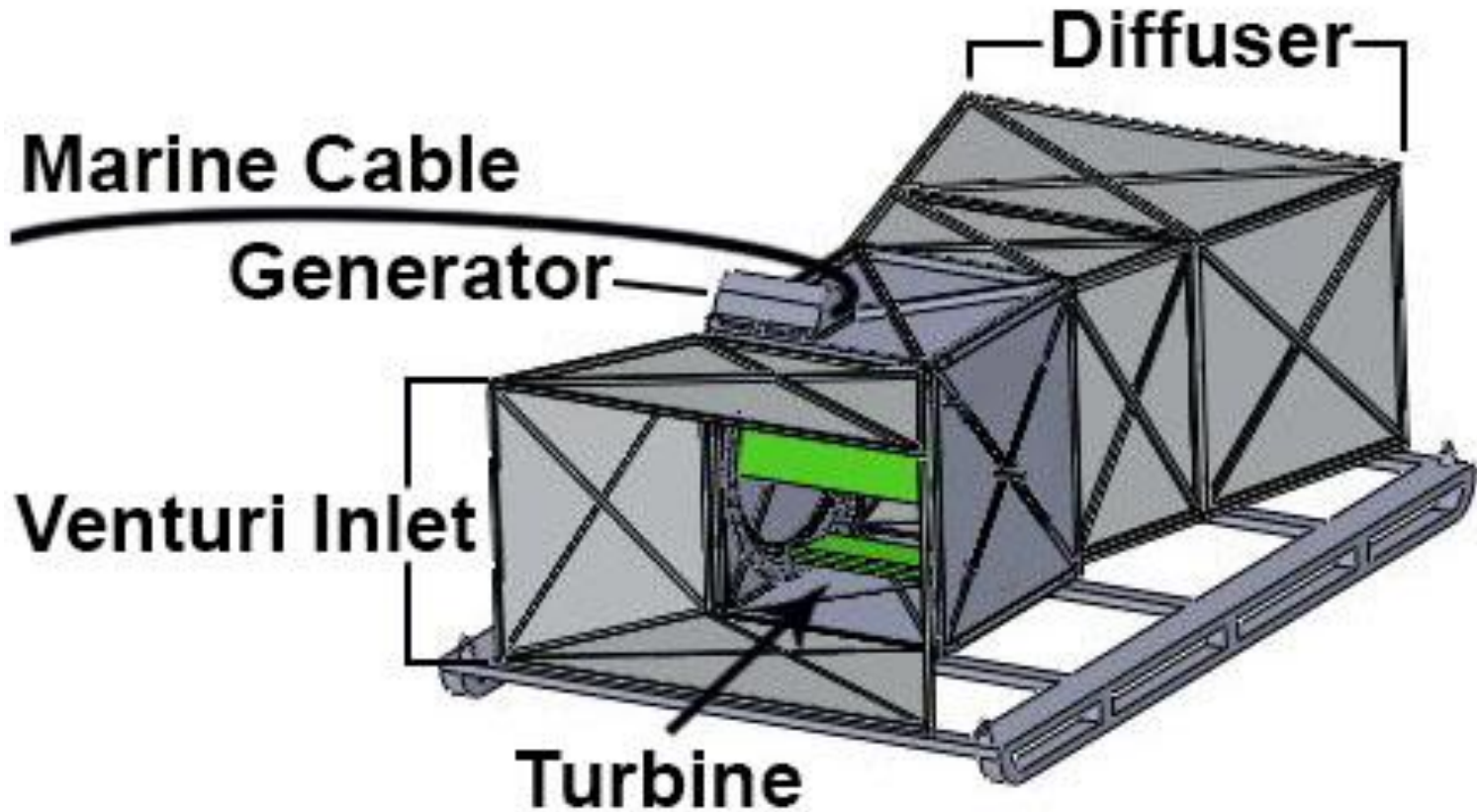
Background

A Navy propulsion research spinoff offers
a “Green” power production opportunity

Extracts energy by controlling blade angle to optimize lift
while minimizing drag

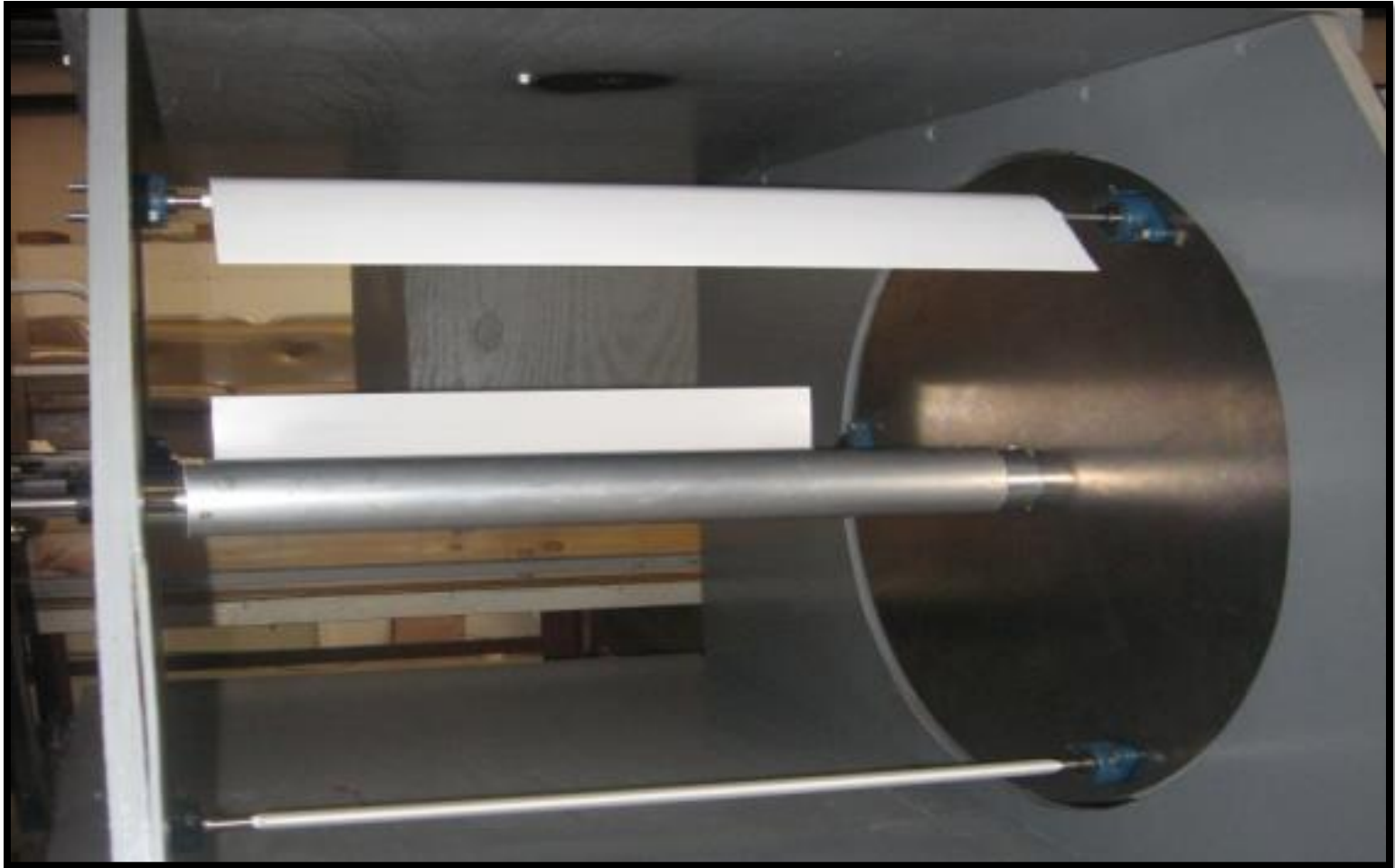
1st Proposal (FY2000) rejected due to policy at that time:
“WATER IS NOT A RENEWABLE RESOURCE”

Hydrokinetic Power Generation by BRI Cyclo-Turbines



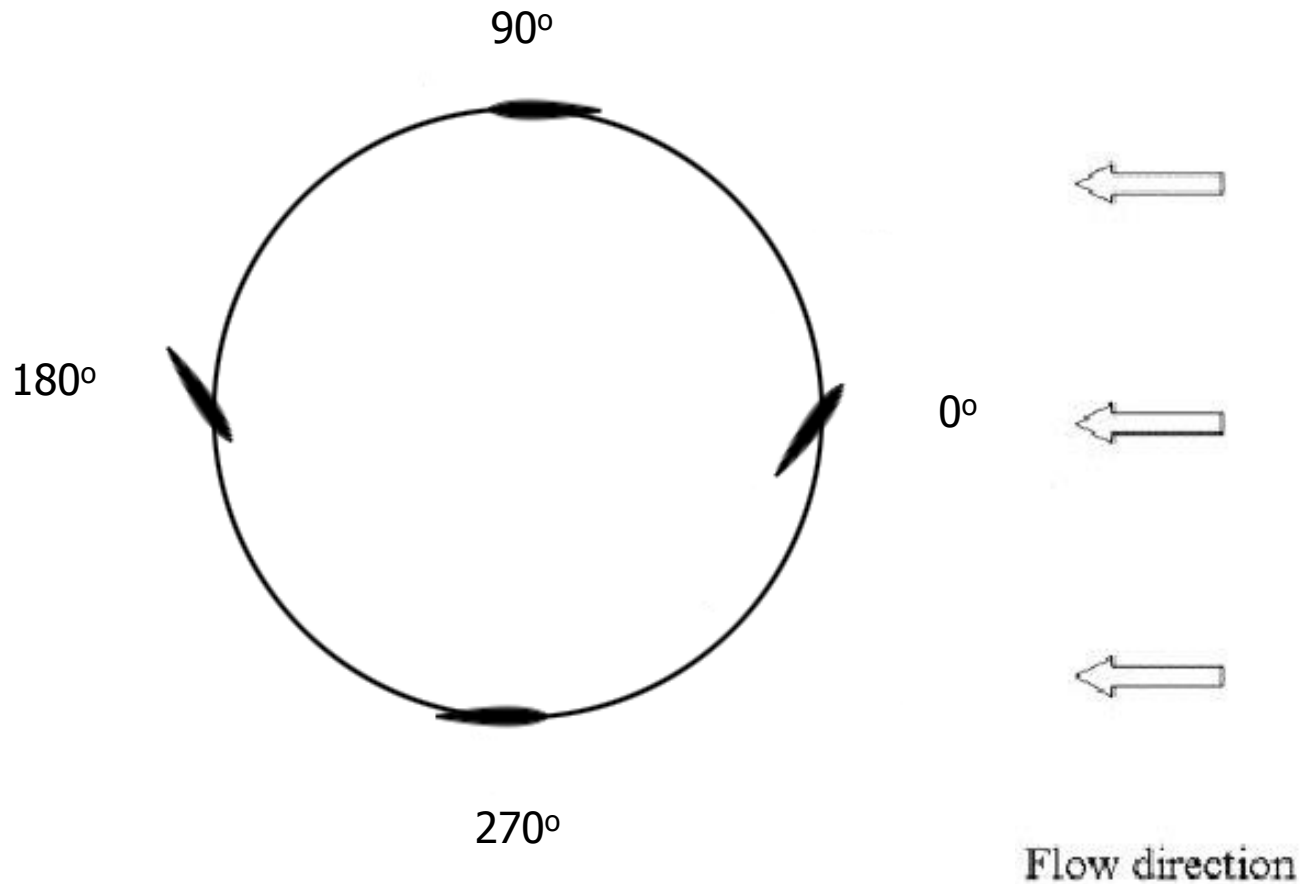
(Debris Guard and Floatation Not Shown)

Curtate Cycloidal Turbine



Curtate Cycloidal Motion

Blade angle of attack (AOA) continuously changes as the blades travel about their orbit.



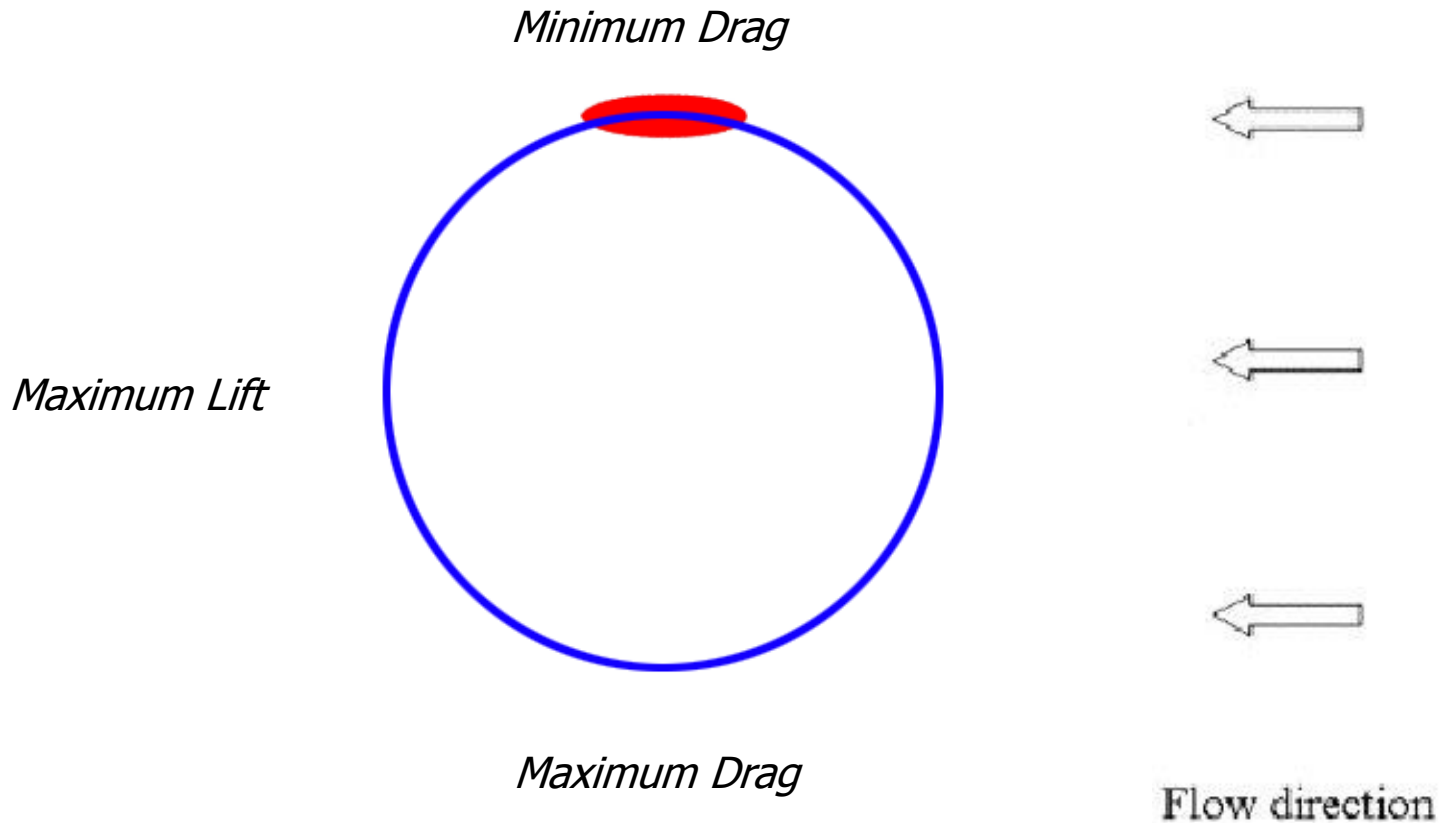
BRI Pi-Pitch Turbine in Final Assembly





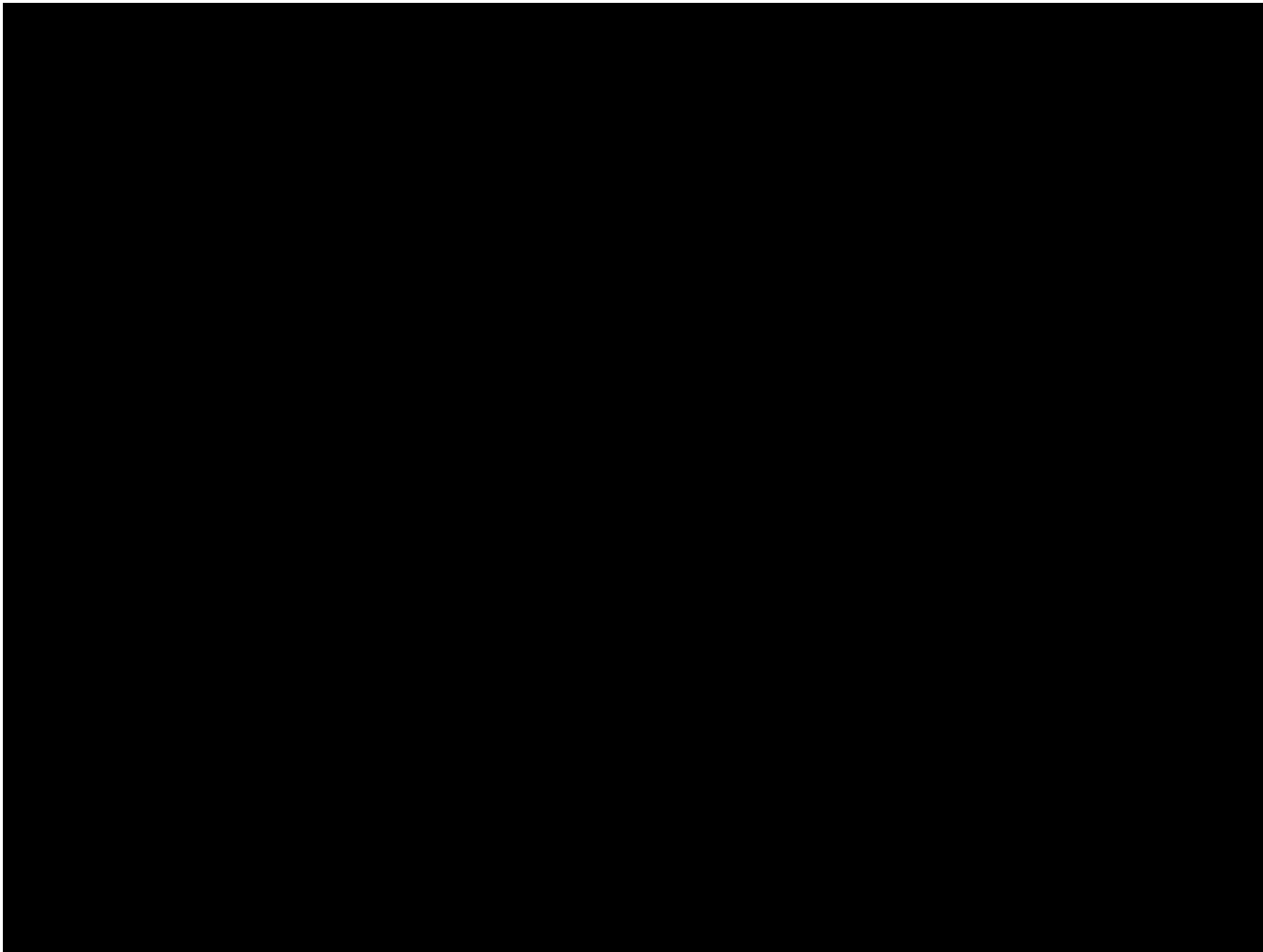
Pi-Pitch Cycloidal Motion

Flow direction insensitive. Effective during both rising and falling tides.
Needs ~10 inches of water. Self-starting at very low flow velocities.
Self-cleaning blades.





BRI Pi-Pitch Turbine in Final Assembly



Debris Guard and Fish Screen Test Fixture with Rotating "Kicker"



Tests in the Flint River showed excellent performance in rejecting multiple types of debris.

Venturi for Flow Acceleration

Venturi flow accelerator increases flow rate at the turbine
($E_k = \frac{1}{2} \rho_w V^2$).



Instrumented Test Platform

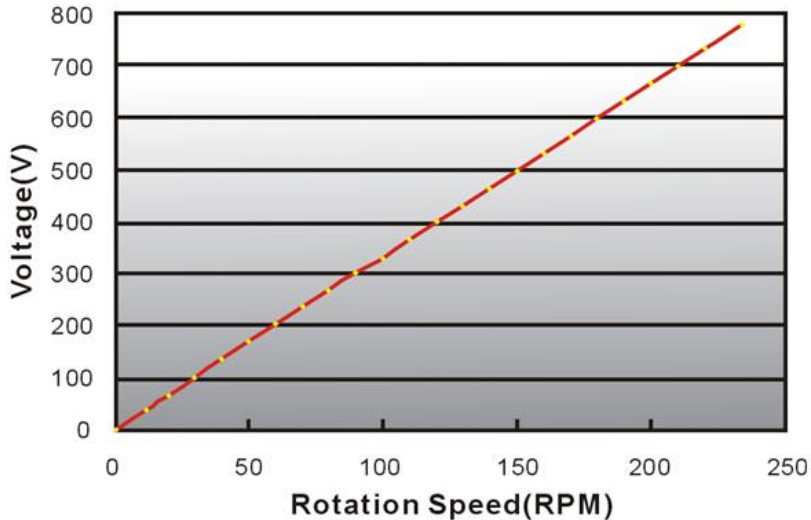


28' Pontoon Boat
Turbine Elevator
2-Point Flow Velocity Torque Meter &
RPM Counter
Computer "Room"
Four 3000lb Winch Corner Lifts
Onboard Aux Generator
Power Meter w/Data Logger &
Generator Temperature
Computer Data Collection
Storm Anchor

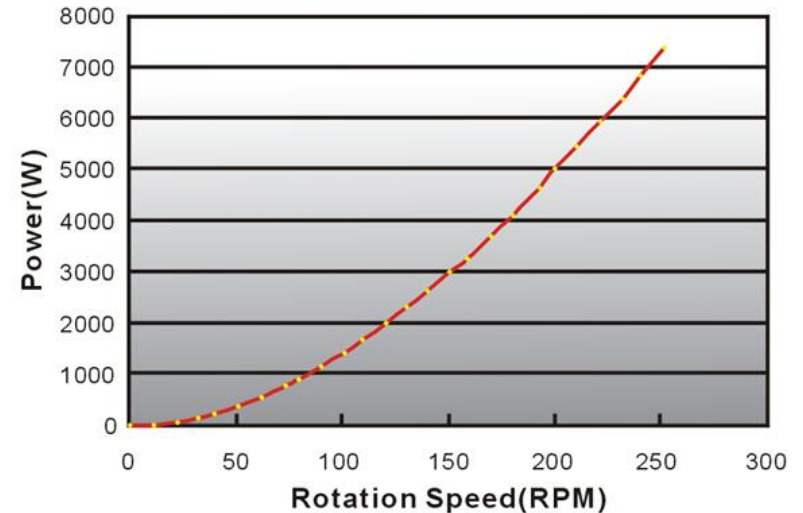
Elevator Down, Data Collect Underway

5kW PM Generator for Igiugig

GL-PMG-5000 PMG Open Circuit Voltage



GL-PMG-5000 PMG Power Curve



Rated rotation speed: 200 RPM
Weight: 130 kg
3-phase star connected AC output
Rectified DC output option
Starting torque: 3.5 NM (2.6 ft lbs)
Torque at rated power: 269 NM (198 ft lbs)



Grid Tie System on Test Stand at BRI

Left to right: AC Safety Switch, AC-DC Converter, Inverters w/transformers, Emergency Cutoff Switch



480/277-Y 3-Phase Grid Tie

Igiugig

December 2008



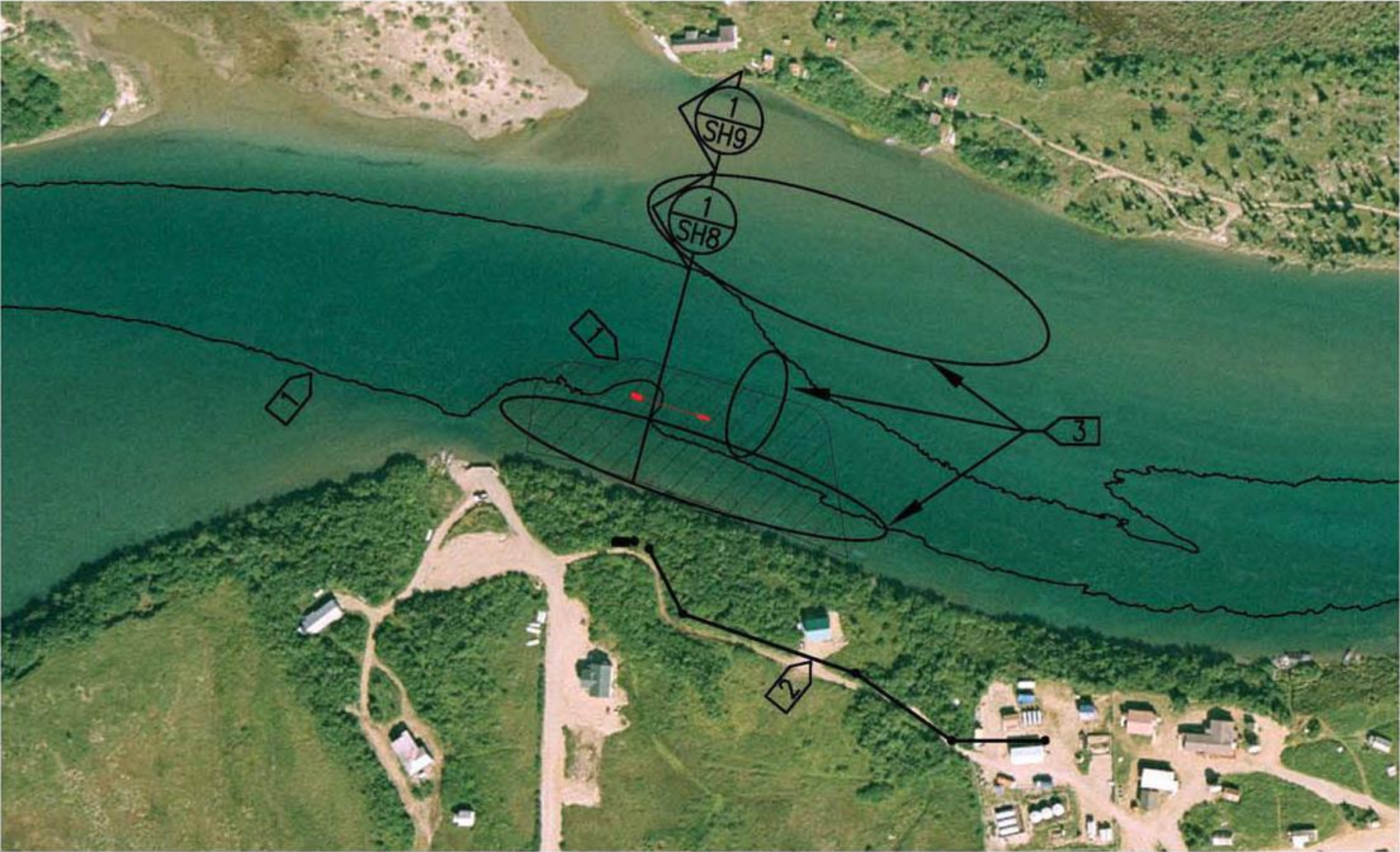
First Visit to Igiugig at the Village Chiefs' Request

Igiugig Village at the Kvichak River

Population 62



Igiugig Proposed Installation Site





BRI 2013 Status

BRI developed *Curtate* and *Pi-pitch* blade motion turbines for river, waste water and tidal applications.

Under contract with the Alaska Energy Authority for deployment of Curtate 5kW unit at Igiugig, Alaska.

Well received marketing activities underway to obtain contracts for waste water energy recovery.

System Technical Improvements: Computer-controlled blade angle, active debris guard, automatic emergency shutdown, and DC-3 aircraft transportable.

The Dollars and Cents of It

Small Hydro = lowest production cost, highest ROI

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2009 \$/megawatthour) for Plants Entering Service in 2016				
		Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	65.3	3.9	24.3	1.2	94.8
Advanced Coal	85	74.6	7.9	25.7	1.2	109.4
Advanced Coal with CCS	85	92.7	9.2	33.1	1.2	136.2
Natural Gas-fired						
Conventional Combined Cycle	87	17.5	1.9	45.6	1.2	66.1
Advanced Combined Cycle	87	17.9	1.9	42.1	1.2	63.1
Advanced CC with CCS	87	34.6	3.9	49.6	1.2	89.3
Conventional Combustion Turbine	30	45.8	3.7	71.5	3.5	124.5
Advanced Combustion Turbine	30	31.6	5.5	62.9	3.5	103.5
Advanced Nuclear	90	90.1	11.1	11.7	1.0	113.9
Wind	34	83.9	9.6	0.0	3.5	97.0
Wind – Offshore	34	209.3	28.1	0.0	5.9	243.2
Solar PV ¹	25	194.6	12.1	0.0	4.0	210.7
Solar Thermal	18	259.4	46.6	0.0	5.8	311.8
Geothermal	92	79.3	11.9	9.5	1.0	101.7
Biomass	83	55.3	13.7	42.3	1.3	112.5
Hydro	52	74.5	3.8	6.3	1.9	86.4

‘Gray’ technologies have pollution footprint.

‘Blue’ technologies are pollution free.

¹ Costs are expressed in terms of net AC power available to the grid for the installed capacity.

Source: Energy Information Administration, Annual Energy Outlook 2011, December 2010, DOE/EIA-0383(2010)



Projected Cost of Waste Water Operations

We estimate the levelized cost for Waste Water Operations at \$55 per MegaWatt hour

Why so Low: No debris, flow controlled, no silt, maintenance crew always onsite, ease of extraction and installation.

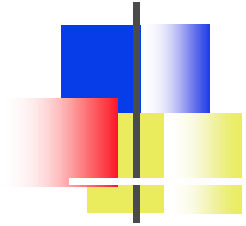
Fast Return On Investment (ROI)



Summary



- BRI Cyclo-Turbine™ offers efficient water-to-power conversion in flowing water, deep or shallow.
- Very broad market includes both developed and developing nations.
- System breaks down for DC-3 transport to deploy to remote areas worldwide.
- Return on Investment is large, and occurs sooner.
- Growth path holds promise for substantial performance gains and increased ROI.



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Service Disabled Veteran Owned Small Business (SDVOSB)

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