



**VERDANT POWER**

# **Hydrokinetic Technologies Technical & Environmental Issues Workshop**

**Technology Class: Axial-flow Turbines**

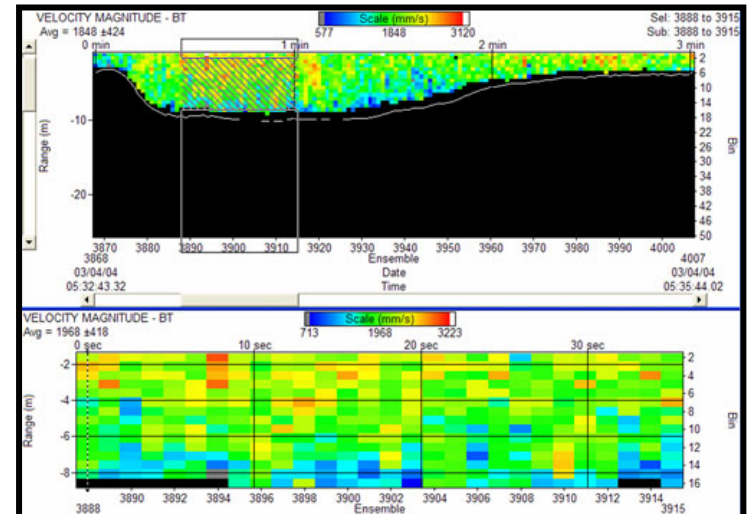
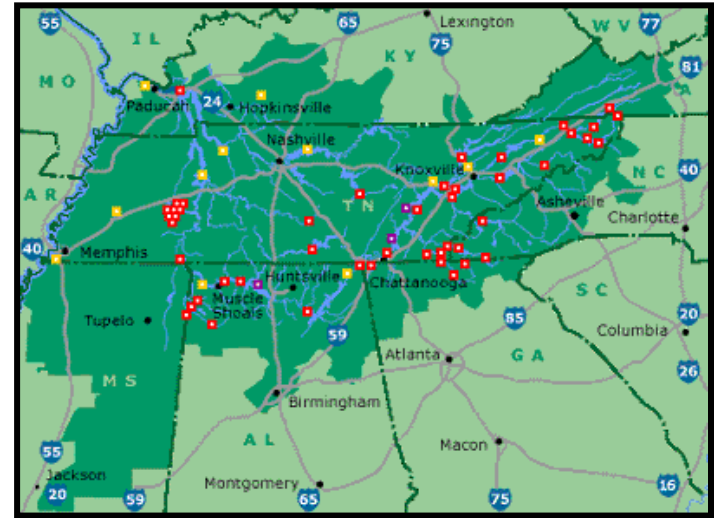
October 26, 2005



# Verdant Power LLC

## Systems Integrator & Developer

- Founded 2000: 25 Employees - CA, NY, DC
- PEs, PhDs, MBAs, Scientists
- Energy & Business Experience
- Leadership
  - Ocean Renewable Energy Coalition
  - National Hydropower Association
  - Hydro Research Foundation
- Assessments
  - TVA & Brazil
  - New York & California
- EPRI TAG Reports – Instream
- Two of Five Primary Families
  - Cross-flow or Cross-axis Turbines
  - Axial-flow Turbines (inc, ducted)





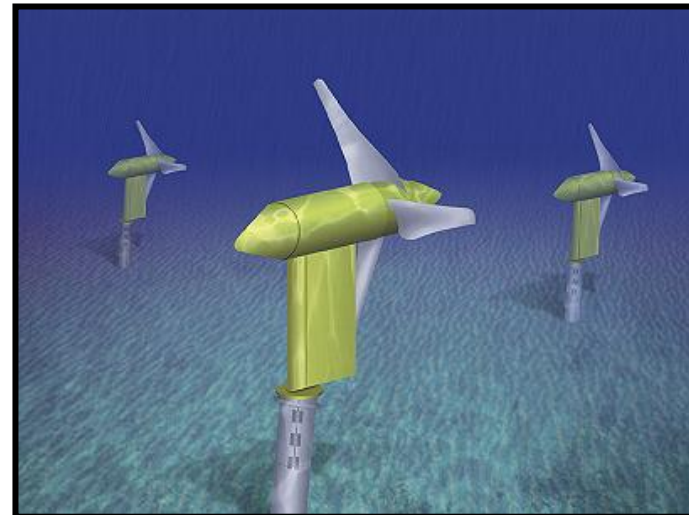
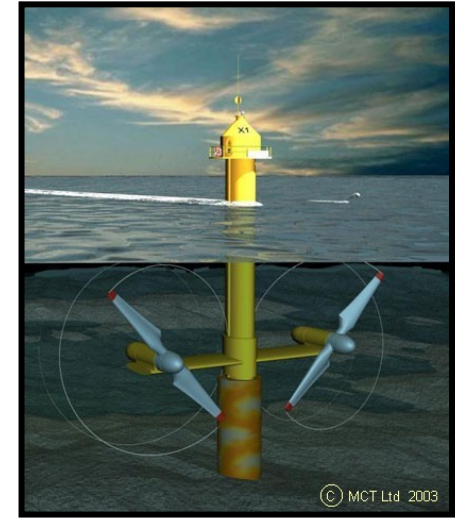
# Description: Axial-flow Turbines - Norway



# Description:

## Axial-flow Turbines - US & Britain

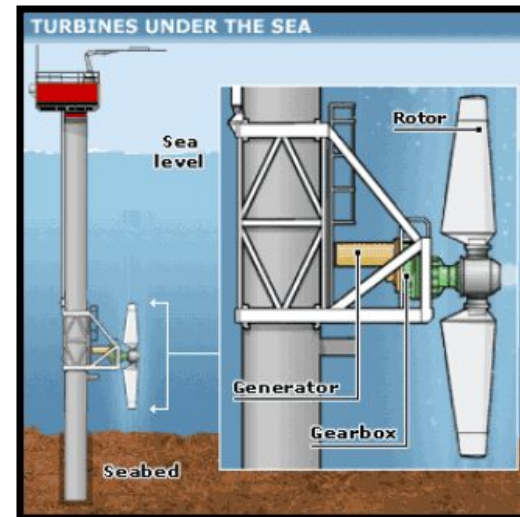
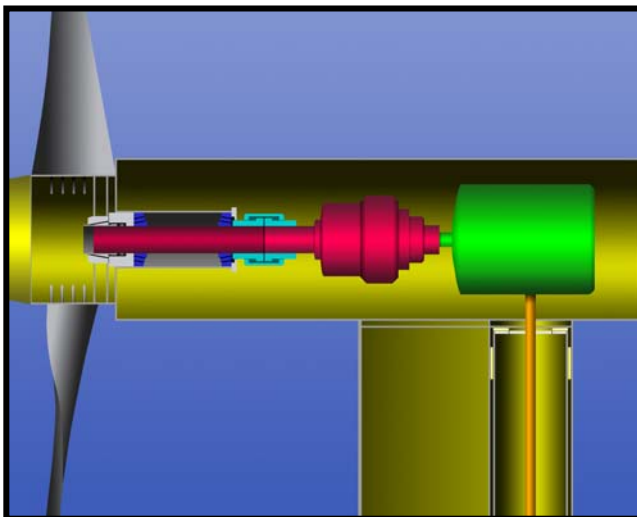
- Horizontal axis  
(driveshaft parallel to water bottom)
- Multi-bladed rotor
- Water current driven
- Uni- or bi-directional
- Similar to wind turbines
- Internal generators
- Internal gearing
- Others - Canada







# Axial-flow Turbines: Verdant & Marine Current Turbines





# Applicable Resource Areas: Instream Generation

- Tidal Straits & Estuaries
- Rivers
- Ocean Currents
- Manmade Channels
  - Canals
  - Aqueducts
  - By-pass Channels
  - Discharge Flumes
  - Head & Tailwaters





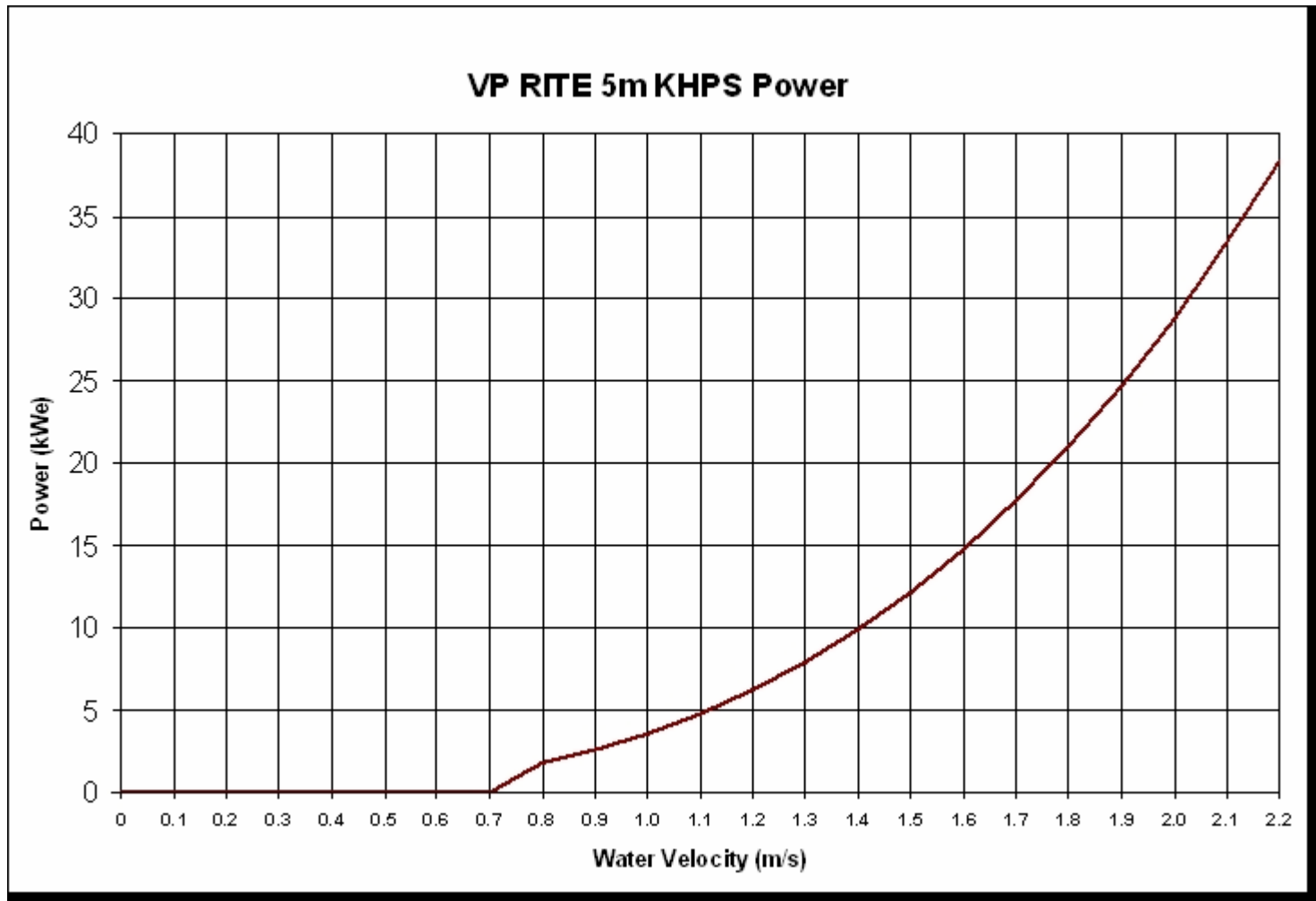
# New York's East River: Roosevelt Is. Tidal Energy Project







# Market Potential: Power Curve - Five-meter Rotor





## Assumptions

- 5-M system price: \$4,000 per kW in '07 to \$2,500 per kW in '10
- Commercialization
- Gross KHPS Potential:
  - >12,500MW – US
  - >50,000MW – Developed Nations (inc. US)
  - >200,000MW – Developing Nations





# Obstacles to Development: Engineering & Technology

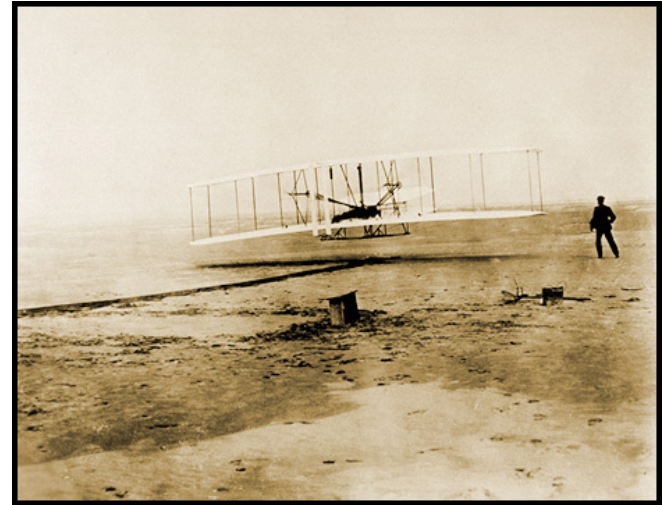
- “Proven & Deployed”
  - Working Prototypes
  - East River Permitted
  - Addressed 87 “Issues”
  - Operational Tests & Fish Monitoring – 11/05 Start
- Deployment Obstacles
  - Yaw Bearing
  - Installation Designs
  - Mounting Systems
  - Scaling & Manufacturing



# Other Obstacles:

“You need a permit to fly that kite!”

- No Large Test Flumes
- Only Natural Streams
- New Technologies
- Regulatory Process - Designed for Existing Technologies
- Little Inter-agency Coordination – “Catch22”
- Lack of Capital Formation
- Little R&D&D Funding





# Axial-flow Turbines: Solutions

- Regulatory Process Change
  - FERC: *Verdant Declaratory Order*
  - NHA: Streamlining Licensing Process
  - Agencies: “Hearing from Higher-Ups”
- Capital Formation Support
  - Refundable Tax Credits
  - Tradable Tax Credits
- New R&D&D Funding
  - Demonstration Grants
  - DOE / Defense / Homeland Security
- Other
  - UK & European Marine Energy Centre
  - CN & CANMET Energy Tech Centre







# Thank You!

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