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Overview
Marine Renewable Energy Technologies

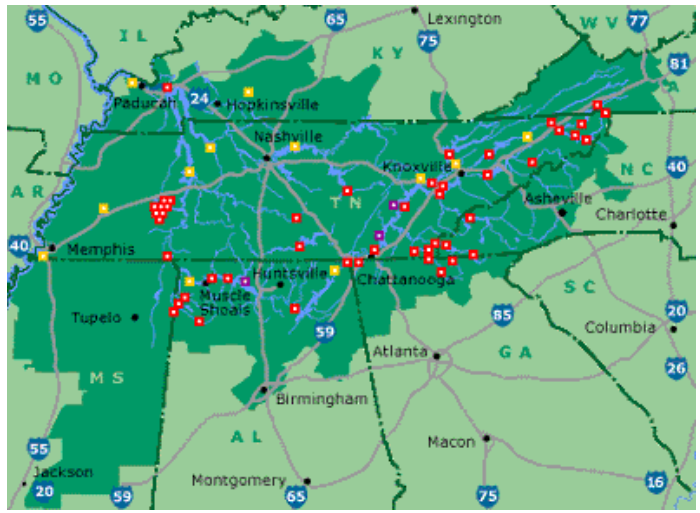
A.K.A. Ocean Energy and
Kinetic Hydropower

April 2008

Founded in 2000 (US) & 2006 (CD)

After Two Previous Years of Examination

- Today: 30 Personnel
  - NY, DC, CA, WA & Canada
- PEs, PhDs, MBAs, Scientists
- Industry Leadership
  - Ocean Renewable Energy Group
  - National Hydropower Association
  - Hydro Research Foundation
- Technology Assessments
  - EPRI: “In-stream Energy Generation Technologies” Renewable Energy TAG Report & TVA Assessment
  - NRCan: “Water Current Turbines for River Applications”



ACORE
American Council On Renewable Energy

NHA
National Hydropower Association

Ocean Renewable Energy Coalition

oreg
The Ocean Renewable Energy Group

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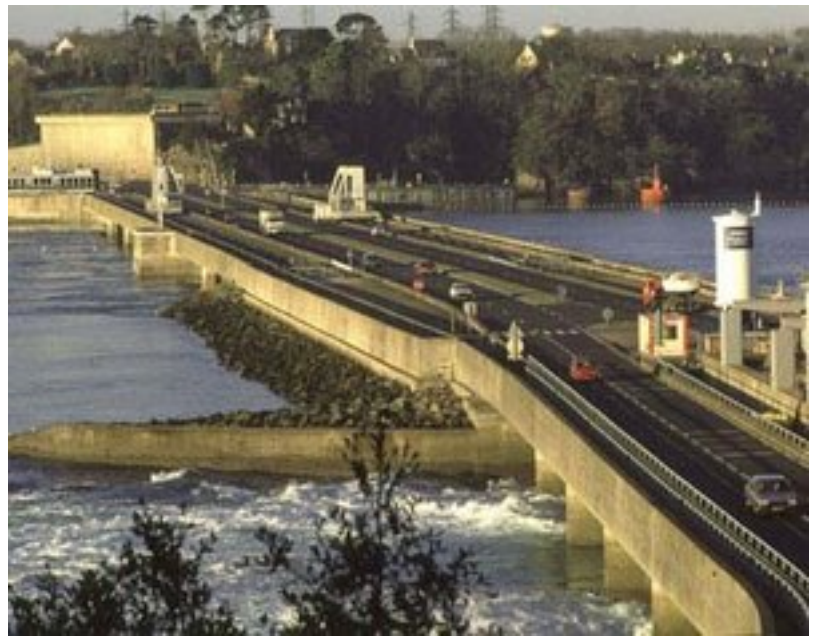
Marine Renewable Energy

Three Basic Families: Wave, Tidal & In-stream

- Tidal Barrages
  - La Rance, France
  - Annapolis, Nova Scotia
- Wave Energy Devices
  - Wave Power Systems
  - Oscillating Water Columns (OWC)
- In-stream Energy Devices
  - Waterwheels
  - Lift or Flutter Vanes
  - Vertical Axis or Cross-axis Turbines
  - Horizontal Axis or Axial-flow Turbines



Wave Power Systems
Finavera's AquaBuOY

PO Box 1276, Mercer Island, WA 98040 • Phone: +1 (425) 430-7924 • Fax: +1 (208) 474-1346 • Email: aqua@aeg-ltd.com

Figure 1
IPS Buoy during ocean testing

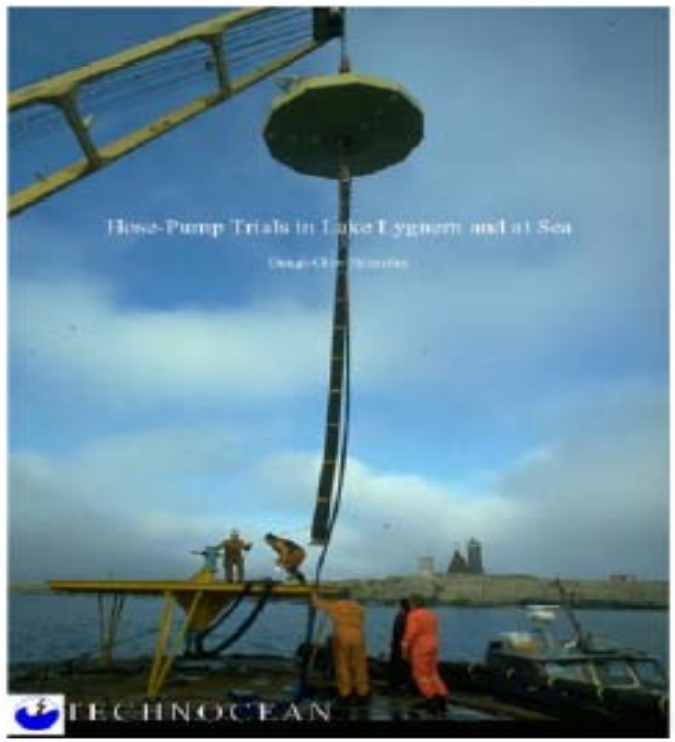


Figure 2
Hose Pump installation

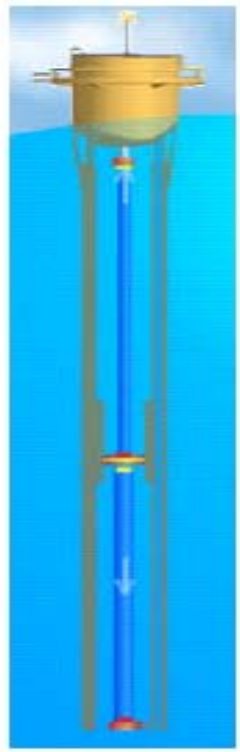


Figure 3
AquaBuOY

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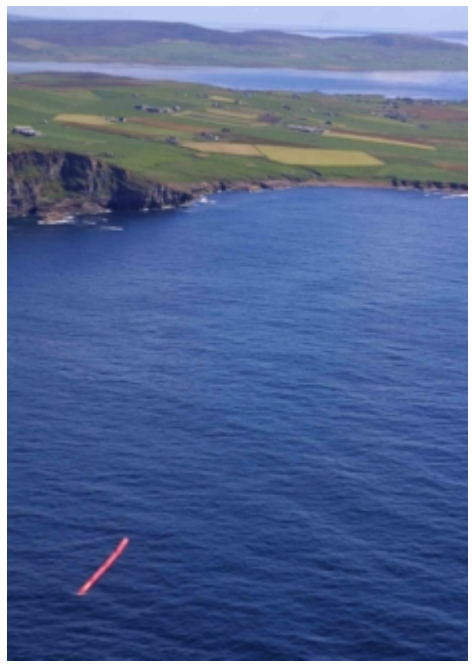
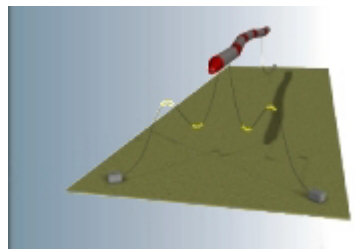
Wave Power Systems

Pelamis Wave Power

The Pelamis Wave Energy Converter

& The European Marine Energy Centre (EMEC)

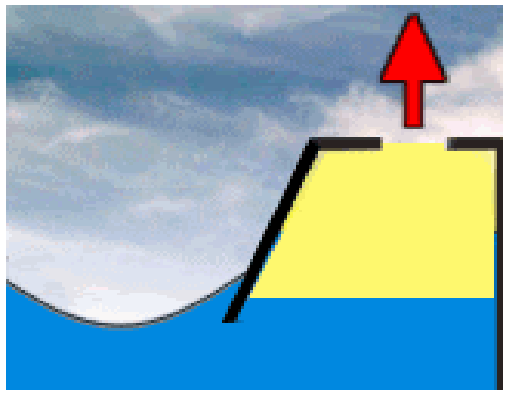




Oscillating Water Columns (OWC)

Wavegen

Limpet Power Station



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In-stream Energy Devices

Axial-flow Turbines

Marine Current Turbines

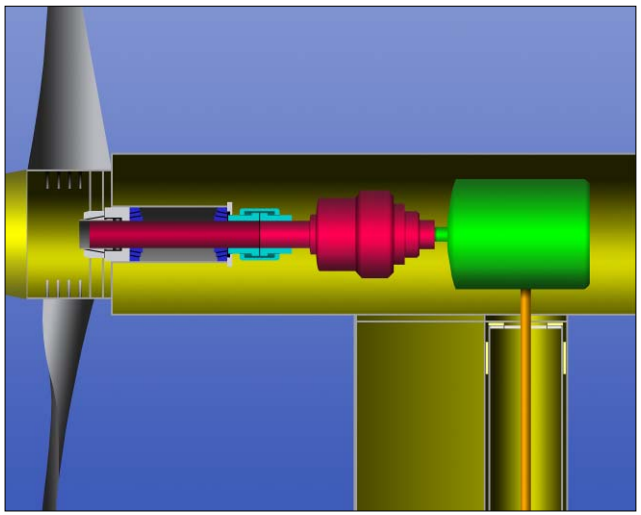
OpenHydro Group

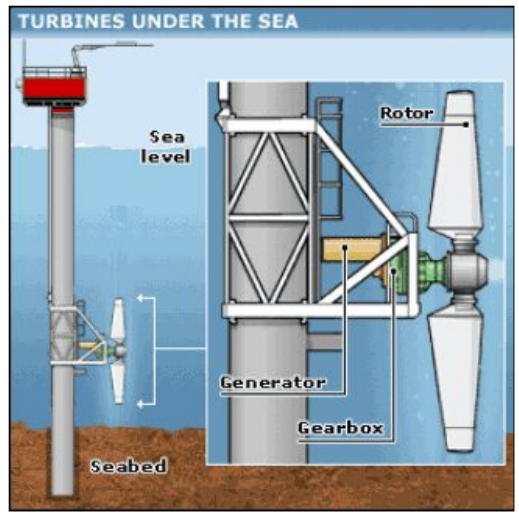
Clean Current Power

- Large Tidal Power Systems: Designed Primarily for Deep Waters
- Cost Considerations
  - Deployment & Local Resources
  - Proximity to Load Pockets (Takers of the Power) & Transmission Lines
- Centralized vs. De-centralized Power

Axial-flow Turbines

Verdant Power & Marine Current Turbines





A Commercialization Path

In-stream Energy – Tidal & River Power

- Funded, Built & Field-Tested Four Alternative In-stream Energy Turbine Prototypes
  - Ducted Axial-flow Turbine – Canada (Ontario Power Generation)
  - Un-ducted Axial-flow Turbines – New York (NY Power Authority)
  - Cross-axis Turbine System – Massachusetts (MA Technology)
- Commercializing System*
- Target: Within 3 Years: $2,400 / kW, Installed (Water-to-Wire)

*(Free Flow System)

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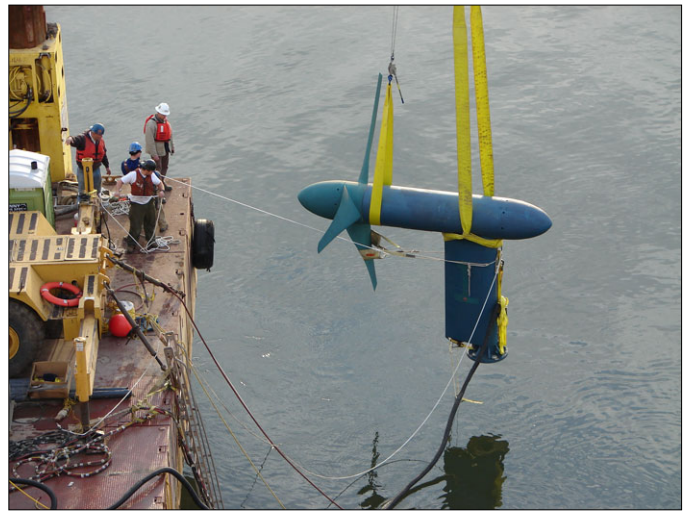
New York's East River (< 10 MW)

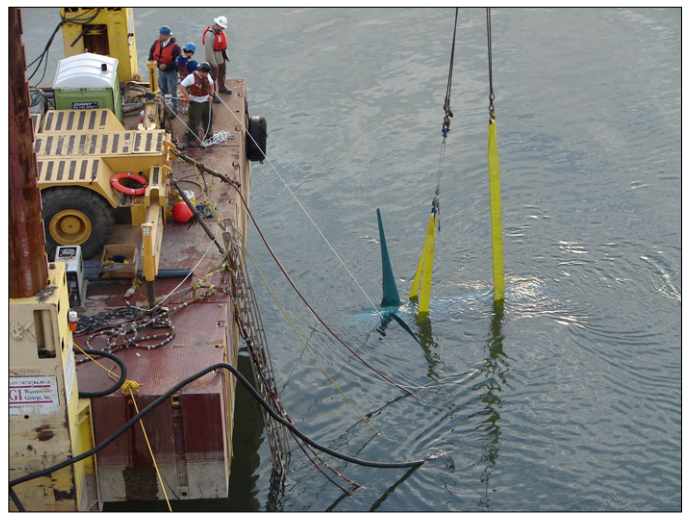
Roosevelt Island Tidal Energy (RITE) Project

RITE Project

Phase 2 of 3: Bottom Mounted Free Flow Units

- 12/2006 to 05/2008 (18 months)
- Generation-4: Pre-commercial Units
  - 3-bladed Axial-flow, Downstream Rotor Turbine
  - 5-meter Diameter Rotor / 35 kW Generator
  - Bi-directional
  - Power to Two Customers
- First Generator Unit (1 Month)
  - 100% Availability - 155 tides
  - Generated Power 77% of Time
  - Average Power Output - 14.5 kW
  - Energy Production - 8.1 MWh / 30 Days





RITE Project

Phase 2 of 3: Operational Hours Adding Up

- Marine Current Turbines (UK)
  - Seaflow System (1 unit)
  - 11-m Rotor / 300 kW Generator
  - From 2003 to date (60 months)
  - 1,600 Operational hours

- Verdant Power (NY)
  - Free Flow System (5 units)
  - 5-m Rotor / 35 kW Generator (175 kW)
  - From 12/2006 to 06/2007 (6 months)
  - 7,000 Operational hours (50 MWh)

KEYSPAN Climate is everything.™

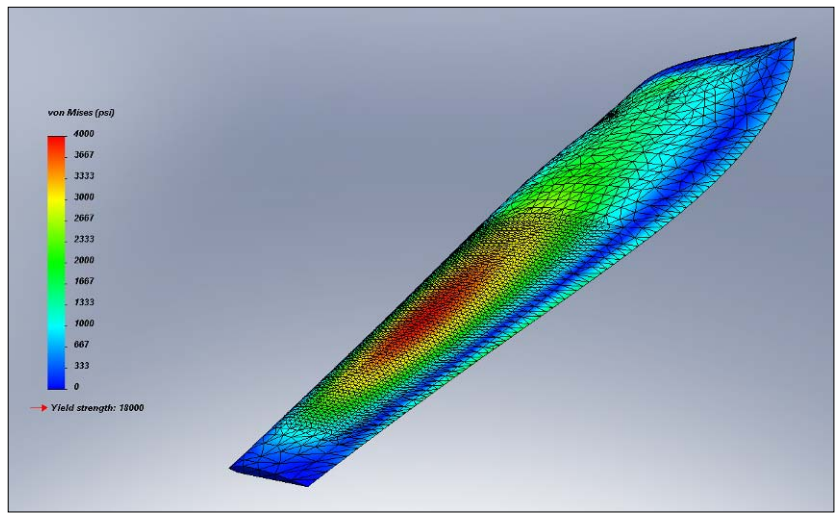
conEdison, inc.

nationalgrid

RITE Project

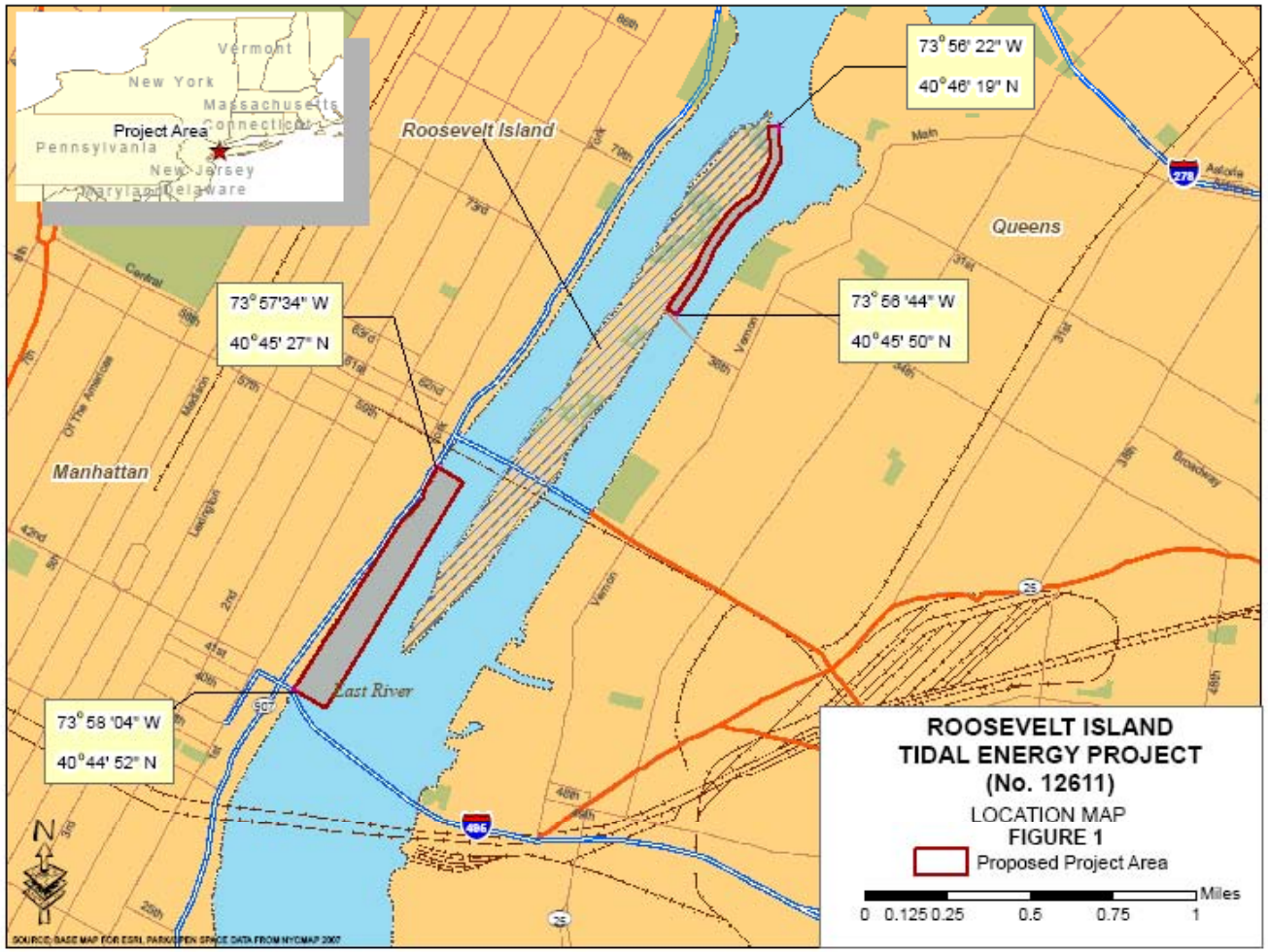
Phase 2 of 3: New Rotor Tests / FERC License

- Fixed Blade Failure
  - Finite Engineering Analysis
  - New Solid Cast AlMag Blade
  - All Critical Components – OK!
- NREL Tests & Re-Install
  - Tested to 200%
  - Scheduled Re-install – May 2008
- FERC License Application
  - File for FERC Pilot License – 2008
  - > 1.5 MW Project
  - First Stage Commercial Build-out



RITE Project (< 10 MW)

Phase 3 of 3: East River Reaches (< 300 Units)



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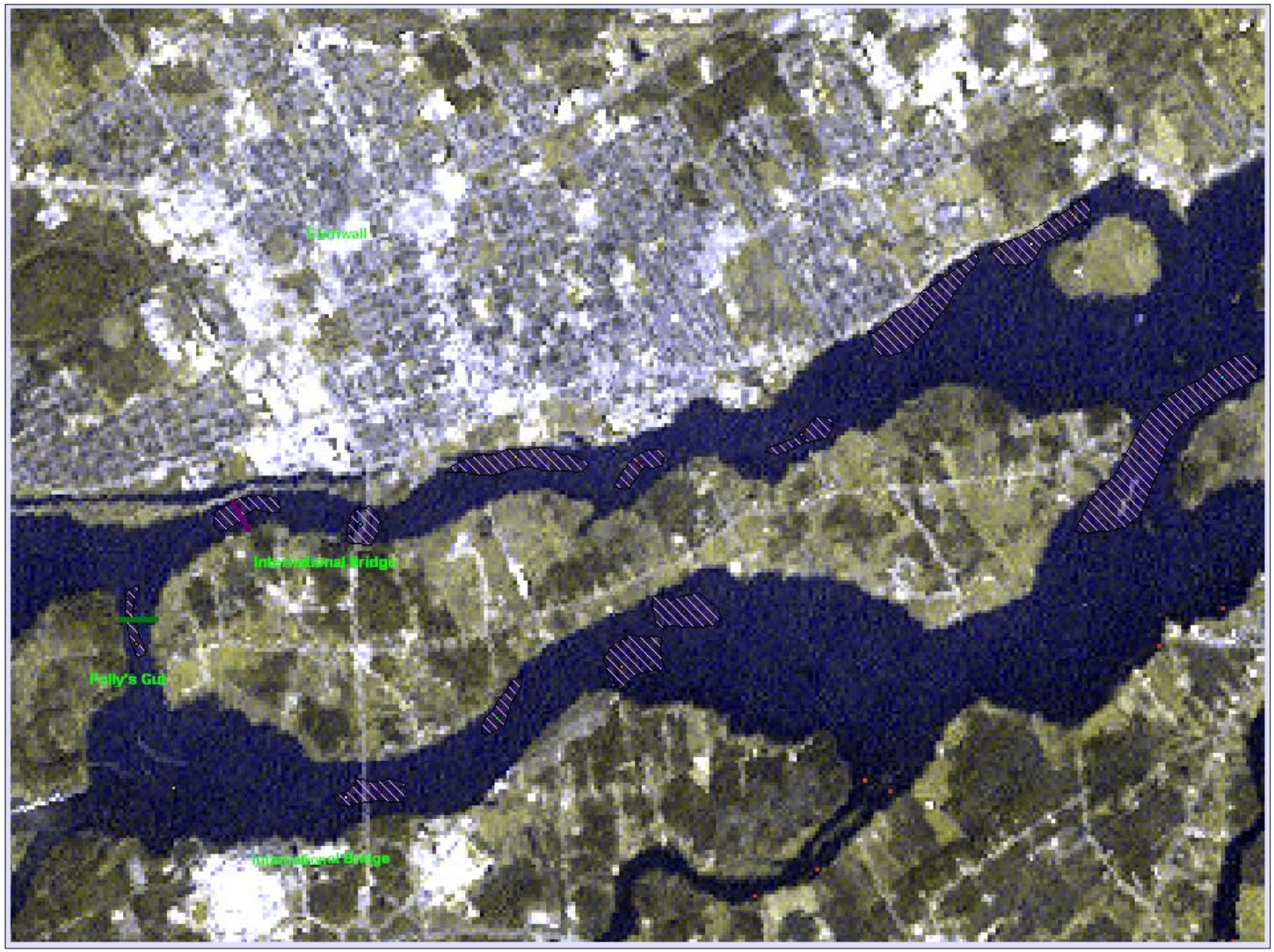
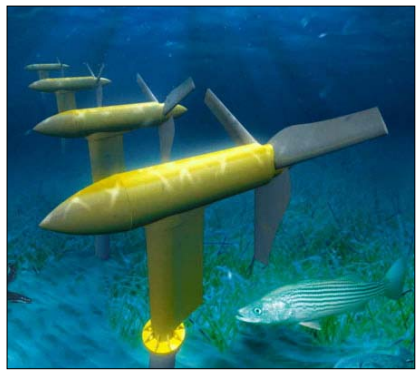
The St. Lawrence River (> 15 MW)

Cornwall Ontario River Energy (CORE) Project



Free Flow System Turbine

Sweep of the Blade & Speed of the Current



Power in kW

Diameter (m)	Speed (m/s) 2	2.5	3	3.5	4
7	55	110	190	300	450
8	72	144	245	395	590
9	92	182	315	500	745
10	115	225	385	615	920
11	138	272	470	745	1110

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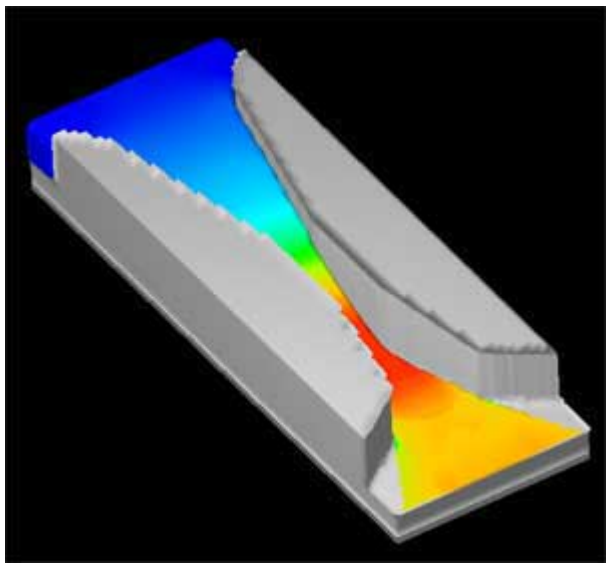
Constructed Waterways

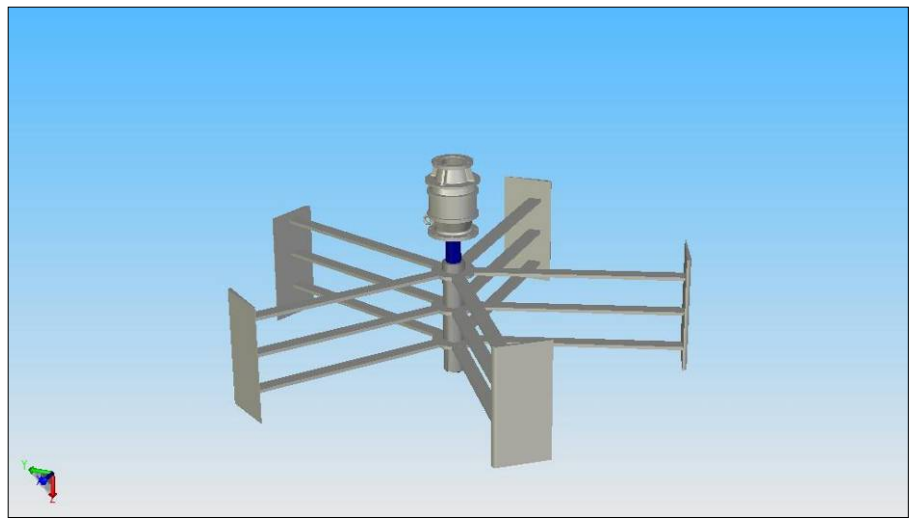
Channels, Canals & Aqueducts (In-stream Energy)

Rapid Flow System Turbine

Designing Systems for Canals (Patent Pending)

Accelerator Increases Water Velocity
from ~3fps to ~15fps Integrated with
Cross-axis Turbine





Where are the Sites?

Undeveloped Hydro Potential: 2.5 Million MW

- North American Instream Potential
  - US: 10,000 MW of Free Flow Capacity
  - Canada: 15,000 MW of Free Flow Capacity
- Global Instream Potential
  - Developed Countries: 50,000 MW ($125B)
  - Developing Countries: 200,000 MW ($500B)
- Benefits (Based on Brazil's 125 TWh)
  - Energy
    - •100 Million Tons of Coal Off-set per Year
    - •340 Million Barrels of Oil Off-set per Year ($34B)
  - Environmental
    - •85 Million Tons of CO_2 Eliminated per Year
  - Economic
    - •Jobs & "Downstream" Supplies / Services Created

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Building Sustainable Communities

An Energy / Water Nexus

- Hybrid & Integrated Renewable Energy Systems
  - Fuel Cells: Electrolysis Systems for Hydrogen Production
  - Wind Power: Integration in Coastal areas and River Valleys
  - Solar Power: Integration with Irrigation Canal Systems
- Water Filtration Systems
  - Reverse Osmosis: Mechanical and Electrical Power
- Irrigation Systems
  - Mechanical Power for Pumping Clean Water
- Aeration Systems
  - Mechanical Power for Pumping Oxygen into Anoxic Waters
- Communication Systems
  - Cell Phone Towers and Satellite Dishes (Accelerated Internet)
- Security Systems
  - De-centralized Power, Distributed Generation, Stand Alone Systems

VERDANT POWER

"Energy Uses Water & Water Uses Energy ... ."

Trey Taylor

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