marinerenewables.ca

Marine Renewable Energy Open House

New Brunswick

June 2016

marine renewables canada

The power to think bigger.

Marine Renewables Canada

- National industry association for marine renewable energy
  - Covering wave, tidal, and river current energy
  - Established 2004
  - Offices on Pacific and Atlantic coasts
- Members:
  - 90 members representing technology and project developers, utilities, researchers, and the energy and marine supply chain

Mission:

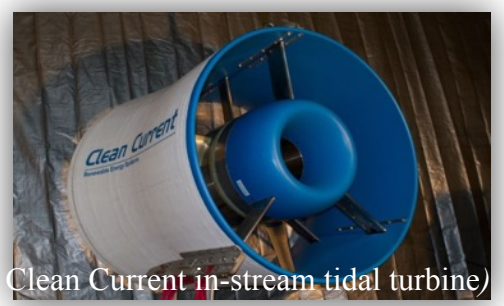
Marine Renewables Canada aligns industry, academia and government to ensure that Canada is a leader in providing ocean energy solutions to a world market.

Who we are


ANDRITZ Hydro
BC hydro FOR GENERATIONS
DP ENERGY
HATCH
Emera
DSA DYNAMIC SYSTEMS ANALYSIS
openhydro a DCNS company
SCHOTTEL HYDRO
VOITH
ACADIA Tidal Energy INSTITUTE
AECON
ASL Environmental Sciences
AOE Accumulated Ocean Energy
AXYS TECHNOLOGIES
bluewater
BOURQUE INDUSTRIAL LTD
BLACK ROCK TIDAL POWER INC.
Broad Spectrum CONSULTING
Cu Canadian Copper & Brass Development Association
cumberland ENERGY AUTHORITY
COLLEGE OF THE North Atlantic
Cascadia Coast Research Ltd.
envigour
Fundy Tidal Inc. ~ Current Thinking.
GO WITH the FLOW TECHNOLOGIES Inc GWFT in SYNERGY with NATURE
grey island energy inc.
HEMMERA
igloo
IME INTERNATIONAL MARINE ENERGY INC
HORIZON MARITIME
Instream Energy Systems
IRVING
Jupiter Hydro Inc.
Knight Piésold CONSULTING
FORCE
MacArtney UNDERWATER TECHNOLOGY
MARINE INSTITUTE
Maritime Tidal Energy Corporation
Manitoba Hydro
MAVI INNOVATIONS
McINNES COOPER LAWYERS | AVOCATS
MCKEIL
Market Pursuits Inc
MERSEN
MinasEnergy POSITIVE SOLUTIONS
Canada NRC·CNRC
New Energy CORPORATION
NOVA SCOTIA Department of Energy
MilAero
ORPC OCEAN RENEWABLE POWER COMPANY
This image
OERA Offshore Energy Research Association
Port Saint John
RJMI CONSTRUCTION LTD. Marine Construction & Demolition
RESOLUTE MARINE ENERGY
ROCKLAND SCIENTIFIC
SMRU CANADA
SRM PROJECTS
Stantec
Strum CONSULTING
TIDAL LAGOON POWER
WCWI

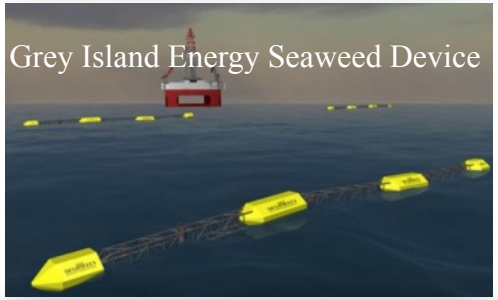
Types of marine renewable energy

- Tidal
  - Tidal current (in-stream)
    - Extracts the kinetic energy (free-flowing) from tidal currents
  - Tidal range
    - Extracts energy from tides using the actual rise and fall of the tide
- Wave
  - Created by the wind passing over the surface of the ocean
- River
  - Devices generate power from kinetic energy of moving water



Clean Current in-stream tidal turbine)


Annapolis Tidal Station

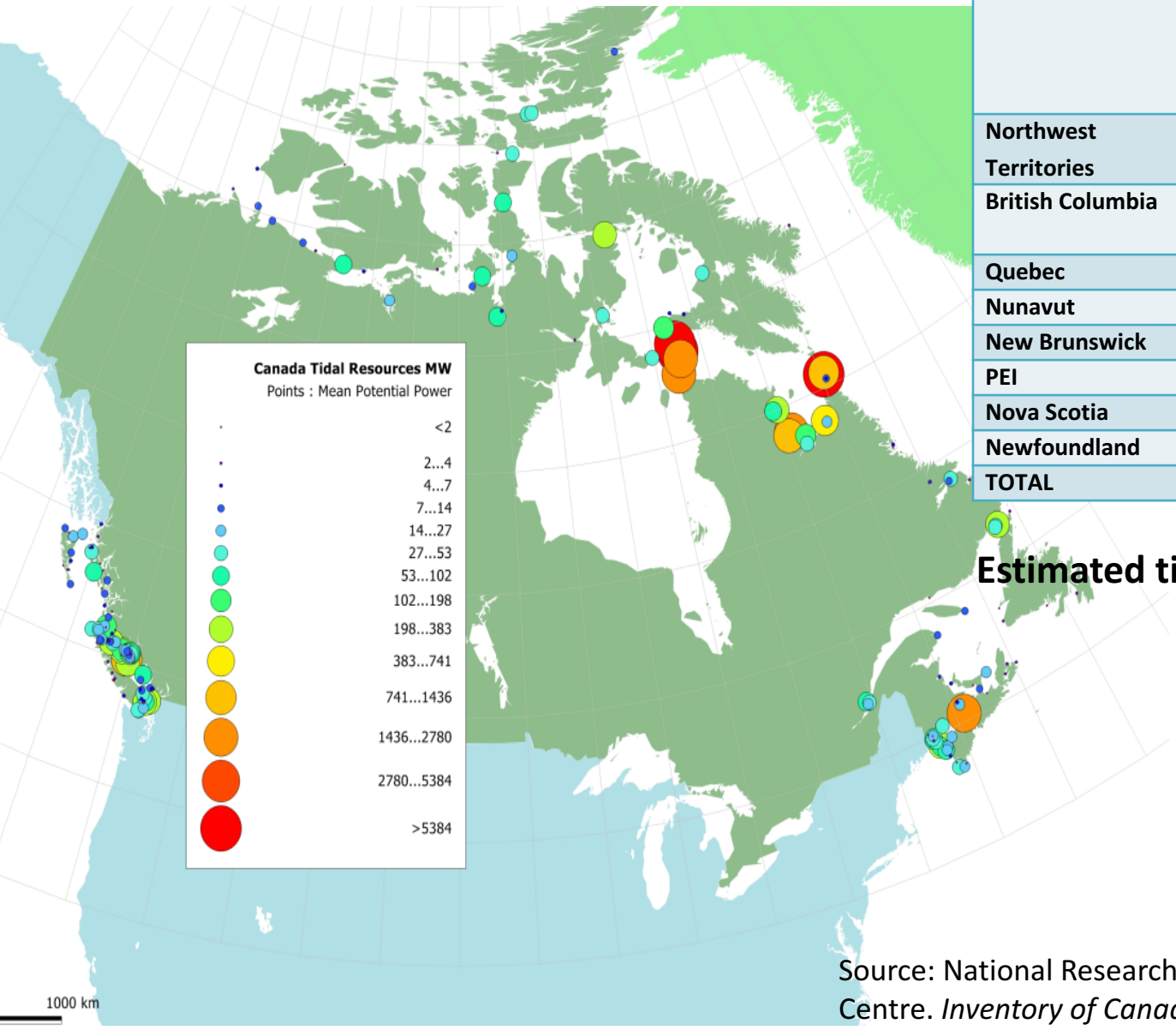

Grey Island Energy Seaweed Device


New Energy Corporation river current device

Value to Canada

- **Significant economic potential**
  - New global market = $900-$1,000 billion value by 2050 (Carbon Trust, UK)
  - Huge export potential for goods and services
  - New jobs and careers
  - Activity occurring in rural communities
- **Clean, renewable energy**
  - Predictable energy resource
  - High power densities - up to 50 times that of wind, and 100 times solar PV
- **Energy security and diversification**
  - Remote and Northern community opportunities throughout the country, offset expensive diesel use

Tidal Energy Resource

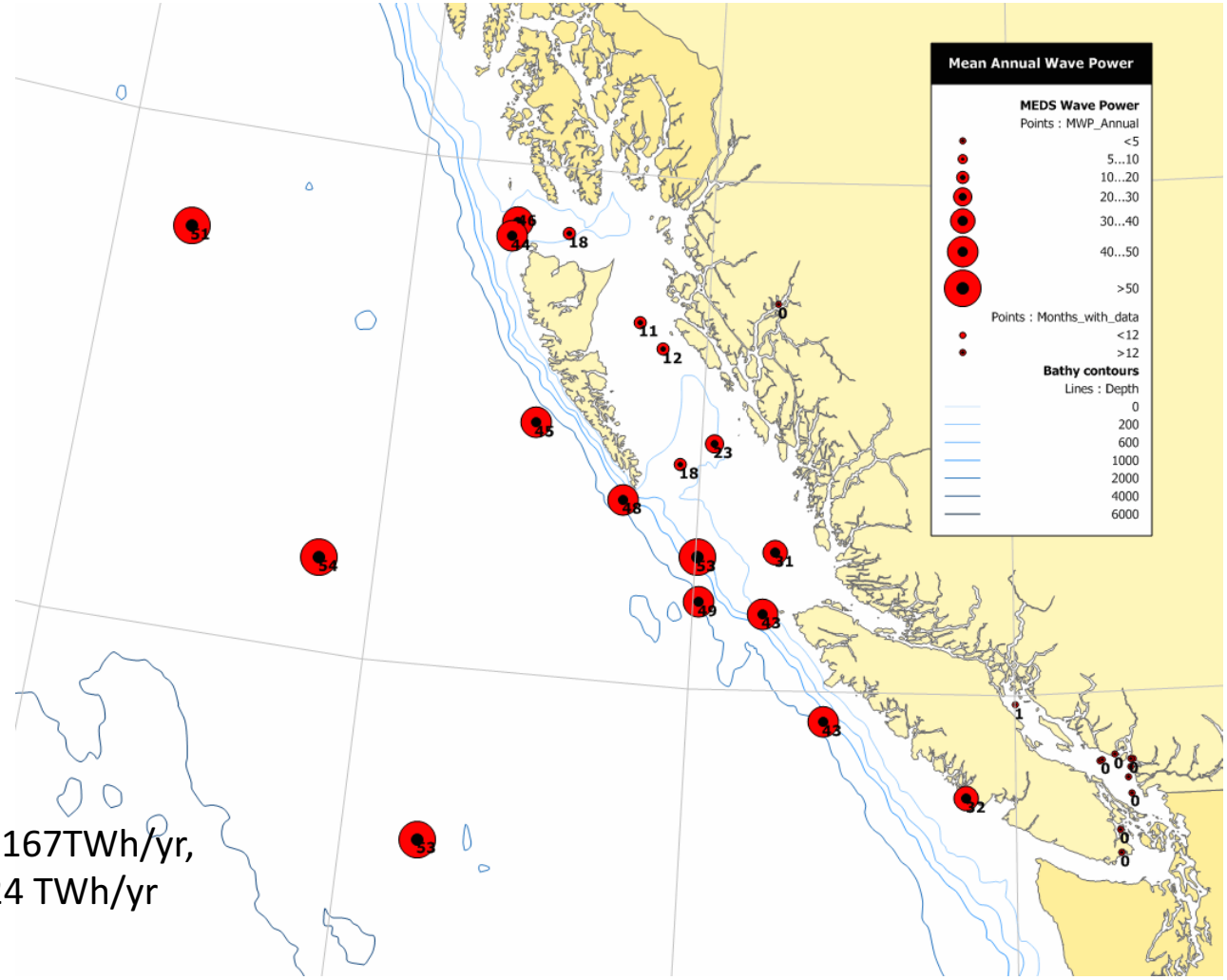


Province	Potential Tidal Current Energy (MW)	Number of Sites (-)	Average Size (MW)
Northwest Territories	35	4	9
British Columbia	4,015	98	45
Quebec	4,288	16	268
Nunavut	30,567	34	899
New Brunswick	63	14	45
PEI	33	4	8
Nova Scotia	2,122	15	141
Newfoundland	544	15	36
TOTAL	42,240	191	221

Estimated tidal resource: 370 TWh/yr

Source: National Research Council, Canadian Hydraulics Centre. *Inventory of Canada's Marine Renewable Energy Resources,* 2006.

Wave Energy Resource

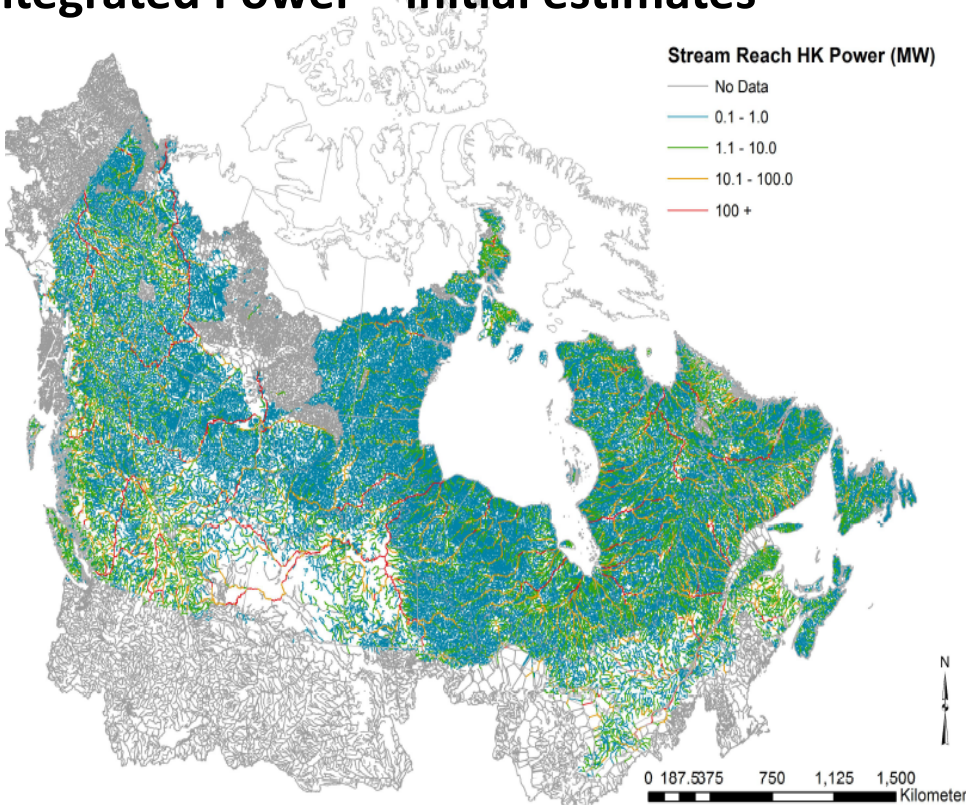


near shore: 167TWh/yr,
offshore: 324 TWh/yr

Source: National Research Council, Canadian Hydraulics Centre. *Inventory of Canada's Marine Renewable Energy Resources,* 2006.

River Current Resource

Integrated Power – initial estimates



Potential hydrokinetic power by region

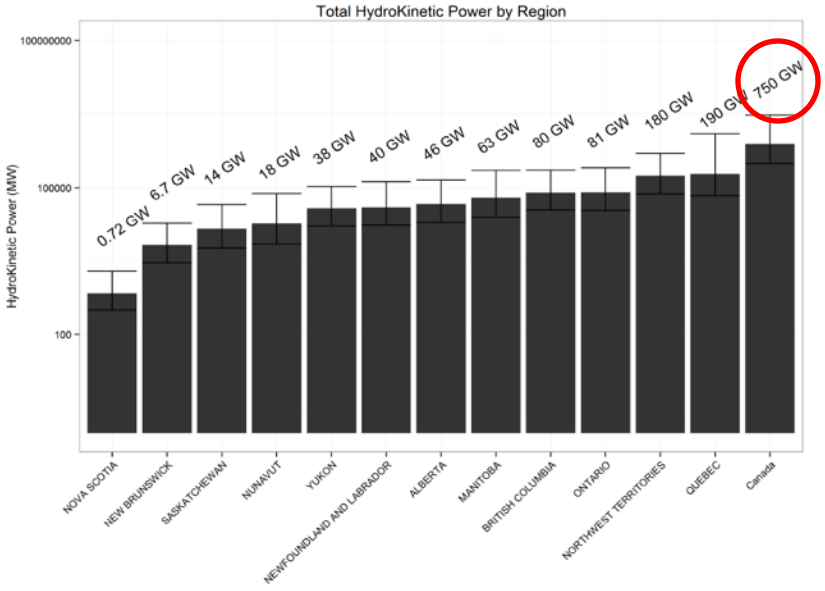


Image source: National Research Council and Natural Resources Canada. "Assessment of Canada's Hydrokinetic Power Potential", CEATI Webinar, 2013.

Global Market

Canada

FORCE
- 22 MW permitted
- 64 MW electrical infrastructure

Fundy Tidal Inc. (NS)
- 3 projects; 2.95 MW

Canoe Pass Tidal (BC)
- 500 kW

West Coast Wave Initiative (BC)

Canadian Hydrokinetic Turbine Test Centre (MB)

10 device developers

Supply chain 150+

France

EDF + OpenHydro
- 14 MW tidal project; operational in 2018

GDF Suez + Alstom
- 8.4 MW; 2017

France Energies Marine
- 5 test sites (tidal, wave, offshore wind)

United Kingdom

MeyGen
- 398 MW tidal project in Pentland Firth

European Marine Energy Centre (EMEC)

WaveHub
- Three 10 MW wave energy arrays planned

Tidal Ventures Limited
- 100 MW tidal project

Fairhead Tidal
- 100 MW tidal project

Perpetuus Tidal Energy Centre
- 30 MW tidal array in the Isle of Wight

OES vision = 748 GW of ocean energy by 2050:

- Nearly 200,000 careers by 2030
- Saving up to 5.2 billion tonnes of CO_2 by 2050
- $900-$1,000 billion value by 2050 *(Carbon Trust)*

Emerging opportunities

- **Chile**
  - Large wave energy potential at 240 GW; tidal energy potential smaller
  - Government pursuing a marine energy strategy
  - Marine Energy International Centre of Excellence established 2014 (DCNS + Enel Green Power)
- **India**
  - 8,000 MW tidal energy potential
  - 250 MW tidal project in Gulf of Kutch being pursued by Atlantis Resources + Gujarat Power Corporation Ltd.
- **Japan**
  - Focus on increasing renewable energy production
  - Japanese Marine Energy Centre (JMEC) being established
  - IHI Corp. + Toshiba to start field testing of tidal energy technology

- Other countries with interest: Australia, Ireland, Korea, New Zealand, Norway, Spain, United States

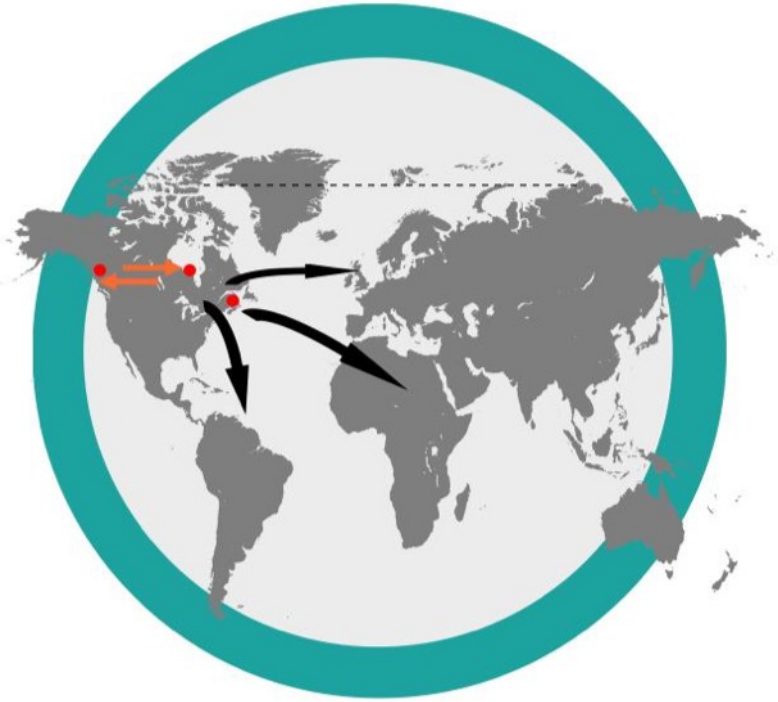
- Small-scale/remote community opportunities worldwide

A local and global opportunity

OPPORTUNITY

- **Resource potential = 10-15% world electricity consumption**
- **IEA's OES VISION is 748 GW ocean energy by 2050 resulting in:**
  - Nearly 200,000 careers by 2030, deploying 5 generators/day
  - Global expenditure of $900-$1,000 billion value by 2050 (Carbon Trust)
  - 70% of project costs to be met with local expertise/supplies

GOALS



- Canadian industry working on generating capacity of 2,000 MW by 2030 = $2 billion annual economic value
- Leadership in technical solutions/services to provide value-added goods and services to 30% of global industry by 2020; 50% by 2030

Industry Activity

FORCE Cable Lay

Photo Credit: FORCE

Device Development

Device Developer	Description
Accumulated Ocean Energy (AOE) British Columbia	Wave
Go With the Flow Technologies (GWFT) British Columbia	Tidal
Grey Island Energy Newfoundland	Wave Point absorber
Idenergie Quebec	River
Jupiter Hydro Inc. Alberta	Tidal, River
Mermaid Power British Columbia	Wave
Mavi Innovations British Columbia	Tidal River
New Energy Corporation Alberta	Tidal, River Vertical axis turbine
Seawood Designs Surf Power British Columbia	Wave Point absorber
Water Wall Turbine British Columbia	Tidal, River Vertical axis turbines

Mavi Innovations Mi1 Turbine

Mermaid Power Neptune 3

Standards Development

TC-114 Canadian Sub-Committee Research Projects

2013-14

- River Current Resource Assessment and Characterization – *Hatch*
- Impact of channel blockage, free surface proximity and foundations on the performance of Tidal/River Energy Converters – *Mavi Innovations*

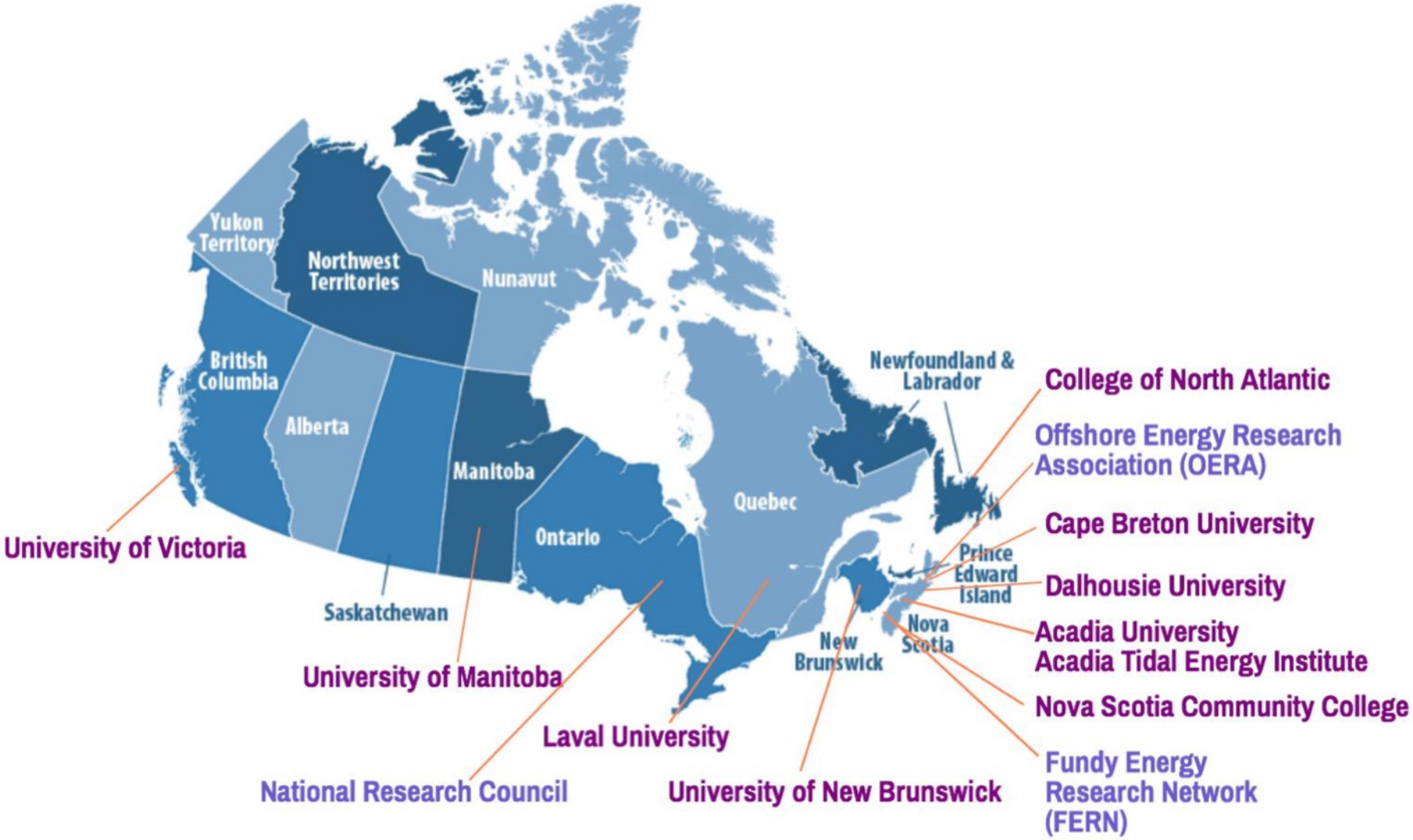
2014-15

- Impact of channel blockage and free surface proximity on the performance of cross-flow hydrokinetic turbines – *Laval University*
- Evaluation of Performance Assessment Procedures for a Floating River Energy Converter – *Mavi Innovations*
- WCWI Extended Research Program - *West Coast Wave Initiative, University of Victoria*

2015-16

- Simulation of Long-term Wave Energy Converter Power Performance – *Cascadia*
- River energy converter environmental condition and load verification – *DSA*

Researchers engaged



Nova Scotia: Early Leadership & Success

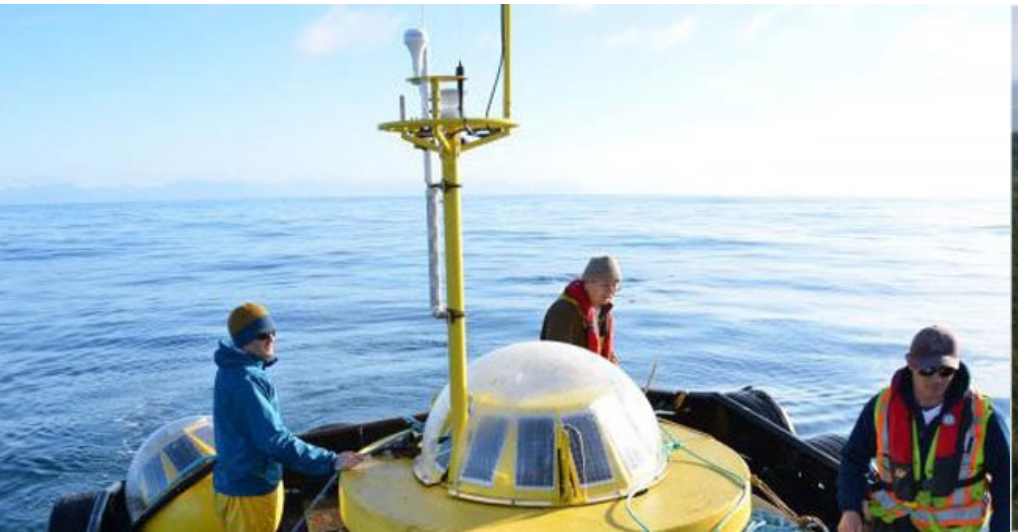
- Government of Nova Scotia – Marine Renewable Energy Strategy
  - Goal of 300 MW
  - Enablers: FITs, legislation, SEAs, support for research
- Fundy Ocean Research Center for Energy (FORCE)
  - Shared infrastructure, R&D, innovation
  - 5 developers at FORCE = ~22 MW approved/permitted
    - Deployment of first arrays
    - Establishing local offices and partnerships
- Community-owned projects = community support
  - Fundy Tidal Inc. (3 project sites) = ~2.95 MW approved/permitted




Wave Energy – West Coast

- West Coast Wave Initiative(British Columbia)
  - Industry/University of Victoria research collaborative
  - Determining feasibility, impacts, and possible structure of wave energy conversion
    - Resource assessment methods, numerical simulation tools, grid integration tools
- Technology development & demonstration underway (AOE, Mermaid Power, Seawood Designs)

AXYS Watchmate Buoy off Vancouver Island

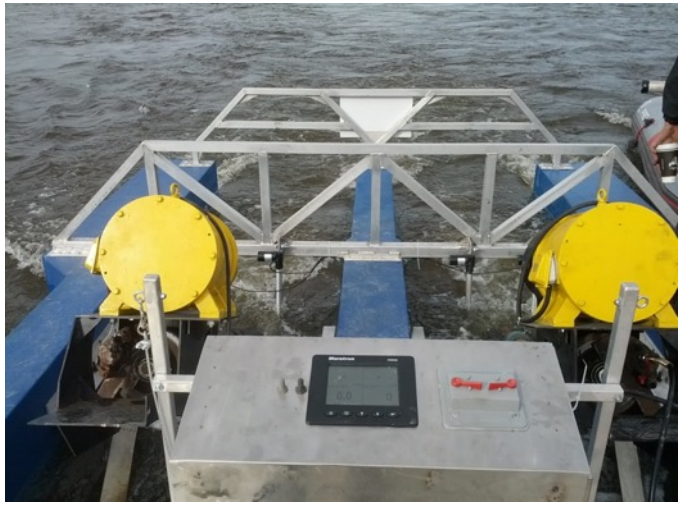


Ucluelet Inlet and Amphitrite Point

River Current Energy (Hydrokinetic)

- Reach beyond coastlines – Quebec, Ontario, Northwest Territories, British Columbia
- Canadian Hydrokinetic Turbine Testing Centre (Manitoba)
  - Test centre (to be grid connected)
  - Perform research on impact of environment on turbines; impact of turbines on aquatic life
  - 10+ devices deployed
    - Mavi, Jupiter Hydro, Clean Current, New Energy Corp.

Clean Current River Turbine test at CHTTC



Jupiter Hydro test at CHTTC

Tidal Energy – West Coast

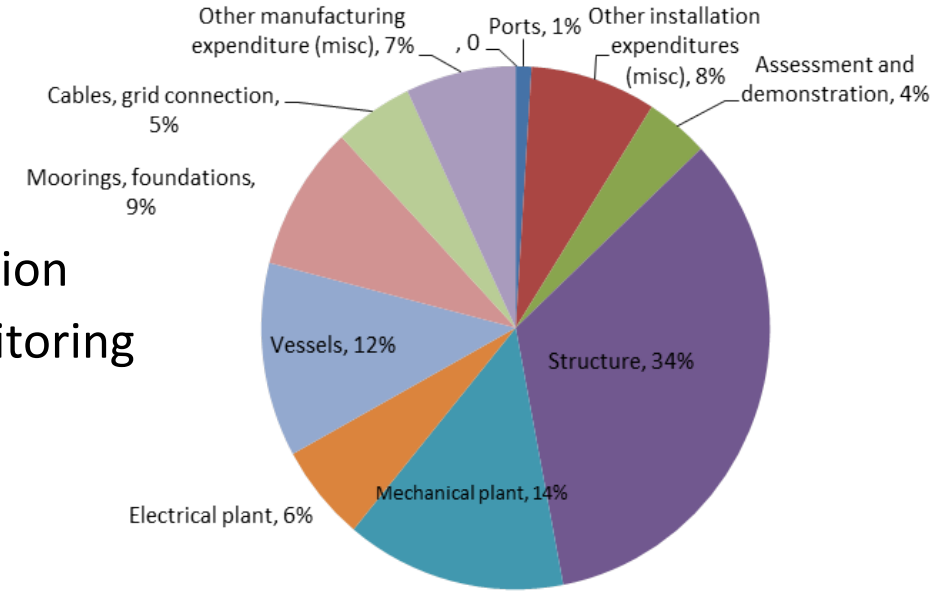
- British Columbia
  - Water Wall Turbine: Dent Island (500 kW)
  - New Energy Corporation: Canoe Pass Tidal (250 kW)
  - Mavi: Blind Channel (22kW)
  - Other opportunities: remote communities, partnering with aquaculture, eco-resorts, etc.

Canoe Pass

Water Wall Turbine concept, Dent Island Tidal Energy Project

Project Needs = Economic Opportunity

- Common challenge across industry = high costs
- Major market potential to innovate and find solutions for projects (lower-costs)
- Gain experience through first projects
  - 70% of project costs to be met with local expertise/supplies
  - Opportunities beyond focus on devices
    - Vessels
    - Infrastructure
    - Core generating device
    - Moorings and foundations
    - Resource and site characterization
    - Sensors, instrumentation, monitoring
    - Cables and grid connection
    - Composites
    - O&M
    - Onsite/local spinoffs



Adapted from Sgurr Energy Limited. Scottish Government Marine Energy Group – Marine Energy Supply Chain Survey, 2009.

Site Screening & Project Feasibility

- Desktop modeling tools and analysis expertise (resource assessment)
- Research support
- Technical and engineering expertise (identification of suitable grid connection, logistics analysis, technology identification)

Planning

- Vessel and operator (range of vessels can be used including local fishing crane, 30m long vessels and specialist physical surveying vessels for environmental surveying)
- Surveying, trawling, and imaging equipment
- Aircraft (helicopter) and operator for aerial survey
- Wildlife observation and data collection by marine biologist, ecologist, environmental scientist, and/or local knowledge from fisherman, etc. (should have knowledge of local species)
- Technical/research consultancy: sediment transfer, geotechnical engineering, analysis of survey data, data analysis and resource modeling, device suitability analysis, metocean
- Meteorological instruments and packaged instruments
- Remotely operated vehicles (ROV) and diver
- Electrical expertise
- Legal expertise

Project Design & Development

- Public relations, consultation, First Nations expertise
- Meeting/conference space (local community centre or hotel)
- Environmental assessment experience
- Permitting and approval of marine projects expertise
- Power project interconnection studies
- Legal expertise
- Health & safety expertise
- Engineering consultants (technology and project design)
- Marine architect (logistical support)
- Procurement & contract management

Project Fabrication

- Marine architect
- Electrical expertise (subsea electrical equipment)
- Health and safety expertise
- Technical experience in construction for short access windows due to tidal flow
- Steel fabrication
- Concrete supplier
- Expertise in corrosion and marine growth prevention
- Local knowledge of marine conditions
- Electrical and hydraulic knowledge in marine environment
- Subsea connectors from device to inter-array cabling
- Specialist sensors and data collection systems.
- Experience in design and use of SCADA systems
- Hydraulic actuators, valves, or other equipment.
- Bearings and actuation components for use in yawing or pitching
- Large-scale and high precision cabling extrusion and assembly equipment
- Expertise in the production of insulation for cables to provide thermal and electrical protection
- Cable armouring products to protect against extreme forces and ensure life of the conductor
- Electrical design knowledge
- Mechanical engineer
- Expertise in the design of dynamic structures for the marine environment
- Corrosion and marine growth prevention products
- Cranes
- Insurance
- Transportation of component parts to site for final assembly

Construction, Installation & Commissioning

- Marine consultant
- Customs broker for importing materials and guidance in obtaining proper permits for temporary use of barge
- Heavy lift capacity of up to 1000 tonnes
- Large lay-down and storage areas to enable assembly of components and rapid deployment of devices for larger scale developments
- Suitable space for final assembly adjacent to quayside
- Dry and potentially wet commissioning of electrical parts
- Sufficient draft and beam to facilitate movement of vessels and devices at a range of tides.
- Electrical Engineer
- Mechanical Engineer
- System Engineers
- Power Engineers
- Certified welders (CWB Class 47.1)
- Journeyman machinists
- Tugboat and operator
- Fishing boats for transporting additional personnel and emergency response
- Health and Safety/Emergency Response preparedness
- Personal protective and safety equipment
- Radios for communication between all parties involved in deployment
- Environmental consultant/researcher
- Diving services
- Instrumentation for communication
- Specialist tooling and ROVs
- Marker buoys and navigational lighting
- Specialist vessels - complex installation procedures.
- Drilling and piling operations

Operations & Maintenance

- Dedicated operations, maintenance staff and control centre
- Marine engineer (class 4 or higher)
- Power Engineer (Class 1 and Class 4)
- Computing systems
- Navigation systems and data
- GIS services
- Subcontractor support services
- Vessels
- Ecologists and marine biologists
- Port facility
- Portside lifting capability to lift the device to shore if needed (crane)
- Local workshop facilities
- Mechanical technicians
- Electrical technicians
- Storage for replacement parts/PTO systems
- Welding and machining
- Health & Safety/Emergency Response
- Diving services

GET IN TOUCH

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