

Design, Build and Deploy

- 14 1st generation 5 and 25 kW systems sold as test or demonstration systems (rivers, canals, and industrial outflows)
- 3 2nd generation 5 kW systems sold final optimization and documentation underway (one unit installed and powering a village in Nepal and two powering a school in Myanmar)
- Second generation 25 kW system to be deployed summer 2016 through the BCIP program in a First Nation community
- 500 kW tidal demonstration project (two 250 kW units)

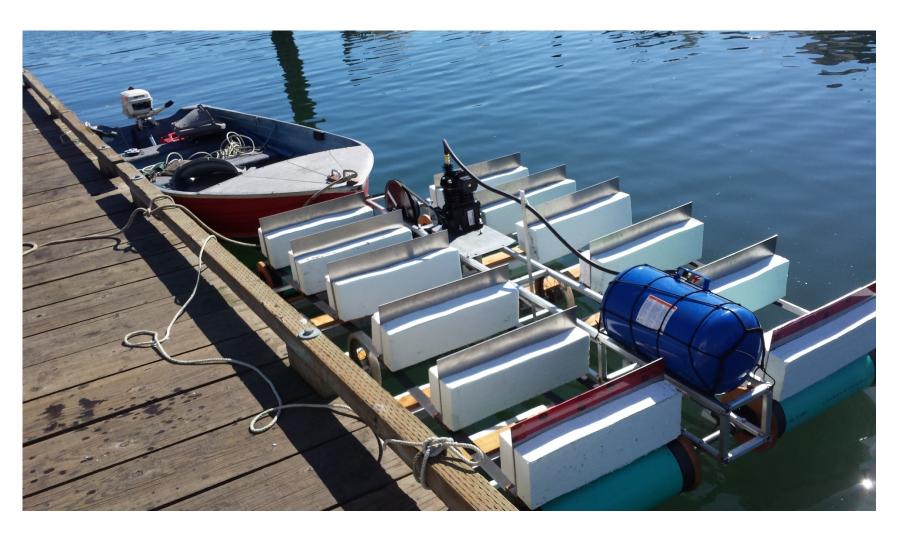


Summary

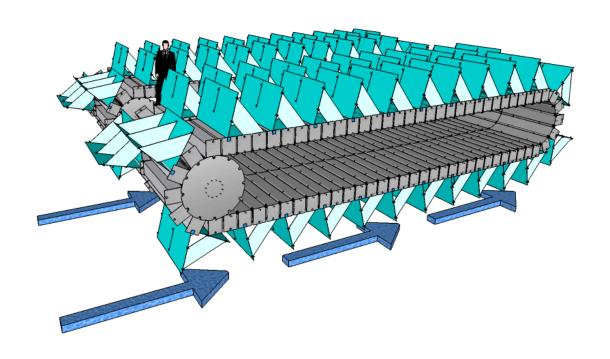
- Our first generation systems provided the experience necessary to develop field hardened designs
- We have moved into commercial production of Generation 2 – 5 kW Direct Drive systems; 25 kW systems to follow
- Product line will be extended with the development of the 250 kW tidal units
- On our way to realizing the vision of a robust <u>Canadian Manufacturing Industry</u>, providing innovative technologies to produce clean reliable power solutions locally and for export

GO WITH the FLOW TECHNOLOGIES INC









GO WITH the FLOW TECHNOLOGIES INC

in SYNERGY with NATURE



WWTURBINE



In-Flow Water Current Technology Features



Highly Efficient Energy Extraction
Low Energy Production Costs
Low Installation & Maintenance Expenses
Installation Simplicity
No Negative Long Term Effect on Habitats
Single or Multiple Installations
Vessel Channels & Accelerates Current
Deep or Shallow Water Operation

Bi- or Mono-directional



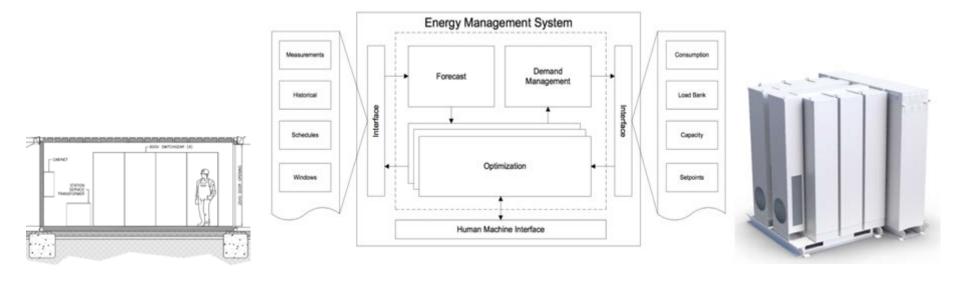
Energy Microgrid & Energy Management System

Microgrid

- Tidal energy power plant
- Battery energy storage system
- Diesel generator sets (3)
- E-house
- Inverters
- Voltage transformers

EMS

- Unit black start and priority
- Load pickup ability
- Load following capability
- Frequency regulation
- Communication scheme
- Total operation control
- Synchronizing process



WWTURBINE





UNLOCKING UNTAPPED ENERGY FROM WATER

June 2016

Instream Energy Systems

Enabling Energy Capture through Innovation



- Instream's revolutionary power generation system and disruptive approach enable clean electricity production in:
 - Canals
 - Rivers
 - Marine environments (near-shore tidal and estuaries)
- The Instream solution is a distributed energy system of small, smart devices that network together to create a high availability power plant
- Patent-pending BAE Systems rotor design increases efficiency over incumbents by 71%
- BAE providing fluid dynamics modelling
- Proven turbine operation with third-party performance validation in canal and river environments
- Intellectual property is 100% owned by Instream







Instream Energy Systems

A Better Way to Generate Clean Electricity





A breakthrough approach to clean power generation that unlocks vast untapped in-stream resources

Instream Energy Systems

Projects and Partners





BChydro 🗭









- BAE Systems design
- Proven performance
- Four-turbine array at BC Hydro facility
- Multi-year project with the USBR and Sandia - \$1M US DOE grant
- First turbine sale to UNH / NH DOT under US NSF grant
- Secured marine pilot site in Washington









MRC Open House

Victoria, BC 14th June 2016

ANDRITZ HYDRO Hammerfest

History and previous milestones

1997

Company started in Hammerfest, Norway

2003

HS300 - 300kW turbine:

World's first tidal turbine prototype connected to the grid.

Installation: 2003 2004 Grid connection:

Re-installation: 2009 (after maintenance) Kvalsund, Finnmark, NO Site:

Rated power: 300kW Water depth: 50m Rotor diameter: 20m Total operating hours: >16,000h

2008

Main Glasgow, UK office established

2011

HS1000 - 1MW turbine:

Operation of turbine was precursor to development of the first commercial project.

Installation: December 2011 Grid connection: February 2012

Site: EMEC, Falls of Warness, Orkney, UK

Rated power: 1000kW Water depth: 52m Rotor diameter: 21m

Promising Results

From tidal turbine testing at EMEC in Scotland

able technology for the gen- ceeding 100 knots at times, meticulous eration of energy from tidal planning was required to take advancurrents is the primary objective of tage of each weather window as it was ANDRITZ HYDRO Hammerfest. presented. Thus, in proving the functionality of turbine HS1000 at the European Ma- the turbine underwent extensive testing, sential knowledge required for commerrine Energy Centre (EMEC) is a ma- with particular focus on comparing dialization. jor milestone in realizing the com- measured loads and performances with mercial potential of this technology. figures calculated during the project de-

The first machine of its kind, the HS1000, represents the forerunner of and loading remaining within the design to harness energy from strong water 3 GWh to the grid annually. currents generated by the lunar tides stalled at EMEC's tidal test site in De- the turbine was retrieved for inspection cember 2011 and the installation was and maintenance. The machine was carried out in three stages, using a found to be in excellent condition, with special offshore construction vessel in a only some minor modifications being. Phone: +43 50805 52694 32-hour operation in the middle of made on internal components. These

local workshops and labor, and the re installation was carried out utilizing local vessels, operated by various companies based in Orkney. In its own right, this maintenance operation has provided the demonstrator device, the tidal. During the first 12 months of operation, extremely valuable experience and es-

Since re-installation in late August 2013 sign phase. Results were very positive, the turbine has been operating continuwith the turbine performing as expected ously in a bid to prove its reliability. The original target was to operate continuthe commercial tidal turbines that will envelope. Specifically, it was clear that ously for 6 months, and export at least be installed in the near future in order the turbine could export in excess of 1 GWh to the grid. At the time of writing, energy export is more than 1.2 GWh firmly surpassing the performance tar-(Hydro News 22). This machine was in-Following this initial 12-month period, gets deemed necessary for the com-

peter.gnos@andritz.com

mercial operation of this technology.















ANDRITZ HYDRO Hammerfest

Technology overview

Main features

- Proven technology solutions
- Proven track record of power delivery to the grid
- Suitable across a range of water depths and velocities
- Reliable operation and maintenance
- Redundancy for high availability
- Optimised turbine control and energy yield
 - Variable speed
 - Blade pitch
 - Nacelle yaw
- Entirely subsea, non surface piercing

Technical characteristics

Rated power: 500-1750 kW (site dependant)

Power regulation: Variable speed, variable pitch, yawing system

Operating depth: 30-60m

Rotor:

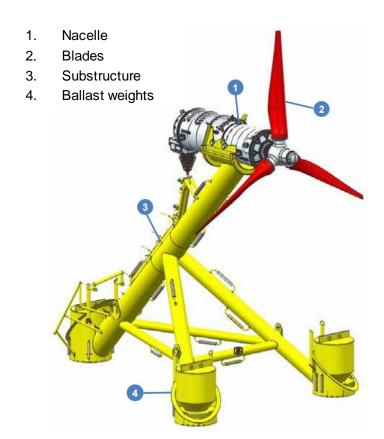
Type: 3 bladed open Rotor swept area: 250-600 m² Nominal speed: 9 - 14.5 RPM

Generator:

Type: Induction
Nominal output: 500-1750 kW

Installation: Heavy lift vessel/barge (with ROV support)

Lifetime / Service: 25 years / every 5 years



Future Innovation

With the technology having been proven the main focus in the future is to bring down the LCOE

- Target costs to be similar to offshore wind
- Technology to be viable if government subsidies reduced.



ANDRITZ HYDRO Hammerfest

Current and future activities

2014 – Current

HS1500 – 1.5MW turbine:

First commercial contract with MeyGen to deliver 3 x 1.5MW machines.

Installation: Q4 2016

Site: Inner Sound, Pentland Firth, UK

Rated power: 1500kW Water depth: 32m Rotor diameter: 18.2m

2017 – onwards

Sound of Islay, Scotland:

Discussions ongoing to supply turbines for a 10MW array

Future

Bay of Fundy, Canada:

Supporting DP Energy in assessment and development of a berth at FORCE.

Indonesia:

Supporting SBS and ESBM in the development of tidal projects in Indonesia.



West Coast Wave Initiative (WCWI) at University of Victoria

Motivation & objectives | Gross resource | Net resource | Usable resource

Mandate:

To understand the potential, opportunities and value for a wave energy industry in Canada.

Resource Assessment

- SWAN wave model
- 12 yr hindcast model
- 48 hr. forecast model
- Fully directional models
- 4 Measurement buoys



GROSS RESOURCE

Technology Modeling

- Fully coupled hydrodynamic, mooring and device models
- Hydraulic, pneumatic & electromagnetic PTO
- Optimal device control
- Uncertainty assessment
- System optimization



NET RESOURCE

Grid Integration

- KW: Off-grid communities
- MW: Vancouver Island
- GW: Provincial / National Scale



USABLE RESOURCE

Resource Assessment: Modelling and Measurement

Motivation & objectives | Gross resource | Net resource | Usable resource

Internationally recognized wave resource measurement and modelling program

Wave Condition Measurement:

- Current: 4 dedicated WCWI buoys
- Future: Additional WCWI buoy and AWAC

Wave Condition Modelling:

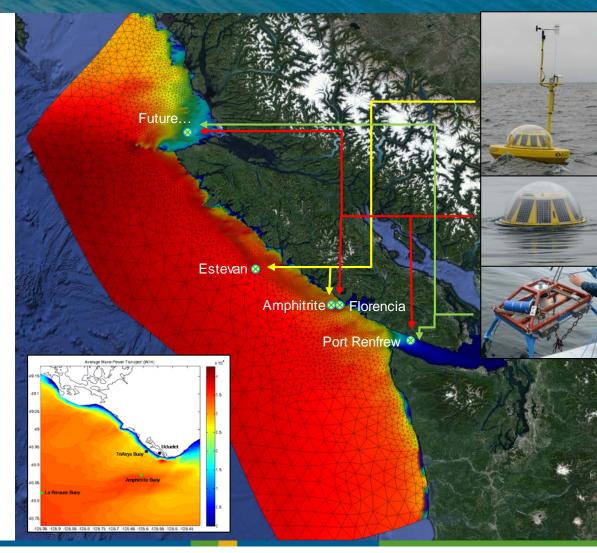
- 12 year hindcast (2004 2015)
- 48 hour forecast
- ~130 000 nodes/locations
- ~ 50m nearshore resolution
- Full frequency-direction wave spectrum.

International Comparison:

- Wave Hub (England): < 25 kW/m
- EMEC (Scotland): 24 kW/m
- Amphitrite Bank (Ucluelet): 34 kW/m

Resource Assessment Partners:

- AXYS Technologies (Canada)
- Cascadia Coastal Research (Canada)
- BC Ministry of Energy and Mines (Canada)
- Sandia National Labs (USA)
- Golder & Associates (International)

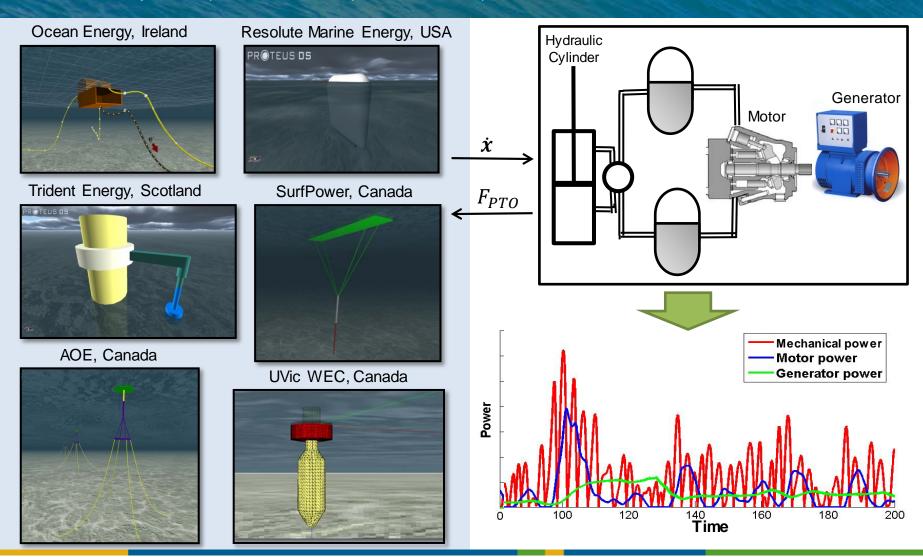






WEC Technology Simulations – Fully Coupled Analyses

Motivation & objectives | Gross resource | Net resource | Usable resource

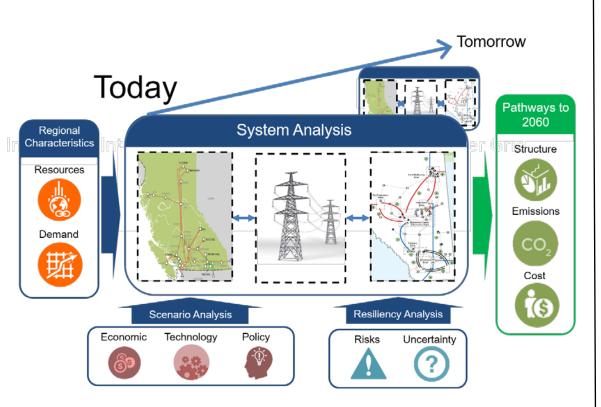






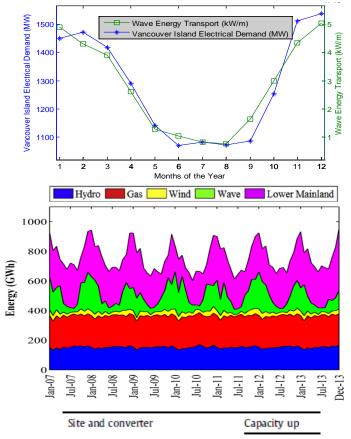
Grid Integration: Value rather than Cost.

Motivation & objectives | Gross resource | Net resource | Usable resource



Grid Integration Partners:

- 2060 Project /IESVic University of Victoria (Canada)
- BC Hydro (Canada)
- Pacific Institute of Climate Solutions (Canada)
- Barkley Project Group (Canada)



Capacity up Reserves (MW)
161.24
67.06
28.67
30.96
35.57









- Point Absorber

 Direct Drive to Generator

- 25,000 kg weight

- Base: 8m by 8m

- Dome: 6 m high

TC Classification:
 Research Buoy



empowering people in harmony with nature

mermaidpower.com





- Small Waves (G.S.)
- 4 Live Cams
- Measuring energy from different sized waves
- Developing

 automatic power
 optimization
 (amps per wave size)



empowering people in harmony with nature

mermaidpower.com

- Testing Moorage

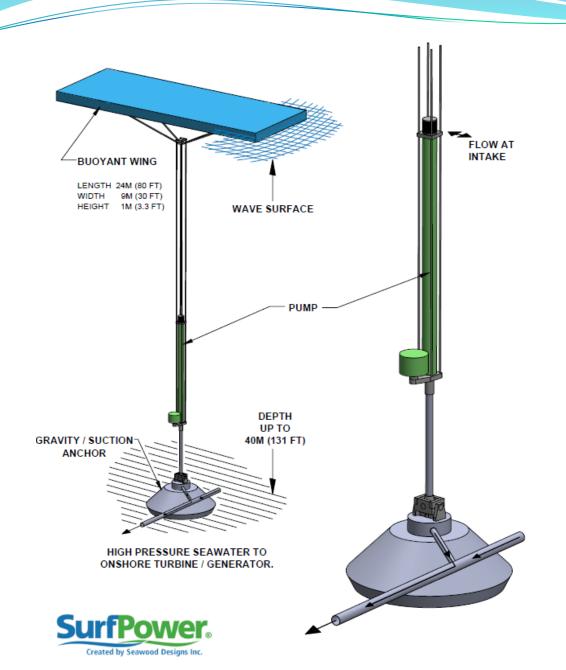


Neptune 4 2017 Objective is to test storm survivability Test Site Needed -- Near Shore -- with BC Hydro meter



empowering people in harmony with nature

mermaidpower.com



Annual Yield"Wave to Wire"1 GWh

90
Average
North American
Households

450
Average
Global
Households
(with power now)

100 Unit SurfPower Array – Cost of Energy

annual energy recovery (wave to wire)
 100 GWh

approximate rated power
 35 MW

installed cost with 10% contingency
 \$118 million US

15.8 cents/kWh Cost of Energy Based on:

installed cost \$118 million

• 50% of service vessel cost \$6 million

50% of manufacturing tooling/plant cost \$10 million

• debt finance 4.5%

• capital finance 12%

annual maintenance/operating expense \$4 million

operating life 40 years

U.S. Department of Energy's 2030 wave energy objective is 15 cents/kWh



Where Next for SurfPower?

- Seek financial partners effort to date has been self-funded with limited government support.
- Design, build and test a ½ linear scale unit.
- Expand our technical team capabilities to ensure SurfPower's long term success.







- ✓ Coastal Modelling
- ✓ Met-Ocean Analysis
- ✓ Marine Renewable Energy

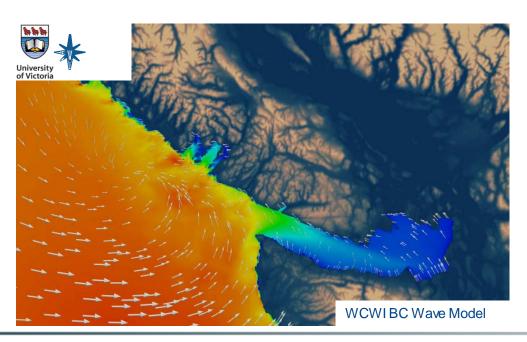


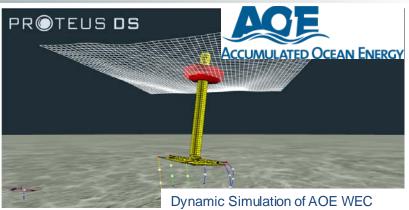
Dr. Scott Beatty

Victoria, BC, Canada www.cascadiacoast.com

CANADIAN ACTIVITIES

- WCWI
- IEC Standards
- AOE Canada



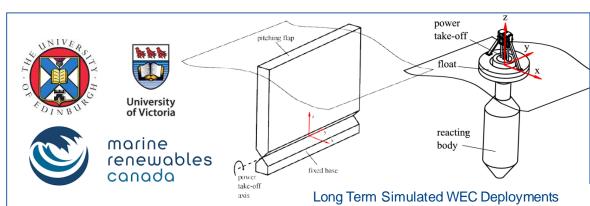


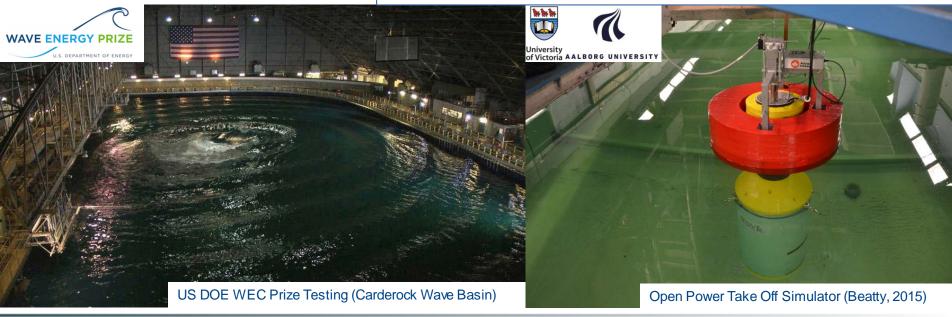




INTERNATIONAL ACTIVITIES

- OPEN PTO
- LTS WEC
- WEC Prize

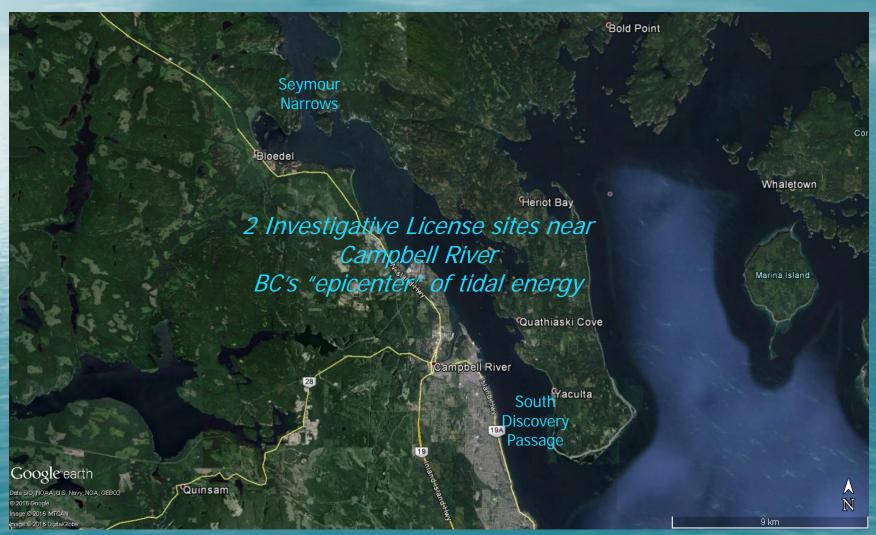






SRM PROJECTS LTD.

BC Tidal Energy Collaborative Initiatives





BC Tidal Energy Collaborative Initiatives

- Hydrodynamic modeling Cascadia Coast 2014
- Marine spatial planning study UBC IRES and Hemmera 2015
- Discovered many marine uses and stakeholders
- Visual impacts i.e. surface TEC's not acceptable
- Key issue uncovered potential for snagging of TEC's by tug/barge tow cables
- Approached DSA and MAX To collaborate on R&D project to better quantify this risk
- Google earth Received SMC/TC 114 standards funding to google earth received SMC/TC 114 standards funding to google earth received SMC/TC 114 standards funding to google earth received street for the standard of the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street for the standards funding to google earth received street funding to google earth recei





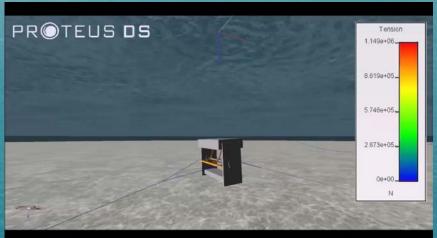


Tow Cable Snag Analysis – 2 Questions

How far do tow cables normally droop?

Can we design a "snag-proof" TEC floating just below surface of the water?





Under worst case running with current at ~4 m/s but otherwise best industry towing practices cable droop was 15 m to 16.5 m

→ Similar to Transport Canada required navigation clearance

The answer appears to be YES!

SUSTAINABLE RESOURCE MECHANICAL ENGINEERING AND PROJECT MANAGEMENT - NANAIMO, B.C., CANADA - WWW.SRMPROJECTS.CA







Part 2 Study in Partnership with Alaska Hydrokinetic Energy Research Center

River Current Debris Impact Analysis

Analysis focused on debris diverter developed by AHERC



Log and root ball impacts were modeled at various current speeds

Calculated impact loads compared qualitatively with field data

The geometry and buoyancy of debris significantly affect impact loads

http://tc114.oreg.ca/?page_id=628 to access the full report







Successful Government/Industry Collaboration Harnessing BC's Expertise

Thanks to NRCan and Marine Renewables
Canada for funding this important work!

http://tc114.oreg.ca/?page_id=628 to access the full report



MacArtney 11 kV (7.6 MW) Wet Mate Connector

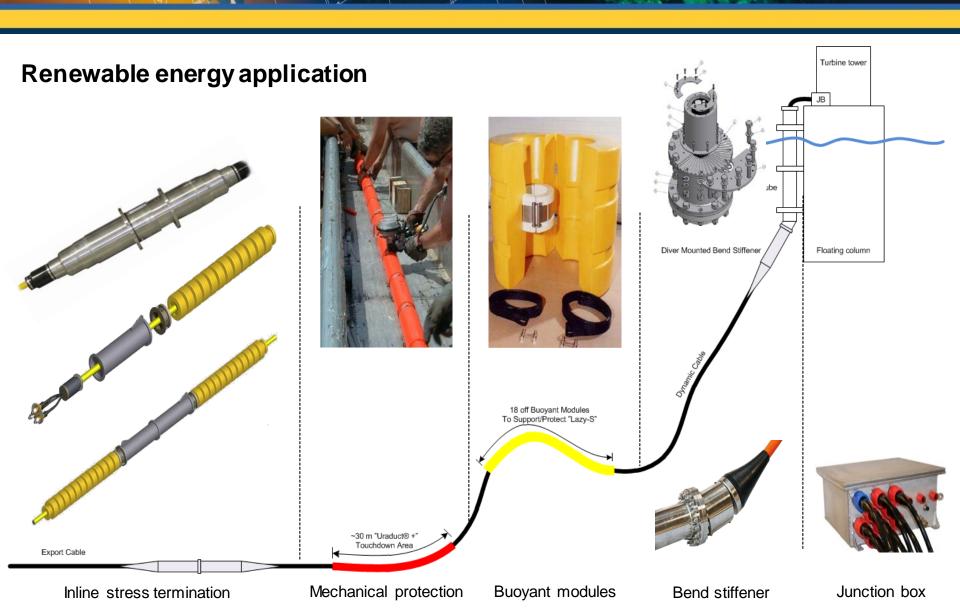












Understanding Potential Interactions between Marine Mammals, Fish

and Tidal Turbines.



SMRU Consulting

Wind, Wave & Tidal

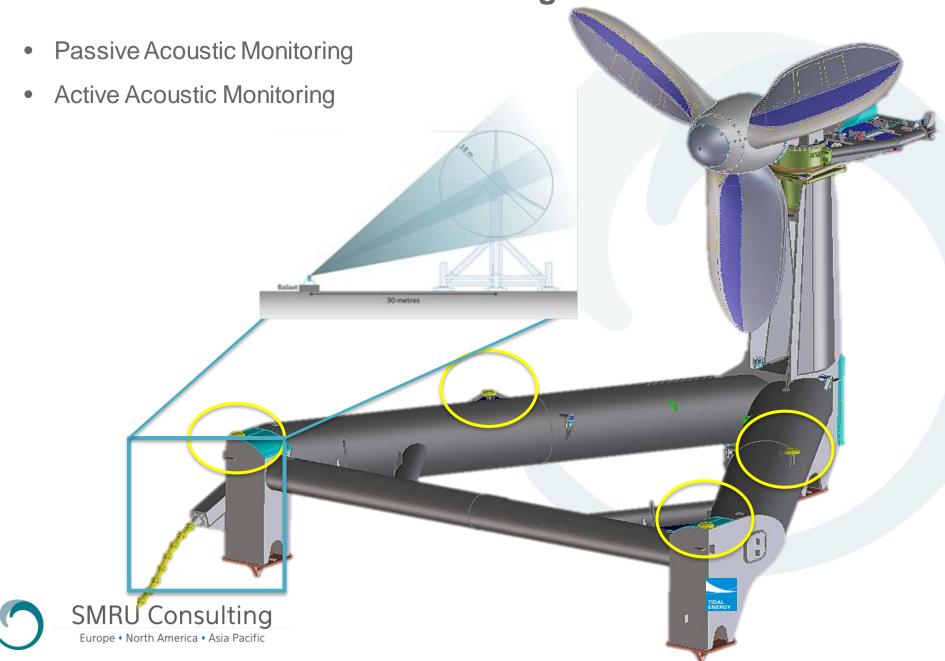








Marine mammal and fish monitoring around tidal turbines



AXYS Technologies - Company Background

40+ years in business (founded in 1974)

Focused on remote environmental monitoring systems

- Metocean Buoys
- Floating LiDAR Buoys
- Wave & Current Buoys
- Custom Buoys & Systems

800+ systems sold across multiple market segments

- Offshore Renewable Energy
- National Weather Service Networks
- Offshore Oil & Gas
- Ports & Harbours
- Science & Research
- Offshore Construction

ISO 9001:2008 Certified



Located in Canada, Belgium, Italy and France

Sustainability & Environmental Policy









AXYS' Renewable Energy Solutions

Wave and Current Buoys

- » Measures directional wave data and current velocity & direction
- » Determine energy potential at location

FLIDAR 6M

- » Wind resource assessment and metocean monitoring from a single platform
- » Deployed on more projects worldwide than any other system

Metocean Buoys

» Measures meteorological and oceanographic data important for engineering design and operational purposes

- Energy resource assessment
- Farm design & contract management data
- Site character weather data

- Real-time metocean data during construction of the offshore farm
- Real-time metocean data after construction of the farm aids with routine service maintenance and validates models
- Metocean data to analyse device performance and/or adding new devices

Time

ASSESSMENT

MANUFACTURING

PRODUCTION

UPGRADE

Renewable Energy Assessment

















vave energy



- 1. University of Michigan
- 2. Fishermen's Energy
- 3. United States Navy
- 4. DONG Energy
- 5. National Cheng Kung University (NCKU)
- 6. Mainstream Renewable Power
- 7. United States Department of Energy (DoE), Pacific Northwest National Laboratory
- 8. EDPi
- 9. EDF Energies Nouvelles
- 10. LEM
- 11. NORCOWE
- 12. Carnegie Wave Energy
- 13. Oceanlinx Wave Energy
- 14. West Coast Wave Initiative
- 15. Northwest National Marine Renewable Energy Center























Key Competence

Turbulence measurements and instrumentation

Company

Established 2005, 16 staff in Victoria, BC

Markets

- Oceanographic research, active in 23 countries
- Universities, Navy, Marine Renewables

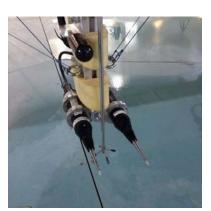
Motivation

Effects on device performance & loading

Activities

- Six successful field projects to study in-situ turbulence at tidal energy sites
- Partnering with 11 entities in Canada and UK
- Designated EUREKA project lead







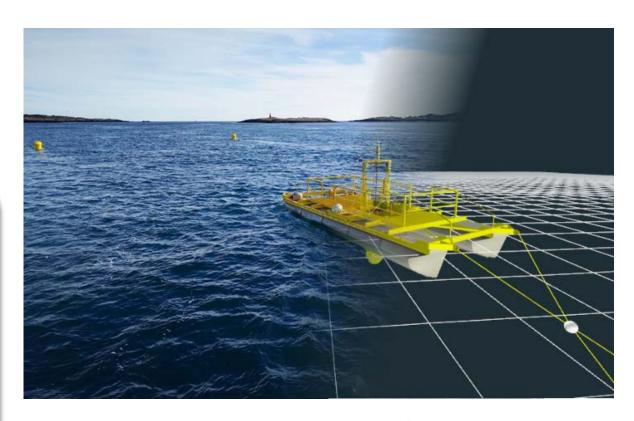


OPERATIONS ANALYSIS

INSTALLATION ANALYSIS

MOTION & TENSION MEASUREMENT

MARINE STANDARDS



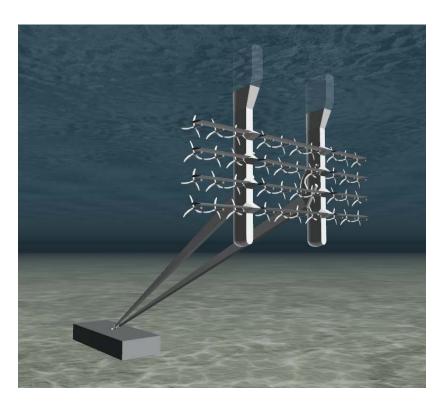


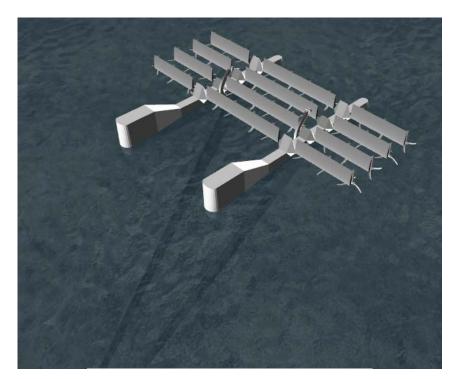


Operations Analysis









PR®TEUS DS



Installation Analysis







