force | Fundy Ocean Research Centre for Energy

Project Update 2020

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2020 Highlights

Technology Demonstration

- **Big Moon Canada Corporation (BigMoon) was announced as the successful applicant to fill berth D** at FORCE. As part of the agreement, the company will also remove the Cape Sharp turbine.
- **SMEC now plans to deploy three new PLAT-I platforms** at FORCE. Each platform will be equipped with SCHOTTEL Instream Turbines (SIT 250), with a rated power output of 420kW. The first platform is now under assembly at A.F. Theriault & Son Ltd in Meteghan. Commissioning trials will take place in Grand Passage during winter 2021, with construction work at FORCE targeted to commence Q2 2021, and with two additional platforms installed at a later date. The deployment of three platforms would represent the completion of phase 1 of SMEC's Pempa'q In-stream Tidal Energy Project.
- **Minas Tidal adopted the technology solution (PLAT-I floating platform with Schottel turbines)** presently being tested by SME in Grand Passage. This technology change was approved by NSDEM.

Research and Environmental Monitoring

- **In 2020, FORCE successfully applied for and won a $2M grant from NRCan's Emerging Renewable Power Program** to support greater regulatory clarity around tidal project development. The Risk Assessment Program (RAP) for tidal stream energy is designed to create a detailed, credible assessment tool to gauge the probability that fish will encounter a tidal device. Key partners include Acadia University, Marine Renewables Canada (MRC), Mi'kmaw Conservation Group (MCG), Confederacy of Mainland Mi'kmaq, Ocean Tracking Network (OTN), and Dalhousie University.
- **FORCE's applied research programs continue**, including the Vectron, radar, hydroacoustics, continued ADCP deployments and data collection, focused effort to characterize the wake from Black, MRE GIS: display and communicate large and complex data sets, tide gauge recovery and repair, and integration of FORCE data into the Canadian Integrated Offshore Observation System (CIOOS)
- **Continued environmental monitoring** at the FORCE site

Project Updates

AWARENESS AND UNDERSTANDING

Social license for MRE depends on public and regulator confidence that the effects of tidal devices on marine life and the environment are understood and acceptable. Ultimately, tidal energy needs to co-exist with other users of the marine environment.

Representatives from fisher associations, First Nations bands, and some members of the public, while supporting marine renewable energy in principle, have expressed concerns about any potential impacts. Some of these concerns relate to adequacy of the near-field monitoring programs of technology developers, potential financial and environmental risks of impacts on marine life, and involvement of foreign companies (particularly after the collapse of OpenHydro).

FORCE's community liaison and environmental monitoring advisory committees have representation from the Nova Scotia Mi'kmaq and fishing communities, and FORCE has had ongoing involvement with lobster fishers who work near the test area. However, FORCE recognizes that there are still many other individuals and communities to connect with. There remains a pressing need to take additional measures to engage with groups from around the province, with a focus on fishing and First Nations communities, to understand concerns.

FORCE outreach activities in 2019/2020 focused on five key engagement areas:

- Online brand and reach
- Attendance at conferences and events in the fisheries, renewables, and ocean technology sector
- Engagement with indigenous groups/organizations
- Government relations
- Visitor Centre activities, including outreach to the local community in Parrsboro and Cumberland County.

BUILDING CAPACITY THROUGH INTERNATIONAL COLLABORATION

OES (formerly Annex IV) State of the Science Report 2020

FORCE Science Director, Dr. Dan Hasselman, collaborated with 14 co-authors from around the world representing academic institutions, governmental organizations, non-governmental organizations, and other relevant stakeholders to produce a chapter for the OES 'State of the

Science Report 2020'. The chapter describes the state of development of environmental monitoring around tidal energy turbines, the outcomes that have been shown, and a process for applying consistent monitoring practices. The report was published June 8, 2020.

TECHNOLOGY DEVELOPMENT

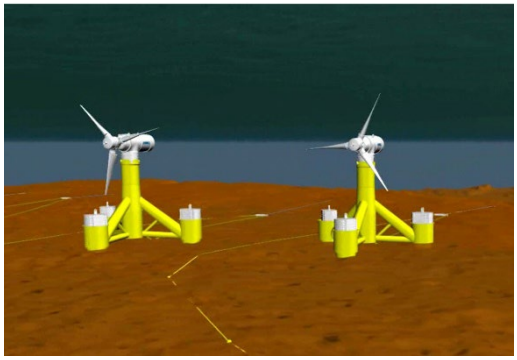
Berth D

The Cape Sharp Tidal turbine remains at berth D at the FORCE site. It is not functioning: its rotor is stationary and does not present a risk to marine life or the environment. This was confirmed by FORCE by monitoring ADCP data during peak tidal flow of each month since March 15, 2019. After a year of monitoring at the FORCE site, the monitoring data continued to demonstrate that the turbine remains non-operational.

In September 2020, Big Moon Canada Corporation (BigMoon) was announced as the successful applicant to fill berth D. As part of the agreement, the company will also remove the Cape Sharp turbine. With authority from the Minister of Energy and Mines, the procurement administrator (Power Advisory LLC, led by John Dalton) has granted BigMoon a Marine Renewable-Electricity license and a power purchase agreement, with an energy rate of $475/MWh. The project start date is largely dependent on the economic recovery from the COVID-19 pandemic, which could impact this anticipated start date. It is not known at this time what the impact of the pandemic will be on Big Moon's supply chain.

BigMoon has provided a security deposit of $4.5 million in relation to their commitment to the retrieval of the Cape Sharp turbine. The company must submit and have a retrieval plan approved by the province and has until Dec. 31, 2024 to raise the turbine.

DP Energy



In 2018, NRCAN announced $29.8 million to FORCE berth holder Halagonia Tidal Energy Ltd. from the Emerging Renewable Power Program for a nine-megawatt tidal energy system at FORCE. The project includes six Andritz Hydro Mk1 1.5MW seabed mounted tidal turbines.

In 2019, DP announced the successful deployment of ADCPs at berth E with support from Seaforth Geosurveys of Dartmouth, Huntley's Sub Aqua Construction of Kentville, and Applied Renewables Research of Northern Ireland.

Sustainable Marine Energy

Sustainable Marine Energy Canada's (SMEC) first PLAT-I prototype was deployed at a test site in Grand Passage in 2018. SMEC now plans to deploy three new PLAT-I platforms at FORCE. Each platform will be equipped with SCHOTTEL Instream Turbines (SIT 250), with a rated power output of 420kW. The first platform is now under assembly at A.F. Theriault & Son Ltd in Meteghan, with

launch scheduled for 2020. Commissioning trials will take place in Grand Passage during winter 2021, with construction work at FORCE targeted to commence Q2 2021, with two additional platforms installed at a later date. The deployment of three platforms would represent the completion of phase 1 of SMEC's Pempa'q In-stream Tidal Energy Project; SMEC believes this will be the world's first floating tidal energy array. Additional platforms are targeted for installation into 2023, representing a total project scope of 9 megawatts for berths A (Minas Tidal) and C.

Minas Tidal

As mentioned above, Minas Tidal adopted the technology solution (PLAT-I floating platform with Schottel turbines) presently being tested by SME in Grand Passage. This technology change was approved by NSDEM.

RESEARCH AND DEVELOPMENT

Risk Assessment Program for Tidal Stream Energy

In 2020, FORCE successfully applied for and won a $2M grant from NRCan's Emerging Renewable Power Program to support greater regulatory clarity around tidal project development.

RAP's goal is a clearer understanding by regulators, rights holders, community stakeholders, and technology developers of any potential risks to marine life in advance of turbine deployment and monitoring. Long-term, direct turbine monitoring remains critical to measuring any potential environmental effects – however, no tool currently exists to quantify what these impacts may be.

The Risk Assessment Program (RAP) for tidal stream energy is designed to create a detailed, credible assessment tool to gauge the probability that fish will encounter a tidal device. The encounter probability will be determined by combining two real-world data sets:

Biological Data

Over the last decade, hydroacoustic receivers have been deployed throughout the Bay of Fundy from research programs in Canada and the United States. These have collected movement data from various fish species carrying acoustic tags and provide a tremendous resource for understanding the distributions of fish species in the Bay of Fundy over time. RAP will utilize these data to build the largest multi-species, spatiotemporal data set of fish distribution in the Bay of Fundy.

Physical Data

RAP will build a high-resolution radar network to create the first spatiotemporal flow atlas of the Minas Passage. This upgrades existing site data to deliver real-time hydrographic mapping (mapping of physical features of the ocean) which will gather data on currents, eddies, and waves – important determinants of marine animal distribution.

FORCE's key partners include Acadia University, Marine Renewables Canada (MRC), Mi'kmaw Conservation Group (MCG), Confederacy of Mainland Mi'kmaq, Ocean Tracking Network (OTN), and Dalhousie University.

The Pathway Program

FORCE is working collaboratively with the OERA to advance 'The Pathway Program' to identify effective and regulator approved monitoring solutions for the tidal energy industry in Nova Scotia.

Phase I, 'Global Capability Assessment' – comprehensive literature reviews about the use of different classes of environmental monitoring technologies for monitoring tidal energy devices around the world were completed in 2019.

Phase II, 'Advancing Data Processing and Analysis' – work with DeepSense (Dalhousie University) to automate the post-processing of hydroacoustic fish survey data is nearing completion. Automation of PAM data and the development of better harbour porpoise click detector and classification algorithms for application to Minas Passage has commenced.

Phase III, 'Technology Validation' – FORCE is working collaboratively with Sustainable Marine Energy Canada (SME) to assess the capabilities of different classes of environmental monitoring technologies in high flow environments. FORCE recently completed a study that compared the efficacy of different PAM devices for monitoring harbour porpoise in the Minas Passage.

Fundy Advanced Sensor Technology (FAST)

As tidal stream projects compete for support in Canada and internationally, there remains a pressing need to identify and validate sites favourable for development. While some tools for capturing marine data exist, many cannot function reliably in high flows – nor do we have standard methods to deploy and recover the instruments, nor standard methods of analysis.

The Fundy Advanced Sensor Technology (FAST) program was designed to address this research gap – combining both onshore and offshore monitoring assets. Work is underway at FORCE in a number of key areas:

Vectron (on FAST-1)

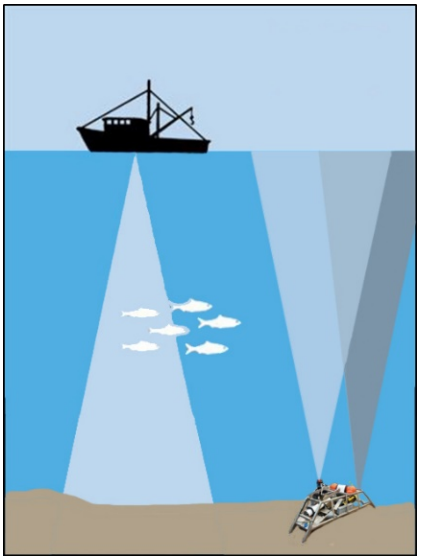
FORCE's Vectron is the world's first stand-alone instrument to remotely measure, in high resolution, turbulence in the mid-water column. It uses a series of five (5) ADCPs aligned so that their beams converge to create a higher resolution data set when compared to a traditional ADCP on its own. Measurements and analysis from the Vectron will help tidal energy companies to better design devices, plan marine operations, and characterize the tidal energy resource.

The Vectron was developed in collaboration with Dalhousie University, Memorial University, Nortek and FORCE. FORCE is again partnering with Dalhousie to complete the Vectron for industry use, with project funding through agreements between FORCE, OERA and ACOA and Dalhousie and RNST. To date, this funding has been used to improve the Vectron power's efficiency, to level the platform to ensure beam convergence, and to scope out and test the new, cost-efficient solution for Vectron deployment.

Hydroacoustics (on FAST-3)

FORCE's third platform has been used for the last two years to monitor fish densities in the mid-field of the turbine. The FAST team conducted comparative research to evaluate the viability of bottom mounted fish profiling data collection as opposed to downward facing fish profiling data from a vessel-mounted hydroacoustic echosounder.

Data collection activities for this project were completed in 2018. FORCE and its partners, including Echoview Software, then conducted the data processing and analysis in 2019. Temporal patterns of fish density in the stationary datasets collected at FORCE highlight the importance of ongoing 24-hr mobile hydroacoustic surveys to understand how fish use the FORCE site. These surveys would benefit from more advanced tools to identify and remove acoustic backscatter from entrained air in the water column. This project was funded by Natural Resources Canada (NRCan), the NSDEM, and the OERA.



Comparing vessel-mounted vs bottom-mounted fish monitoring

Radar

Since 2015, an X-band marine radar has been continuously operating atop the FORCE Visitor Centre, overlooking the western Minas Passage. Through a collaboration with the National Oceanography Centre, U.K., software was written for converting the radar backscatter into spatial maps of the velocity field. Further work with FORCE's Project Scientist, Jeremy Locke, has led to the development of new methodologies for high-resolution eddy mapping, as well as the installation of a second radar on Cape Sharp headland, which will be combined with the FORCE visitor centre radar to provide a view of the full Minas Passage and allow for both monitoring of the sea state and vessel activity.

Radar MkII installation at FORCE VC in April

Other Projects

- Continued ADCP deployments and data collection to better understand the resource at the FORCE Site, and to characterize wake effects of turbines
- A focused effort to characterize the wake from Black Rock as RADAR has identified significant turbulence about the relatively large geological mass
- MRE GIS: display and communicate large and complex data sets
- Integration of FORCE data into the Canadian Integrated Offshore Observation System (CIOOS)

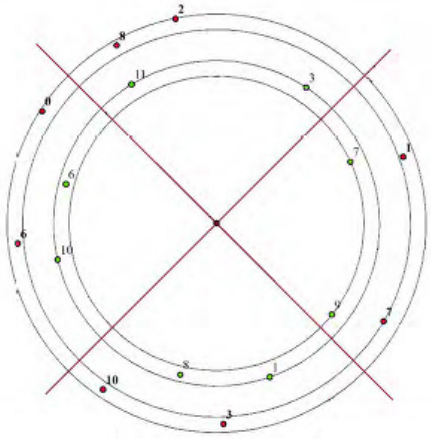
ENVIRONMENTAL EFFECTS MONITORING

Monitoring activities began at FORCE in 2009, with the most recent phase beginning in May 2016.

Academic and research partners include Acadia University (Wolfville, NS), Envirosphere Consultants (Windsor, NS), GeoSpectrum Technologies Inc. (Dartmouth, NS), JASCO Applied Science (Dartmouth, NS), Luna Ocean Consulting (Shad Bay and Freeport, NS), Nexus Coastal Resource Management (Halifax, NS), Ocean Sonics (Great Village, NS), Sea Mammal Research Unit Consulting (Canada) (Vancouver, BC), and the University of Maine (Orono, ME).

Lobster.

FORCE conducted a baseline lobster catchability survey in fall 2017 (NEXUS Coastal Resource Management Ltd., 2017). This survey consisted of commercial traps deployed at varying distances around the future location of the CSTV turbine. Although a repeat of the survey was planned for fall 2018, the non-operational status of the CSTV turbine meant the objectives of the 2018 survey effort could not be achieved.



The lobster catchability study consisted of two concentric rings increasing in distance from the turbine.

In 2019, FORCE commissioned TriNav Fisheries Consultants Ltd. (TriNav) to redesign FORCE's lobster monitoring program based on feedback from regulators to include a more statistically robust study design. TriNav identified the combination of a modified catchability survey design and a mark-recapture study using conventional tags as the best approach for monitoring lobster at the FORCE site.

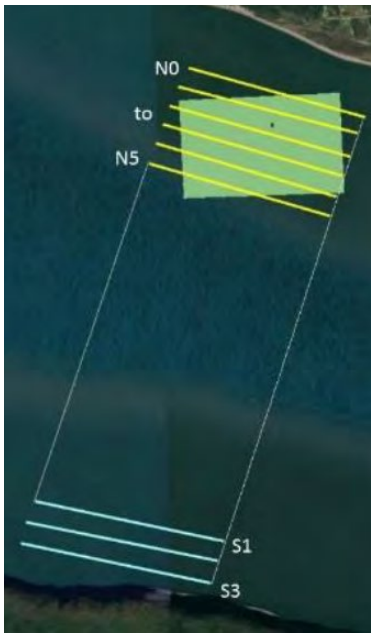
Given the operational restrictions generated from the COVID-19 pandemic in 2020, this new study design is intended to be implemented in 2021.

Read more about lobster studies at FORCE here.

Fish:

FORCE has been conducting mobile hydroacoustic fish surveys since May 2016 to test the EA prediction that tidal stream turbines are unlikely to cause substantial impacts to fishes at the test site (AECOM, 2009). To that end, the surveys are designed to:

- test for indirect effects of tidal stream energy turbines on water column fish density and fish vertical distribution; and
- estimate the probability of fish encountering a device based on any 'co-occurrence' relative to turbine depth in the water column.



Mobile fish surveys encompass two tidal cycles and day/night periods traveling with and against the tide across transects, shown here.

In 2019, the University of Maine conducted an analysis for 15 fish surveys conducted from 2011-2017. The report identified a statistically significant difference in fish presence/absence and relative fish density between historical and contemporary data sets that may be attributable to differences in the survey design/execution between the time periods, or could reflect changes in fish usage of the site. As such, remaining analyses were restricted to the contemporary data sets. The results revealed that:

i) data collection during the ebb tide and at night are important for understanding fish presence in the CLA,

ii) various explanatory variables and their additive effects should be explored further, and

iii) increasing the frequency of surveys during migratory periods (consecutive days in spring/fall) may be required to understand to patterns and variability of fish presence and density in Minas Passage.

Mobile surveys use a scientific echosounder, the Simrad EK80, mounted on a vessel

Importantly, the report suggested a statistically significant difference in fish presence/absence and relative density between the CLA and reference site, suggesting that the reference site may not be sufficiently representative to serve as a control for the CLA, and for testing the effects of an operational turbine on fish density and distribution in Minas Passage. Additional work is underway using data from eight additional contemporary fish surveys (2017-2018) to determine whether this finding is biologically meaningful, or whether it is simply a statistical artefact of how the data was aggregated in the original analysis.

Read more about fish surveys at FORCE here and read the report from the University of Maine here.

Marine mammals:

In 2020, FORCE continued two main activities to test the EA prediction that project activities are not likely to cause significant adverse residual effects to marine mammals within the FORCE test site (AECOM, 2009).

Passive Acoustic Monitoring (PAM)

FORCE uses marine mammal click detectors known as C-PODs that record the vocalizations of toothed whales, porpoises, and dolphins. The environmental monitoring focuses mainly on harbour porpoise – the key marine mammal species in the Minas Passage (Gaskin, 1992). The goal is to understand if there is a change in marine mammal presence in proximity to a deployed tidal turbine.

Retrieving C-PODs

SMRU recently provided a report describing the results of C-POD deployments from May 5, 2018 – August 14, 2019. This report is available as Appendix I of the Environmental Effects Monitoring Program Quarterly Report April - June 2020 available on the FORCE website at fundyforce.ca/document-collection.

C-PODs were not deployed during the first quarter of 2020 due to a combination of weather-related delays and the availability of vessels suitable for deployment during January and February, and the spread the COVID-19 virus in March. This coincides with the period of reduced harbor porpoise activity at the FORCE site. C-PODs underwent regular annual maintenance and were deployed at FORCE on June 12, 2020 to resume monitoring.

Observation Program

FORCE's marine mammal observation program in 2020 includes observations made during biweekly shoreline surveys, stationary observations at the FORCE Visitor Centre, and marine-based observations during marine operations.

FORCE is preparing to use an Unmanned Aerial Vehicle (UAV) for collecting observational data along the shoreline and over the FORCE site using transects by programming GPS waypoints in the UAV to standardize flight paths. Several FORCE staff are now licensed to safely operate the UAV at the FORCE site.

You can read more about marine mammal monitoring at FORCE here.

Seabirds:

Since 2011, FORCE and Envirosphere Consultants Ltd. (Windsor, NS) have collected observational data documenting seabird species presence, distribution, behaviour, and seasonality throughout the FORCE site. FORCE recently commissioned Envirosphere Consultants Ltd. and Dr. Phil Taylor

(Acadia University) to synthesize the results of its observational seabird surveys (2011-2018) at the site, and to evaluate advanced statistical techniques for analyzing seabird count data in relation to environmental predictor variables.

The results of the analyses revealed that overall, a model is suitable to characterize count data for some species, and that there are clear patterns of effects of time of year, wind speed and direction, tide height and time of day on the number of seabirds observed. However, the analyses also revealed that not all species reported at FORCE have been observed frequently enough to be modelled effectively, particularly migratory species that are only present at the FORCE site for brief periods during annual migrations. Given these results, the report recommends that future monitoring and analyses focus on locally resident species (i.e., great black-backed gull, herring gull, black guillemot and common eider).

You can find the report from Envirosphere attached as Appendix II to the March 2020 Environmental Monitoring Effects Program report here, and more about seabird monitoring at FORCE here.

Sound:

Results from previous acoustic analyses completed at the FORCE site indicate that the Cape Sharp Tidal turbine was audible to marine life at varying distances from the turbine, but only exceeded the threshold for behavioural disturbance at very short ranges and during particular tide conditions (Martin et al., 2018).

In previous years, regulators have encouraged FORCE to pursue integration of results from multiple PAM instruments deployed in and around the FORCE test site. FORCE and its partner JASCO Applied Sciences (Canada) Ltd. pursued a comparative integrated analysis of sound data collected by various hydrophones which revealed that flow noise increased with the height of the hydrophone off the seabed and had little effect on hydrophones deployed closer to the sea floor.

Plans are currently being developed to test the capabilities of recent technological advancements for characterizing the soundscape of the FORCE test site and for assessing turbine generated sound in high-flow environments like the Minas Passage.

You can read more about marine noise monitoring at FORCE here.