

ENVIRONMENTAL EFFECTS METADATA SURVEY FORM

Name of person updating the form

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Date submitted

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Project name: Fundy Ocean Research Center for Energy (FORCE) test site

Planned In Operation Completed

Project description:

Project Developer: FORCE

Technology Developer: FORCE

Technology type: Berths for four in-stream turbines or arrays

Resource (wave, tidal): Tidal

Project scale (test site, prototype, array, commercial): Test site with four berths for different berth holders

Installed capacity (MW): 20 MW (Planned Export Capacity by 2020)

Project Website: <http://fundyforce.ca>

Launch Date: November 2010

End Date:

Additional Description: The Fundy Ocean Research Centre for Energy (FORCE) was established in 2009 as Canada's leading test centre for tidal energy technology. FORCE is a non-profit grid-connected in-stream tidal energy test facility in the Minas Passage, Bay of Fundy, intended to allow developers, regulators, scientists and academics to study and demonstrate the performance of in-stream tidal energy turbines and their interactions with the environment. The FORCE site consists of four undersea berths for tidal in-stream energy conversion (TISEC) devices, four subsea power cables (to be installed in 2014) connecting the turbines to land-based infrastructure, one subsea data cable (installed in 2013), an onshore transformer substation, and a shore-based visitor centre. The marine portion of the project is located in a Crown Lease Area, 1.6 km by 1 km in area, in the Minas Passage near Black Rock, and the onshore facilities are on leased lands on the West Bay Road approximately 10 km West of Parrsboro.

Location: FORCE's test site is in the Minas Passage area of the Bay of Fundy near Black Rock, 10 kilometres west of Parrsboro, Nova Scotia. Minas Passage, only 5 km wide and bordered by basalt cliffs, is the entrance to Minas Basin, the region of the world's highest tides.

At mid-tide, the current in Minas Passage is about 4 cubic kilometres per hour, the same as the estimated combined flow of all the rivers and streams on Earth combined. With the incoming tide, approximately 14 billion tonnes of sea water flows through Minas Passage into Minas Basin, and central Nova Scotia tilts slightly under the immense load.

Coordinates (please use Mercator): 45.36976°, -64.40254°

Process status: The first TISEC turbine (Open Hydro Design) was deployed on November 12, 2009 by NSPI. The NSPI/Open Hydro turbine was retrieved in December 2010, and since then no further tidal devices have been deployed in the FORCE demonstration area. The current four berth holders are scheduled to install their devices beginning in 2015 / 16. They are as follows:

- Minas Energy, Marine Current Turbines (a Siemens company), and Bluewater Energy Services B.V. - *Current proposed design*: 2 MW SeaGen F floating tidal current turbine
- Atlantis, Lockheed Martin and Irving Shipbuilding - *Current proposed design*: 1.5 MW AR-1500 turbine
- OpenHydro (a DCNS company) and EMERA - *Current proposed design*: 4 MW tidal array
- Black Rock Tidal Power - *Current proposed design*: TRITON platform developed by TidalStream, supports 36 lightweight horizontal axis SCHOTTEL STG turbines for the production of 2.5MW

FORCE installed a 3km fibre-optic data cable at the site (the first ever in the Minas Passage) in mid-December 2013. The cable installation is part of the Fundy Advanced Sensor Technology (FAST) Platform project to build the— a recoverable instrument platform designed to monitor and characterize the FORCE site. The data cable will allow continuous, real-time data transmission from the platform to shore. Additionally, the cable installation provides valuable knowledge and experience in planning the deployment of four subsea power cables in 2014, which will connect tidal turbines to the FORCE shore facility and on to the power grid. The objective of the FAST project is test multiple under water instruments to measure environmental and physical parameters for application in high flow environment.

FORCE also installed the following instrumentation in August-September 2013 at the FORCE site:

- a weather station in cooperation with the Nova Scotia Community College;
- a digital tide gauge; and
- an X-band radar system in a joint project with Acadia University, to generate maps of surface currents and wave fields.

An Environmental Effects Monitoring Program (EEMP) was developed to determine the accuracy of the environmental effects predictions, effectiveness of mitigation measures and compliance with conditions of provincial and federal authorizations and permits. An adaptive management approach to the EEMP has been taken to review outcomes and activities continuously and modify techniques to meet monitoring objectives. An independent Environmental Monitoring Advisory Committee (EMAC), a

technical committee with members from academia, fishers, First Nations, government and other recognized scientists, provides advice on the EEMP.

The FORCE EEMP has been operating since September 2009 and the key results from 2009 to January 2011 were summarized in the FORCE 2011 EEMP Report (available on FORCE website). The second EEM report is expected to be completed in late 2014, and will incorporate final data analyses for several studies that were conducted as baseline studies with no turbines in the water. These reports will be used by the Environmental Monitoring Advisory Committee (EMAC) in designing future EEM programs at FORCE in anticipation of turbines being deployed.

Licensing information (brief description): New developers wishing to test their technology at FORCE will not be required to make an Environmental Assessment application to the Province of Nova Scotia or the Government of Canada, as long as the new device:

- Occupies one of the four existing berths at FORCE;
- Replaces one of the four turbines tested;
- Is not predicted to have significantly different environmental impacts from the previous technologies tested.

The complete Environmental Assessment Registration Document for FORCE (Registered on June 17, 2009 under the Nova Scotia Environment Act), including the Terms and Conditions of Approval can be viewed at: <http://fundyforce.ca/environment/environmental-assesment/>. New developers are responsible for obtaining the following Federal authorizations and/or permits prior to device deployment: Fisheries Act (administered by Fisheries and Oceans Canada); Navigable Waters Protection Act (administered by Transport Canada); Canadian Environmental Protection Act (administered by Environment Canada).

Key Environmental issues: Physical environment, benthic habitat, fish movement, marine mammals, sea birds and lobster presence in the Minas Passage.

Environmental webpage: <http://fundyforce.ca/environment/>

| Baseline, Monitoring and adaptive management: Fundy Ocean Research Center for Energy | | | | |
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| General description | | Various studies conducted under the Environmental Effects Monitoring Program (pre-deployment data collection and monitoring) and Research Programs. | | |
| Receptor | Monitoring program description including question and/or objective | Design and methods (brief description) | Results (brief description) | Status (planned, underway, completed, with dates) |
| | Fundy Advanced Sensor Platform | See above | | Ongoing |

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| | (FAST) | | | |
| Physical Environment | Currents, waves and tides. | Vessel mounted ADCP. Moored ADCP. X-band radar, tide gauge. Modelling. | Data collection and modelling of currents, turbulence, waves and tides for use by berth holders and scientists. | Ongoing |
| Lobsters | Lobster Catch Survey. | This study was based on measuring lobster catches within test and control areas using commercial lobster traps, in an attempt to assess potential changes in fishing success as result of the deployment and operation of a tidal turbine. Three surveys were conducted, two in the Fall of 2009 (before and after turbine deployment) and one in the Spring of 2010. | Lobster fishing is essentially the only commercial fishing activity which occurs in the vicinity of the tidal energy demonstration area. The key results are summarized for the 2009 and 2010 surveys; these include independent statistical results review and recommendations for future surveys. | Completed |
| Lobsters | Lobster tagging to determine the year-round use of Minas Passage as a corridor for movement of lobster. | Adult American lobster were captured, tagged with VEMCO acoustic transmitters and released back into the Minas Basin. The lobsters were tracked by bottom-mounted acoustic receiver stations deployed in the Minas Passage. Tracking occurred November – December 2011; April – August 2012; and December 2012-October 2013. | Preliminary results suggest lobsters in the Minas Basin move through the Minas Passage towards the Minas Channel in the late fall/early winter and may move back eastward in the spring. Some lobsters may remain in the Minas Basin over the winter and move back through the Minas Passage. | Baseline surveys ongoing pending funding; Continuation post turbine deployment under consideration |
| Sea and Shore Birds | Seabird visual survey. | Data on presence and activity of seabirds in the Minas Passage near the tidal energy project site using shore- and vessel-based visual observation surveys (standard observation protocols). <u>Survey periods</u> Spring, Summer 2010 Spring, Summer & Winter 2011 Summer 2012. | Annual reports. 2014 EEMP includes results of 2011 and 2012 seasons, as well as analysis of 4-year program (2009-2012). | Baseline surveys ongoing pending funding; Continuation post turbine deployment under consideration |

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| Marine Mammals | Marine mammal visual survey. | Data on presence and activity of marine mammals in the Minas Passage near the tidal energy project site using shore- and vessel-based visual observation surveys. <u>Survey periods</u> Spring, Summer 2010 Spring, Summer & Winter 2011 Summer 2012. | Annual reports. 2014 EEMP includes results of 2011 and 2012 seasons, as well as analysis of 4-year program (2009-2012). Harbour porpoise are the predominant marine mammal observed, with a few seals. | Baseline surveys ongoing pending funding; Continuation post turbine deployment under consideration |
| Marine Mammals | Passive Acoustic Monitoring of Cetacean Activity Patterns and Movements in Minas Passage. | Passive acoustic monitoring of harbour porpoise using C-POD & ICListen hydrophones in the Minas Passage during spring, summer and fall to assess how these vary temporally (with respect to time of day, weeks, months and across years), spatially (within and outside the FORCE test area) and with current patterns (tidal cycles and current velocity). These baseline data will be necessary to assess how activity patterns vary subsequent to the deployment of tidal energy devices or cable-laying operations. <u>Sampling periods</u> August – November 2010 (pilot study) – 3 C-Pods, 2 within test area and one in control site May - November 2011 and 2012 - seven C-PODs in the Minas Passage, 2 within the FORCE test area and 5 outside the area August 2012 – ICListen hydrophone pilot project. | Baseline presence of harbour porpoise around FORCE site and comparison of acoustic devices for monitoring in high flow environments. | Baseline surveys ongoing pending funding; Continuation post turbine deployment under consideration |
| Benthic Environment | Multibeam sonar survey of berth sites and cable routes. | | Characterization of bathymetry, geology and sediment transport and suspended sediments. | Completed |
| Benthic | Environmental | A side-scan sonar and towed | The analysis showed no | Completed |

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| Environment | Monitoring of Seabed Sediment Stability, Transport and Benthic Habitat at the Reference Site and the Vicinity of the deployment site. To determine conditions on the bottom after the recovery of the NSPI/OH turbine in 2010. To determine both natural change and possible effects of the turbine placement, operation, and removal over a one year time frame. | video camera survey was conducted at the Reference Site and at the location of the NSPI/OH test deployment site. Sonograms and side-scan sonar mosaics were interpreted, compared and contrasted with previously collected multi-beam bathymetry and derived backscatter and slope imagery. | detectable seabed change at the Reference Site since the original data was collected over 5 years ago. | |
| Benthic Environment | Bottom Substrate and Associated Epibenthic Biota of the FORCE Tidal Energy Test Site in Minas Passage. | Analysis of video and still photographs taken in 2008-9 survey to characterize pre-deployment (baseline) benthic habitat within the FORCE test site, including benthic substrate type and macrofaunal biota present. | The survey detected a low number of species present in the FORCE lease area and cable routes, with yellow breadcrumb sponge being the most abundant species. | Baseline surveys and analysis completed. Continuation post turbine deployment under consideration |
| Fish | Acoustic Tracking of Fish Movements in Minas Passage. | A multi-year tracking study was conducted to assess the movements of four species of concern that utilize the FORCE test area as a migratory route and for other movements (e.g. foraging) - Atlantic sturgeon, Atlantic salmon, American eel and striped bass. Thirty receiver stations were deployed in the Minas Basin and Passage to detect near year-round animal movements (path, velocity and depth) and | The report summarizes findings on baseline movement of fish species in the Minas Passage and through the test site. Results show that the corridor for fish migration through the Minas Passage is broad and includes the FORCE test area. The results of this study provided evidence of minor use of | Baseline surveys ongoing pending funding; Continuation post turbine deployment under consideration |

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| | | behaviour of 386 fish tagged with VEMCO transmitters from 2010-2013. | the passage by out-migrating American eel and Atlantic salmon smolts and more frequent use of the passage by Atlantic sturgeon and striped bass. | |
| Fish | Investigation of Temporal Patterns in Fish Presence and Abundance at Intertidal Weirs in Minas Basin. | Fish catches at two commercial fishing weirs in the Minas Basin were recorded to examine the temporal and environmental (e.g. temp, tide height) patterns in the presence and abundance of resident and migratory fishes. Sampling was conducted during April/May – August 2013 near weekly during daytime low tides and day and night sampling was conducted on 14 consecutive low tides in July at one site. | Data collected provides pre-turbine baseline data on many migratory fishes that move in and out of the Minas Passage. | Completed. Continuation post turbine deployment under consideration |
| Fish | Hydroacoustic and midwater trawl survey in Minas Passage. | Boat surveys from June to August 2010, using a mid-water trawl and an echosounder fish monitoring system. Echosounder system sampled acoustic backscatter from throughout the water column to provide information on fish biomass seasonally and spatially and the fishing was used to identify specific species and sizes of fish likely forming the acoustic targets. <u>Survey Period</u> June-October 2010 | Results indicate presence and relative abundance, of a wide range of fish species which use Minas Passage through the summer and fall. | Completed |
| Water quality | Oceanographic Measurements. | Measurements included water column temperature, salinity and turbidity profiling; suspended sediments. | Information on water transparency, suspended sediment, and water temperature. | Completed |
| Acoustic Environment | Acoustic monitoring. | The goals of this project were to: <ul style="list-style-type: none"> Collect pre-deployment (baseline) data on the ambient acoustic | The results demonstrate that it is possible to collect ambient and in-stream turbine noise signatures in high flow | Completed. Continuation post turbine deployment under |

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| | | <p>environment in the FORCE test site using fixed hydrophone</p> <ul style="list-style-type: none"> Assess and refine mooring designs for acoustic monitoring systems in high flow environments | <p>conditions using a fixed autonomous recorder. Mooring designs were tested and improved.</p> | <p>consideration</p> |
| Electromagnetic fields | <p>Assessment of Potential Ecosystem Effects from Electromagnetic Fields (EMF) Associated with Subsea Power Cables and TISEC Devices in Minas Channel.</p> | <p>Review of Current Literature and Assessment of Risk from EMFs on organisms in Minas Passage.</p> | <p>Report presents overview and preliminary evaluation of risk to priority species in Minas Passage.</p> | <p>Completed</p> |
| Reports or Papers | <p>Studies associated with the EIA and Environmental Effects Monitoring Program are available on the website http://fundyforce.ca/monitoring-and-research/monitoring/</p> | | | |
| Research Projects | | | | |