INTELL-ECHO

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Economic Information Observatory
a regional cooperation project between
Atlantic Canada and **Saint-Pierre and Miquelon, France**

Marine Energy

Collaboration CACIMA PROVLS

Economic Information Observatory
Intell-Echo

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Atlantic Canada,
4 provinces:
Prince Edward Island (PEI),
New Brunswick (NB),
Nova Scotia (NS),
Newfoundland and Labrador (NL)

Marine Energy in Atlantic Canada

In this issue:

Although the renewable energy (wind, solar, biomass) sector is highly active and continuing to grow in regions across Atlantic Canada with results that are both immediate and measurable, the exploitation of marine energy has remained in the experimental stage despite the immense potential that exists for this alternative resource. With the highest tides in the world, the Bay of Fundy offers enormous energy potential including the possibility of reducing our dependence on fossil fuels. Nova Scotia is a pioneer in this fast-growing sector, and the technology and expertise being developed in that province have the potential to change the rules of the game in energy production.

Tidal power is one form of renewable hydro energy used to generate electricity from the movement of water displaced by the tides, either by making use of the difference in height between high and low tides or by exploiting the tidal stream directly through use of capture mechanisms such as turbines, tidal lagoons or tidal barrages.

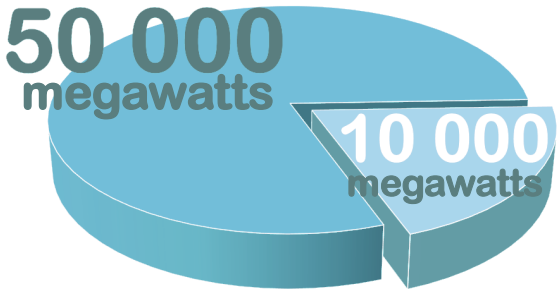
More than any other form of marine energy (including wave energy), tidal power offers the greatest potential for Canada:

- 190 sites conducive to tidal power development have been identified to date across the country
- total generation capacity is estimated at 42,000 MW, corresponding to 63% of total national energy consumption
- Atlantic Canada has an estimated potential total capacity of 146,500 MW

Ecological security: The Bay of Fundy, Atlantic Canada's main tidal energy extraction site, also represents a diverse ecosystem with some 22 species of marine mammals, 130 bird species and numerous fish and invertebrate species, all of which are essential resources for the region's fishery-based economy.

Energy potential of the Bay of Fundy

One of the earliest studies to explore the potential for generating electricity from tidal power in the Bay of Fundy, in 2007, identified a total extraction capacity of approximately 90 megawatts, enough to supply electricity to 25,000 people. More recent studies have gauged the Bay of Fundy's energy potential at more than 10,000 megawatts and as much as 50,000 megawatts.



10,000 megawatts, or one-fifth of the electricity production potential of the Bay of Fundy, is sufficient to power **3 million** households

Characteristics of the Bay of Fundy

- One of the Seven Natural Wonders of North America
- 160 billion tonnes of sea water displaced by every tide
- Average tide height of 16 metres and surface velocity of 5.14 m/second or 18 km/hour
- The water displaced by tides in the Bay of Fundy is equivalent to four times the estimated combined flow of the entire world's freshwater rivers during the same 6-hour interval

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Current Projects and Outlook

Renewable Energy in Atlantic Canada

Long disregarded as being too costly, tidal power has been underdeveloped to the benefit of other alternative energy sources such as wind energy. The first feasibility study on tidal energy, initiated in 2007 under a partnership between New Brunswick and Nova Scotia, led to implementation of a pilot project overseen by Irving through 2010. However, renewed interest in tidal energy has developed in recent years, and, building on the energy potential of the Bay of Fundy, Nova Scotia has been devoting significant efforts to positioning itself as a global leader in this sector.

(For an overview of the energy sector in Atlantic Canada, please see Intell-Echo, vol. 2, no. 5, 2015)

Comparison:
Wind energy in Atlantic Canada

PEI

90 turbines = 167 MW

NB

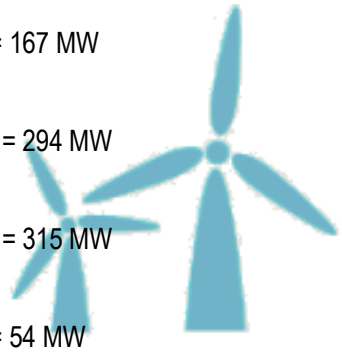
113 turbines = 294 MW

NS

174 turbines = 315 MW

NL

18 turbines = 54 MW



Nova Scotia leading the way

By 2040, according to the **Offshore Energy Research Association of Nova Scotia**, the tidal energy industry in Nova Scotia will represent:

$1.7 billion
for the tidal energy sector by 2040

22,000 jobs
by 2040

$815 million
in employment income by 2040

60% – 70%

Canada has the resources and expertise to supply 60% to 70% of inputs (products, goods and services) required to develop the tidal energy sector at the national level.

Overview of the subsea energy sector in Nova Scotia

- 125 companies active in the subsea energy (including tidal energy) sector
- Total of $23 million invested in 2015

Tidal energy extraction in NS:

- Initial tidal power production quota of 300 megawatts (enough electricity to supply nearly a quarter of the province's population)
- Electricity sale price ranging between 37 and 50 cents per kilowatt hour
- Maximum of 22 megawatts of tidal power electricity permitted per site for the time being to limit any increase in cost to the public to no more than 2%

Ocean Frontier Institute

Dalhousie University, Halifax, NS

With a total of $220 million in funding, $94 million of that amount coming from the federal Canada First Research Excellence Fund, Dalhousie University is launching a new research program in ocean science to study topics including:

- climate and ocean change
- the decline of certain marine species
- fishing and aquaculture
- ocean ecosystems and energy
- the regulatory framework

Major Events in 2016

MR Energy Industry Open House
Marine Renewables Canada
March 23, 2016, Ottawa, ON
http://www.marinerenewables.ca/

Oceans Week Halifax
June 3 – 12, 2016, Dartmouth, NS
http://www.oceansweek.ca/

11th Bay of Fundy Science Workshop
Bay of Fundy Ecosystem Partnership
June 8 – 10, 2016, Fredericton, NB
http://www.bofep.org/

NB Tidal Power Summit
Opportunities NB and Port Saint John
June 24, 2016
https://www.sjport.com/

3rd International Submarine Canyon Symposium
Ocean Networks Canada
July 25 – 27, 2016, Victoria, BC
http://incise2016.oceannetworks.ca/

2nd Annual Energy Symposium
Cumberland Energy Authority
September 22 – 23, 2016
Springhill, NS
http://www.cumberlandcounty.ns.ca/

Core Energy Conference 2016
Maritimes Energy Association
October 4 – 5, 2016, Halifax, NS
http://maritimesenergy.com/

2016 Annual Conference
Marine Renewables Canada
November 3 – 4, 2016, Halifax, NS
http://www.marinerenewables.ca/

FORCE (Fundy Ocean Research Center for Energy)

Nova Scotia's **Fundy Ocean Research Center for Energy (FORCE)** is the Canadian leader in research and development targeting the commercialization of tidal power. Located in the Minas Passage of the Bay of Fundy 10 km from Parrsboro, NS, FORCE is situated in an area where every tide displaces 14 billion tonnes of water and the tidal current reaches 4 km^3 of water per hour. Since its founding in 2009, FORCE has been working to establish tidal power as the energy resource of the future in Atlantic Canada and North America. This experimental project is collaborating with companies around the world as well as the science community and the public sector. Equipped with observation and research facilities, underwater infrastructures and a pre-approved testing area, FORCE provides the electrical infrastructure used by developers to connect to the provincial power grid. With its generating capacity of 64 MW, enough to supply 20,000 homes, FORCE also oversees an independent environmental monitoring program. Several business consortiums currently have projects

Atlantis Operations Canada (4.5 MW)

- company owned by Atlantis Resources of Singapore
- developing a 1.5 megawatt turbine project
- second turbine model developed and tested in collaboration with the Irish company DP Energy
- anticipated construction start date: 2017

Minas Energy (4 MW)

- partnership with the German corporation Siemens
- project to build a 2 megawatt turbine generator attached to a floating platform

Black Rock Tidal Power (5 MW)

- project using technology of Germany-based Schottel
- demonstration of 36 small (2.3 MW) turbines tethered to a submersible base

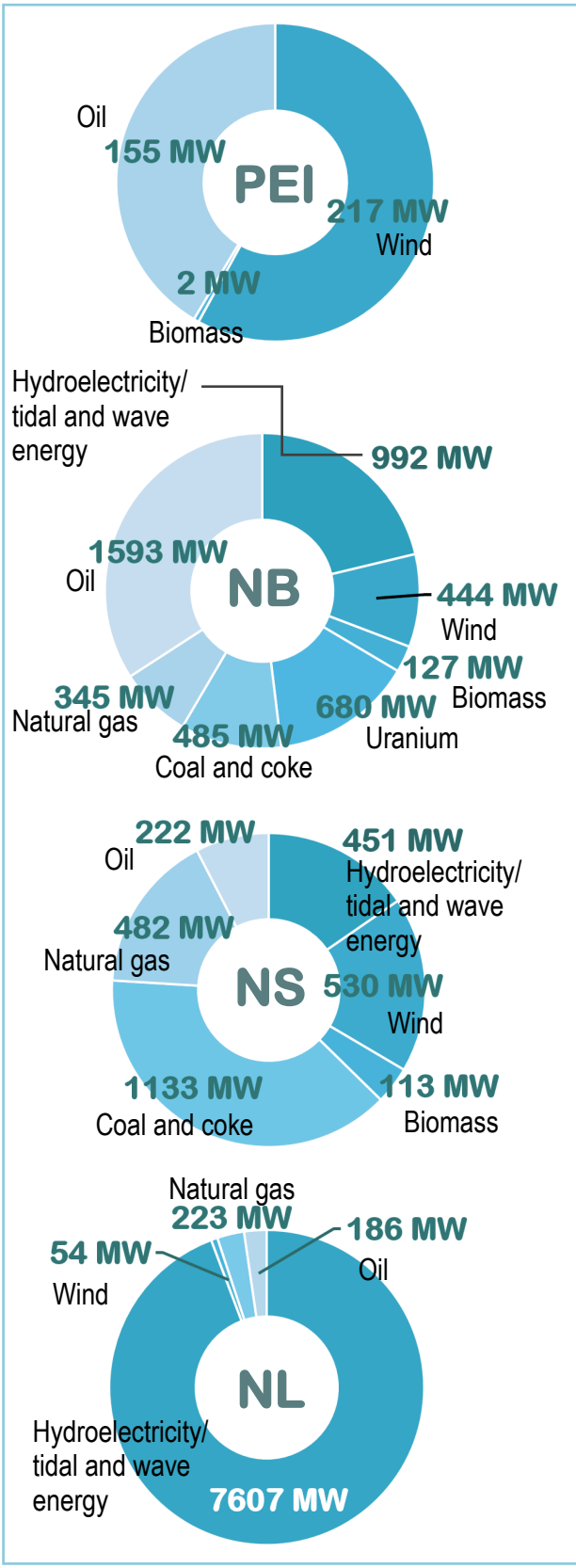
Cape Sharp Tidal Venture (4 MW)

- partnership between Open Hydro, a subsidiary of French industrial group DCNS, and Emera
- project to operate 2 embedded turbines with a total 4 megawatt capacity
- objective: achieve production of 300 megawatts by 2020, enough to supply power to 75,000 customers

Jasco

- project to monitor underwater sound using passive acoustic technology

Power generation capacity in Atlantic Canada in 2020



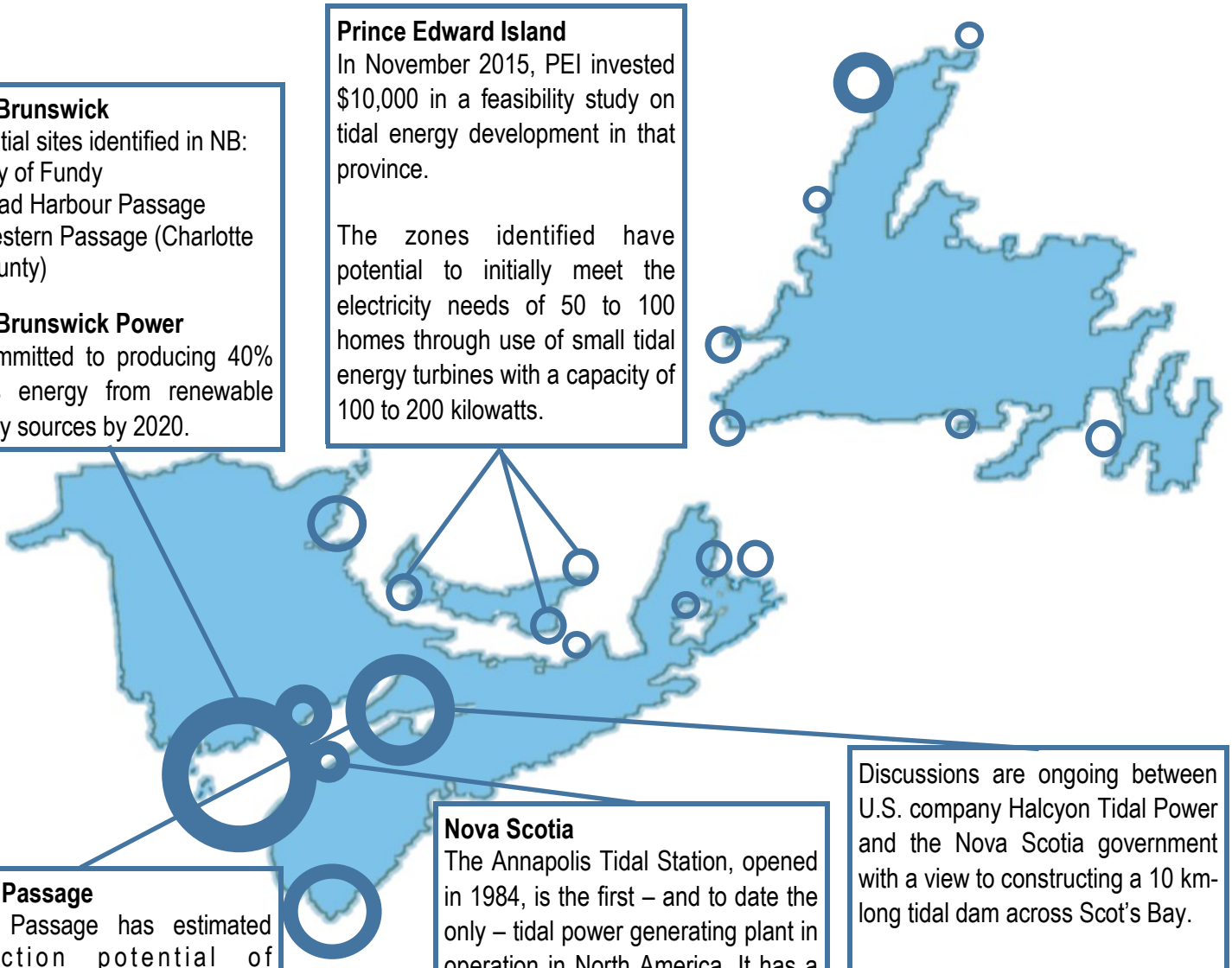
Map of Tidal Energy Potential in Atlantic Canada*

New Brunswick
Potential sites identified in NB:
- ▶ Bay of Fundy
- ▶ Head Harbour Passage
- ▶ Western Passage (Charlotte County)

New Brunswick Power
is committed to producing 40% of its energy from renewable energy sources by 2020.

Prince Edward Island
In November 2015, PEI invested $10,000 in a feasibility study on tidal energy development in that province.

The zones identified have potential to initially meet the electricity needs of 50 to 100 homes through use of small tidal energy turbines with a capacity of 100 to 200 kilowatts.



Minas Passage
Minas Passage has estimated extraction potential of 2,500 megawatts, approximately equivalent to 2 mid-sized nuclear reactors.

Nova Scotia
The Annapolis Tidal Station, opened in 1984, is the first – and to date the only – tidal power generating plant in operation in North America. It has a generation capacity of 20 MW and produces 80 to 100 MWh daily.

Discussions are ongoing between U.S. company Halcyon Tidal Power and the Nova Scotia government with a view to constructing a 10 km-long tidal dam across Scot's Bay.

This large-scale project, to be built at a cost of $3 billion, could generate up to 1,100 MW.

* Zones identified are geographic approximations. Energy potential is not represented exactly to scale.

Useful links: National Energy Board, https://www.neb-one.gc.ca; Fisheries and Oceans Canada, http://www.dfo-mpo.gc.ca; Natural Resources Canada, http://www.rncan.gc.ca; Innovation, Science and Economic Development Canada, https://www.ic.gc.ca; NRCan's Clean Energy Portal, http://www.nrcan.gc.ca/energy/renewable-electricity/marine-energy/7385; Ocean Energy Systems Technology Collaboration Programme (OES), https://www.ocean-energy-systems.org; Ocean Renewable Energy Group (OREG), http://www.oceannetworks.ca; Institute for Ocean Research Enterprise (IORE), http://iore.ca; Offshore Energy Research Association of Nova Scotia (OERA), http://www.oera.ca; FORCE, http://fundyforce.ca; Fundy Energy Research Network (FERN), http://fern.acadiau.ca; Marine Renewables Canada, http://www.marinerenewables.ca; Maritime Electric Company, http://www.maritimeelectric.com; New Brunswick Power, https://www.nbpower.com; Nova Scotia Power, http://www.nspower.ca; Newfoundland Power, https://www.newfoundlandpower.com; Newfoundland and Labrador Hydro, https://www.nlhydro.com

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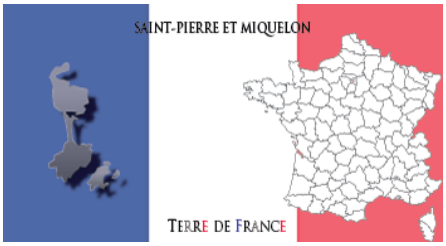

Dans ce numéro:

Innovations

The future of marine energies

Renewable marine energies (RME) are attracting investors and are becoming increasingly enticing. The following is a list of the 10 winning projects from the call for projects ITE EMR 2015 for the development of the renewable marine energy industry in France. A partnership between the French government and France Énergies-Marines, these projects ultimately will complement the French expertise on subjects which present major challenges for research in the field and for the industrialization of technologies.

HYD2M / PHYSIC / THYMOTE: characterization and modeling of various complementary aspects of the marine tidal resource at Raz Blanchard. **TROPHIK:** role of offshore wind turbines in changing the functioning of coastal food webs and their cumulative impacts. **BENTHOSCOPE 2**: monitoring the impacts of renewable marine energy on the benthic zone. **INDUSCOL**: sustainability of multi-material structures in renewable marine energies. **EOLINK**: new concept of large floating wind turbines (structure, float and anchoring system). **OMDYN**: development of dynamic umbilical cables. **HYFLOELFLU**: development of innovative tidal technology for rivers. **3MDDTA**: 3D modeling of tidal stream marine parks.

Atlantic France-The energy projects of today, to their industrialization tomorrow.

- **The Waveroller: Wave Energy -Brittany**

A partnership between AW-Energy, DCNS and Fortum - Sweden has already implemented the Waveroller in a 10 MW pilot farm; this project allows the use of wave energy through a device anchored between 8 and 20 meters deep. Consisting of a panel moving to the rhythm of the waves, it can produce electricity. This solution will be implemented off the coast of Brittany, but is currently still in the R &D phase. It will produce between 500 KW and 1 MW of power.

- **SEA REED Floating Wind Turbine - Morbihan**

DCNS plans to install its wind turbine off the coast of Morbihan, anchored by cables at 300 metres deep. The partnership between Alstom and DCNS has allowed the development of a floating wind turbine and a first pilot farm is planned to be located between the islands of Groix and Belle-Île. More powerful than other marine energy projects, it could allow the development of a capacity of 6 MW in 2017 from a single wind turbine.

- **Sabella D10 Tidal Turbine - Finistère**

From the research department of Sabella, the marinel turbine anchored off the coast of Ushant in the Fromveur passage is one of the most promising projects for the production of marine energy. Since July 2015, it has been providing up to 60% of the electricity consumed on the island. It can provide between 500 KW and 1 MV of power.

For more information please consult **www.enr.frs** syndicat des énergies renouvelables en France:
- http://www.enr.fr/userfiles/files/Brochures%20Eolien/SER_feuillederouteSEReolienenmer2030.pdf
- http://www.enr.fr/userfiles/files/Brochures%20EMR/SER-BrochureEMR2014_web.pdf

Sources: www.france-energies-marines.org ; engie ; www.enr.fr ; e-rse.net ; www.developpement-durable.gouv.fr

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For each territory, it's marine energy

Focus - the French Atlantic coast

France has the second largest tidal energy source in Europe, following Great Britain, with an annual production of 5 to 14 TWh. 80% of production takes place in Fromveur and Raz Blanchard, two strategic geographic zones situated on the Atlantic coast.

Competitiveness Centre and Cluster - BRITANNY

A key region in the development of renewable marine energy. Approximatively 180 companies are positioned for RME in the region.

- **Pôle Mer Bretagne Atlantique**: Includes 39 projects related to marine energies on the French coast. 42 major groups, 206 SMEs, 56 research and training institutions, 44 professional organizations.

⇒ All projects: http://pole-mer-bretagne-atlantique.com/fr/ressources-energetiques-et-minieres-marines

- **Bretagne pôle naval**: Is positioning itself on 5 technologies: tidal, fixed bottom offshore wind turbines, floating offshore wind turbines, wave power, ocean thermal energy. 124 members, of which 34 are training organisations and public institutions, and 8 partner clubs.

⇒ Directory: http://www.bretagnepolen aval.org/?mode=prod uits-services-emr

- **Breizh EMR:** Facilitates relationships among its members to develop commercial and industrial synergies. 14 members and 3 partners.

⇒ http://www.breizh-emr.com/

Competitiveness Centre and Cluster - AQUITAINE

The south Atlantic coast offers the potential for significant development and innovation for RME. The 12-mile zone is conducive to the operation of tidal turbines, fixed bottom wind turbines and wave power. About 140 regional companies are identified on the RME value chain.

- **Aquitaine Wind Industry Cluster**: The Aquitaine Wind Industry Cluster aims to develop an organized industrial sector. 37 members.

- **Aquitaine croissance verte**: URABAILA project for developing river turbine technology at a low cost. 20 members.

⇒ http://www.aquitainecroissanceverte.com/nos-actions/urabaila

Competitiveness Centre and Cluster - NORMANDIE

Normandy is recognized as a center of excellence in terms of tidal and offshore wind energy. There are approximatively 550 companies that are qualified in the RME industry.

- **Ouest Normandie Energies Marines (ONEM) :)**: is working with the French government towards the emergence of a French market for RME. Five (5) projects for wind farms and tidal farms. 21 members make up this cluster.

⇒ http://www.ouest-normandie-energies-marines.fr/fr/index.php

- **CEVEO Cluster:** Focused solely on wind power, this cluster has 14 partners.

⇒ http://www.ceveocluster.org/

Competitiveness Centre/Cluster - POITOU-CHARENTE

This region has significant potential for RME and has more than 140 qualified companies in this field.

- **Cluster énergies marines:** : brings together approximatively 40 companies, led by the Pôle des Eco-Industries.

Competitiveness Centre/Cluster - PAYS DE LA LOIRE

New maritime economy region.

- **Neopolia EMR**: 115 industrial companies including thirty with expertise in the field.

⇒ http://www.emr.neopolia.fr/

- **Pôle EMC2** : Point of reference, in France and internationally, for advanced manufacturing. The cluster has 15 partners and 187 projects that are ongoing or completed.

⇒ List of projets: http://www.pole-emc2.fr/liste-des-projets-emc2.html?limit=6&limitstart=102

- **Pôle interrégional S2E2** : smart electricity technologies for energy management. It has 175 members.

⇒ http://www.s2e2.fr/

Competitiveness Centre and Cluster - HAUT DE France

- **Euraénergie:** composed of 73 members, this cluster supports the economic development of the energy sector through innovation. In particular for offshore wind turbines, tidal power and heat pumps.

⇒ http://energie2020.fr/euraenergie/

Sectoral Focus

Marine energies in France

France has one of the largest maritime areas of the world; therefore, it has a tremendous potential for exploiting Renewable Marine Energy (RME) in mainland France and overseas.

Renewable Marine Energies include several types of energies that exploit different facets of nature including:

- **Marine turbine energy** (energy of ocean currents).
- **Tidal power** (energy from the tides)
- **Offshore wind turbines**, fixed bottom or floating.
- **Wave energy** (energy from the waves).
- **Ocean thermal energy conversion** (uses the thermal gradient between deep ocean water and surface water).
- **Osmotic energy** (using the salinity gradient at the mouths of rivers).

Since 2009, RMEs have been considered a strategic industrial sector for green growth for France. However, currently only tidal energy is exploited on an industrial scale. Exploitation of marine energy is only yet at an experimental phase; its widespread development is expected by 2020. A 'blue revolution' is already being talked about, with the emergence of industries and new marine technologies for the exploitation of energy.

France hopes to become the market leader in renewable marine energy under the leadership of *France Energie Marine,* and with major investments in this area. In fact, France has 11 million square kilometers of maritime area, as well as the technological and industrial skills required for the development of this industry. Helped by incentives, the establishment of industrial-scale facilities is underway all across France. It is estimated that by 2030, between 30,000 and 40,000 jobs will have been created and according to IFREMER, renewable marine energy could produce the equivalent of 3 to 5% of national electricity consumption (0.5% currently), excluding hydroelectric power.

Every year in France, the European Thetis RME takes place; this tradeshow covers all technologies related to renewable marine energy. The 2016 show was held in Paris on May 10 and 11.

Main sources: réveildelafrance.fr; NEMO project AkuoEnergy; France marine energy; Engie; Le Figaro ; renewable energies

Status Update in France – Overview

Offshore fixed bottom wind turbines

- France has set a target of 6,000 MW from offshore wind turbines in 2020. In 2016, no wind turbine park is yet in service.
- **Projects:** Construction of 7 wind farms (Fécamp, Courseulles-sur-Mer, Saint Nazaire, Saint-Brieuc, Yeu-Noirmoutier (Vendée), Tréport (Seine-Maritime) and Dunkirk).
- **Benefits:** creation of 10,000 jobs expected.
- **Cost of production**: target of less than €130 / MWh in 2020 (€ 190 / MWh currently).

Tidal energy

- France has the second largest source of tidal energy in Europe.
- **Projects**: three (3) projects for pilot farms at Raz Blanchard (Cotentin) and Fromveur (Finistère).
- **Benefits:** a market estimated at 15 billion euros worldwide. Creation of 40,000 jobs.
- **Cost of production**: less than €120/ MWh eventually (€173 / MWh with current technology).

Wave power

- The industrial development of this technology using wave energy, which has significant potential, will take place in the second part of this decade (2020).
- Currently, there is an abundance of technologies that have yet to demonstrate their technical feasibility.

Floating offshore wind turbines

- Set up offshore where the wind blows more strongly and more regularly.
- **Projects:** Four (4) calls for projects in 2015 for the deployment of test farms (Languedoc - Roussillon and Brittany).
- **Benefits:** creation of 1,000 jobs by 2020.
- **Cost of production**: between €150 and €275 / MWh, with a goal of being less than €120 / MWh in the long term.

Marine thermal energy

- Energy restricted to warm waters due to the temperature difference of more than 20 degrees between the surface and the seabed.
- **Projects:** Construction of a plant in l'ile de la Réunion and in Martinique in 2017 and in Tahiti in 2019.
- **Benefits**: creation of 4,000 jobs.
- **Cost of production:** estimated at between €250 and €300 / MWh, with a goal of less than €130 / MWh in the long term.

Overseas

Focus - Saint-Pierre et Miquelon

Potential exploitation of various RME technologies for overseas regions

*Zero potential or potential not yet known Source: UICN Comité Français

The potential exploitability of these different technologies for the overseas regions specified in the visual below is based on the known weather and oceanographic conditions of these areas and regions.

Today the development of so-called renewable energy has become one of France's priorities for its overseas territories.

The University of Polynesia has just created a new masters degree entitled "management of energy in island and tropical environments" in order to train young Polynesians for energy transition. Financial assistance is available to develop the sector of marine energy which is in full expansion.

Project - NEMO

In Saint Pierre and Miquelon - initiated by the DTAM in collaboration with IFREMER, two projects to study the marine environment have been ongoing for several years.

The study of ocean currents will be completed by the end of 2016. The aim of this study is to identify sites that can be used to generate energy using the speed of currents. The study is taking place in order to later consider the deployment of an underwater turbine and the construction of a power plant if an zone of strong potential is indicated by the data of the study.

The second study uses a swell recorder and an ADCP (Acoustic Doppler Current Profiler - sonar that measures the speed of currents), to collect data on the swell. This study will end in 2017. Today, there is no reliable system in existence that allows the use of wave power technology to produce energy; it will therefore be necessary to wait for a technological breakthrough in order to be able to exploit a site if this form of energy can be used in the archipelago.

The study of multi-energy marine platforms, composed of wind, solar, tidal and wave power technologies, is also being considered as a possible alternative for producing the renewable energy of the future in the archipelago.

INTELL-ECHO

Are you seeking business opportunities in this sector?
CACIMA and FCCC-AN can facilitate your business prospection process and help with establishing new partnerships (targeted information and network contacts)

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