NORTH AMERICAN OCEAN ENERGY STATUS – MARCH 2007

Roger Bedard [1], Mirko Previsic [2], George Hagerman[3], Brian Polagye[4], Walt Musial[5],
Justin Klure[6], Annette von Jouanne[7], Uday Mathur[8], Craig Collar[9], Charles Hopper [10],
Scott Amsden[11]

[1] Electric Power Research Institute (EPRI), Palo Alto, CA,
USA Email: rbedard@epri.com
[2]re vision consulting, Sacramento, CA, USA
[3]Virginia Tech, Arlington, VA, USA
[4]University of Washington, Seattle, WA USA
[5]National Renewable Energy Laboratory (NREL), Boulder, CO, USA
[6] Oregon Department of Energy, Salem, OR, USA
[7] Oregon State Universities, Corvallis, OR, USA
[8] Pacific Gas and Electric Company, San Francisco, CA, USA
[9] Snohomish Public Utility District, WA, USA
[10]Nova Scotia Power Inc, NS, Canada
[11] Tacoma Power , Tacoma, WA, USA

Abstract

Ocean energy resources are attractive renewable supply alternatives for North America because good wave, tidal and river energy resources are found in close proximity to population centers. The Electric Power Research Institute (EPRI) established two North American collaborative programs to demonstrate ocean energy conversion in North America. The two collaborative programs bring together the resources and knowledge of 10 State Agencies, 2 Federal Agencies, 17 Electric Power Utilities, 3 Universities and over 30 Technology Developers. This paper summarizes key findings of these collaborative programs and provides the current status of the North American wave, tidal in-stream and river in-stream programs.

Ocean energy accomplishments in North America to date include:

- The first two tidal in-stream demonstration plants began operation in late 2006
- Approximately 30 preliminary permits applications for tidal plants have been filed by private investors with the Federal Energy Regulatory Commission (FERC)
- Nova Scotia Power has announced a multi million dollar tidal in- stream pilot demonstration plant
- Approximetaly 10 preliminary permits applications for wave plants have been filed with FERC.
- The first full license application for a wave plant was filed with FERC in November, 2006
- A river in-stream energy conversion feasibility study is underway.

Keywords: Ocean energy, wave energy, tidal in-stream energy, river in-stream energy.

Resource

The US wave and current energy resource potential that could be credibly harnessed is about 400 TWh/yr or about 10% of national energy demand. EPRI studied the U.S. wave energy resource and found it to be about 2,100 TWh/yr (Figure 1). Assuming an extraction of 15% wave to mechanical energy (which is limited by device spacing device absorption and sea space constraints), typical power train efficiencies of 90% and a plant availability of 90%, the electricity produced is about 260 TWh/yr or equal to an average power of 30,000 MW (rated capacity of about 90,000 MW). This amount is approximately equal to the total 2004 energy generation from conventional hydro power (which is about 6.5% of total US electricity supply). The Canadian wave energy resource was studied by Natural Resources Canada (NRC) and found to be about 1,600 TWh/yr. (Figure 1).

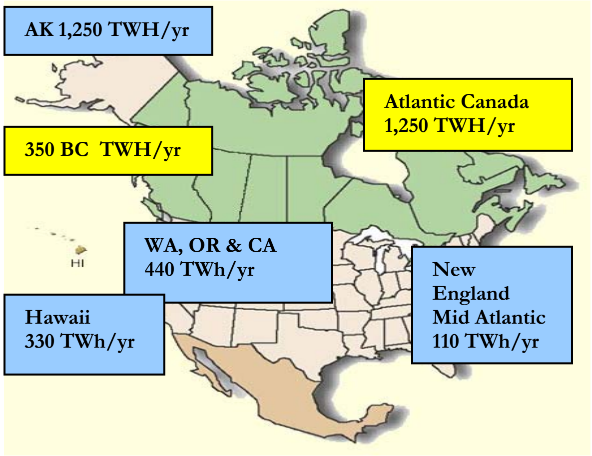

Figure 1. Wave Energy Resource Estimate

EPRI has studied the North America tidal energy potential at selected sites shown in Figure 2. The tidal energy resource at those US tidal sites alone is 19.6 TWh/yr. EPRI also performed tidal feasibility studies at two Canadian sites; Minas Passage NS and Head Harbor NB. Assuming an extraction of 15% tidal kinetic energy to mechanical energy, typical power train efficiencies of 90% and a plant availability of 90%, the yearly electricity produced at the U.S. sites below is about 270 MW (average power, rated capacity is about 700 MW).

New York University estimated electricity output from U.S. river in-stream sites at 110 TWh/yr or 12,000 MW (Miller et al, NYU, 1986). Adding up all U.S. tidal and river in stream sites yields about 140 TWh/yr which when added to the 260 TWh/yr from wave generated electricity is about 400 TWh/yr or about 10% of US national electricity demand.

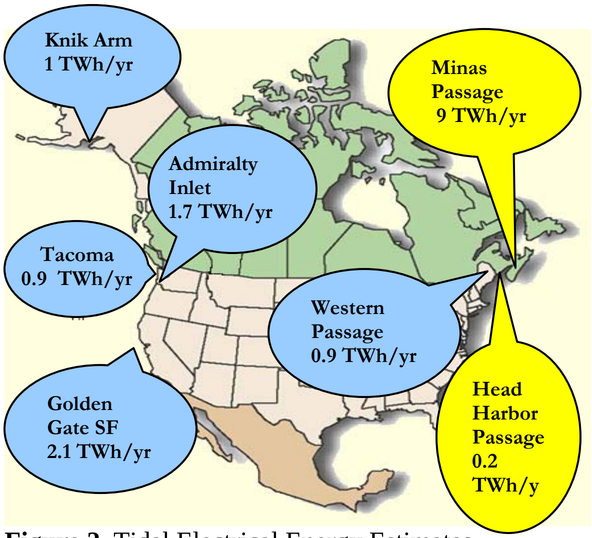

Figure 2. Tidal Electrical Energy Estimates

The NRC Canadian Hydraulics Centre (CHC) has inventoried its wave and tidal energy resources (Cornett, NRC, 2006). The annual mean wave power along the 1,000 meter isobath for both coasts is about 180,000 MW or in terms of energy, about 1,600 TWh/yr. Canada is also endowed with sizable tidal current energy resources. The CHC identified a total of 190 sites with a mean potential power of 42,000 MW, or in terms of energy, 370 TWh/yr.

The advantages of ocean energy are numerous. First and foremost is the high power density (kW/m^2 for currents and kW/m of wave crest length for wave). The higher the power density, the smaller the energy conversion machine needed. Other benefits include: 1) providing a new, environmentally friendly and easily assimilated grid-connected option for meeting load growth and legislated Renewable Portfolio Standard requirements; 2) easing transmission constraints with minimal, if any, aesthetic concerns; 3) reducing dependence on imported energy supplies and increasing national energy security; 4) reducing the risk of future fossil fuel price volatility; 5) reducing emissions of greenhouse gases as compared to fossil fuel-based generation; and 6) stimulating local job creation and economic development.

The economic opportunities are significant. A relatively minor investment today could stimulate a worldwide industry generating billions of dollars of economic output and employing thousands of people while using an abundant and clean natural resource in the future.

EPRI initiated system definition and feasibility studies in 2004 for wave generation and in 2005 for in-stream tidal generation. A feasibility study is the initial phase of a four phase project to study, permit, build, and test a new technology. The EPRI feasibility studies have had a significant impact. In late 2005, Tacoma Power applied for and received a Federal Energy Regulatory Commission (FERC) preliminary permit for a tidal plant at the Tacoma Narrows. Since then, private investors and municipalities have filed for approximately 35 tidal preliminary permit applications in numerous locations throughout the U.S. and Canada. Snohomish County Public Utility District (SnoPUD) has received seven preliminary permits for sites in the Puget Sound. SnoPUD is also subject to a Renewable Portfolio Standard that will require the addition of ~140 MW of renewable energy resources by 2020. Much of the SnoPUD district borders the expansive and tidally active Puget Sound estuary making the potential of clean, renewable, and predictable tidal energy particularly compelling. A private investor, Golden Gate Tidal Company, has received a preliminary permit for a tidal plant in the San Francisco Bay. In addition, the City of San Francisco and Pacific Gas and Electric have announced tidal projects for the San Francisco Bay. In Nova Scotia Canada, a multimillion dollar pilot tidal plant has been announced by Nova Scotia Power, the province's major utility, as well as plans for non-utility generators to exploit this locally abundant energy source. In June 2006, the first commercial U.S. wave energy preliminary permit application was filed with the FERC; the Ocean Power Technology (OPT) Reedsport Oregon Project. Approximately 10 preliminary permit applications for wave power plants in the Pacific Northwest have been filed with FERC. FERC recently (Feb 2006) granted a preliminary permit to Ocean Power Technology (OPT) for the Reedsport Oregon Wave Energy Park and is in the process of evaluating all other preliminary permit applications. Lastly, Pacific Gas and Electric (PG&E) submitted applications for wave plant preliminary permits to FERC for two sites in Northern California on February 27, 2007.

Currents

To convert tidal currents to electricity, Tidal In-Stream Energy Conversion (TISEC) devices are placed in the flowing tidal stream where they harness the kinetic power of the moving water. Unlike traditional hydroelectric generation, they do not require a dam or impoundment. In-stream tidal is a renewable form of energy.

Like most renewable energy sources, such as wind, solar or wave, in-stream tidal is an intermittent resource. However, unlike wind, solar and wave energy, tidal power generation is much more predictable into the future. Where wind, solar and wave energy rely on weather prediction (a science whose accuracy extends days into the future at best), tides are controlled by the gravitational pull of the Moon and Sun on the Earth's oceans which can be predicted years into the future. For this reason, generators of tidal energy will be able to sell electricity as firm power to the electrical grid thus avoiding the need for costly and possibly environmentally damaging reserve power sources.

Another compelling characteristic of tidal power is its cross-over development potential. While TISEC technology lags wind technology in terms of development by about 20 years, the emerging TISEC industry, is expected to rapidly incorporate technologies being refined by the wind industry as well as related industries such as power electronics, composite materials and underwater construction.

In 2005/2006, EPRI performed a TISEC feasibility definition study examining seven locations in North America. Design, performance, cost and economic assessments were made for sites in Alaska, Washington, San Francisco, Massachusetts, Maine, New Brunswick and Nova Scotia. Designs were developed for both demonstration-scale and commercial-scale power plants based on the Marine Current Turbine (MCT SeaGen dual open rotor horizontal axis turbine. Estimates for commercial scale plant performance are contained in Table 1. A 15% energy extraction size limit was imposed by the EPRI Ocean Energy Team based on a review of the literature and a desire to avoid any significant environmental effects. We recognize that this limit is strongly site dependent containing a high level of uncertainty at this time. In two cases (California and Maine shown shaded in the tables below), the 15% extraction limit could not be reached due to the relatively small high-current area limiting the number of turbines which can be deployed. Existing turbine designs and spacing constraints introduced by rotor wakes drives this limit.

Table 1. TISEC Commercial Plant Designs

	AK	**WA**	**CA**	**MA**	**ME**	**NB**	**NS**
Site	Knik Arm	Tac Narr's	Golden Gate	Musk-eget	West Pass	Head Harbor	Minas Pass
Unit Rated Power MW)	0.76	0.7	1.1	0.46	0.83	0.31	1.11
Unit Rated Speed(m/s) (1)	1.9	1.9	2.1	1.6	2.0	1.4	2.2
Unit Avg Power (MW)	0.22	0.21	0.37	0.18	0.38	0.13	0.52
# of Units	66	64	40	9	12	66	250
Avg Power MW)	14.6	13.7	16.5	1.6	4.6	7.3	130
1000 Homes Powered (2)	11.2	10.5	12.8	1.3	3.5	6.5	100

(1) Rated power at rated speed is optimized for lowest COE
(2) 1.3 kW per average U.S. home per IEA

EPRI independently estimated the plant system cost based on the MCT SeaGen dual rotor turbine design. Using the economic methodology, financial assumptions and incentives described in Report TP-002, EPRI calculated the cost-of-electricity (CoE) for a taxable utility generator, a non-taxable municipal generator, and the internal rate of return for a taxable non-utility generator. The results of this preliminary analysis are contained in Table 2.

Table 2. TISEC Costs ($M) and CoE (cents/kWh)

	AK	**WA**	**CA**	**MA**	**ME**	**NB**	**NS**
Site	Knik Arm	Tac Nar's	Golden Gate	Musk eget	West Pass	Head Harbor	Minas Pass
# of Turbines	66	68	40	9	12	66	250
Plant Cost	110	103	90	17	24	68	486
Annual O&M	4.1	3.8	3.6	0.6	1.0	2.3	18
Annual Energy (GWh)	128	121	129	1.5	40	64	1,140
UG COE	10.8	10.6	7.6	9.9	6.5	11.7	4.6
MUG COE	8.4	8.4	5.6	6.7	4.8	11.2	4.6
IPP IRR	None	None	21%	None	34%	None	31%

The CoE is defined as the total plant cost times the fixed charge rate plus the annual operation and maintenance (O&M) cost divided by the annual energy produced. The fixed charge rate is the percentage of the total plant cost that is required over the project life to cover the minimum annual revenue requirements, and as such, accommodates the individual state/provincial tax rate and incentives structure. The CoE for a utility generator and municipal utility generator is in the range of 5 – 12 cents/kWh (2005 US$). The internal rate of return (IRR) for an independent power producer or non-utility generator is in percent.

TISEC device technology is similar to wind technology and has benefited from the knowledge gained from wind machine production experience, both on shore and off shore. Additional TISEC cost reductions will be realized through value engineering and economies of scale.

The current comparative costs of several power generation technologies are given in Table 3 using generally accepted average numbers from EPRI sources. The tidal plant capacity factor is a function of the tidal flow profile with capacity factors higher on the East Coast than on the West Coast due to lesser diurnal inequalities (a strong tide followed by a weak one). The tidal plant cost and CoE is a function of the plant size, tidal flow profile, bathymetry and geotechnical properties of the seabed.

The Marine Current Turbine (MCT) 300 kW experimental SeaFlow unit (Figure 3) was installed in May 2003 and is the world's first marine renewable energy system of significant size to be installed in a genuinely offshore location. The site is 1 km off the coast of North Devon, UK. It was deployed almost 4 years ago and has provided the operational experience to allow MCT to design and build the 1.2 MW SeaGen commercial prototype unit.

Table 3. Technology Comparisons (2005$)

	Capacity Factor (%)	**Capital Cost (1) ($/W)**	**COE (2)(cents/ kWh)**	**CO2 (lbs per MWh)**
Tidal In-stream Power Density > 3.0 kW/m2 1.5-3.0 < 1.5 kW/m2	29-46	1.7-2.0 2.1-2.4 3.3-4.0	4 – 7 . 4 – 11 6 – 12	None None None
Wind (class 3- 6)	30-42	1.2 – 1.6	4.7-6.5	None
Solar Thermal Trough	33	3.3	18.	None
Coal PC USC (1)	80	1.3	4.2	1760
NGCC @ $5/MM BTU (2)	80	0.5	4.8	860
NGCC @ $7/MM BTU (2)	80	0.5	6.4	860
IGCC w CO2 Capture (3)	80	1.9	6.1	344

(1) 600 MW Plant, Pittsburgh #8 Coal
(2) GE 7 F machine or equivalent
(3) 80% removal

Figure 3. MCT SeaFlow

The Verdant Power 5.5 meter diameter axial flow turbine (Figure4) is used in the Roosevelt Island Tidal Energy (RITE) Project in the East River, New York, NY. The first two of six turbines were installed in December 2006 with the remaining four planned for installation in the spring of 2007. An 18-month experimental project is part of the full licensing process. This project will evaluate fish-turbine interactions and other environmental parameters.

The Canadian Race Rocks British Columbia Tidal Project turbine (Figure 5) was deployed on September 27, 2006 and delivered electricity for the first time on December 5, 2006. The unit is undergoing testing and is expected to be fully operational by mid 2007.

The Open Hydro 300 kW unit (Figure 6), deployed in November 2006, was the first TISEC device deployed at the European Marine Energy Center (EMEC) in the Orkneys UK. It will be the development platform for the 1 MW turbine selected by Nova Scotia Power for its Minas Passage demonstration project. The final design of the 1 MW turbine is expected to be a fully submerged.

Figure 4. Verdant Power RITE Turbine

Figure 5. Clean Current Race Rocks Turbine

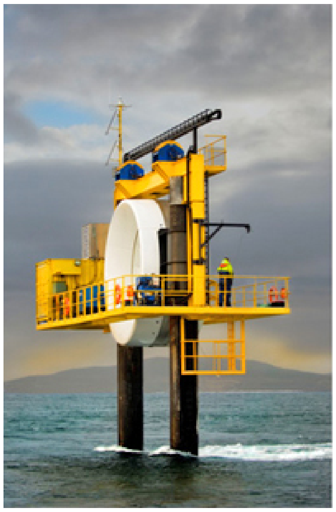

Figure 6 Open HydroTurbine

Additional TISEC devices include the MCT dual 16m diameter rotor 1.2 MW SeaGen prototype to be deployed in 2007 at Strangford Lough, North Ireland and the Lunar Energy RTT1000 and SMD Hydrovision 1 MW prototypes scheduled for deployment at the EMEC in 2007/2008. A description of these TISEC devices is contained in EPRI Report TP-004 available under the Tidal page at www.epri.com/oceanenergy/

River In-Stream Currents

The river in-stream resource contains a component that is stochastic in nature and dependent on precipitation. In 1986, New York University conducted a study of the energy potential of credible river in-stream sites which resulted in an estimate of about 110 TWh/year (Miller et al, NYU, 1986). EPRI will perform a study in 2007 that will estimate the river in-stream energy resource for selected river sites in Alaska and will perform techno-economic feasibility studies at selected sites.

The energy conversion devices needed to convert the kinetic energy in rivers are very similar to those for tidal; the major differences being that river current streams are unidirectional and composed of fresh water.

Ocean Currents

The only viable opportunity to harness ocean currents in the U.S. may well be the Gulf Stream off the coast of Southern Florida. The energy conversion devices for ocean are similar to tidal and river in-stream devices; perhaps larger in size due to the size of the Gulf Stream itself. EPRI is not engaged nor does it have plans to engage in this application for reasons which include the relationship of the ocean currents to global climate, the uniqueness to a single region, the long distance transmission distances, and the very deep water depths necessitated by this application.

Waves

In 2004, EPRI performed an offshore wave energy conversion (WEC) feasibility definition study examining five locations and two WEC technologies. Design, performance, cost and economic assessments have been made for sites in Hawaii, Oregon, California, Massachusetts, and Maine. Designs have been developed for both demonstration-scale and commercial-scale power plants. All wave plants are based on the Ocean Power Delivery (OPD) Pelamis WEC device (Figure 7). A second study was performed for the San Francisco, California site with an Energetech oscillating water column (OWC) device (Figure 8).

The only deployed US wave project is the US Navy- Ocean Power Technology (OPT) project at the Kaneohe Marine Base in Hawaii (Figure 9). A 40 kW buoy was deployed in the summer of 2004. An improved PowerBuoy^{TM} will be installed in the spring of 2007. The Finevera Renewables Makah Bay Washington project filed a full license application with FERC in November 2006, the first U.S. wave project to do so (the OPT project was licensed by the Navy). This project proposes to build and deploy a 1 MW wave plant consisting of four (4) 250 kW AquaEnergy AquaBuOYS. Preliminary permit applications have been filed for numerous wave power plants in Oregon and Northern California by Oregon County governments, private investors (OPT and Finevera) and a utility (PG&E).

The estimated utility generator CoE of the commercial-scale plants, each sized to provide 300,000 MWh/yr, is shown in Table 4 with the Pelamis design as CA1 and the Energetech as CA2. The economic assessment methodology is described in EPRI WP-002.

Figure 7. Ocean Power Delivery Pelamis

Figure 8. Energetech Oscillating Water Column

Figure 9. Ocean Power Technology PowerBuoy^{TM}

Table 4. WEC Costs ($M) and CoE (cents/kWh)

	HI	OR	CA1	CA2	MA	ME
# of Units 300,000 MWh/yr	180	180	213	152	206	615
Total Plant Investment	270	235	279	238	273	735
Annual O&M Cost	11	11	13	11	12	33
10-Year Refit Cost	24	23	23	15	26	74
CoE	12.4	11.6	13.4	11.1	13.4	39.1

WEC and TISEC Technology Status

There are many conceptual ocean energy conversion devices. However, only a few dozen have progressed to rigorous subscale laboratory tow or wave-tank model testing, only a two dozen have advanced to short-term (days to months) tests in natural waters .Even fewer have progressed to long-term (>1 year) testing of full-scale prototypes in natural waters.

The time period for wave technology to progress from a conceptual level to deployment of a long-term full-scale wave prototype tested in natural waters is on the order of 5 to 10 years. The time period for development of TISEC devices is less because of the synergy with wind energy conversion turbines. The technology is in its emerging stage and it is too early to know which technology will turn out to be the most cost-effective, reliable and environmentally sound.

Environmental Assessment

Given proper care in siting, deployment, operation, maintenance and decommissioning, wave and in-stream tidal power promise to be one of the most environmentally benign electrical generation technologies available to our society. We anticipate that these projects will require coordination with local, state, tribal and federal agencies and may include field studies. Baseline assessments can frequently be accomplished through review of existing information and databases and through consultation with appropriate resource agencies and stakeholders. During the environmental permitting process for each project, it is expected that resource agency staff, other stakeholders, and developers will discuss concerns regarding potential project effects, project operation characteristics, and how effects can be avoided or minimized. Because of uncertainty about environmental effects, ocean energy plants will most probably be first deployed in pilot arrays and “built out” to commercial plant sizes using an adaptive management approach of monitoring and feedback to assure the integrity of the promise of minimum environmental effects.

Societal Cost of Electricity Generation

Electricity is a critical ‘backbone’ in sustaining the nation’s economic growth and development and the well-being of its inhabitants. Nearly 70% of U.S. electricity is generated using fossil fuels. Electric power plants that burn fossil fuels emit several pollutants linked to the environmental problems of acid rain, urban ozone, and global climate change. The economic damages caused by those emissions are viewed by many economists as "negative externalities" and reflect inefficiency in the market. Current electric power rates do not reflect these “negative” societal costs. On the other hand, renewable power production from solar, wind, wave and tidal usually have a lower environmental impact which represents a societal benefit over more traditional fossil fuel generation options.

For planning new power generation, should regulators favor technologies with lower capital cost but higher emissions over other technologies with higher capital cost and no emissions? We will *not* attempt to answer that question. However, we will present data that will enable the reader to be able to weigh the costs, both capital and emission cost, of alternative electricity generation technologies. At the end of the day, society, through its politicians and regulators representing the will of the people, will answer this question.

Over two decades ago, as wind technology was beginning its emergence into the commercial marketplace, the CoE was in excess of 20 cents/kWhr (in 2006$). The historical wind technology CoE as a function of cumulative production is shown in Figure 10. Over 75,000 MW of wind has now been installed worldwide and the technology has experienced an 82% learning curve (i.e., the cost is reduced by 18% for each doubling of cumulative installed capacity). The CoE is about now 6 cents/kWhr (in 2006$ with no incentives) for an average 30% capacity factor (CF) wind plant. Wave energy technology today is about where wind was twenty years ago; just starting its emergence as a commercial technology. There are only a few MWs of wave energy capacity installed worldwide and the first commercial plant is being installed in Portugal at the 30 MW size.

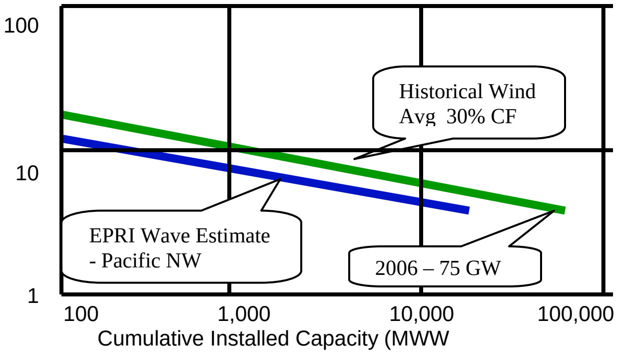

Figure 10. Notional Cost of Electricity, $/MWh, 2006$ w/o incentives

EPRI wave energy feasibility studies performed in 2004/2005 project that wave energy will enter the market place at a lower entry cost than wind technology did and will progress down a learning curve that is similar to that of wind energy. A challenge to the wave industry is to maintain long-term energy production with highly reliable and available turbines and to assure that the inherently higher cost of offshore O&M compared to on-land wind O&M allows the wave technology total capital plus O&M CoE to be economically viable.

In order to quantity the monetary value of the emissions displaced by using wave energy instead of coal (whether wave will displace coal, gas or some other fuel is a question whose answer is site specific), we take the pragmatic approach of monetizing SOx, NOx, Mercury, and CO2 coal emissions at rates being paid in some areas. How much is being paid to avoid emissions provides an imperfect, but explainable approach in estimating how great a harm the emissions are causing. The value of avoided emissions is contained in Table 3.

Table 3. Emissions Avoided

	CO2 $/ton	**SOx $/ton**	**NOx $/ton**	**Mercury $/lb**
Value	10-20	500-1,000	3,000-4,000	10,000-25,000

For a 500MW pulverized coal (PC) plant, monetizing the SOx, NOx and mercury emissions at the abovementioned cost increases the COE from the standard PC plant amount of 4.8 cents/kWh to about 5.0 cents/kWh. Monetizing the CO2 emissions at $15/ton CO2 increases the COE from 5.0 to 6.2 cents/MWh.

The avoided emissions at a deployment level of 4 GW of wave plants operating at 40% capacity factor, using a proxy coal fired plant with emissions at the New Source Performance Standard (NSPS) limit of what can be permitted (actual plants may be less), is shown in Table 4 (note that the emissions rate for mercury is for Bituminous coal and the NSPS for mercury varies with coal type).

Table 4. Emissions Avoided

Pollutant	**Emissions Rate (lbs/MWhr)**	**4,000 MW Wave Plant (tons/year)**
SOx	1.4	10,000
NOx	1.0	7,000
CO2	1,600	11,000,000
Mercury	2.1×10^{-6}	0.014
Particulates	0.2	1,400

Barriers

The primary barrier to the development of tidal in-stream and wave energy in the US is regulatory in nature. The regulatory process being applied today was designed over a half century ago for conventional hydroelectric plants and is not suited for the characteristics of today's wave and tidal in-stream energy conversion technology. Because extensive regulation applies to even small pilot projects whose purpose is to investigate the interactions between the energy conversion devices and the environment in which they operate, the regulations are lengthening the time for experimental projects to get off-the-ground and into the water. The impacts of these pilot demonstration projects are expected to be minimal given the small size of the projects. Developers cannot gather data on potential impacts through installation and operation of a short-term pilot demonstration project without going through the same license process that applies to 30 to 50 year licenses for major conventional impoundment or dam-type hydro projects. There is a provision whereby the FERC will waive the requirement for a license for a small, experimental, short term pilot plant as long as the developer does not realize revenue for the electricity that is generated and pays the local utility for the electricity that they do not generate; a condition which many developers find unacceptable. Licenses to install and operate a pilot project are still required from many other federal, state and local regulatory agencies.

In the absence of information on how projects operate in real-world conditions and related effects to the environment in which they operate, ocean energy developers cannot attract capital. This existing regulatory situation is hampering and will continue to hamper the progress of the ocean energy industry in the U.S. The cost of regulatory delays to U.S. business is significant and will continue to mount. Other parts of the world are moving forward with this technology while the U.S. remains on the sidelines; neither benefiting its own industry nor benefiting itself by taking the steps necessary to overcome its reliance on fossil fuels.

While no technology barriers are evident, further technology advances are essential to achieving reductions in electricity cost from wave power plants. The lack of U.S. Government R&D funding also a barrier, but this is offset by advancements made by other Governments and from private investors.

Once regulatory barriers are removed, the next largest barrier may be the leveling of the playing field for ocean energy vis-à-vis fossil fuel and those renewable technologies that rely on government incentives. It is very difficult for a new technology to overcome market introduction barriers compared to established technologies even with a level playing field. The regulatory barrier established whereby fossil fuel generation technologies do not account for negative externalities and wind and solar generation technologies are the sole renewable recipients of tax credits will hamper the progress of the ocean energy industry in the U.S.

EPRI will continue to work to help the electric utility industry develop and demonstrate new renewable options for diversifying and balancing their generation portfolios and will continue to work to knock down the barriers that are impeding the investigation of these renewable generation options. We have a dream of an affordable, efficient, and reliable power supply and transmission system that is environmentally responsible and provides for a strong economy. This electricity system is supported by an effective regulatory system that fosters the application of the best electricity generation technology for the good of society as a whole. EPRI will continue working to try to make this dream a reality.

As we live in an increasingly global society, it is up to us, each and every one of us, to work together, not only to dream about our desired energy future, but to actively work together to make it happen.

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(2) WP-002-US Rev 4 Cost of Electricity Assessment Methodology for Offshore WEC Devices
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(4) WP-003-WA Results of Survey and Assessment of Potential Wave Energy Sites in Washington
(5)WP-003-OR Results of Survey and Assessment of Potential Wave Energy Sites in California
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(13) WP-006-SFa System Level Design, Preliminary Performance and Cost Estimate – San Francisco, California Polaris Offshore Wave Power Plant
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