Economic and Legal Aspects of Ocean Wave Energy Conversion

Submitted To

Dr. Annette Muetze

Prepared By

Jennifer Vining

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Electrical and Computer Engineering Department
University of Wisconsin - Madison

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ABSTRACT

With the recent advent of commercial ocean wave energy projects, there is no clear economic model or legal process for developers to follow. This report focuses on wave energy business and legal jurisdiction issues. These issues are addressed with regards to siting license dilemmas, which government agencies may assert jurisdiction, economic / business incentives for renewables, and wave energy economic factors. This report also investigates regulatory actions and incentive programs needed to promote wave energy conversion technology. All topics are discussed from the view point of an engineer on the subject of making emerging technologies such as wave energy converters successful.

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LIST OF ABBREVIATIONS USED

Acronym Definitions	
Acronym	**Definition**
ACoE	Army Corps of Engineers
AMT	Alternative Minimum Tax
DOC	Dept. of Commerce
DOI	Dept. of Interior
FAA	Federal Aviation Administration
FERC	Federal Energy Regulator Commision
MACRS	Modified Accelerated Cost Recovery System
MMS	Minerals Manangement Service
NARUC	National Association of Regulatory Utility Commissioners
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
PUC	Public Utility Commission
ROC	Renewables Obligation Certificate
RPS	Renewable Portfolio Standard
RTO	Regional Transmission Organizations
TREC	Tradable Renewable Energy Credit
WEC	Wave Energy Converter

1.0 INTRODUCTION

This report pertains to U.S. policy and economics that affect the use of wave power for generation of electric energy. Topics in the report center on the legal and business issues faced by wave energy developers with a few European comparisons. These issues include governmental regulatory aspects, the process for licensing wave energy installations as compared to offshore wind energy, renewable energy incentives, and cost factors. Currently appropriate activities to support the development of economically and politically sustainable commercial markets for wave energy are also identified.

The first three sections of this report deal with legal features of wave energy installations, specifically government entities and their involvement in licensing and operating. The last three sections cover economic topics with regards to government incentive programs, cost factors, and overall cost estimates of wave energy installations.

2.0 GOVERNING BODIES INVOLVED IN WAVE ENERGY LICENSING

Wave energy is a newly emerging industry, and as such, does not have a clearly defined process to cut through the bureaucratic red tape. At this point, there is no central licensing agency to direct the disparate other agencies and no licensing exemptions for pilots or prototypes, although the Federal Energy Regulatory Commission has tried to assert jurisdiction over all offshore ocean energy projects, citing them as "power houses" within Federal waters under the Federal Power Act [1, 2]. Future legislation will be needed to assign tasks to individual government agencies without stifling over-regulation or conflicting regulatory policies which will suppress wave energy development. These agencies will handle all aspects of the installation and maintenance process. The next section mentions many of the agencies currently involved and describes their involvement.

2.1 GOVERNMENTAL AGENCIES AND THEIR REGULATIONS

Several Federal and State agencies will be involved over the lifetime of a wave energy park. The expected roles of these agencies is to:

1) Lease/permit/site offshore land
2) Provide environmental review and ongoing inspection
3) Insure safety of installation
4) Regulate energy markets
5) Handle legal disputes (i.e. siting disputes or challenges to right-of-way)

Table 1 on the next page outlines some of the major agencies involved and gives a brief description of their role.

Table 1. Roles of Government Agencies in Licensing and Operating

Government Agencies Involved in WEC Installation Process	
Agency	**Role**
Federal Energy Regulatory Commission (FERC)	Holds jurisdiction under the authority of the Federal Power Act to issue licenses for up to 50 years for non-federal hydrokinetic and ocean technologies, and can provide limited waivers from licensing to developers of pilot projects. Oversees generation, state grid interconnection, and interstate electric transmission. (Also: Oversees issuance of stock and debt securities for energy companies. Reviews officer and director positions held jointly between utility companies and firms with which they conduct business. Sets wholesale electricity rates.) [3]
Minerals Management Service under Dept. of the Interior (DOI: MMS) **	Energy Policy Act of 2004 gives MMS the power to distribute ocean floor space through least or rent payments to the federal government. The Federal Government would share this revenue with the nearest State. MMS also leads the NEPA review [4].
U.S. Army Corps of Engineers (ACoE)	Provides environmental assessment or impact statement and issues permits to construct facilities on federal lands. [4]
National Oceanic and Atmospheric Administration under Dept. of Commerce (DOC: NOAA)	Supplies environmental information and ensures ocean/coastal activity does not threaten the ecosystem. Ensures sustainable use of resources. May allocate wave energy rights in the future. [1, 2]
U.S. and State Coast Guards	Ensures safety of shipping routes around marine installations. [5]
National Association of Regulatory Utility Commissioners (NARUC)	Provides indirect jurisdiction through each State Public Utility Commission. [6]
State Public Utility Commission (PUC)	Provides jurisdiction over construction and maintenance of state utilities (water, electricity, communications) [3]
State agency responsible for land and natural resources	Siting and project land use planning [7]
State agencies responsible for coastal zones	Siting and project land use planning (states have jurisdiction on land up to 3 miles from shore under the Submerged Lands Act [4]) **
**Exception: Texas entered the nation as a sovereign state and retained title to lands 10.36 miles from shore. Thus, Texas may control offshore leasing as opposed to MMS [8].	

2.2 STATE VS. FEDERAL JURISDICTION

In the United States, both Federal and State agencies oversee the installation of electrical facilities with State jurisdiction varying from state to state. This situation mirrors the layout present in the European Union between the EU and member [9]. While states own offshore lands up to three miles from shore under the Submerged Lands Act [4], the Federal government owns all lands beyond that. However, the federal government reserves the right to develop water power in state waters under the Submerged Lands Act as well. States maintain control over construction of new generation and transmission by issuing certificates of public necessity and convenience, yet FERC may preempt the State by issuing a hydro license [4].

The level of State or Federal interaction with developers depends on many factors, and in most cases, roles at the State and Federal level overlap. For example, the Federal government oversees environmental impact assessments under the National Environmental Policy Act (NEPA) while approximately twenty states have their own “little NEPA” programs [10]. Generally, Federal interaction occurs when electricity is crossing state boundaries, when federal lands are used or affected, when federally regulated natural resources are involved, or when the project site overlaps an endangered species habitat/migration corridor [7].

State jurisdiction:

1) Environmental assessment
2) Siting (varies from state to state – sometimes siting regulation is local instead of state headed which involves county commissions, planning and zoning boards, or other local government departments responsible for conditions of approval)
3) Safety: Construction and Maintenance
4) Laying of transmission cables

Federal jurisdiction:

1) Environmental assessment if project overlaps endangered species habitat
2) Interstate transmission
3) Approval of wholesale electricity rates

Proposed additional regulatory agencies recommended by the FERC [3]:

1) Regional Transmission Organizations (RTO)
2) Generator Interconnection Group

2.3 FUTURE RECOMMENDATIONS

Given the fact that offshore wind energy penetrated the energy market some time ago but has no clearly defined bureaucratic process yet, improving government regulation is an ongoing issue. For example, Cape Wind project has seventeen Federal and State agencies reviewing it since the agencies involved are not accustomed or properly prepared to process this type of permitting request. One would expect that fewer agencies will be involved when the process is streamlined. At the present rate of pace, this may take years to accomplish.

3.0 INSTALLATION PROCESS FOR WAVE ENERGY CONVERTERS

Current wave energy conversion siting processes have been heavily influenced by the government's direct involvement in the projects. At the time this report was written, there were only two operable, commercial wave energy installations in the U.S., both of which are licensed as prototypes and contracted to Ocean Power Technologies through the government – one through the Navy in Hawaii and the other through the New Jersey Board of Public Utilities. Even so, both projects had to meet economic and environmental criteria.

3.1 SITING ISSUES

As mentioned previously, the process for siting a WEC installation varies from state to state. Each state – and local government – has its own distinctive rules and regulations. For instance, some states require that the state public utility commission issue a certificate of need before the project may begin. Common site review and permitting issues include:

1) Energy transmission (new transmission lines and interconnections)
2) Resource assessments (logical place for such an installation)
3) Permitting processes (agencies involved)
4) Study of the population(s) affected (creation of local jobs, community benefits, hazards, public acceptance/opposition, etc.)
5) Resource rights (ocean waves in this case, wind in the case of wind energy)
6) Environmental laws

3.2 RECOMMENDED SITING PROCESS IMPROVEMENTS

Suggestions for improving/streamlining the siting process:

1) Clearly defined laws
    - Federally mandated state-level siting statutes (create laws with project requirements)
    - State mandated local government siting rules (state may create model ordinances that local governments can implement)
2) Set time frame
    - Reasonable public comment period
    - Limit amount of time to issue permits

- Expedite the judicial review process when siting decisions are contested

3) Appoint one state agency to coordinate all state agencies involved in the siting process

4.0 LICENSING PROCESS COMPARISON: WAVE VS. WIND ENERGY

The process for permitting a wave energy farm should be similar to the current process for offshore wind installations. A key difference between the two is public acceptance due to the visibility factor. Whereas a wave farm constructed of underwater buoys or floating water column devices will not be highly visible from the shore, an offshore wind facility will create a noticeable eye-sore. Along these lines, the offshore wind farms must meet FAA airspace requirements unlike wave energy farms. Nevertheless, each company must face the arduous Federal, State, and local licensing processes. Appendix A gives a comparison of offshore wind and wave energy installations planned in the U.S. with key licensing issues.

4.1 WIND INSTALLATION PROCESS

Galveston, Texas: The state of Texas is eager to be the first with an offshore wind energy installation. They own OCS land out to 10 miles but still have to obtain a permit to install from the ACoE. The fact that Texas has a central agency dealing with this installation speeds up the process and lowers the associated legal/permitting cost. Having one agency deal with the process also ensures that certain tasks are not completed twice by different agencies [8].

Nantucket Sound, Massachusetts: Cape Wind, which has not begun installation, has been in the litigation process since 2004 due to endless public and Federal legal proceedings against the project. This public outcry has led to a mounting number of legal issues, in addition to expenses, that Cape Wind must deal with. This process can become unduly cumbersome and overwhelm new companies with experimental technologies. The process is even more confusing for wave energy companies because no one has gone through the entire procedure before – the two operating facilities are merely prototypes not connected to the grid and thus have not completed the process. No Federal or State agency has a clear cut role; however, the Federal Energy Regulatory Commission has taken the lead in asserting authority – as mentioned in Section 2 and further in this section – over licensing in conjunction with the Army Corps of Engineers while the Dept. of the Interior, specifically the Minerals Management Service, has taken over leasing the land [11].

4.2 WAVE ENERGY INSTALLATION PROCESS

A power struggle has taken hold at the Federal level, and confusion still exists as to which agency has jurisdiction over what. The companies Energetech, Aqua Energy Group, and Verdant Power have petitioned FERC saying that FERC does not have jurisdiction but to no avail [2]. FERC justifies their jurisdiction by stating that ocean energy converters constitute "power houses" under the Federal Energy Act. They also state that a non-Federal hydroelectric project must be licensed if it occupies lands or navigable waters of the United States, utilizes surplus water or waterpower from a government dam, is located on a body of water over which Congress has Commerce Clause jurisdiction, and affects the interests of interstate or foreign commerce [1]. Verdant was granted a temporary license by FERC because

1) The devices will not supply electricity to the grid.
2) The installation will have little effect on interstate commerce (Verdant may not sell electricity during the test period).
3) The technology being tested is experimental.
4) The duration of their initial test installation is short and meant only to prepare them for the full FERC license application process.

A search through FERC documents shows no correspondence with Ocean Power Technologies. So it seems they have bypassed the FERC process for now, a big boon for them in terms of fewer initial costs in deploying their prototype for testing purposes. Whenever it is possible to bypass the Federal level in any licensing, the cost is dramatically less. Nevertheless, they will have to deal with FERC once they are ready to sell electricity.

The U.S. Army Corps of Engineers (ACoE) will conduct an environmental assessment of each offshore project (wind and wave), and the Minerals Management Service (MMS) will oversee the implementation of NEPA regulations regardless of whether FERC is involved. Hence, the duties of the MMS and ACoE overlap in this case, creating extra strain on new offshore wind and wave energy developers. This process is intensive, consequently AquaEnergy had to hire an outside contractor to prepare a Preliminary Draft Environmental Assessment document [5], adding to their installation costs. Another case of overlapping duties is the separate public comment periods carried out by both the ACoE and FERC [12, 13], which partly determines each agency's course of licensing actions.

Whereas it is important to provide a comprehensive environmental review before installing an offshore ocean energy device, this type of review may prove to be too much for the prototyping phase now occurring in the ocean energy community. When Ocean Power Technologies went public with their plan to install a prototype off the coast of New Jersey, the public struck back with an accusation that there was not enough regulatory oversight to the project, especially since New Jersey Gov. Codey had imposed a 15-month moratorium on offshore wind turbines [14]. Thanks to New Jersey's Dept. of Environmental Protection, Ocean Power Technologies was able to proceed.

4.3 FUTURE LICENSING NEEDS

The treatment of similar ocean projects by government agencies, such as FERC, has not been uniform. The licensing process has caused confusion, and each company has gone through a different process as policies regarding ocean energy development have changed with new legislation and policy decisions (e.g. recently giving offshore land leasing power to the Interior Department). Undoubtedly, new rules and policies must be instituted to aid the licensing process for both offshore wind and wave power installation.

5.0 RENEWABLE ENERGY INCENTIVES

Renewable energy projects would not exist if it were not for government subsidies. If no incentives existed, the most economically viable renewable energy would probably be wind energy, but this technology depended on incentives to stay commercially active not long ago. The fact of the matter is that all forms of energy are subsidized in the U.S. It is no surprise that renewable energy will continue to receive government support from the Energy Policy Act of 2005 even though most of the $80 billion dollars goes to oil, coal, and nuclear [15]. And with the passage of the Energy Policy Act of 2005, wave energy may now receive the same benefits as other renewable energy technologies. Appendix B identifies current official Federal strategies to support renewables.

5.1 RENEWABLE ENERGY PROGRAM CLASSIFICATIONS

How renewable energy incentives are rated depends on the desired outcome of the incentive distributor. If the incentive program is meant to increase renewable energy production, then the implementation method would differ from that of an incentive meant to introduce new technologies. In order to begin an analysis, one must know the base case without any incentives. This is used for comparison against models where incentives are added. In reality, there are many incentives, and their individual effects cannot be easily identified but rather must be analyzed as a whole. Based on this, the following section compares and contrasts many incentive programs.

The types of programs may be classified in many ways:

1) Market push or pull policies
2) Direct or indirect cash assistance
3) Low-cost debt financing
4) Customer choice

Market push and pull policies provide an umbrella for classifications 2-4 to be placed into. With that in mind, a program is categorized as either a market push or pull policy. Market push policies create a market for renewables and directly reduce the cost of renewable energy for the customer. Market pull policies reduce renewables development costs or increase revenue. Whether a program provides direct/indirect cash assistance, low-cost debt financing, or customer choice is independent of its market push/pull classification.

An indirect cash incentive would take the form of a tax incentive whereby the operator's tax burden is lowered. The direct cash incentive provides cash subsidies or price support payments to the wave energy developer. The direct cash incentive is more desirable from the standpoint that investors may not be able to fully absorb all tax incentives due to their alternative minimum tax (AMT) obligation. The AMT weakens the effectiveness of tax incentives since it requires the financier to have a sufficient tax load.

Low-cost debt financing programs decrease costs incurred by project financiers to acquire capital usually by means of loan strategies. Customer choice programs involve the rights of the customer to purchase electricity generated by renewable sources.

Table 2 illustrates possible renewable energy incentives [9, 16-28] as further described in the next section.

Table 2. Renewable Energy Incentive Classifications

Renewable Energy Incentive	Market Push	Market Pull	Direct Cash Incentive	Indirect Cash Incentive	Low-Cost Debt Financing	Customer Choice
Accelerated Depreciation Schedule		X		X	X	
Direct Investment Incentive (Grants)		X	X			
Direct Production Incentive		X	X			
Fixed Tariff (German)		X	X			
Government Subsidized Loans		X			X	
Investment Tax Credit		X		X		
Production Tax Credit		X		X		
Project Loan Guarantees		X			X	
Property Tax Reduction		X		X		
Renewables Portfolio Standard -- via Tradable Renewable Energy Credits	X					X
Sales Tax Reduction	X			X		
Utility Green Pricing Program	X					X

5.2 DESCRIPTION OF INCENTIVE TYPES

Table 2 illustrates many renewable energy incentives possibilities. These are categorized by how they operate. This report uses four categories: customer choice, direct cash incentives, indirect cash incentives, and low-cost capital programs.

5.2.1 Customer Choice Incentives

5.2.1.1 Renewables Portfolio Standard – Tradable Renewable Energy Credits

Tradable renewable energy credits (TREC) are allocated to renewable energy suppliers for each kWh generated. Renewable energy suppliers may sell TRECs separate from the power itself. The TREC plays the key role in instituting the Renewables Portfolio Standard (RPS) that is becoming popular among several states at increasing renewables. While the RPS may be implemented without TRECs, it would be much more difficult for energy suppliers to guarantee that their product came from a certified renewable generation facility. Electricity providers would have to buy/lease a renewable energy facility, provide a distinctive path for the renewable-generated electricity, and match the variable energy profile of renewables to customers' load profiles. With TRECs, these transaction barriers are lifted, and the cost of complying with the RPS and selling renewable energy on the market decreases [21]. And in the spirit of capitalism, TRECs depend on the private market for their realization [20]. As such, market forces will theoretically provide competition and deliver renewable energy at the lowest price; however, the inherent instability in the energy markets will cause the prices of TRECs to fluctuate and may also cause instability in the TREC market.

A considerable advantage of tradable credits is that they may be sold in both the regulated and deregulated energy markets. This is a valuable property which will bridge the gap in market structures. Not only that, any individual customer can purchase TRECs no matter who their electricity provider is. In the U.S., more than 20 companies actively market TRECs [17]. TRECs have also become popular with nonresidential customers. For example, Whole Foods market purchased enough RECs to supply all their stores and offices with renewable energy.

5.2.1.2 Utility Green Pricing Program

Utility green pricing programs are closely linked with the RPS and TRECs. As many states push for the RPS, utilities are required to provide a certain amount of their electricity from renewable sources which may be obtained through TRECs. It has been shown that the effectiveness of utility green pricing is independent of utility ownership (private vs. public) once size is controlled for [18]. Although this type of scheme usually refers to pricing of renewables in noncompetitive, i.e. traditionally regulated, electricity markets, it may be extended to the deregulated market. In some of the deregulated retail electricity markets, customers may switch providers to obtain their electricity from green sources, but again, the term 'utility green pricing program' does not necessarily apply to the deregulated market.

The number of participants in green pricing programs grows each year and as of 2005, these programs sell approximately 2.7 billion kWh annually [29]. There are several pricing methods for these programs. The majority of larger programs offer fixed pricing schemes for the customers, where the customer signs a contract to purchase the renewable energy for a fixed price over a fixed period of time [30]. On the business side of things, this helps finance renewable energy installations because the price paid for each kW may be fixed by the utility company with which the renewable generator has a contract with or is owned by, thereby enabling the renewable energy company to obtain financing since they can plan their balance sheets ahead of time and show evidence to the lender that the project is profitable. NREL estimates that more than 520 MW of new renewable capacity was installed as of 2004 as a result of these programs [31].

5.2.2 Direct Cash Incentive

5.2.2.1 Fixed Tariffs

Fixed tariffs require utility providers to purchase renewable energy at fixed prices, set by some regulating agency. A case study between Germany and U.K. shows that the fixed tariff structure in Germany created more renewable energy capacity and generation than the U.K.'s Renewables Obligation Certificates (ROC), similar to the RPS, even though the U.K. has better resources [9]. One may question whether the ROC was well managed since the RPS has been successful in the U.S. This also brings up the argument that the tariffs do not expose project developers to price competition, and it is assumed that renewable energy is not provided at the lowest possible price in Germany [9]. Nevertheless, fixed tariffs enable newer technologies to compete on a level playing field for the meantime. A reasonable solution to this problem may be to switch over to TRECs from fixed tariffs after a predetermined time period, thus allowing the renewable generating company to become settled before being introduced to market pressures. This will help the company secure debt financing in order to begin operations and purchase capital but then introduce it to a dose of market competition.

5.2.2.2 Direct Production Incentive

The direct production incentive provides renewable generators with cash payments based upon the amount of electricity generated by the facility [27]. This promotes renewable energy facilities that perform well (i.e. they produce reasonable amounts of electricity). Unlike fixed tariffs, this money is provided by the government rather than the utility provider. A government subsidy of this sort allows renewable generators to compete with traditional electricity providers without losing money. Customers will not directly pay more for renewable energy with this incentive, but they will pay more indirectly through government taxes [26]. Since the direct production incentive is like cash, it increases revenue directly and helps the renewables company sustain lower-cost debt [20], a valuable feature for such capital intensive projects. The problem with implementing a production incentive is the complexity involved in documenting the amount of electricity produced and distributing benefits annually.

5.2.2.3 Direct Investment Incentive

A direct investment incentive is much like a grant in that a generator receives cash for investing in renewable energy [20], which effectively reduces the capital cost of the renewable energy project. From the vantage point of the investor, a direct investment incentive is highly desirable due to the large up-front costs of installing a renewable generating facility. Conversely, investment incentives do not ensure that the facility performs well like the production incentive does [26]. This drawback may be overcome by combining investment and production incentives into one package. Then again, the investment incentive is preferred over the production incentive because the one-time payment of the investment incentive is easier to implement than the ongoing yearly payments of the production incentive.

To recap, the investment incentive works to increase renewable generation capacity while the production incentive rewards facilities that produce more electricity. If a policymaker's goal is to increase both the capacity and electrical output of renewable energy sources, then a mixture of the two incentives should be implemented.

5.2.3 Indirect Cash Incentive

5.2.3.1 Production Tax Credit

The production tax credit operates similar to the direct production incentive. The main difference between the two is that the direct production incentive provides cash while the production tax credit acts to lower taxes [32]. In this scheme, the renewable facility receives an annual tax credit linked to the amount of electricity produced. The main shortcoming of the tax credit when compared to the direct incentive is the alternative minimum tax (AMT) requirement. The AMT causes the investor to not fully absorb the credit if they do not have a sufficient tax load – the baseline tax load [20]. Another limitation is that nontaxable entities may not use the tax credit. As with the direct production incentive, the production tax credit rewards facilities that perform well.

5.2.3.2 Investment Tax Credit

Investment tax credits work the same way as direct investment incentives; however, financiers receive tax credits for investments rather than cash. This benefits equity investors who receive a tax credit for their capital investment in renewable energy facilities [20]. The same tax credit drawbacks mentioned with regards to the production tax credit exist for the investment tax credit. Along the same lines as direct production and investment incentives, the investment tax credit increases renewable generation capacity but does not guarantee electrical output as the production tax credit does. Also, investment tax credits are easier to implement than production tax credits since the investment tax credit is a one-time deal while the production tax credit must be administered annually. This may be why the investment tax credit has historically been one of the leading methods to stimulate renewable energy development [20].

5.2.3.3 State and Local Sales Tax Reduction

Reducing sales tax on the components of a renewable energy facility reduces the installation and overall levelized cost of the project [17]. Given that renewable energy projects have high capital costs, it makes sense to decrease sales tax on the materials. This places renewable energy on a level playing field with traditional facilities since fossil fuels are typically exempt from sales taxes [20]. A reduction in sales tax will also help increase renewable energy capacity.

5.2.3.4 Property Tax Reduction

Property taxes are usually imposed as a percentage of the assessed value of a facility and can be more significant than sales taxes. Therefore, property tax exemptions/reductions may be more effective than sales tax reductions [20]. Whether or not reducing property tax affects wave energy developers depends on how the Minerals Management Service (MMS) regulates offshore land leasing. If the MMS decides to merely demand rent or lease payments, reducing property taxes would not be a viable option. Regardless of how the MMS implements its land leasing system, simply reducing the amount of money paid to use offshore land will decrease operating costs and likely increase renewable energy capacity.

5.2.3.5 Accelerated Depreciation Schedule

Depreciation in the U.S. tax code allows companies to claim the loss of asset value as a noncash expense which may be deducted from taxable income and thus decrease annual income tax. The method of depreciation in the U.S. is known as the Modified Accelerated Cost Recovery System (MACRS). MACRS sets the time period over which an asset is depreciated and the percent of depreciation per year. A nonrenewable power facility typically falls into either the 15- or 20-year depreciation schedule [20], but with accelerated depreciation, the assets of a renewable energy facility may be placed on the 5-year schedule where tax benefits occur earlier in the project lifetime [27]. This is favorable to investors because of the time value of money associated with inflation where an after-tax dollar is worth more today than in the future. Accelerated depreciation can make a large difference on income tax since federal income tax rates for corporations run at about 35% [20]. As with tax credits, the AMT may decrease the effectiveness of accelerated depreciation.

5.2.4 Low-Cost Debt Financing

5.2.4.1 Government Subsidized Loans

The cost of debt, in the form of interest, is a significant portion of the levelized cost of renewable energy installations because of the excessive loans needed to cover high capital costs. Interest on these loans tend to be higher due to the fact that banking institutions view renewable energy as a risky investment [20]. Without a secure stream of revenue, as is the case with renewable energy, simply obtaining mortgage-style debt is difficult. A government-subsidized loan would assist project developers finance their project with lower interest rates. The major obstacle to implementing subsidized loans is that the government assumes a level of risk that the project will default on the loan. The government also has to take on the role of lender and all the overhead of administering the loans.

5.2.4.2 Project Loan Guarantees

Project loan guarantees are an alternative to subsidized loans. Rather than administering the loans directly, the government instead guarantees that the loan will be repaid to the lender [28]. This helps new-technology such as wave energy obtain debt financing. In addition, the time-honored procedures used by commercial and investment banks to ensure project viability may be applied by the lender. This eliminates the government loan review needed for government-subsidized loans, but all the risk is still shifted from the project financiers and lender to the government [28].

5.3 SUMMARY OF RENEWABLE INCENTIVES

Table 3 on the next page provides a brief description of each incentive mentioned in this section. Out of all these incentives, four are actually currently available: the direct production incentive (Section 5.2.2.2), production tax credit (Section 5.2.3.1), accelerated depreciation (Section 5.2.3.5), and government loan guarantee (Section 5.2.4.2) – see Appendix B for contact information on these incentive programs. The success of any of these depends on many factors such as the market price of power, the stability and length of time the incentive is available, and the magnitude of the incentive. In general, renewable developers should not depend on these incentive programs because some are subject to annual appropriations [27] or have a low level of permanency.

Table 3. Description of Incentive Programs

Overview of Incentive Programs		
Incentive Category	**Incentive**	**Brief Description**
Customer Choice Incentives	Renewables Portfolio Standard (RPS) – Tradable Renewable Energy Credits (TREC)	TRECs are allocated to renewable energy suppliers for each kWh generated and may be used to fulfill the RPS
	Utility Green Pricing Program	A special pricing program for renewables as provided by utilities
Direct Cash Incentive	Fixed Tariffs	Requires that utility providers purchase renewable energy at fixed prices, set by some regulating agency
	Direct Production Incentive	Provides renewable generators with cash payments based upon the amount of electricity generated by the facility.
	Direct Investment Incentive	Much like a grant in that a generator receives cash for investing in renewable energy
Indirect Cash Incentive	Production Tax Credit	Provides an annual tax credit linked to the amount of electricity produced
	Investment Tax Credit	Provides a one-time tax credit for renewable energy investments
	State and Local Sales Tax Reduction	Reducing sales tax on the components of a renewable energy facility reduces the installation and overall levelized cost of the project
	Property Tax Reduction	Reduces the price paid for land used in a renewable energy installation
	Accelerated Depreciation Schedule	Allows companies to claim the loss of asset value as a noncash expense which may be deducted from taxable income and thus decrease annual income tax
Low-Cost Debt Financing	Government Subsidized Loans	Assists project developers finance their project with lower interest rates
	Project Loan Guarantees	The government guarantees that a loan will be repaid to the lender

6.0 COST FACTORS

The largest shortcoming of wave energy is its cost compared with conventional sources. *The Economist* claims that wave power costs at least 18 or 20 cents per kWh while conventional sources range between 3 and 5 cents per kWh [33]. Maturation of wave energy conversion and economies of scale will alter this in the future with prices projected to fall.

Several factors weigh in on the costs of developing a wave farm. These costs will vary by region and wave energy converter topology, making analysis dynamic and complex. The following is an enumeration of a few cost factors associated with a wave farm.

1) Siting and permitting
2) Components: initial and ongoing capital costs
3) Installation
4) Operation and Maintenance
5) Taxes
6) Depreciation schedule
7) Financing costs: debt management (interest on loans which is tax deductible)
8) Project life time
9) Average annual energy production: capacity factor of individual technology in a particular wave climate

Probably the most important factors have to do with the comparative weight of project costs (installation, financing, operation, etc.) per kWh to the average annual energy production. If the annual energy sales offset costs so as to be profitable over the project lifetime, the project will be successful. The next section compares the capital and operating costs of different technologies.

7.0 OVERALL ECONOMIC ANALYSIS

> "Moderately good wave climates should produce power using first generation systems at a cost of around 10 cents US per kWh, and ideal sites at a cost around 5 cents. Over time, on moderately good sites, with capital cost savings from second generation designs, we can see the technology regularly delivering electricity at around 4 cents US kWh." – Energetech America L.L.C. [34]

This statement from 2006 expounds on the benefits of the economies of scale associated with mass production of wave energy devices and should hold true. With increased fuel costs and fluctuating energy prices, a stable source of electricity such as wave energy should become popular and thus increase demand. With conventional supply versus demand analysis, this should bring about more wave power.

Each wave energy company has quoted different prices for their installed systems. Differences are most likely due to the cost of the components and the various installation methods. Seeing as how this technology is so new, the quoted price per installed kWh is merely a good estimate. Table 4 includes a comparison of operating costs and installation costs for various energy sources as presented to the Senate by Ocean Power Technologies in 2001 [35]. An important point to be drawn from this information is that the cost of wave energy is competitive with other sources when used as a primary power source.

Table 4. Cost Comparison of Energy Sources

Installation / Capital Cost Comparison Between Renewable Energy Sources (2001 $/kW) [35]		
Energy Source	**Cost as Primary Source (100 MW)**	**Cost as Secondary Source (1 MW)**
Coal Plant	1,500 - 3,500	n/a
Fuel Cells	n/a	5,000
Wind/Solar	4,000	8,000
Wave	2,300	6,200
Operating Cost Comparison with Traditional Power Sources (2001 ¢/kWh) [35]		
Energy Source	**Cost as Primary Source (100 MW)**	**Cost as Secondary Source (1 MW)**
Photovoltaic (Solar)	10-15	25-50
Diesel	n/a	12-100
Wind	5-6	10
Fossil Fuel	3-5	n/a
Wave	3-4	7-10

In-depth analysis of wind energy reveals that there is no single price for wind energy, but a range of prices depending primarily on the wind resource (capacity factor), the location (transmission line losses and cost of infrastructure), and cost of components. This holds true for wave energy as well, the difference in this case being the capital cost and the capacity factor associated with the wave climate. These variables cannot predict the entire economic profile of wave energy because individual business models – how a company operates – yield different results.

8.0 CONCLUSION

As this report has outlined, there are several questions as to the proper way to promote commercialized wave energy. Wave energy developers face a myriad of obstacles to obtain licensing and financing. Licensing woes are due to the legal requirements of the many government agencies involved. These legal problems may be solved by streamlining the licensing/permitting process by assigning certain government agencies with clearly defined functions closest to their historical jurisdiction. This will ease the transition each government agency has as it begins to handle wave energy technology.

Time will show whether or not investors' opinion that wave energy is a high-risk new technology is true. Existing Federal assistance programs may help ease the financial impediments faced by developers, yet the process for claiming benefits takes a significant amount of effort since wave energy developers must prove that their technology qualifies for assistance. Even so, the demand for more electricity worldwide will drive development. This sentiment is best summed up by John Kennedy:

> "A revolution is coming - a revolution which will be peaceful if we are wise enough; compassionate if we care enough; successful if we are fortunate enough - but a revolution which is coming whether we will it or not. We can affect its character, we cannot alter its inevitability."
> -John F. Kennedy, 1963 [36]

Many of the effects of programs/regulations presented in this report are mere speculation. The best course of action to take now is to implement them and study their effects. Thus, the ones with the best effects will be identified and promoted.

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APPENDIX A – COMPARISON OF OFFSHORE OCEAN AND WIND ENERGY INSTALLATIONS IN THE U.S.

A Comparison of Offshore Ocean and Wind Energy Installations in the U.S.

Offshore Wind Installations

Company	Location	Device	Project Description	Siting / Permitting Process (date of inception)	Notes	Website
Cape Wind™ Associates L.L.C., under Energy Management Inc. [13]	5.2 miles from the closest shore in Horseshoe Shoal in Nantucket Sound, Massachusetts	468MW, 130 General Electric 3.6MW turbines (turbine tower is 247' tall with a base 16' in diameter and a blade radius of 170')	Several groups advocate the wind farm, but opposition remains. The project is slated to produce an average of 170MW, which will provide about 75% of the 230 MW average demand for Cape Cod and the Islands of Martha's Vineyard and Nantucket.	There are seventeen Federal and State agencies reviewing Cape Wind in addition to a drawn-out public comment period with significant litigation. The MMS is conducting a NEPA review while the ACoE has issed a Draft Envinronmental Impact Statement and will issue a Final Environmental Impact Statement later. The U.S. Coast Guard is currently reviewing Cape Wind for maritime safety. In Massachusetts, the Executive Office of Environmental Affairs is conducting an environmental review which overlaps that of the MMS.	A complicating factor is that some members of Congress want to delay decisions on the project until regulations governing offshore wind development have been completed [38]. Cape Wind claims that this wind project has received more scrutiny than any of New England's fossil fuel plants.	http://www.capewind.org/
FPL Energy under the direction of the Long Island Power Authority (LIPA) [39]	8 square miles of land southeast of Jones Beach State Park and southwest of Robert Moses State Park, NY	144MW, 40 General Electric 3.6MW turbines [4]	LIPA plans for the Long Island Offshore Wind Park to be developed, built, and operated by FPL Energy.	The initial permit to the ACoE has been accepted with the public comment period having ended. The comments will determine whether an environmental assessment or environmental impact statement must be completed for the ACoE. Other permits and approvals must come from the NY State Department, NY State Office of Parks, Recreation, and Historic Preservation, U.S. Federal Aviation Administration (FAA), U.S. Coast Guard, U.S. MMS, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service.	There has been less public scrutiny in the public comment period for this project compared to the Cape Wind project.	http://www.lipower.org/cei/wind.html
Galveston-Offshore Wind L.L.C., a division of Wind Energy Systems Technology [8]	7 miles off the coast of Galveston Island, Texas	50 wind turbines to produce an expected 150 MW	Construction could take as long as 5 years to complete.	Due to its sovereignty over all submerged lands in the Gulf of Mexico out to 10.36 miles, Texas believes it will be able to bypass much of the Federal permitting processes. The project will still need U.S. Coast Guard and USACE permits to continue, however, offshore land leasing will be through the state rather than the MMS. At the state level, Texas has streamlined the process by giving jurisdiction to one agency, the Texas General Land Office (GLO). The GLO will coordinate with the USACE and the Texas Coastal Coordination Council.	Texas believes it is in a good position to have the first U.S. offshore wind farm	http://www.eere.energy.gov/states/state_news_detail.cfm/news_id=9502/state=TX

Offshore Ocean Wave Installations

Company	Location	Device	Project Description	Siting / Permitting Process	Notes	Website
Energetech America L.L.C. [34]	Approximately 1.2 miles off of Point Judith Harbor of Refuge in the Town of Narragansett, Washington County, Rhode Island	500kW Oscillating Water Column (100' long X 120' wide X 40' above water level)	GreenWave Rhode Island is a not-for-profit pilot project in conjunction with three state renewable energy programs (Rhode Island, Connecticut and Massachusetts) and the University of Rhode Island (URI).	Permitting has involved the RI Coastal Resource Management Council, RI Dept. of Environmental Management, U.S. Army Corps of Engineers, and FERC. There was a public comment period. [1, 37]	Began surveying the installation area in 2003 and the permitting process with FERC in 2005	http://www.energetech.com.au/
AquaEnergy Group, Ltd. [40]	Water depths of about 150 feet, approximately 3.2 nautical miles (or 3.7 statute miles) off of Hobuck Beach in Makah Bay, Washington State	1MW (multiple devices) AquaBuOY hose-pump type point absorber (625' long X 450' wide, below water)	Team members for marine, mechanical, or electrical research on the Project include: University of Washington, Oregon State University, Northwest National Lab, Battelle Marine Sciences Lab, Evans-Hamilton, Inc., Parametrix, Inc., Thales GeoSolutions (Pacific), Inc., Sound and Sea Technologies.	AquaEnergy has received permits from NOAA, the U.S. Coast Guard, and the U.S. Army Corps of Engineers and is currently proceeding through FERC's Alternative License Process to obtain the required NEPA and SEPA reviews. An environmental analysis insured compliance with the U.S. Clean Water Act and Coastal Zone Management Act, and Washington State Shorelines Management Act and Hydraulic Code. This led to regulatory approval from Washington State Departments of Ecology, Washington Department of Fish and Wildlife, and Washington Department of Natural Resources. Rather than obtain a lease from the MMS (DoI), a Washington State Department of Natural Resources (DNR) Aquatic Lands Lease was obtained. Other agencies involved include the Makah Tribal Council, Washington State University Energy Program, Clallam County Economic Development Center, Clallam County Public Utility District (PUD), and WA Public Utility Districts Association. [12, 45]	Has been embattled with FERC since 2002 and plans to be delivering power to the Clallum County Public Utility's grid by the end of 2006.	http://www.aquaenergygroup.com/
Ocean Power Technologies [41]	Water depths of 30 meters, 1-3 miles off of Kaneohe Bay, Hawaii	Modularized for up to 1MW, PowerBuoy™ point absorber	The official customer of this project is the U.S. Navy for the Marine Corps Base on the island of Oahu.	An Environmental Assessment (EA) was completed by the Office of Naval Research (ONR). The National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (USFWS) concurred with the Navy's Finding of No Significant Impact (FONSI). U.S. Army Corps of Engineers issued a water permit to deploy the system.	Installation was operational as of June 2004.	http://www.oceanpowertechnologies.com/
Ocean Power Technologies [41]	Water depths of 18 meters, 1-3 miles off of Atlantic City, New Jersey	40kW (one device), PowerBuoy™ point absorber	The official customer of this project is the New Jersey Board of Public Utilities under the Renewable Energy and Economic Development program.	NJ Dept. of Environmental Protection to issue a state waterfront development permit, U.S. Coast Guard for maritime navigation, NJ Board of Public Utilities Renewable Energy and Economic Development	Installation was operational as of Oct. 2005 and has since withstood the wind and wave forces of Hurricane Wilma.	http://www.oceanpowertechnologies.com/
Verdant Power L.L.C. [42]	Tidal region of East River, New York along the east shore of Roosevelt Island	Up to 10MW of free-flow horizontal axial turbines, each 5m long at 35kW, to collect tidal energy (the array spans 77' wide X 217' long)	Roosevelt Island Tidal Energy Project (RITE): Verdant has worked with the Massachusetts Technology Collaborative, New York Power Authority (NYPA), New York University (NYU), New York State Energy Research and Development Authority (NYSERDA), Consolidated Edison, and the U.S. Dept. of Energy.	After Verdant successfully completed the study scoping process at the Joint Agency/Public Meetings and Site Visit in Dec. 2003 and the Public Study Scoping Meeting and Site Visit in June 2004, the New York State Department of Environmental Conservation submitted its permits for Verdant power project to FERC in Oct. 2005. The U.S. Coast Guard has permitted the installation as well. [43, 44]	Verdant received a temporary license waiver from FERC for testing purposes in 2005 but will have to complete the traditional licensing process after the preliminary period [1].	http://www.verdantpower.com/

APPENDIX B – FEDERAL GOVERNMENT RENEWABLE ENERGY PROGRAMS

Federal Government Funded Renewable Energy Programs

Name of Incentive	Incentive Type	Description	Renewable Energy Sources Covered	Legislative Coverage and Applicable Effective Dates	Website
Renewable Energy Production Incentive (REPI)	Direct Production Incentive	REPI offers 1.5 cents per kWh produced (1993 dollars, indexed for inflation annually) to not-for-profit electrical cooperatives, Indian tribal governments, state & local governments, commonwealths & territories & possessions of the U.S., and municipal utilities for a ten-year period. Funding is subject to annual appropriations in each Federal fiscal year. If funding is insufficient, 60% of appropriated funds go to solar, wind, ocean, geothermal, or closed-loop biomass while the other 40% goes to other projects.	Solar thermal electric, photovoltaics, landfill gas, wind, biomass, geothermal electric, livestock methane, tidal energy, wave energy, ocean thermal, fuel cells with renewable fuels.	42 USC § 13317 as amended in 2005 from the original 1993 version Effective: fiscal years 2006 - 2026	http://www.eere.energy.gov/wip/program/repi.html
Modified Accelerated Cost Recovery System (MACRS)	Accelerated Depreciation Schedule	This corporate depreciation program under MACRS provides a five-year accelerated depreciation schedule.	Solar water heat, solar space heat, solar thermal electric, solar thermal process heat, photovoltaics, wind, geothermal electric.	26 USC § 168 Effective: 1986 and on	http://www.irs.gov
Renewable Electricity Production Tax Credit (REPC)	Production Tax Credit	REPC gives commercial and industrial corporations a tax credit (1.9 cents or 0.9 cents per kWh generated in 2005 dollars, indexed for inflation annually) over a ten-year period.	1.9 cent credit: wind, closed-loop biomass, and geothermal. 0.9 cent credit: open-loop biomass, small irrigation hydroelectric (150 kW - 5 MW), landfill gas, municipal solid waste resources, and hydropower.	26 USC § 45 (2005), Energy Policy Act of 2005: Section 1301 Effective: 8/8/2005 – 1/1/2008	http://www.irs.gov/pub/irs-pdf/f8835.pdf
Small Business Administration 7(a) Loan Guaranty Program (SBA 7(a) Loan)	Small Business Loan Guarantee	SBA's 7(a) Loan Program provides a maximum loan of $2 million dollars but will only guarantee $1.5 million to lenders. The guarantee covers up to 85% on loans $150,000 and less, and up to 75% on loans above $150,000. Working capital is eligible for loan periods up to 10 years while fixed asset loans are extended up to 25 years.	To be eligible, the business must meet SBA size standards, be for-profit, use proceeds according to SBA standards, not already have internal resources (business or personal) to provide financing, and be able to demonstrate repayment.	The Investment Company Act of 1958 established the Small Business Investment Company (SBIC) Program, under which the SBA is licensed.	http://www.sba.gov/financing/sbaloan/7a.html