

Master's Thesis



# Understanding Socioeconomic Issues and Opportunities of an Emerging Tidal Energy Industry in Nova Scotia

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## **Declaration**

I hereby confirm that I am the sole author of this thesis and it is a product of my own academic research.

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Carrie L. Drake



# Abstract

The global issue of climate change has necessitated a reduction of greenhouse gas emissions and consequently, an increase in the development of clean energy solutions. The province of Nova Scotia is seeking to secure a green energy supply, which includes plans to develop a tidal in-stream energy conversion (TISEC) industry. This master's thesis explores the socioeconomic issues and opportunities of TISEC development in Nova Scotia. Data was collected through a comprehensive state-of-knowledge review of socioeconomic issues associated with TISEC (and other renewable energy technologies) on a provincial, national, and international scale by highlighting research, regulatory frameworks, and projects. Best practices, case studies and tools are discussed as they relate to socioeconomic benefits and community development. Four specific components of TISEC development are addressed: 1) technology, supply chain, and workforce development; 2) policy, assessment, and stakeholder processes; 3) financing and funding; and 4) community benefits and economic development. A gap analysis on the Nova Scotia TISEC context outlines the current state, gaps, and possible actions as it relates to research, legislation, and practices to date. Several issues are identified, including the need for: a) a strategic plan for the development and deployment of TISEC devices that is consistent with the Marine Renewable Energy Technology Roadmap (developed by Natural Resource Canada); b) jurisdictional and regulatory clarity; c) streamlining of the evaluation, permitting, and decommissioning process; d) community buy-in to projects and protecting lower income Nova Scotians from energy rate increases; and e) clarity on how benefits to the community will be incorporated into development agreements.









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# Acronyms

ComFIT –	Community Feed-In Tariff
EIA -	Environmental Impact Assessment
FIT –	Feed-In Tariff
FORCE –	Fundy Ocean Research Centre for Energy
GHG –	Green House Gas
GIS –	Geographic Information Systems
ICZM –	Integrated Coastal Zone Management
IPCC –	Intergovernmental Panel on Climate Change
kWh –	Kilowatt hour
MRE -	Marine Renewable Energy
MSP –	Marine Spatial Planning
MW -	Megawatt
OE –	Ocean Energy
OEER -	Offshore Energy Environmental Research Association
ppm –	parts per million
RE –	Renewable Energy
R&D –	Research & Development
SEA –	Strategic Environmental Assessment
TISEC –	Tidal In-Stream Energy Conversion
TW –	Terawatt

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# 1 Introduction

## 1.1 Overview

In this section, an overview of the thesis topic will be provided. The research frame, research questions, methodology, and limitations will be presented.

## 1.2 Climate Change and the Ensuing Energy Crisis

Climate change and the associated rise in global average temperatures is unequivocal (IPCC, 2007a). In 2007, The United Nations Intergovernmental Panel on Climate Change (IPCC) produced the most comprehensive study on climate change ever taken, and reported the results in *Climate Change 2007*, the Fourth Assessment Report (IPCC, 2007a). Thousands of authors, editors, and reviews from dozens of countries contributed to the report, citing over 6,000 peer-reviewed scientific studies. The report documented that the major contributor to climate change is the increase in heat trapping greenhouse gases (GHGs) from the combustion of fossil fuels and other agricultural and industrial processes (IPCC 4AR, WG I, 2007).

According to IPCC (2007b), “global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have significantly increased as a result of human activities since 1750” (p.2). IPCC states that

...carbon dioxide is the most important anthropogenic greenhouse gas. The global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm<sup>3</sup> in 2005. The atmospheric concentration of carbon dioxide in 2005 exceeds by far the natural range over the last 650,000 years (180-300 ppm) as determined from ice cores. The annual carbon dioxide concentration growth-rate was larger during the last 10 years (1995-2005 average: 1.9 ppm per year) than it has been since the beginning of continuous direct atmospheric measurements (1960-2005 average: 1.4 ppm per year) although there is year-to-year variability in growth rates (IPCC, 2007b, p.2).

The increased atmospheric concentration of carbon dioxide primarily results from fossil fuel use. (IPCC, 2007b). At present, atmospheric carbon dioxide is approximately 390 ppm (Scripps CO<sub>2</sub> Program, 2011). The UN Framework Convention on Climate Change calls for an atmospheric stabilization of GHG concentrations at a safe level (Moomaw, 2008). Many



governments have established a goal of avoiding global warming of more than 2°C, which would require keeping concentrations of carbon dioxide below about 450 ppm (Moomaw, 2008). Effectively, this will require a reduction of emissions by 80 percent over the next half century, at a rate of 3 percent per year (Moomaw, 2008). Other GHGs that need to be reduced by comparable amounts include methane, nitrous oxide, and various industrial gases (Moomaw, 2008).

In order to avoid dangerous anthropogenic damage to the climate system, policy makers need to decide on reduction emission strategies. The implementation of low carbon emitting energy technologies will be critical in achieving GHG concentration reduction goals (Moomaw, 2008). If fossil fuels continue to be used, carbon dioxide must be removed through processes such as physical capture and storage (IPCC, CCS, 2005). Enhancement of biological sequestration in forests and soils can also reduce atmospheric GHG concentrations (IPCC, LULUCF, 2000). However, one of the most important mitigation strategies is the development of highly efficient, low and zero carbon energy systems (IPCC 4AR, WG III, 2007). At present, the only options for substituting fossil fuels are nuclear power and a variety of renewable energy technologies (Verbruggen et al., 2010).

### **1.3 Development of Renewables**

The development of renewable energy technologies has made significant advances in recent years. Renewable energy can be defined as “any energy source that is naturally regenerated over a short time scale and either derived directly from solar energy (solar thermal, photochemical, and photoelectric), indirectly from the sun (wind, hydropower, and photosynthetic energy stored in biomass), or from other natural energy flows (geothermal, tidal, wave, and current energy)” (Cleveland & Morris, 2006, p. 371). Renewable energy (RE) sources are playing an increasingly important role in global energy markets. RE technologies help decrease reliance on imported energy, contribute to sustainable development, and assist in diversifying sources of energy production (Resch et al., 2008). However, in order to mitigate the problems associated with GHG emissions and energy security, a large-scale conversion to RE must take place at a low cost (Jacobson & Delucchi, 2011a).

A study conducted by Jacobson and Delucchi (2011a and 2011b) analyzed the “feasibility of providing worldwide energy for all purposes (electric power, transportation, heating/cooling, etc) from wind, water, and sunlight (WWS)”(p.1154). Through discussing “global energy system characteristics, current and future energy demand, availability of WWS resources, numbers of WWS devices, and area and material requirements”, they estimate that by 2030 the world can rely on WWS for all purposes (Jacobson & Delucchi, 2011a, p.1154). To achieve this, it will be necessary to have “~3,800,000 5 MW wind turbines, ~49,000 300 MW concentrated solar plants, ~40,000 300 MW solar PV power plants, ~1.7 billion 3kW rooftop PV systems, ~5350 100 MW geothermal power plants, ~270 new 1300 MW hydroelectric power plants, ~720,000 0.75 MW wave devices, and ~490,000 MW tidal turbines” (Jacobson & Delucchi, 2011a, p.1154). Such infrastructure would “require reduced world power demand by 30%, and requires only ~0.41% and ~0.59% more of the world’s land for footprint and spacing, respectively” (Jacobson & Delucchi, 2011a, p.1154). The authors conclude by stating that the barriers to achieving this WWS global energy system are “primarily social and political, not technical or economic” (Jacobson & Delucchi, 2011b, p.1154). This conclusion further justifies the need for more research into the socioeconomic dimensions of RE development.

## **1.4 Ocean Energy**

Ocean energy is an important and emerging energy sector, which is one of the greatest sources of RE on the planet (Soerensen & Weinstein, 2008). Ocean energy (OE) is an umbrella term that represents a number of energy conversion principles:

- Wave energy is represented by surface and subsurface motion of the waves;
- Hydrokinetic energy that harvests the energy of ocean currents and tides ;
- Ocean thermal energy uses the temperature differential between cold water from the deep ocean and warm surface water;
- Osmotic energy is the pressure differential between salt and fresh water (Sorensen & Weinstein, 2008, p. 94).

Offshore wind energy may also be considered an OE technology. Another term commonly used is marine renewable energy (MRE), which includes offshore wind. The largest OE generating facility is a tidal barrage in France, with an installed capacity of 240 MW, yet most

OE facilities are much smaller (Sorensen & Weinstein, 2008). Much advancement in the OE sector has occurred in the last five years, with many large scale test facilities being developed (Sorensen & Weinstein, 2008). As the OE sector is in its nascent stage of development, there is no current commercially leading technology, yet it is expected that various technologies will be utilised to accommodate for the variability of ocean environments (Sorensen & Weinstein, 2008).

## 1.5 Hydrokinetic Energy

Hydrokinetic energy, or tidal energy, “exploit the natural rise and fall of the level of the oceans caused by the interaction of the gravitational fields in planetary system of the Earth, the Sun, and the Moon “ (Hohmeyer & Trittin, 2008, p.97). Tidal periods mainly occur every 24 hours (diurnal) or every 12 hours and 25 minutes (semidiurnal) (Hohmeyer & Trittin, 2008). Throughout the year, the tides are influenced by the planets relative positions. Large tidal ranges take place during spring tides, which “occur when the tide-generating forces of the Sun and Moon are acting in the same directions ” (Hohmeyer & Trittin, 2008, p.97). Smaller tidal ranges take place during neap tides, which “occur when the forces of the sun and moon are acting at right angles to each other” (Hohmeyer & Trittin, 2008, p.97).

Tides cause vertical water movements (range) as well as horizontal water movements, known as tidal currents (Hohmeyer & Trittin, 2008). Therefore, tidal energy is composed of two energy types:

- Tidal range energy, make use of the potential energy from the difference in height (or head) between high and low tides, and
- Tidal current energy, the kinetic energy of the water particles in a tide or in a marine current (Hohmeyer & Trittin, 2008, p. 97).

Tidal currents tend to follow a predictable elliptical path, where tidal currents are channelled through constraining topography (e.g. straights and between islands), and can reach faster velocities (Hohmeyer & Trittin, 2008). Currents can also be caused by winds, temperature, and salinity differences, but these currents are less suitable for harvesting energy as they are generally much slower (Hohmeyer & Trittin, 2008).

According to Hohmeyer and Tritin (2008), the “global tidal *range* energy potential is estimated to be about 3 TW, about 1 TW being available at comparably shallow waters”

(p.97). The most promising sites are located within Europe, Canada, Russia, Argentina, Western Australia, and Korea (Hohmeyer & Trittin, 2008). It is unknown what the global tidal *current* energy potential is, but it is estimated that the resource potential in Europe exceeds 12,000 MW of installed capacity, while other promising sites are located in South East Asia and Canada (Hohmeyer & Trittin, 2008). One particularly promising site is the Bay of Fundy, located in eastern Canada.

### **1.5.1 Tidal Current Energy**

Harvesting the energy of tidal currents can be done using similar turbine technology to that used in harvesting wind energy (Hohmeyer & Trittin, 2008). However, unlike wind, tidal currents can be accurately predicted and are consistent over time (Hohmeyer & Trittin, 2008; OEER Association, 2008). Since water is much more dense than air, the energy potential of water currents is significantly higher than wind (Hohmeyer & Trittin, 2008). As a result, tidal current turbines can be built considerably smaller than wind turbines (Hohmeyer & Trittin, 2008).

Although tidal current devices are in the nascent stages of development, preliminary research suggests that such devices will have limited environmental impact. According to Hohmeyer and Tritton (2008):

...installation requires minimal land use, and fully submerged devices will not affect optically or acoustically their surroundings. Their effects on flora or fauna have not been studied extensively yet, but it is unlikely that they will be of significance. Finally, submerged marine current converters are considered to operate in a safe environment: disturbances caused by extreme weather conditions are significantly attenuated to the depths of about 20-30 metres where the devices will normally operate (p. 98).

There are currently about 20 different types of tidal in-stream technology (TISEC) devices on the market at various stages of development (OEER Association, 2008). Typically TISEC devices have turbine blades mounted on a horizontal axis (Figures 1 and 2), and some have ducted blades, creating a tunnel which accelerates the flow of water past the blades (Figure 3) (OEER Association, 2008). TISEC devices may be rigidly attached to the seafloor by means of a piling or gravity-based structure, or may be anchored to the bottom and suspended in the water column (OEER Association, 2008). Although many TISEC technologies

have undergone testing and demonstration phases, there are no commercial scale developments currently in place.



*Figure 1 and 2: Marine Current Turbines SeaGen technology (Marine Current Turbines Ltd., n.d.)*



*Figure 3: OpenHydro technology showing ducted blades (OpenHydro Group Ltd, 2012).*

## **1.6 TISEC Development in Nova Scotia**

Nova Scotia is a small province located on the east coast of Canada, and is home to the Bay of Fundy (Figure 4). The Bay of Fundy has the most potential for TISEC development within all of North America (EPRI, 2006). Each day, the Bay of Fundy cycles 100 billion tonnes of water in one small, 5km channel. It is expected that new TISEC technology has the

potential to generate 300 MW from only two locations in the Bay of Fundy (Government of Nova Scotia, 2008).



*Figure 4: Map of Nova Scotia and the Bay of Fundy (Google Inc, 2011).*

Nova Scotians began harvesting energy from the Bay of Fundy as early as 1607, when a mill was built in Port Royal, that was partly powered by the tides. The early mills converted approximately 25 to 75 kilowatts of energy from tidal power (Government of Nova Scotia, 2008). In 1987, the Annapolis Tidal Station (Figures 4 and 5) was built, which is one of only three tidal barrages in the world (NS Power, 2011). It has a capacity of 20 MW and a daily output of 80-200 MW hours, depending on the tides (NS Power, 2011). Annapolis Tidal Station produces enough power for about 6,000 homes (Government of Nova Scotia, 2008).





*Figure 5 and 6: Annapolis Tidal Power Plant (NS Power, 2011).*

In the last five years, there has been a resurgence of tidal energy research and development in Nova Scotia. The focus has been on TISEC technology rather than tidal barrage technology, as TISEC is believed to have less environmental impact than tidal barrages, and is less costly (O'Rourke et al., 2010), although research on impacts is ongoing (Issacman & Lee, 2010; Tollit et al, 2011).

The Province of Nova Scotia has shown a high level of commitment to developing a TISEC industry. In 2009, the Government of Nova Scotia passed regulation stating that by 2015, at least 25 percent of the province's electricity *must* come from renewable sources (Nova Scotia Department of Energy, 2010). Currently, about 17% of the electricity consumed in Nova Scotia is generated from renewables (Nova Scotia Power, 2012). The new Renewable Electricity Plan states a *goal* of sourcing 40 percent of the total electricity demand to be from RE developments by 2020 (Nova Scotia Department of Energy, 2010). This goal includes a greatly expanded role for tidal energy and the Plan includes feed-in-tariffs (FIT) – premium prices to be paid for renewable electricity that reflect the higher costs of generation. In July 2011, the Nova Scotia Utility and Review Board introduced community feed-in-tariffs (ComFIT) to encourage small-scale community tidal energy projects by guaranteeing \$0.652 per kWh electricity sold to the Nova Scotia grid (Nova Scotia Department of Energy, 2011).

Large-scale TISEC devices are currently being tested by the Fundy Ocean Research Centre for Energy (FORCE), located near Parrsboro, along the northern shore of the Bay of Fundy. FORCE is a not-for-profit institute and test centre for TISEC technology, which is supported by federal, provincial, and private funding (FORCE, n.d.). FORCE “provides a shared observation facility, submarine cables, grid connection, and environmental monitoring” for developers and researchers to study the potential for various TISEC technologies (FORCE,

n.d., p.1). There are four berths available for commercial turbines located in the Minas Passage, where current velocities are among the highest in the world, allowing TISEC technologies to test their limits (FORCE, n.d.). One TISEC device, belonging to the OpenHydro–NS Power consortium, was deployed and retrieved in 2010 (FORCE, 2010). There are four test turbines planned for deployment at the FORCE site between 2012-2013 (FORCE, n.d.)

With supporting legislation, a world class testing facility, federal and provincial funding, and excellent tidal conditions, Nova Scotia has the potential to lead the emerging TISEC industry on a global scale.

### **1.6.1 Socioeconomic Impacts of TISEC Development**

Most of the research on TISEC development has focused on engineering challenges, biological and ecological effects, hydrodynamics and geophysics. While these are important investigations, there is an overall lack of necessary socioeconomic research. There are many socioeconomic variables involved in TISEC development and commercialization.

Socioeconomic research needs to address how to develop the industry sustainably, balancing the needs of society and economies without compromising the environment. It is important to find out how coastal communities will be impacted by TISEC developments, both positively and negatively. Positive impacts may be related to local economic development, with increased employment, leases, taxation, and tourism. Negative impacts might be related to conflict between uses, access, spoiled seascape or landscape, or a decrease in tourism. A priority area for research is to investigate how to best manage the industry through proper planning, policy, and legislation. At present, there are only a handful of TISEC projects deployed around the world. The United Kingdom, Ireland, Korea, China, the US, and Canada are currently the leaders in the development of demonstration projects. Yet due to the pre-commercial stage of TISEC technology, many questions remain on how successful the industry will be in delivering renewable energy targets, and to what extent positive socioeconomic benefits will be realized as a consequence.



## **1.7 Research Questions**

The purpose of this thesis is to define the scope and scale of socioeconomic issues involved in TISEC developments in Nova Scotia. To address this purpose, the following research questions will be pursued.

1. What are the socioeconomic issues and opportunities of TISEC development in Nova Scotia?
2. What are the priorities and research gaps of the socioeconomic issues?
3. How can the TISEC industry be managed through planning, policy, and legislation?

To address these questions, four specific components of TISEC development are discussed: 1) technology, supply chain, and workforce development; 2) policy, assessment, and stakeholder processes; 3) financing and funding; and 4) community benefits and economic development. These four areas will form the foundation of the analysis.

## **2 Theoretical Overview**

The TISEC field is an emerging industry in Nova Scotia that lacks a comprehensive state of knowledge review. There is very little data available. However, by looking at ocean energy (OE) developments in other areas and other renewable energy developments (e.g. wind energy), issues and opportunities of socioeconomic nature can be identified and addressed.

This thesis will follow a case study approach of multiple socioeconomic perspectives, informed primarily by an extensive review of literature consisting of scholarly, government, and industry publications. Based on this review, a grounded theory approach to analysis will provide an opportunity for key themes to emerge from the data.

## **2.1 Limitations**

The literature reviewed was limited to papers and reports written in English. There has been some work on TISEC and other OE developments in non-English speaking countries such as South Korea and Denmark. However, due to language and translation deficiencies, non-English reports were excluded.

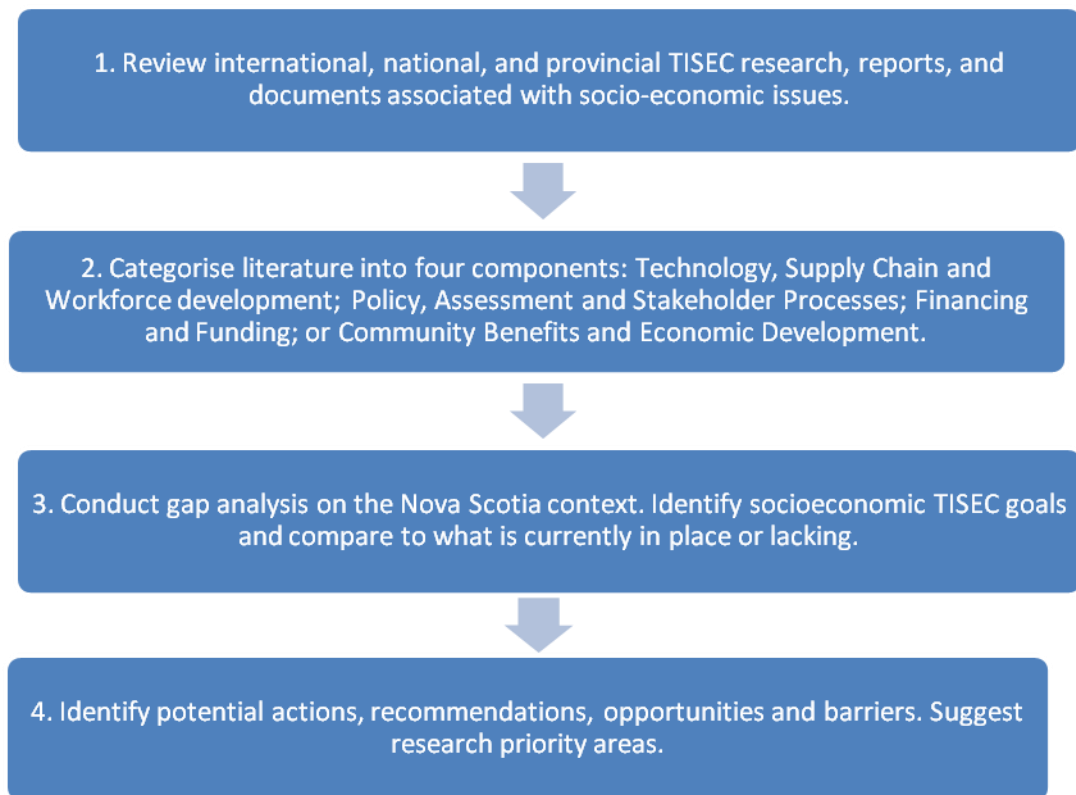
### 3 Methods

The methodology of this study consists of an exploratory approach involving case studies and best practices of TISEC development at an international, national, and provincial level. Data is collected from an extensive review of tidal energy and ocean energy research, reports, policy documents that cover a multitude of socioeconomic perspectives from scholarly, government, and industry perspectives. Based on this review, a grounded theory approach to analysis provided an opportunity for key themes to emerge from the data (Grounded Theory Institute, 2008). Individual reports were coded and grouped into four specific themes that covered the various socioeconomic dimensions of TISEC development. The themes were chosen based on similarity of content, which include:

1. Technology, Supply Chain and Workforce Development;
2. Policy, Assessment and Stakeholder Processes;
3. Financing and Funding; and
4. Community Benefits and Economic Development.

The Nova Scotia TISEC context was examined and a gap analysis was used to identify what is known and not known with regard to socioeconomic issues and opportunities. The gap analysis highlights specific goals (e.g. developing legislative clarity on tidal resource rights and access) that have been identified elsewhere. These goals are compared to what is currently in-situ in Nova Scotia to identify if and to what extent a gap exists. Where applicable, a possible action to address the gap or compliment current activity is proposed. The purpose of the gap analysis is not to comment on the quality, validity or legibility of what is currently available in Nova Scotia to support marine renewable and TISEC, but to identify if and what is available. Following the gap analysis, a table of recommendations and potential actions is provided that could be useful in meeting the goals identified in the gap analysis. Reports and articles that support these recommendations and actions are cited. Figure 6 outlines the

procedure taken to answer the primary research questions posed in section 1.7.



*Figure 7: Summary of Research Procedure.*

## **4 Results**

The results of this study are shown through an examination of international TISEC socioeconomic research and best practices, followed by a gap analysis on the status of TISEC development in Nova Scotia.

### **4.1 Research External to Nova Scotia**

The socioeconomic factors associated with TISEC development are broad and wide ranging, and exclude engineering and biophysical dimensions. For the purpose of this study, socioeconomic dimensions of TISEC have been categorised into four sections:

- Technology, supply chain and workforce development,
- Policy, assessment and stakeholder participation,
- Financing and funding, and
- Community benefits and economic development.

An examination of each socioeconomic TISEC category follows.

#### **4.1.1 Technology, Supply Chain and Workforce Development**

In this section, an overview of issues related to technology, supply chain, and workforce development are presented. These three areas are included together as they are interrelated and often overlapping. The various research and infrastructure needs, such as test site construction, management and developing grid connection technologies all represent potential sectors that could create jobs and provide skilled training opportunities. This is, of course, as long as local labour and technology are able to meet industry demands. Technology, supply chain and workforce development are all topics that will require government, academic and industry research efforts.

#### **Technology Development**

TISEC technology is still in its infancy. There are still many test models in development with a limited number of demonstration projects around the world

(RenewableUK, 2011). The recent report by Renewable UK (2011), “Wave and Tidal Energy in the UK: State of the industry report”, highlights the variety of designs that are currently in the demonstration phase in the UK, with no best model being apparent. Despite the variety of models and research sites developed (the UK has four wave and tidal test sites available for proving technology and grid connectivity), there remains opportunities for additional research in all aspects of marine renewables (Mott MacDonald, 2011; Renewable UK, 2011). Several reports and researchers have suggested that technology development is a fundamental issue that should be addressed to more rapidly move towards the commercialization of TISEC technology and marine renewables (Colander & Monroe, 2011; O’Rourke, Boyle & Reynolds, 2010; SQWenergy, 2010).

The creation of a robust industry requires a strong supply chain, knowledgeable workers, and readily available financing (SQWenergy, 2010). In an industry that is just starting out, such as TISEC, there is a need to develop networks of suppliers, support sectors such as engineering, and project management, as well as ensure potential consumers are aware of industry actions. As suggested in the report by Mott MacDonald (2011) – *Accelerating the Deployment of Offshore Renewable Technologies*, this should be done in as broad a manner as possible to ensure that all potential connections between industry segments can be established and that new entrants to the industry are able to make informed decisions.

### Test Site Availability

The ability to test technology in realistic conditions is an essential step in continuing to move TISEC to full scale commercialization. The ability to monitor the performance and impacts of tidal devices in ocean environments is a fundamental piece of industry infrastructure (Dalton et al. 2009; O’Rourke, Boyle & Reynolds, 2010; SQWenergy, 2010). According to Dalton et al., (2009):

Test sites are usually government funded facilities that ideally would provide at least the following:

- Approved site with existing licensing
- Environment impact assessment waiver (EIA)
- Free cable connection,
- Free data collection
- Adjacent service facilities (p.2).

Several test sites for ocean and tidal energy have been developed around the world. The United Kingdom hosts four sites that are good examples of facilities for the testing of marine energy devices (Renewable UK, 2011):

**QinetiQ:** provides wave and tidal device developers the ability to prove their systems really work, by testing ideas and technology. The facility hosts hydrodynamic model testing facilities: the “ocean basin (122m x 61m x 5.5m) and ship towing tank (270m x 12m x 5.5m), both of which incorporate wave making capability”(Renewable UK, 2011, p.17).

**Narec:** is the national centre “dedicated to advancing the development, demonstration, deployment and grid integration of renewable energy and low carbon energy generation technologies, established in 2002 as an independent R&D centre serving the renewable energy industry” (Renewable UK, p.17). Narec has a “large-scale wave flume, and a tidal testing facility to allow scale models of prototype devices to be tested in a controlled and monitored environment”(Renewable UK, 2011, p.17).

**European Marine Energy Centre:** “was established in 2003 and offers developers the opportunity to test full-scale grid-connected prototype wave and tidal stream devices. The centre operates two sites – a wave test facility and a tidal test facility – which have multiple berths that allow devices to be tested in the open sea. The berths have an existing connection to the onshore electricity network and facilities for technology and environmental monitoring” (Renewable UK, 2011, p17).

**Wave Hub:** is a “grid-connected offshore facility in south-west England for the large-scale testing of wave energy technologies that generate electricity from the power of waves. It leases space to wave energy device developers and exists to support the development of marine renewable energy around the world. With four berths able to connect up to 5MW each, Wave Hub has the potential to connect 20MW of wave energy” (Renewable UK, 2011, p18).

## **Port Access**

Port access is another major factor in the deployment of tidal devices (Renewable UK, 2011; Carbon Trust, 2011; EquiMar, 2011). In a report titled “Assessment of the Irish Shipping and Ports Requirements for the Marine Renewable Energy Industry”, Wells & McConnell (2011)

identified the importance of ensuring ports have the infrastructure necessary for the deployment and maintenance of marine energy devices. Spatial analysis of supply chain components relative to available port sites and tidal resources is required to strategically plan for future port development as necessary (Wells & McConnell, 2011). Also, as technology progresses, the relocation of key manufacturing closer to deployment sites to minimise onshore transport should be considered (EquiMar, 2011b). Easy access to service ports and the “availability of skilled service personnel with appropriate equipment” are essential for the effective development of the marine energy industry (Dalton et al., 2009, p.1).

### **Grid Access**

Grid connectivity is a major issue for TISEC development. In order to more equally distribute OE and to reduce the high costs of radial lines (which may be several kilometres from shore), it has been suggested that developing simpler, centralized and less costly grid connections is important to more rapid technology diffusion (Colander & Monroe, 2011). In the UK, “the current transmission-charging regime, which levies high charges on those projects furthest from the market, has been identified as a major impediment to the growth of renewable projects in remote locations...” (RenewableUK, 2011, p.19). Other mechanisms such as a locational charging mechanism for grid connection may increase the barrier to entry for investors (RenewableUK, 2011).

### **Supply Chain Development**

The cost of OE development is much higher than land-based developments due to a variety of reasons. These include, the assortment of specialized tools and equipment required to install devices, and the limited capacity of the supply chain to provide materials and services (Green & Vasilikos, 2011). In discussing the supply chain for the offshore wind industry in Europe, Green & Vasilakos (2011) identify a “limited production volumes of equipment and parts” and therefore limited installation vessels and long queues from device component suppliers (p.496). Interestingly, there are difficulties in the offshore wind supply chain in Europe, despite the majority of the world’s wind energy devices being located there, and the long history of industry development. Denmark, for instance, began actively promoting wind energy since the 1970’s (Sovacool et al., 2008). This would suggest that



TISEC is likely to face similar issues. Generally, any shortages in supplying device components, connection systems and construction materials can impact on project timelines and turn profitable projects into losses (Mott MacDonald, 2011). Canada, the UK, and other European nations have already completed national level studies in supply chain gaps in renewable and OE (DTI, 2004; Wells & McConnell, 2011; EquiMar, 2011b; Natural Resources Canada, 2011). A report by Natural Resources Canada (2011) suggests Canada's MRE supply chain is currently in the prototype stage, which means the supply chain is not fully established. However, the report also suggests that this is acceptable, as prototype technologies do not require multi-unit manufacturing. The report lists ten segments in the Canadian MRE supply chain, which are provided in Table 1.

*Table 1: Supply chain segments.*

<b><i>Supply Chain Segments</i></b>	
Technology developers	<i>Marine energy device innovators, designers and developers</i>
Manufacturers and suppliers	<i>Manufacturers and components suppliers</i>
Project developers	<i>Utilities and independent power producers</i>
Development services	<i>Resource assessment modelling, mapping, environmental impact assessment, permitting, approvals planning, etc.</i>
Supporting technology providers	<i>Wave/tidal current resource measurement devices, environmental monitoring devices, technical resource monitoring and data collection</i>
Engineering and construction	<i>Onsite management and construction</i>
Operations and maintenance	<i>Operational monitoring , transportation, port facilities and marine operators with related experience</i>
Research and development	<i>Public and private research bodies</i>
Policy and industry support	<i>Government policy development, industry associations and non-governmental organizations</i>
Business services	<i>Legal, financial, insurance, communications, market research and training activities</i>

(Natural Resources Canada, CanmetENERGY, 2011).

In the case of Canada, the report identifies the following strengths and weaknesses in the supply chain, which are provided in Table 2.

*Table 2: Strengths and Weaknesses of the Canadian supply chain.*

Weaknesses	Strengths
<ul style="list-style-type: none"> <li>• Device manufacturing</li> <li>• Engineering and construction</li> <li>• Foundations/anchoring</li> </ul>	<ul style="list-style-type: none"> <li>• Deep sea ports</li> <li>• Marine construction</li> <li>• Resource monitoring and analysis</li> <li>• Environmental assessment</li> <li>• Marine supplies</li> <li>• Commercial diving</li> <li>• Transport</li> </ul>

(Natural Resources Canada, CanmetENERGY, 2011).

Supply chain studies in the UK for specific tidal energy projects found similar gaps in their supply chains. The Mersey and Severn Tidal Power projects supply chain findings are discussed below.

#### *Mersey Tidal Power project*

The socioeconomic impact study completed for the Mersey Tidal Power project (which investigated the feasibility of tidal barrage, tidal fence and a tidal power gate devices) in the Liverpool City Region of the United Kingdom suggested that little is known about the tidal power supply chain – mainly because it is such a nascent industry and that it is many years behind wind power in terms of development (Regeneris Consulting & URS Scott Wilson, 2011). However, the report also suggests that firms active in the supply chain for offshore wind power could be well placed to compete in this market as there is a wide range of common infrastructure requirements, as well as shared service industries for tidal and wind power projects, particularly in earlier stages of the supply chain (feasibility planning, etc.) (Regeneris Consulting & URS Scott Wilson, 2011). This suggests that these firms with experience in wind power projects could be well placed to benefit from a developing tidal industry (Regeneris Consulting & URS Scott Wilson, 2011).

#### *Severn Tidal Power project*

In 2010, a supply chain survey report was compiled for the Severn Tidal Power project, a tidal barrage project in the UK (which did not go ahead), to explore what demands the project would place on the supply chain and what gaps, if any, were present. The report specifically identified the following supply chain inputs as important to the tidal project:

- Vessels for dredging, caisson<sup>1</sup> installation, and embankment construction;
- Aggregates for concrete, ballast and embankment fill (sand and gravel, crushed rock and armour stone);
- Concrete for caissons and other civil works (cement, rebar, etc);
- Caisson construction yards;
- Turbines and generators; and
- Availability of skilled labour.

The report identified that there would, in fact, be shortages for a tidal barrage project of this type. In particular there would be supply chain gaps in:

- Vessels for construction. These are limited in the UK and Europe and would have to be ordered 1-2 years ahead of time to ensure they are available when needed and that they are the appropriate vessels.
- The project demand for some but not all types of aggregates are far beyond what the local market could supply.
- Caisson construction yard quality was unknown and may not be suitable, and some additional ones might be needed.
- Turbines were not expected to be able to be produced in the quantity necessary within the UK, and would likely have to be sourced from several different countries such as China and Brazil.
- The report also identified a potential shortage in the workforce in marine and civil engineering, mechanical and electrical installation and project supervisors. It was suggested that this would be due to the various other energy projects scheduled/proposed in the UK in the period to 2030, which would all be competing for the same workers.

There are two essential strategies for supply chain stakeholders (manufacturers, installation and construction) to approach entry to a new market such as TISEC. The first is to be in position to supply goods or services in advance of demand. If a supplier already has a production capability for the required components, then there is likely to be minimal risk or delay in supplying at volume. The second route is to wait until demand for good/services is strong enough and move in to supply the industry. A late-mover approach will facilitate

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<sup>1</sup> A **caisson** is a “retaining, watertight structure used, for example, to work on the foundations of a bridge pier, for the construction of a concrete dam, or for the repair of ships” (Wikipedia, 2012, webpage).

learning from earlier mistakes, and a late entrant might enter a more stable industry (EquiMar, 2011b). There are pros and cons to either approach. Both routes involve an element of risk both for developers and suppliers. The late-mover can learn from the negative experiences of others. The early-mover – assuming they are still in business – will have learnt from their mistakes, will have ideas for improvement and had the chance to build a relationship with the client (EquiMar, 2011b).

It has been suggested that government policies that attempt to select the best technological approach and support a specific technology at the expense of others that are intended to achieve the same objective, can be risky, distort natural market forces, and undermine opportunities for innovation (Mott MacDonald, 2011). While this approach can yield substantial benefits, as has been seen in Germany and Denmark in the promotion of wind energy, there can be negative impacts in the long-term, as some technologies and their supply chains are not able to be developed (Mott MacDonald, 2011). Some offshore wind energy companies may be able to shift their resources to meet the fabrication and other needs of tidal and wave energy, but this may take some time. Picking a specific industry at the consequence of others may provide short-term gains, but may cause shortages in other industry supply chains, leading to longer development time lines, which in turn impacts on the ability to effectively finance projects (Wells & McConnell, 2011; EquiMar, 2011b).

Another important component to effective supply chain development is the spatial arrangement of device manufacturing, maintenance and port facilities (Sustainable Energy Authority of Ireland & Irish Maritime Development Office, 2011). If possible, these should be arranged to maximize industry linkages between manufacturers, R&D, deployment and support services, and support efficiency in supply chain and transportation systems.

In economic development literature, the expectation is that as technology matures and more projects are built, project costs will decrease. In terms of renewables, wind is often considered one of the more mature technologies and consequently should have lower costs relative to other technologies. Green and Vasilikos (2011) note, however, that “in recent years, offshore wind costs have risen rather than fallen, driven partly by increase in material prices (particularly for steel) and partly by a rapidly rising demand relative to supply chain capacity”(p.496). Therefore, it is important to be mindful of potential external factors, which may impact on supply chain performance.

## **Manufacturing**

The manufacturing sector represents a very significant player in the tidal energy supply chain. As was mentioned in the section “Technology Development”, TISEC devices vary widely in design, meaning many of the component parts are particular to a given design, reducing any economy of scale benefits. Also, companies that have invested heavily in R&D may be reluctant or unable to have many parts manufactured outside their own facilities, consequently lowering the potential for manufacturing jobs in device deployment locations. This may be limited to highly technical components rather than structural pieces. In some cases, the design may necessitate the manufacture of components near deployment sites due to them being uneconomical to ship internationally or inter-regionally. However, emerging businesses may not be able to meet demand immediately and some leakage may occur. In the early 2000’s in the UK, early entrants to wind energy device manufacturing were unable to meet project timelines and, as a consequence, many pieces had to be imported, thus reducing local economic benefit and slowing industry learning rates (DTI, 2005).

## **Construction**

Like offshore wind technologies, OE incur initial construction costs and can be as high as 75-80 percent of the total project cost (Carbon Trust, 2011). Port access and suitability is a central component to establishing strong and reliable construction and maintenance infrastructure for marine renewables. The development of appropriate locations is essential to ensuring that the benefits of operations and maintenance hubs for offshore projects are captured (Sustainable Energy Authority of Ireland & Irish Maritime Development Office, 2011). While port access is a necessary feature, the availability of ships with the capacity to carry the necessary equipment and loads required to install and service tidal devices is an important component as well. The availability of these types of ships is limited and they can be very costly (SeaGen presentation, 5/10/11, Acadia University). This factor can significantly impact on project timelines and costs. However, in many cases, researchers “contend that a large percentage of employment will remain domestic (i.e. they are not at risk of being fulfilled by overseas labour)”, in particular because one of the largest stages of any renewable project, the installation phase, involves “site-specific installation and construction” (Carley et

al., 2011, p. 289). However, the benefits for a region in terms of the long range impacts from construction is dependent on the consistency of contracts, the current availability of skills and experience and the ability to develop skills and experience that can be exported. As TISEC is being pursued in one form or another throughout the world, the ability for one region to reach a point where they can export services and expertise will depend on how they fare in relation to other jurisdictions.

## Workforce Development

Numerous reports suggest that workforce retention, development, and the impacts of worker flows across industries and sectors are important socioeconomic policy considerations for the marine energy industry (RenewableUK, 2011; Mott MacDonald, 2011; FREDS, 2009; Munday et al., 2011). Munday et al. (2011), suggest economic development benefits from renewables, such as wind, are generally low overall – start up is high but once systems are running there is limited direct benefit unless there is the ability to develop skills and R&D options in situ.

There are four workforce development issues that have been identified for the marine renewables industry and renewables generally:

- Professional skills availability, in particular for engineering and project management professionals (FREDS, 2009; Frondel et al., 2010),
- General labour availability in communities where devices are deployed (quantity and skills mix) (Munday et al., 2011),
- Inter-industry interactions and flows of workers (Frondel et al. 2009),
- Quality and duration of jobs and how they address income distribution in the community (del Rio & Burguillo, 2009).

Government and industry should consider these issues when shaping renewable energy policy. As Frondel et al. (2010) point out, Germany has seen strong competition for employees in the renewables and “green” technology sectors since the establishment of the Renewable Energy Sources Act (EEG), which established renewable energy targets and industry development objectives. Renewable industries typically require medium and high-skilled workers of which, as Frondel et al. (2010) point out, there is strong competition for employees. This has called into question the net employment effects of the Renewable Energy Sources Act (p. 4054).

Competition for graduates in engineering and project management from other sectors, such as oil and gas, means that there may be a shortage of talent to apply to marine energy. There is an identified need, at least in the UK, to create a slack labour market in order to funnel the necessary skills into marine energy (FREDS, 2009). Another issue that has not been addressed extensively is the demographic shifts occurring throughout the developed world. An ageing population will mean not only certain skilled workers, but workers generally may be in short supply (Natural Resources Canada, 2011). The impact of policies (or lack thereof) that address labour market shortages should be considered when looking at the development of the tidal energy industry.

The first stage in addressing skills shortages is a comprehensive review of the current skills base in order to assess the future requirements at national or regional levels. This should be performed through consultation with industry, and based on realistic growth targets for the offshore renewable energy sector (Mott MacDonald, 2011). A strategy should be developed to address skills shortages, and should be supported by industry, public and private education providers, and other stakeholders (Mott MacDonald, 2011).

A potential best practice may be the development of “Skills Academies” such as those initiated by the UK government. National Skills Academies are “led by employers who work with government and training providers to shape the training and qualifications that will help them compete in global markets (Mott MacDonald, 2011, p. 127). Such academies will help ensure an adequately skilled workforce as the tidal industry develops.

**Box 1: Best Practice: Establish Industry Bodies to Promote, Plan and Develop the Industry**

As an emerging industry, TISEC will likely garner interest from a variety of stakeholders as it develops. Having a centralized access point to provide information to industry members and those interested in investment or career opportunities in marine renewables could be beneficial in the promotion of the industry.

**Example: UK Marine Industries Alliance**

The Alliance is a strategic collaboration of UK Marine companies and related stakeholders with free membership. The Marine Industries Leadership Council set it up on behalf of the

industries. The Council includes trade associations, regional groupings, Government Departments, devolved administrations, and other public bodies. The Alliance provides support between and across various segments of the marine industry, including a one stop place to learn about different industry sectors.

## Knowledge Transmission and Research Collaboration

An important issue that often arises in TISEC and renewable energy research, is how to share knowledge on successes, failures and best practices. TISEC is in its early stages, and little is known on many of the impacts of the technology and what is possible should the industry flourish. While post-secondary and research institutions do share information and findings, through formal means such as conferences and academic papers, there is still a need to have a coordinated and open approach to research. Some reports have advocated for the sharing of findings to be negotiated as part of the permitting process so there is a limited lag time between the points at which data is available and the time it is able to be shared (Mott MacDonald, 2011). The creation of centres of excellence in offshore renewables, and supporting “conferences, seminars and other forms of networking and knowledge transfer ” have also been cited as important for industry development (Mott MacDonald, 2011, p.viii). A potential problem is that industry players may be reluctant to share information that could compromise their competitive advantage. Another issue is the variance in different monitoring, impact assessment and other data collection, and research methods that may limit the ability to generalize findings from one jurisdiction to another. The establishment of agreed upon industry standards as well as research methods, indicators and tools for marine renewables may allow easier knowledge transfer and the development of best practices.

There has already been the development of several online research libraries by a number of European based organizations. Many of these organizations and projects provide open access to a wide range of environmental, engineering and economic studies and reports. The European Marine Energy Centre, SuperGen Marine Research Consortium, Marine Scotland, the EquiMar Project website and International Energy Agency –Renewable Energy Technology Deployment and a number of nation specific research bodies are some of the key players in marine renewables research. The SeaGen project is the only known tidal energy project which provides information on its process and outcomes.



#### **4.1.2 Policy, Assessment and Stakeholder Participation**

This section provides an overview of policy, assessment and stakeholder processes relevant to tidal energy development. As TISEC is still in the nascent stages of development, there is little data available on potential impacts of future developments. Policy and legislation specific to TISEC is undeveloped and inconsistent. There have been several reports written to date on policy and assessment of marine energy arrays<sup>2</sup>, which have gleaned many lessons from the offshore wind industry. It has been recognized that “the successful licensing, planning, deployment, and operation of a marine energy array depends to a large degree on a well planned and executed consultation with stakeholders” (EquiMar, 2011c, p.7-11). The stakeholder participation section focuses on identification of stakeholders and stakeholder processes.

##### **Policy**

As the marine energy industry gains momentum with advances in research and development, several governments have introduced policies to support demonstration projects and eventual deployment of OE projects (AEA Energy & Environment, 2006). However, there is still a lack of appropriate legislation specific to tidal and wave energy projects, and there is a need to “establish some coherency in this field in order to promote an international standardization of environmental legislation requirements ”(EquiMar, 2009a).

Permitting new and complex technologies in an efficient and consistent manner requires specialised expertise and enough experience to develop a well-informed perspective on key issues, such as risk. While data on regulator expertise on offshore renewable energy deployment is not readily available, a lack of regulator expertise and consistent approach is a common challenge in the implementation of environmental innovations (Mott MacDonald, 2011).

Several best practices have been identified in policy making as it relates to siting and permitting of OE. The UK and Germany are moving particularly quickly in developing marine

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<sup>2</sup> A marine energy array is a spatial arrangement of one or more MRE devices within the water column of a given area.

energy. Portman (2010) conducted a review of marine renewable energy policies which are summarized in this section.

### **United Kingdom: Proactive Siting and “One-Stop Shopping”**

Portman writes (2010):

In 2006, the British government launched the Wave and Tidal Stream Energy Demonstration Scheme, which provides capital grants and revenue support for pre-commercial demonstration of ocean energy system farms. Although developers pay a one-time lease fee for the use of UK ocean space, financial incentives are available to them in the form of capital grants, exemption from the climate change levy (4.3 pence per kWh [p/kWh]), and through the opportunity to sell renewable obligation credits (5p/kWh). In addition to public funding and some market-based incentives, ocean energy development is facilitated by proactive identification of potential sites and a clear regulatory framework (Portman, 2010, p.102).

When developing wind power, pro-active siting restricted proposals to three strategic wind project areas, which already had preliminary environmental assessments completed. A clear regulatory framework is provided by the Marine Management Organisation (MMO), which was created in 2009 after the Marine and Coastal Access Act was passed. The MMO is now the main planning body which manages activities in the coastal zone. The Coastal Access Act “requires proponents of offshore renewable energy projects to obtain a single consent to construct and operate a renewable energy project from the MMO” (Leary & Esteban, 2009; as quoted in Portman, 2010, p.103).

### **Germany: Cautious Commitment**

Although Germany has relatively limited coastline, OE is included under the existing renewable energy framework, particularly for offshore wind energy. A public-private partnership program was launched in 2005 – the “Offshore Wind Energy Foundation – comprised of members of the offshore wind power industry, power utilities, financiers, nongovernmental organizations, representatives of coastal states, and other federal ministries” (Portman, 2010, p. 103). The market-based incentives include feed-in tariffs which are a higher amount to reflect the higher costs of developing in offshore regions. The regulatory process is led by the Federal Maritime and Hydrographic Agency, which develops “standards for “wind farm authorizations, operations, and decommissioning”(Portman, 2010, p.103). These standards are being revised in an ongoing fashion – which is perhaps an example of adaptive management. Portman (2010) states:

German law expedites the approval of offshore renewable energy projects by considering authorization a nondiscretionary administrative act” (*gebundene Entscheidung*; Portman et al., 2009). As such, the presumption is in favor of approval that is rebuttable only by specific reasons of a limited nature (e.g., impairment of safety and /or efficiency of navigation or threat to the marine environment) (p.103).

### **Portugal: Maritime Pilot Zone**

Portugal has focused on developing various forms of wave energy, which has been included in the National Ocean Strategy. An important development in the OE sector was the opening of the Wave Energy Centre, which was formed by a group of companies, academia, and R&D institutes. The government has also financially supported scientists working on wave energy applications “with €5M committed for ocean energy research, development, and demonstration projects per year from 2000 to 2009 (AEA Energy & Environment, 2006)”(Portman 2010, p.104). In 2008, the Portuguese government created a Maritime Pilot Zone “for wave energy extraction to support of the deployment of offshore wave energy prototypes and farms” (Portman, 2010, p. 104). Portman (2010) continues:

The Maritime Pilot Zone is located off the west coast of São Pedro de Moel, between 30 m and 90 m water depth, and covers an area of 320 km<sup>2</sup>. The main R&D objective is to monitor and learn from field results. Knowledge gleaned from this test site will be used for the development of Portuguese (and international) regulations (Palha et al., 2010). Other than its R&D goals, the Maritime Pilot Zone is also meant to guarantee simplified and fast licensing and permitting through a managing body that will also identify and promote the establishment of offshore corridors and the construction and maintenance of surrounding (including land-based) sector infrastructure (Waveplan, 2008). Since 1999, Portugal’s feed-in tariffs for renewable energy are determined by the technology used for generation, according to a formula that is based on an environmental package associated with avoiding CO<sub>2</sub> emissions (p.104).

Most feed-in tariffs (FITs) to date have been for onshore wind, however the government agreed to a FIT (€0.23/kWh ) with a wave energy developer to operate within the ocean energy pilot zone (Portman, 2010).

### **USA: Lease Fees**

The US regulatory system differs from the systems of Western European countries mostly by its “ lack of development standards or proactive siting in the Exclusive Economic Zone, such as through marine spatial planning or a strategic environmental assessment process” (Portman, 2010, p.101). Also, the US charges “lease fees (rents and royalties) to developers for use of the seabed for renewable energy production”(Portman, 2010, p.101). The

Minerals Management Service and the “Federal Energy Regulatory Commission are involved in regulation of energy projects; they have jurisdiction to issue leases and licenses for hydrokinetic projects” (p.101). Agreement and consolidation of authority between the two agencies occurred in 2009. The Department of Energy has also financially supported hydrokinetic energy research (Portman, 2010; Noblett, 2009).

### General Comments

In Portman’s review, she categorized “policy-related features of development” into three categories:

1) research and innovation policies that help to develop emerging and improved technologies; 2) market-based policies that underwrite the cost of introducing technologies into the market, provide a competitive market framework, and may internalize externalities in terms of energy security, environmental protections, and economic efficiency; and, 3) regulatory advances that simplify and improve the efficiency of permitting offshore energy facilities (Portman, 2010, p. 101) (Table 3).

*Table 3: Country comparisons of policy measures in: research and innovation; market-based incentives/controls; and regulatory improvements (Portman, 2010):*

<b>Country</b>	<b>Research and Innovation</b>	<b>Market-based incentives/controls</b>	<b>Regulatory improvements</b>
<b>UK</b>	Earmarking of lease fee	Sales of renewable obligation credits	Establishment of Marine Management Organization
<b>Germany</b>	Government-supported offshore wind R&D	“Bonus” feed-in tariffs for offshore wind	Renewable energy plant approval: Nondiscretionary administrative act
<b>Portugal</b>	Government support for Wave Energy Center	Feed-in tariff for wave energy	Streamlined approval for projects in Maritime Pilot Zone
<b>US</b>	DOE funding for marine renewable energy research	Production tax credits for renewable energy	Minerals Management Service/Federal Energy Regulatory Commission cooperation

(p. 102).

The EquiMar report, titled “Existing legislation, perspectives and evolution of other similar technologies”, is a particularly useful reference document (EquiMar, 2009a). It provides a review of existing legislation at the international, European, and national level for

the leading ocean energy countries (Denmark, France, Portugal, Spain, United Kingdom, Canada, and United States), as well as incoming legal instruments with impacts on tidal energy (including the Water Framework Directive, the Marine Strategy Framework Directive, and Maritime Spatial Planning) (EquiMar, 2009a). The report concludes with the following recommendations and key points:

- To avoid over-regulation or conflicting regulatory policies, a one-stop-shop entity should be established. “Improved coordination between authorities or agencies can make the process less burdensome” (EquiMar, 2009a, p.18).
- Maritime Spatial planning can promote OE development, as has been the case for offshore wind energy development (EquiMar, 2009a).
- The environmental assessment should be tailored to specific developments, since impacts vary from project to project, depending on device characteristics and location (EquiMar, 2009a).

Lastly, the authors conclude (EquiMar, 2009a):

As a final recommendation and for both practical and legal purposes, it is important to streamline and focus the environmental assessment process defining the relevant impacts that should be considered in the analysis as well as the correspondent baseline descriptors which are going to be used for comparison during impacts valuation. The list of potential impacts to be evaluated should be prioritised with care and updated in the light of ongoing research since there are some generic and critical uncertainties of the device impacts on the environment that require further basic research. The legal framework should be designed to cover impact uncertainties and allow for amendment of protocols as and when the uncertainties are resolved. This approach is known as Adaptive Management and should be incorporated in the legal framework of ocean energy schemes (p. 18-19).

(Adaptive management is further explained on page 37 of this thesis).

When numerous different agencies and departments must approve permits for OE, a significant barrier is imposed upon developers. O’Hagan and Lewis (2011) notes that a lack of inter and intra departmental communication on oceans and coastal management issues and developments in Ireland means that much work occurs on an ad hoc basis, leading to lag time in decision making which consequently increases uncertainty in development. Multiple permitting stages in the US have led a large number of offshore wind and ocean energy developers to get stuck at the permitting phase (Colander & Monroe, 2011). The concept of a one-stop-shop or a single point of access for licensing, planning, and assessments is cited as

being a crucial element in encouraging investors to participate in OE projects (Dalton et al., 2009). The advantages of a one-stop-shop facility are savings in time, effort and cost, and facilitating the most appropriate use of data (EquiMar, 2010). However, a one-stop-shop approach may provide disadvantages as well. With just one single point of access, it is possible that certain elements of the project proposal may be overlooked if the one-stop-shop facility becomes overburdened with applications, or if staff are insufficiently trained to critically evaluate proposals.

One further point on the necessity of establishing a common baseline for environmental legislation requirements is to ensure “no country could benefit from a more environmentally permissive legislative framework to deploy projects” (EquiMar, 2009a, p. 1). Such measures will help to ensure a level playing field among all nations, while maintaining best environmental practices.

**Box 2: Case Study: Scotland first Marine Bill and creation of Marine Scotland**

A “one stop shop” consent process is now in place for offshore wind and wave and tidal development within Scotland’s territorial waters. First, a new legislation, the Marine (Scotland) Act (2010) was introduced, which “*provides a framework which will help balance competing demands on Scotland's seas. It introduces a duty to protect and enhance the marine environment and includes measures to help boost economic investment and growth in areas such as marine renewables*” (Scottish Government, 2010). One of its main features is to simplify the licensing system by reducing the number of individual consents. Second, a marine management organisation for Scotland, Marine Scotland, was created in April 2009. Marine Scotland amalgamated the roles previously played by three organisations and its responsibilities extend to a number of areas including planning, licensing, environment, science, energy, fisheries and compliance (Mott MacDonald, 2011, p. 121).

Policies and regulations should also recognize the variety of scale among tidal energy projects as there will be significant differences in impacts of a commercial-scale array compared to a single small-scale project. The permitting and planning process should reflect the scale of the project being proposed rather than be generic. In addition, umbrella applications for grid connections (to allow for the proper megawatt scale for connections)

would allow small-scale projects to apply within a group who would otherwise not necessarily have the available funds to apply (FREDS, 2009, p. 31).

## Impact Assessment

Tidal energy developments require various impact assessment measures as an accepted form of best practice. The *EquiMar Protocols for the Equitable Assessment of Marine Energy Converters* (EquiMar, 2011d), outline high level assessment protocols for wave and tidal energy development. These protocols best reflect industry standards and are summarized below.

## Resource Assessment

The resource assessment should provide “an understanding of wave and tidal climates from which estimates of energy production can be made”(EquiMar, n.d., p.1). This information is also required for engineering design, as the end user may be interested in seasonal aspects, expected average output (in periods such as months, seasons, and years) as well as longer-term project length estimators. The EquiMar protocol subdivides resource assessment into two sections, resource characterisation and site assessment, which are described below (EquiMar, n.d.):

- 1. Resource Characterisation** - is normally carried out to establish suitable geographic locations for deployment, and has the following objectives:
  - To ascertain the potential resource for energy production with an explicitly stated degree of uncertainty; and
  - To identify constraints on resource harvesting.
- 2. Site Assessment** – is normally carried out prior to deployment, to establish the detailed physical environment for a particular marine energy project, with the following objectives:
  - To assess the energy production throughout the life of the project;
  - To characterise the bathymetry of the site to an explicitly specified, and appropriate accuracy;
  - To ascertain the spatial and temporal variation of the resource with an explicitly stated degree of uncertainty;
  - To describe met-ocean conditions;

- To establish extreme (survivability) conditions with a defined return period; and
- To identify potential interference between multiple devices located at the site (p.1)

The EquiMar protocol goes on to state that “ both *resource characterisation* and *site assessment* should result in the following (EquiMar, 2011d):

1. Analysis of the level of resource;
2. Description of the limits of the assessment;
3. Description of the particulars of the site where the development is to be placed,
4. Description of the instrumentation used to collect site data;
5. Explanation of the analysis methods used in determining the potential resource and how they meet the criterion for accuracy and consistency;
6. Explanation of the use of numerical models in providing the resource assessment; and
7. Model results and observation data, archived in a consistent, documented and accessible manner for possible future re-analysis ( p. 25- 26).

## Environmental Assessment

According to EquiMar (2011d), the “purpose of an environmental assessment is to understand and evaluate the potential environmental effects of a marine renewable energy project and to promote the sustainable development and implementation of ocean energy projects. The assessment should be used by stakeholders and consenting or regulatory bodies to inform the decision making process from concept to decommissioning” ( p. 29).

The objectives of an environmental assessment of a marine renewable energy project include (EquiMar, 2011d):

- a) Identify, predict, evaluate and classify the potential environmental and socioeconomic impacts (beneficial and harmful) from concept to decommissioning;
- b) Recognize and evaluate possible cumulative impacts of the project itself and in combination with other projects and/or marine activities;
- c) Contribute to site selection by identifying significant environmental and socioeconomic features of the possible deployment areas, by estimating their sensitivity to the project characteristics (baseline survey outcomes);
- d) Select appropriate mitigation measures for harmful impacts;
- e) Establish a monitoring programme for the deployment, operation, decommissioning and post-decommissioning stages;



- f) Consult with and inform stakeholder groups and the public in general;
- g) Propose and implement environmental management actions<sup>3</sup>; and
- h) Inform the project development process (p. 29).

An Environmental Impact Assessment (EIA) report typically includes the results of the environmental assessment. The environmental analysis should form an integral part of the project planning process. EquiMar (2011d) further explains:

In this way, there are several environmental assessment techniques (SEA, ERA, LCA<sup>4</sup>) that can be consulted / applied before conducting an EIA to inform and support the decision making process of the device concept design and activities planning. The results of these complementary environmental assessment techniques / instruments can further be integrated in the EIA report. An EIA usually comprises the following phases:

- Screening, which identifies the areas of legislation under which the project falls;
- Scoping, which establishes the boundaries of the investigation, the assessments and measurements required, and any assumptions to be made;
- Baseline survey, which identifies the state of the environment at the deployment site and in surrounding areas, prior to any installation or deployment activity;
- Potential environmental impacts identification and evaluation, both positive and negative;
- Monitoring programme for the deployment, operation, decommissioning and post-decommissioning stages of the project;
- Mitigation measures, to reduce or eliminate adverse impacts; and
- Consultation, with feedback from stakeholders and general public, which should feed constantly into the EIA process (p.29-30).

Each phase listed above comprises an active process that culminates with a report (EquiMar, 2011d). In addition, EIA planning should also include as assessment of the political and legal landscape at potential project sites through a Strategic Environmental Assessment (described on page 36 of this thesis) (EquiMar, 2011d).

### ***Baseline characterisation***

Environmental assessments should contain baseline characterisation on environmental and social factors. EquiMar (2011d), list the following points on baseline characterisation:

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<sup>3</sup> An adaptive management process should be followed in the early stages of technology development aiming to improve the efficiency and effectiveness of the environmental assessment process

<sup>4</sup> SEA: Strategic Environmental Assessment; ERA: Environmental Risk Assessment; LCA: Life Cycle Assessment.

- Describe the key aspects of the receiving environment that should, as a minimum be considered in environmental assessment of a site (including environmental, commercial and leisure uses);
- Provide a rationale for characterising the sensitivity of a site that will affect the extent and variety of data gathering from the site;
- Describe a systematic approach for identifying environmental and social factors that may affect site selection;
- Particular attention should be paid to environmental characteristics that correspond to the risks identified for the designs under consideration;
- All data gathering should utilise any established protocols that are appropriate to the site and should show variability (seasonal and interannual) so that subsequent monitoring can demonstrate any significant environmental effects;
- Any amendments to generic protocols required to deal with site specific issues should be based on expert advice, taking full account of the analytical framework within which the data collection is nested (p. 32-33).

### ***Monitoring***

Project monitoring should occur throughout all phases of project development, including installation, operation, and decommissioning phases of prototypes and commercial projects. A “monitoring plan should follow an adaptive management process in order to identify and respond to uncertainties” (EquiMar, 2011d,. The results of monitoring efforts should be made available to stakeholders, and wherever possible, to other developers (Ingram et al., 2011).

### **Economic Assessment**

In order to attract investors and assist in tidal energy development, economic assessments are essential. According to EquiMar (2011d), “Economic assessments are conducted by utilities and investors to identify the technology and layout for a site that satisfies a stated set of investment criteria” (p. 48). To further quote EquiMar (2011d):

Typically a number of project designs will be available and the objective of a project assessment is to identify the marine energy project design which, subject to levels of uncertainty consistent with the project and technology development stage, satisfies the specified investment criteria. To achieve this it is necessary to:

- a) Quantify expenditure over the project life;
- b) Quantify revenue over the project life;
- c) Calculate economic indicators to compare to specified criteria; and

- d) Identify risks associated with the project and assess their effect on the economic indicators (p. 48).

A report on economic viability should include statements of: economic indicators; “major capital cost components”; “major contributions to annual expenditure including planned and unplanned maintenance activities”; “expected project revenue”; “methods used to quantify risk”; and “methods used to determine transmission costs” (EquiMar, 2011d, p.1).

## Strategic Environmental Assessment

In addition to various site level assessments discussed above, the tidal energy industry can greatly benefit from strategic environmental assessment (SEA) processes. The ultimate aim of SEA is to promote sustainability by integrating sustainability issues into the decision making process. SEA is defined as:

*...a systematic process for evaluating the environmental consequences of proposed policy, plan or programme initiatives in order to ensure they are fully included and appropriately addressed at the earliest appropriate state of decision making on par with economic and social considerations (Sadler & Verheem, 1996, as quoted in Partidário, date unknown, p. 10).*

Generally, a SEA is conducted before a corresponding Environmental Impact Assessment (EIA) is undertaken, as it occurs at a higher level of decision making.

SEA is a relatively new practice that has evolved from standard EIAs, to allow for enhanced response to complexity and to orchestrate higher level planning. To meet sustainability objectives, it is important that SEA reports thoroughly evaluate socioeconomic as well as environmental impacts.

## Risk Management

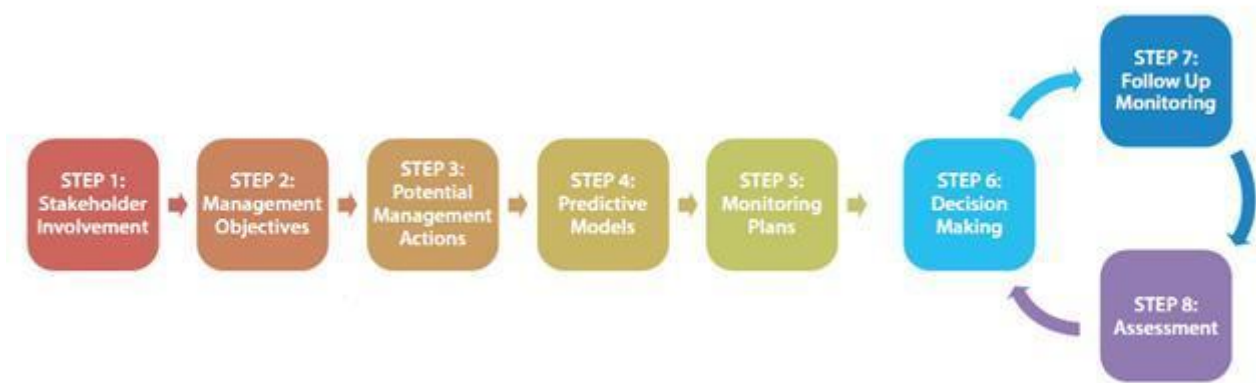
Complex activities such as offshore energy development include risks and liabilities that require a formal assessment with a robust approach to identify and reduce risks to an acceptable level. The technology used to harness OE must withstand harsh marine environments, and many risks associated with TISEC technology are uncertain and unidentified (Buckle, 2011). Arguably, the greatest risk of TISEC development is associated with technological viability as it relates to environmental challenges, operation and

maintenance (Buckle, 2011). The level of acceptance is based on a collective understanding of what risk can be taken and the implicit liability or cost associated with the risk level (EquiMar, 2011d). The aim of risk management is to identify what level of risk is tolerable to a project, or a company, and to ensure that all identified risks have applied measures to maintain them at or below a tolerable limit. Buckle (2011) states that in order for developers “to secure funding, they must demonstrate their successful designs supported by good risk management to assure investors that risk exposures are limited and that developers have the appropriate insurance cover with regards to their devices” (Buckle, 2011, p. 91). It is expected that as the understanding and knowledge of marine energy technology increases, a general de-risking of marine energy arrays will follow.

## Adaptive Management

One method of dealing with risk and uncertainty is through adaptive management. Although there are various definitions of adaptive management, Oram and Marriott (2010) identify a common theme among definitions: “adaptive management is an iterative process used by resource managers to improve management processes over time when environmental impacts are uncertain”(p.93). Adaptive management is different from contingency planning by virtue of being open-ended, which adds greater control over the reaction to realized impacts (Oram & Marriott, 2010). However, as the impacts of marine energy technologies become better understood, uncertainties will diminish and so will the need for adaptive management schemes. At such point, contingency plans will become more appropriate (Oram & Marriott, 2010). However, at the onset of development, adaptive management allows projects to be permitted and installed while providing stakeholders the opportunity to verify anticipated impacts (EquiMar, 2011d).

As Figure 9 demonstrates, there are various steps involved in creating an adaptive management plan. Stakeholders are heavily involved in the process, and the first step is to establish consensus among all stakeholders about how the process should proceed, and establish procedural guidelines (Oram & Marriott, 2011).



*Figure 8: “Steps for applying adaptive management to project development” (Oram & Marriott, 2011, p. 94).*

With reference to marine energy development, Oram and Marriott (2011) make five recommendations for structuring adaptive management programs:

- 1) Adaptive management must be a voluntary endeavour;
- 2) Adaptive management plans must be project-specific;
- 3) Agencies’ statutory and regulatory mandates must guide adaptive management;
- 4) Disputes may arise during the iterative processes of follow-up monitoring, assessment, and decision making, and
- 5) An adaptive management plan should specify how the parties will resolve those conflicts (Oram & Marriott, 2010, p. 95-96).

The authors conclude: “Adaptive management is not a new concept, but, as applied to wave and tidal energy projects, it will require creativity and bold leadership by agencies and developers alike. For initial projects, adaptive management will be a critical tool to get projects in the water, and may require more flexibility on the part of agencies and developers than either is used to providing” (Oram & Marriott, 2010, p.97).

## Marine Spatial Planning

Marine spatial planning (MSP) is considered a best practice to minimize barriers in the offshore renewable energy industry (Mott MacDonald, 2011). MSP is a “public process of analyzing and allocating the spatial and temporal distribution of human activities in marine

areas to achieve ecological, economic, and social objectives that usually have been specified through a political process” (MSP Initiative, 2010). It is a practical tool for managing multiple uses and interactions in marine areas, while balancing development and maintaining environmental, social, and economic needs (AWATEA, 2009). MSP is an excellent tool that has potential to assist in tidal energy development. There are several examples of successful MSP initiatives around the world such as:

- Eastern Scotian Shelf Integrated Management Plan;
- Rhode Island Ocean Special Area Management Plan; and
- Integrated Management Plan for the North Sea 2015.

Marine Spatial Planning is a recognized method of maximising the socioeconomic benefits of marine planning for coastal communities, and minimising spatial conflicts of competing uses (Roger Tym Partners, 2011). Most Marine Spatial Plans actively use Geographic Information System (GIS) tools to map and site use areas, including potential sites for renewable energy developments (Defne et al., 2011).

### **Box 3: Case Study: Rhode Island Ocean Special Area Management Plan**

The Rhode Island Ocean Special Area Management Plan (Ocean SAMP) offers insight into one of the most progressive coastal management tools available today. It is the first Ocean SAMP to be completed in the USA, and serves as a model for coastal management. The Coastal Zone Management Act encourages states to prepare these types of plans. According to the Legal Information Institute (n.d.):

The term "special area management plan" means a comprehensive plan providing for natural resource protection and reasonable coastal-dependent economic growth containing a detailed and comprehensive statement of policies; standards and criteria to guide public and private uses of lands and waters; and mechanisms for timely implementation in specific geographic areas within the coastal zone (Section 17).

SAMPs work to better align coastal policy and address complex multi-stakeholder issues. Many states have developed SAMPs with varying degrees of success. The state of Rhode Island currently has six SAMPs implemented by the Rhode Island Coastal Resources Management Council (Ocean SAMP, 2010).

#### *History*

The Ocean SAMP was initiated by political mandate to achieve the goal of 15 percent of the

state's electrical power by 2019. To achieve this goal, the Coastal Resources Management Council proposed an Ocean SAMP to engage stakeholders and provide policies and recommendations for potential offshore wind energy sites (Ocean SAMP, 2008). The Coastal Resources Management Council Ocean SAMP proposal to the Rhode Island Economic Development Corporation was approved in August 2008. The first year of the project was dedicated to research, stakeholder participation, and development of a preliminary zoning map. The second year (August 1, 2009 – July 31, 2010) was “slated for research refinement (continued analysis), outreach (stakeholder process and community events), decision making (development of CRMC policy and standards), and submission of the completed SAMP document for state and federal approval (Ocean SAMP, n.d, p.1).

The Ocean SAMP may make Rhode Island a world leader in offshore development issues because “it is the fastest, most efficient and cost-effective way to approve and site offshore renewable energy projects” (Ocean SAMP, 2008, p.1). In addition to addressing offshore development issues, the Ocean SAMP comprehensively addresses issues of ecology, global climate change, cultural and historic resources, fisheries, recreation and tourism, marine transportation, and future uses of the Rhode Island marine area (Ocean SAMP, 2010).

#### *Funding Sources*

The Ocean SAMP was funded \$3.2 million from federal funds for the two-year project as requested in the 2008 proposal. In 2009, the project was granted an additional \$660,050 from federal funds. This money was given by the Rhode Island Economic Development Corporation's Renewable Energy Fund, which is supported by a surcharge on public utility bills. In 2009, Ocean SAMP was awarded a \$2.8 million grant from the office of Governor Donald Carcieri, which enabled staff to expand research projects and address new issues. The University of Rhode Island and the University of Rhode Island Graduate School of Oceanography contributed over \$1 million worth of sea time and services, along with its research vessel, the Endeavor (OceanSAMP, 2009).

In summary, the Ocean SAMP was completed very quickly, with a relatively small budget considering the task at hand. The Ocean SAMP still needs to be tested on whether its implementation is successful. Yet as the initiative moves forward, it has the support of both the state and federal governments, and is working from the foundation laid by its years of research and experience from the SAMP technique. The Ocean SAMP will test tools that will be directly applied to marine planning and management processes.

The Ocean SAMP initiative is committed to broad and open sharing of information and lessons learned. Their website features links to key documents, interactive marine spatial planning maps, and GIS data sets (Figure 8).

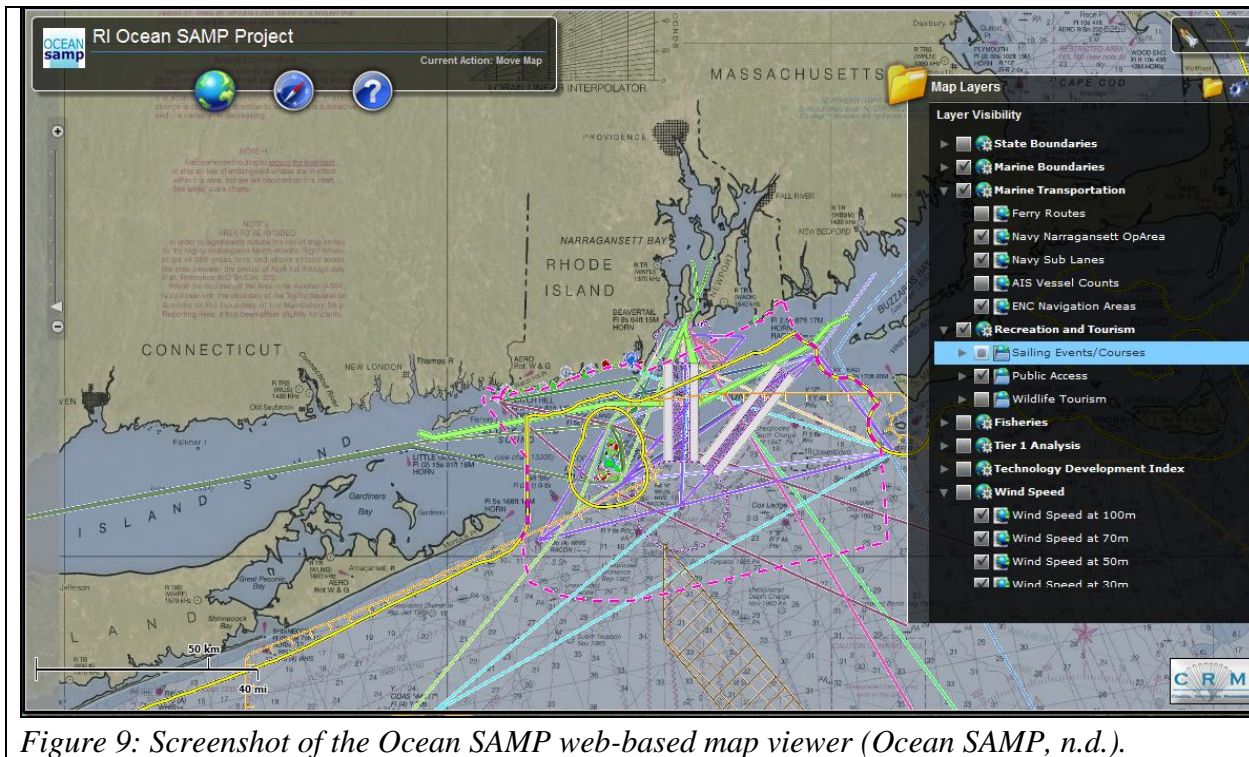


Figure 9: Screenshot of the Ocean SAMP web-based map viewer (Ocean SAMP, n.d.).

## Space-Use Conflicts

Coastal and offshore regions are used by a multitude of users, often with conflicting interests, which may result in space-use conflicts. According to EquiMar (2009s), “potential space-use conflicts common to all types of offshore alternative energy facilities include commercial fisheries, subsistence fishing, marine recreational activities such as boating, fishing, scuba diving, and surfing, sand and gravel extraction, oil and gas infrastructure, navigation, aquaculture, proximity of designated conservation areas and other alternative energy facilities” (p.12). It may be difficult to find a marine area without space-use conflicts. More research needs to be conducted on space-use conflicts of tidal energy, and reasonable compensation measures if conflicts cannot be mitigated or avoided.

## Integrated Coastal Zone Management

Integrated Coastal Zone Management (ICZM) or Integrated Coastal Management (ICM) is another tool which can facilitate tidal energy development. With so many conflicting



and competing coastal and offshore interests, it is imperative to develop an overarching and comprehensive ocean management plan. The World Bank (1996), defines ICZM as:

a process of governance consisting of the legal and institutional framework necessary to ensure that development and management plans for coastal zones are integrated with environmental (including social) goals and are made with the participation of those affected (p.1).

ICZM utilises an adaptive and participatory approach to achieving sustainable development. It is a process that has the freedom to utilize tools and methodologies from different disciplines to meet the unique requirements of coastal regions. ICZM integrates dimensions of political and jurisdictional units, economic sectors, natural and physical processes, and horizontal and vertical integration of government levels.

### Stakeholder Participation

As tidal energy is a new and emerging industry, the planning and decision-making processes are less developed. Therefore, it is imperative that industry recognizes the critical role of early and continuous stakeholder consultation. Public and stakeholder participation is recognized as critical to long-term project success, and lessons of successful participatory processes can be gleaned from other renewable energy developments. Participatory processes promote collaboration between those who have an interest in the uses and benefits associated with coastal areas. This is particularly relevant to tidal energy developments, as there is likely to be a wide range of stakeholders affected. Experience shows that participatory processes facilitates consensus, conflict management, builds a sense of property and local pride, and creates confidence, trust and greater cooperation. Initial research on public acceptance of a tidal energy project in Northern Ireland showed “strong support for the project, arising from beliefs that the project enhanced local distinctiveness by ‘putting the area on the map worldwide’; appeared visually familiar, and helped tackle climate change” (Devine-Wright, 2010, p. 83).

EquiMar prepared a report titled “Impacts upon marine energy stakeholders” which outlines how to identify the stakeholders involved in the development of a MRE array, and plan a procedure to consult with them (EquiMar, 2011c). Since MRE arrays are still in early development stages, the terms and processes described in the EquiMar (2011c) report consider

lessons learned from the offshore wind industry, and interactions with stakeholders. Some key points of this report are summarized below (EquiMar, 2011c).

## Identification of Tidal Energy Stakeholders

Tidal energy developments occur in coastal and offshore regions in areas where multiple interests and users interact in what is considered a common resource. As such, there are many stakeholders involved with tidal developments.

A stakeholder can be defined as any person, group, or organisation that has a stake in a tidal energy development, and who can affect and be affected by the actions taking place prior, during, or after the development, and also affect or be affected by the objectives and policies involved (EquiMar, 2011c).

At the initial stages of a tidal project development, the stakeholder body might typically include owners (shareholders), developers, suppliers, employees, the government, unions, and individuals or whole communities located near or in the vicinity. When the tidal project is fully operational creditors and end energy users could be included as well (EquiMar, 2011c, p. 2-1). The British Wind Energy Association (BWEA) conducted extensive stakeholder processes with offshore wind farm developments in the UK. The BWEA developed a document titled “Best Practice Guidelines: Consultation for Offshore Wind Development”, which can be of use for tidal energy stakeholder engagement processes. BWEA (2002) and EquiMar (2011c) categorise stakeholders into the following four categories:

- **Statutory consultees**  
Statutory consultees are authorities, agencies, groups or bodies defined in local, national or international legislation, which the developers are obligated to consult. A pre-defined statutory process is usually followed by the developer, but in the same time, no restrictions exist on including this category of stakeholders in non-statutory consultation as well.
- **Strategic stakeholders (non-statutory consultees)**  
This category includes local, regional, national or international organisations (and their representatives) who have important information, experience and expertise to contribute, and the final stand of whose, either positive or negative, affects significantly the overall progress of the development. If the development refers to an array of onshore marine energy converters or nearshore with onshore support facility requirements, land owners may be part of this category as well.

- **Community stakeholders**

This category includes any individual, groups of individuals or organisations, whose lives, interests and welfare can be affected by the development.

- **Symbiotic stakeholders**

Symbiotic stakeholders can be owners or organisations who may have an interest on or may have mutual benefits from a co-development (EquiMar, 2011c, p. 2-1).

Examples of these categories are given in Table 4 below.

*Table 4: Examples of typical stakeholders: subject to national and regional differences (EquiMar, 2011c).*

<b>Statutory consultees</b>	<b>Strategic stakeholders</b>	<b>Community stakeholders</b>	<b>Symbiotic stakeholders</b>
<ul style="list-style-type: none"> <li>• Department for Environment, Food and Rural Affairs.</li> <li>• Department of Culture Media and Sport.</li> <li>• Department of Trade and Industry.</li> <li>• Department of Transport, Local Government and the Regions.</li> <li>• Centre for Environment, Fisheries and Aquaculture.</li> <li>• Civil Aviation Authority.</li> <li>• Countryside Agency.</li> <li>• Local Authorities.</li> <li>• National Heritage and Nature.</li> <li>• Ministry of Defence.</li> <li>• Maritime and Coast Guard Agency.</li> </ul>	<ul style="list-style-type: none"> <li>• Investors.</li> <li>• Marine Archaeological interests.</li> <li>• Marine Conservation society.</li> <li>• National Fishermen's Organisations.</li> <li>• National Trust.</li> <li>• Ramblers Association.</li> <li>• Societies for the protection of birds.</li> <li>• Yachting Association.</li> <li>• Fishery Committees.</li> <li>• WWF.</li> <li>• Green Peace.</li> <li>• Surfers Against Sewage</li> <li>• Surfriders Foundation.</li> <li>• The Wildlife Trust.</li> <li>• Trade Unions.</li> <li>• Land owners.</li> </ul>	<ul style="list-style-type: none"> <li>• Residents associations.</li> <li>• Individual residents.</li> <li>• Sailing clubs.</li> <li>• Recreational groups.</li> <li>• Regional or local fishermen associations.</li> <li>• Local companies.</li> <li>• Local touristic agents and / or agent associations.</li> <li>• Women's Institutes.</li> <li>• Community councils.</li> <li>• Church groups.</li> </ul>	<ul style="list-style-type: none"> <li>• Offshore wind energy industry.</li> <li>• The wind industry supply chain.</li> <li>• Offshore oil industry.</li> <li>• Electrical grid owners.</li> </ul>

• National Parks.	• Universities. • Project Developers.		
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(p. 2).

Identifying stakeholders may be a challenge, however, it is important to include as many stakeholders as possible to avoid excluding a stakeholder that may be crucial to the process. Experience from BWEA (2002) shows that even local individuals can cause delays or cancellations in the overall development. EquiMar (2011c) offer the following questions to aid in identifying stakeholders:

- Who is investing on the development?
- Who will the development affect, either positively or negatively?
- Which are the changes the development will bring and who supports or opposes such changes?
- Who is influential in the local community?
- Who are the representatives of local organisations with environmental or social interests?
- Who are the representatives of local organisations with economic interests?
- Who are the representatives of similar (if any) developments in the area, such as existing offshore wind farms?
- Was there anybody involved in similar issues in the past?
- Who are the local policy makers?
- Who are the representatives of the local / regional research community?
- Who else should be involved? (p.3).

## Stakeholder Process

The BWEA (2002) report, “Best practices guidelines: Consultation for offshore wind energy developments”, outlines processes and techniques for stakeholder consultation in the offshore wind industry. The document is meant to be used by developers, planners, government departments, local organisations, and communities to set a standard for good consultation. The guidelines recognize that each site, community, and development plan will be unique, but the principles and techniques offered can be applied to different situations. Therefore, this document can be of use for the planning of stakeholder processes in the tidal energy industry.

BWEA's (2002) principles of consultation include the following:

- 1) "The purpose of stakeholder consultation is to enable all stakeholders to make known their views and to work together to ensure they are addressed"(BWEA, 2002, p.8). Everyone needs an opportunity to share their view.
- 2) "Consultation needs to be inclusive"(BWEA, 2002, p.8). Although there are many ways to conducting consultations, the most important thing is to use the most appropriate techniques at different stages of the development process. To avoid exclusion, techniques such as participatory appraisal and community mapping can be useful in the early stages.
- 3) "People need to be treated equally"(BWEA, 2002, p.8). Ideas should be judged on their merits, not on their source.
- 4) "Responsibility for the process and the feedback needs to be shared"(BWEA, 2002, p.8). Many consultation processes fail because needs of stakeholders are not met, or because participants feel they have not been kept fully informed of what has been done with their ideas and opinions. It is up to those convening the process to ensure everyone's needs are met – and to take responsibility for disseminating the results and information about their input is linked to decision-making processes.
- 5) "The use of independent professional facilitators should be considered"(BWEA, 2002, p.8). Independent facilitators can ensure that meetings are conducted impartially, and as balanced and even-handed as possible.
- 6) "The process must be transparent, especially about uncertainties"(BWEA, 2002, p.8). When uncertainties arise, it is best to be open and honest about it. Stakeholders may already be critical, and will be very upset if not told the truth. Furthermore, stakeholder processes can actually help manage uncertainties by, for example, organizing local research or developing shared contingency plans.

## Statutory Consent and Environmental Impact Assessment Requirements

Developers usually have to obtain several different kinds of statutory consent, including the submission of an Environmental Impact Assessment (EIA). EIAs mostly focus on the physical and natural environment, but there is also a requirement to assess socioeconomic impacts as well. EIA processes also have an established formal procedure for stakeholder consultation. The BWEA (2002) report outlines a "wider voluntary" consultation process that includes more stakeholders than the formal EIA process. Table 5 shows how the EIA process links to the stakeholder consultation process. Note that the stages may not happen exactly in parallel as shown in the table, and that stakeholder consultation processes need to be

iterative. In other words, “information gained in Stages 2 or 3 may make it essential to return to Stage 1” (BWEA, 2002, p.10).

*Table 5: Summary of statutory and stakeholder processes (BWEA, 2002).*

<b>Stakeholder Consultation Process</b>	<b>Environmental Impact Assessment and Planning Process</b>
<b>Stage 1: Identifying stakeholders, issues and processes</b> <ul style="list-style-type: none"> <li>- Create core team to advise on consultation</li> <li>- Identify stakeholders and issues</li> <li>- Establish key contacts</li> <li>- Draw up detailed consultation process plan</li> <li>- Prepare information for dissemination</li> </ul>	<b>Stage 1: Site selection and Scoping</b> <ul style="list-style-type: none"> <li>- Undertake pre-feasibility studies</li> <li>- Site selection</li> <li>- Screening under the habitats directive, if appropriate</li> <li>- Outline environmental profile</li> <li>- Consideration of alternatives</li> <li>- Scoping exercise (identification of main environmental effects)</li> <li>- Production of scoping report</li> </ul>
<b>Stage 2: Listening and learning</b> <ul style="list-style-type: none"> <li>- Clarify issues, expose assumptions, reduce uncertainties, build on common ground and explore ideas to resolve differences</li> <li>- Commission independent research and fact-finding to avoid the ‘adversarial science’ problem</li> <li>- Improve communication and relationships</li> <li>- Manage ongoing uncertainties</li> <li>- Turn new ideas into solutions</li> <li>- Agree on changes to existing plans where necessary/possible</li> <li>- Develop continuing commitments</li> <li>- Establish monitoring and reporting procedures</li> </ul>	<b>Stage 2: Commission EIA and Scheme Design</b> <ul style="list-style-type: none"> <li>- Description of the development</li> <li>- Description of existing environment</li> <li>- Description of environmental impacts</li> <li>- Identify residual effects</li> <li>- Interpretation of scale and significance of impacts</li> <li>- Identification of mitigation measures</li> <li>- Development of management systems and controls to avoid, reduce and enable mitigation</li> <li>- Propose possible monitoring and reporting measures</li> <li>- Advertise application and lodge in public domain for review and comment</li> </ul>
<b>Stage 3: Monitoring, evaluation and maintain contacts</b> <ul style="list-style-type: none"> <li>- Reporting back to stakeholders on results of consultation</li> <li>- Reporting back to stakeholders on how results were used as part of decision-making processes on the development</li> <li>- Evaluation of consultation process</li> <li>- Ongoing contacts</li> </ul>	<b>Stage 3: Post Granting of Consents</b> <ul style="list-style-type: none"> <li>- Implementation of mitigation or compensation and control measures</li> <li>- Monitoring and reporting</li> <li>- Continual adjustment where monitoring reveals undesirable results</li> </ul>

- Return to earlier stages if and when necessary	
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(p. 11).

The BWEA (2002) report then goes on to describe in detail the processes of each of the three Stages of the stakeholder consultation. Key points are summarized below.

### **Stage 1: Starting the consultation process**

The first task is to select who will lead the consultation process (usually the developer), and identify one person to lead the consultation and maintain contact with stakeholders throughout the process. The steps are to (BWEA, 2002)

- Identify the stakeholders and do an initial scoping of the issues, probably also clarifying which issues are important to which stakeholders
- Plan and design the consultation process, agreeing on objectives and outputs, techniques, key events, timing, resourcing (including budgets), and co-ordination with other statutory and non-statutory processes
- If and when meetings are required, draft invitations and indicate whom the stakeholders can liaise. Who sends the invitations and ‘hosts’ the events may vary: it may be the developer, local councils, a local coastal partnership, or sometimes an independent body such as a local college
- Decide and prepare presentations and documents for distribution before or during meetings, and agree administrative and logistical preparation: efficient logistics helps build confidence in the process (p. 13).

In order to minimize conflict, BWEA (2002) suggests that initial consultation should occur during the site selection phases development.

A consultation plan will benefit both stakeholders and the development team by clarifying what the consultation process is, and clarifying links to statutory organisations, regulators, NGOs, and other relevant bodies. Generic elements of the consultation plan include (BWEA, 2002):

- Objectives and scope of the consultation process
- Environmental, economic and social issues raised by the development
- Why the development is being proposed
- Time-frame for consultation set out in parallel with the timing of related activities
- Locations and logistics of consultation

- Tools and techniques of consultation
- Roles and responsibilities of those involved
- Resources for consultation are allocated
- Feedback mechanisms (p. 13).

## **Stage 2: Listening and learning**

The main interactive work of the stakeholder process starts around the same time as work on the Environmental Impact Assessment is emerging. This stage needs to (BWEA, 2002):

- Clarify issues
- Expose assumptions
- Identify, manage or reduce uncertainties
- Build on common ground
- Explore ideas to solve problems and resolve differences
- Establish what changes may need to be made
- Commission independent research and fact-finding
- Establish monitoring and reporting procedures, and arrangements for responding to them
- Try generally to improve communication and relationships, and develop continuing commitments (p. 14).

If there are issues that require more in-depth discussion, working groups can be established and their remits agreed by all stakeholders. The BWEA (2002) report further discusses stakeholder input to the EIA process.

## **Stage 3: “Monitoring of the consultation process, evaluating, and maintaining contacts”** (BWEA, 2002, p. 15).

As the development process continues, the consultation process should continue checking the following (BWEA, 2002):

- Whether all appropriate stakeholders have been consulted
- Whether the stated objectives of the EIA and consultation processes have been achieved
- What changes to the project have been made as a result of the consultation process, and why
- Whether the consultation process has allowed sufficient time to consider social, economic and environmental impacts to the depth necessary



- Whether stakeholders feel that the consultation has been conducted in a way that has enabled them to contribute fully and freely to the EIA process (p. 15).

The consultation plan needs to identify techniques that monitor consultation objectives. For example, a core group of stakeholders who meet over the lifetime of the project and are available to discuss arising issues. The BWEA (2002) report briefly summarizes the most common tools and techniques of consultation, including: “providing information”; “gathering information”; “face-to-face meetings”; “public meetings”; “workshops”; “liaison groups”; “public exhibitions”; and “the internet” (p. 17-19).

Figure 9 shows a series of generic steps linked with the various development and deployment stages of a tidal energy array. The iterative process is demonstrated where information is shared, collected, gained and used within subsequent steps that may make it essential to return to the first step and repeat the procedure (EquiMar, 2011c).

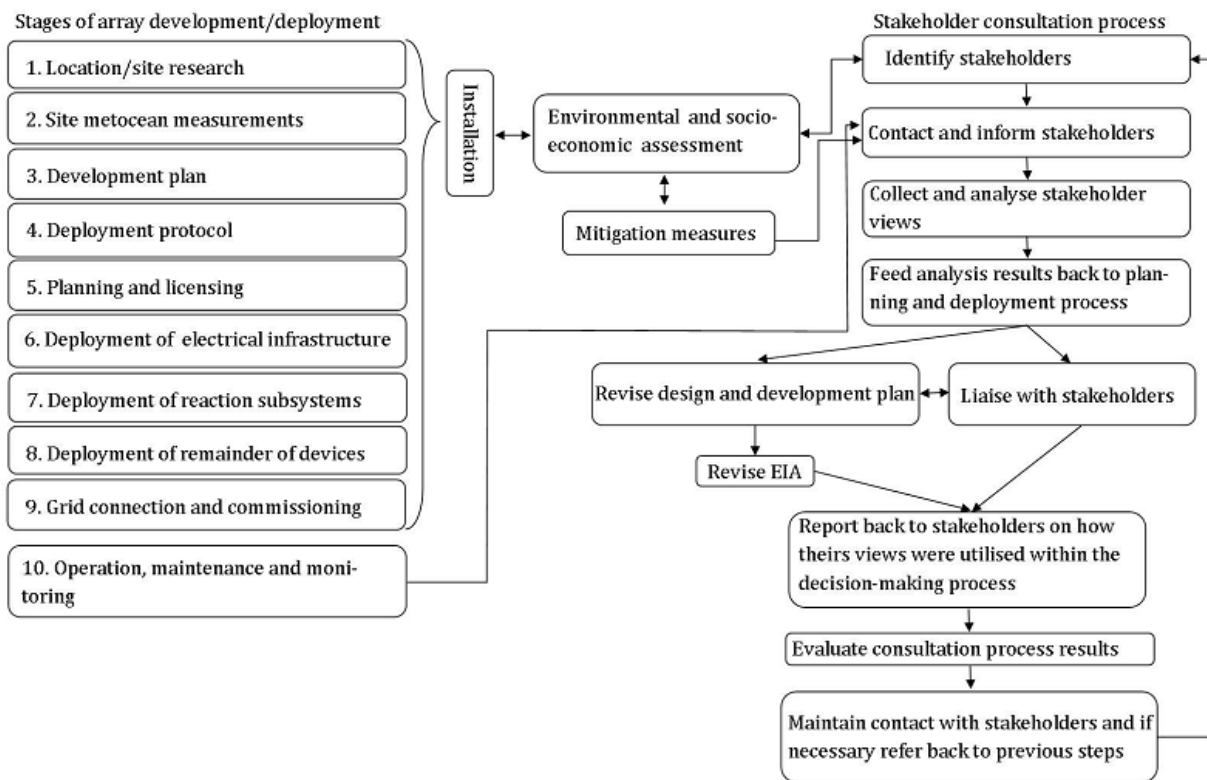


Figure 10: Example of an iterative stakeholder consultation process based on subsequent steps linked to various stages of the array design, deployment and operation (EquiMar, 2011c, p. 7).

#### **Box 4: Lessons from the UK Sustainable Development Commission's Public and Stakeholder Engagement Programme on Tidal Power**

The UK Sustainable Development Commission (SDC) began a research project on tidal power in the UK in 2006, which was “followed by a public and stakeholder engagement programme” (Warburton, 2008, p.2). This programme was evaluated with a focus on the “deliberative public engagement elements of the consultation, and the stakeholder workshops, as these were the elements of the process that potentially had the most lessons for future SDC public and stakeholder engagement work” (Warburton, 2008, p.2). The Warburton (2008) report summarises the evaluation methodology, which may be of use for future tidal energy stakeholder process evaluations. Warburton outlined elements of the process that were more and less successful, and made recommendations for future practices. General aspects of what works best included: “learning; having a say and being listened to; sharing views with others; small group discussions; and making contacts and networking” (Warburton, 2008, p.34). Participants placed a high value on talking with and listening to each other at meetings. General aspects of what was least successful included: the need for more information; reporting back to participants; and “nothing” – meaning that there was nothing that did not work well (Warburton, 2008).

### **Public Opinion and Acceptance**

Stakeholders form opinions on renewable energy developments based on their perception of the environmental, socioeconomic and emotional impacts the proposed development has on them, and their area (EquiMar, 2011c). Several “opinion studies conducted in Europe and the US indicate that the public is generally supportive of developing alternative energy sources specifically onshore and offshore wind energy” (Coyle, 2007; Ladenburg, 2006; & Dong Energy, 2006 as quoted in EquiMar, 2009b, p.11). A study conducted by Michel et al. (2007) on public acceptance of offshore wind energy in the UK and Denmark shows that:

- 1) The public is in favour of offshore wind energy also in the region where they reside;
- 2) Visual impacts appear to be the primary issue of public concern;
- 3) Offshore wind park development appears to gain public approval as the community is exposed to operational projects;
- 4) Early local input to the planning process is critical to gain public acceptance (As quoted in EquiMar, 2009b, p. 11).

Public opinion is generally shaped by awareness of environmental and socioeconomic impacts. People tend to accept RE developments due to environmental issues (such as climate change), but concerns arise due to potential environmental impacts related to “marine mammals, landscape/seascape changes, and noise”(EquiMar, 2009b, p.11). Onshore MRE devices may create a “Not in my backyard” (NIMBY) effect, meaning that although the public accepts the development of MRE, they do not want developments in their neighbourhood (EquiMar, 2009b). Other negative attitudes may arise due to conflicts with activities such as fishing (commercial, recreational, and subsistence), navigation, sand and gravel extraction, and recreation such as boating, surfing and diving. Experience from the offshore wind industry shows the importance of informing the public, but it might be necessary to avoid technical language that is difficult for the public to understand (EquiMar, 2009b).

## Navigational Practice and Safety

The presence of offshore man-made structures is increasing, which has implications for shipping, navigation, and safety. The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) is monitoring the development of offshore structures and has created documentation to “ensure clear and unambiguous marking of waterways for safe navigation, protection of the environment, and protection of the structures themselves” (IALA, 2008, p.7). IALA created a document titled “IALA Recommendation O-139 on the Marking of Man-Made Offshore Structures” which covers marking of offshore structures in general, as well as marking of MRE devices. The recommendations provided by the IALA should be implemented as a minimum requirement. The IALA suggests that development of all structures “should not prejudice the safe use of Traffic Separation Schemes, Inshore Traffic Zones, recognized sea lanes and safe access to anchorages, harbours and places of refuge”; stakeholder consultation should occur at an early stage; and authorities should consider establishing Exclusion or Safety Zones on a case-by-case basis which would prohibit vessels from entering the structure area (IALA, 2008, p.8). IALA provides 11 suggestions for marking wave and tidal energy devices, which includes use of navigational buoys, lights, radar reflectors, transponders, paint and colour markings, and provides visibility and distance guidelines (IALA, 2008, p. 20-21). Considerations during construction and decommissioning

are provided, such as: the “use of guard ships in areas of high traffic density”; “Notices to Mariners”; “Radio Navigational Warnings”; trenching of subsea cables to avoid exposure to scouring or fishing activities; temporary marking for construction and decommissioning phases; and removal of obstructions that could be hazardous to navigation after decommissioning (IALA, 2008, p. 21-22). The IALA also recommends that contingency and/or emergency response plans be developed to address the possibility of individual devices breaking loose and becoming floating hazards. Automatic location and tracking devices should be considered (IALA, 2008, p. 22).

The Maritime and Coastal Agency (UK) published a marine guidance note titled “Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues” (Maritime and Coastal Agency, 2008). This document provides further guidance, and a series of annexes that address similar issues that the IALA (2008) document addresses. The main safety issues associated with offshore renewable energy projects are summarized in Table 6 below, along with mitigation measures.

*Table 6: Main health and safety issues and mitigation measures.*

<b>Issues</b>	<b>Mitigation Measures</b>
Construction and operation activities	<ul style="list-style-type: none"> <li>- Selection of appropriate vessels, contractors, personnel</li> <li>- Planning</li> <li>- Monitoring and forecasting of weather conditions</li> <li>- Evidence of good safety record and culture in contractors</li> <li>- Occupational Health and Safety Management System (OHSMS) 18001 accreditation of contractors</li> </ul>
Emergency planning and response	<ul style="list-style-type: none"> <li>- Emergency plan and procedures in place within health and safety management system</li> <li>- Shelter areas</li> </ul>
Collision risk and navigational safety	<ul style="list-style-type: none"> <li>- Collision risk study</li> <li>- Design of structures</li> <li>- Exclusion zones and siting</li> <li>- Signals and markings</li> </ul>
Access and personal transfer	<ul style="list-style-type: none"> <li>- Specialised vessels and access procedures</li> <li>- Staff training and qualification</li> <li>- Personal Protective Equipment</li> <li>- Personnel tracking</li> </ul>
Weather	<ul style="list-style-type: none"> <li>- Monitoring and forecasting of weather conditions (wind speeds, wave heights, period and direction, tidal range and flows, temperature)</li> <li>- Understanding of acceptable envelopes for safe operation or construction</li> </ul>

Divers and subsea work	<ul style="list-style-type: none"> <li>- Competency and training</li> <li>- Suitable and specialist vessel and equipment</li> <li>- Remote Operating Vehicles</li> </ul>
Electrical installations	<ul style="list-style-type: none"> <li>- Personnel competency and training</li> <li>- Signage</li> <li>- Restricted areas</li> </ul>
Safety interfaces	- Interface matrices and structure clearly define respective roles and responsibilities between owners, operators, and contractors.
Appropriate standards and guidance Legal requirements	<ul style="list-style-type: none"> <li>- Development of specific guidance and standards by the industry, regulators, certification bodies and international organisations</li> <li>- National and international dissemination of best practices</li> <li>- National and international harmonisation</li> </ul>
Availability of skilled personnel	<ul style="list-style-type: none"> <li>- Development of training courses and certification</li> <li>- Campaigns to promote career prospects within education systems</li> <li>- Programmes to support and facilitate transfer of skills from other (declining) industries</li> </ul>

*(Mott MacDonald, 2011 p. 107-108).*

In the UK, the British Wind Energy Association (BWEA) and the European Marine Energy Centre (EMEC) in Orkney have developed Guidelines for Health and Safety in the Marine Energy Industry. Such guidelines may provide some level of risk abatement and may speed up permitting along with potentially decreasing lender reluctance.

#### **4.1.3 Financing and Funding Tidal Energy**

The development of tidal in-stream energy conversion (TISEC) industry will require a large amount of capital investment, funding and other financial mechanisms. The expectation is that few developers or communities will have enough capital to internally fund projects. This situation is not unfamiliar in renewable energy development (Bahaj, 2011), and often communities or developers need to seek external financing to bring projects to fruition. Given the nascent development of TISEC technology, there remain uncertainties around regulation and permitting of tidal energy projects, which makes them inherently risky. Consequently, financing options can be limited or prohibitive. This section will explore barriers to financing projects and mechanisms for funding.

#### **Developing Lender Confidence**

In tidal energy and renewables development in general, financing has been identified as a major barrier (Mott MacDonald, 2011; RenewableUK, 2011; Ecofys International BV, 2008; Boettcher, Nielsen & Petrick, 2008). Lending or equity raising terms can be prohibitive in many cases (i.e. high interest rates or expected returns on equity put pressure on project development timelines or returns on energy production that any alteration from the project plan can result in project failure). The higher the presumed or expected risk of a project, the less likely a lender is to provide financing or they will put in place measures to protect themselves which puts pressure on the project developer to see early and positive returns (Ecofys International BV, 2008). In the Ecofys International BV report the authors suggest that it is imperative to remove policy barriers to renewable energy financing so that: a) projects can move forward with more leeway to allow for necessary amendments to the project timeline; and b) a greater number of projects can be successful and thus increase confidence in renewable energy projects for lenders. By increasing the number of projects that are revenue positive, valuable examples are provided to lenders and other developers, who, over time will see renewable energy projects as less risky.

Any security that can be provided, in terms of a projects costs and revenue, will be a benefit. A measure that many jurisdictions have adopted to increase lender confidence and reduce uncertainty is the use of market signals such as feed-in tariff's (Boettcher, Nielsen, & Petrick 2008; Sustainable Development Commission, 2007). A feed-in tariff (FIT) can accelerate RE investment by offering long-term contracts to energy producers at a fixed energy price per kWh (Couture & Gagnon, 2010). New RE technologies, such as wave and tidal energy are offered a higher price per kWh, to reflect the higher costs of producing energy. Couture and Gagnon (2010) state that "Recent experience from around the world suggests that feed-in-tariffs (FITs) are the most effective policy to encourage the rapid and sustained deployment of renewable energy" (p.955).

## Risk Reduction and Management

The central barrier to securing financing is the level of risk associated with a project. Lenders are reluctant to provide funding to a project if they deem it to be too risky, and the ability of the borrower to repay debts is assumed to be low (Ecofys International BV, 2008). In simple terms, not reducing risk to investors will directly limit the amount of entrants to the

market (Woodmann & Mitchell, 2011). A variety of ways to mitigate risk and increase lender confidence have been identified. Many of these actions need to be initiated by government, but can and should include industry stakeholders. Such actions include the following:

- Establishing clear market signals such as Feed-in-Tariffs (Woodmann & Mitchell, 2011);
- Increase production experience and learning processes (Mott MacDonald, 2011);
- Demonstrating political commitment to renewable energy development such as keeping funding for support schemes external to government budgets to ensure stability (Ecofys International BV, 2008);
- Promoting or enabling Public Private Partnerships P3 or community buy-in development models (Walker, 2008);
- Develop strategic grid connections;
- Provide developer assistance to ensure that due diligence is done (Ecofys International BV, 2008);
- Committing to and delivering strategic infrastructure development for tidal energy;
- Establishing and funding research institutes;
- Establish permitting processes that are clear to avoid uncertainty;
- Develop national standards and monitoring programs for occupational health and safety (e.g. the guidelines developed by the European Marine Energy Centre and British Wind Energy Association); and
- Create and maintain up to date databases on:
  - a) energy resources;
  - b) current projects; and
  - c) current and potential changes in legislation.

Other steps that can be taken by industry or project developers include the following:

- If active in a project create a project website and make project reports available;
- Demonstrate due diligence in technology, legal and commercial aspects; and
- Demonstrate that all possible grant programs have been accessed.

Government supports have been essential to the success of renewable industries worldwide (Leary & Esteban, 2009; Cansino et al. 2010). However, policy shifts, due to budget constraints or elections are common. Where an industry is highly reliant on an individual or group of government policies, there is the potential risk that they could be withdrawn should politics change. In order to reduce this uncertainty, government supports should be designed to be long term and consistent regardless of internal changes (Ecofys International BV, 2008).

Energy purchasing schemes are a major consideration for lenders, as are the length and security of these schemes (Woodmann & Mitchell, 2011). The political commitment towards RE needs to be embodied throughout the government organisation (Woodmann & Mitchell, 2011). Poor funding and policies can complicate or even halt associated benefits of RE development (Carley et al., 2011):

On-again, off-again funding makes it difficult for industry actors, community stakeholders, and other involved parties to plan projects, especially projects that take a long time to complete or require years of experience before they reach optimal performance. Consistent, predictable, and sustainable funding streams are therefore vital to the further development of this field and a successful transition toward sustained energy based economic development practice (Carley et al, 2011, p. 293).

## Funding and Financing Schemes

Securing capital to develop TISEC projects is a major hurdle to moving the industry forward. There are a variety of ways to help fund or finance tidal energy projects suggested in industry reports and academic literature. The efficacy of any model is largely contingent on the political will of government, and the ability to demonstrate that a project is viable. A variety of public and private financing and funding models have been developed. Government methods can provide either tax credits for the developer of a project, or to tax other industries or consumers using fossil fuels to generate funds to support renewables such as carbon and gas taxes, which seek to price the negative externalities of other industries. A range of barriers and associated mitigation strategies to securing financing are outlined in Table 7.

*Table 7: Range of barriers to securing finance in offshore renewable energy projects (Mott MacDonald, 2011).*

<b>Barrier</b>	<b>Mitigation Strategy</b>
Early stage technology research and development with no near term commercial prospects.	Government grants, tax incentives for R&D.
Lack of business planning skills.	Capacity-building, incubator programmes.
Late stager development: unproven technology.	Government grants for demonstration. Funding for test centres and validation, incentives for government and private sector collaboration.
Inability to gain finance for scaling up due to insufficient cash flow.	Capital grants, public procurement mechanisms, incentives for the adoption of innovative technology



	(tax incentives), soft loans, loan guarantees.
Market failure due to high cost of new technology.	Income support measures, regulatory drivers to adopt new technology, strategies to develop economy of scale.
Project development risk.	Loan guarantees, streamlined permitting, site pre-assessment (Strategic Environmental Assessments)
Project interface risk.	Tendering arrangements that reduce the number of contracts, especially at key interfaces.

(Mott MacDonald, 2011).

Federal support for RE development in the US has been delivered primarily by tax benefits, however, many RE “project developers are unable to use the majority of these tax benefits directly or immediately, and have therefore turned to third-party tax equity investors that can monetize the available tax benefits while also providing investment capital”(Bolinger, Wiser & Darghouth, 2010, p. 6804). In the US, the Section 1603 Treasury cash grant program allowed RE developments to apply for cash grants in lieu of tax credits (Bolinger, Wiser & Darghouth, 2010). A total of 6.2 GW of the 10 GW of new wind energy developed in 2009 elected grants rather than tax credits (Bolinger, Wiser & Darghouth, 2010).

In Germany, “duty on electricity is waived if it is generated exclusively from renewable sources and taken from a power grid or a line supplied exclusively with electricity from such sources”(Cansino et al., 2010, p. 6004). In Denmark, the tax law on electricity “establishes that an exemption from excise duty applies to electricity produced in small plants (less than 150kW), or by wind, hydropower or solar cell systems” (Cansino et al., 2010, p. 6005).

There are a number of revenue support mechanisms that have been developed such as renewable quotas and tradable green certificate systems (Mott MacDonald, 2011). However, the most common mechanism cited as a best practice is the Feed in Tariff (Mott MacDonald, 2011; SQWenergy, 2010; Dinica, 2008). Suppliers of debt finance, such as banks tend to favour feed-in tariffs (FITs), due to their long term certainty (Mott MacDonald, 2011). Many countries have established feed-in-tariffs systems to one extent or another, such as the UK, Denmark, Germany, Spain, and many others. In Canada, Ontario and Nova Scotia have established FITs, and other provinces are at different stages in the development of FITs.

Several expenditure support mechanisms were developed over the years to support RE (Bhattacharyya, 2011). Table 8 shows some examples provided in the report “Accelerating the Deployment of Offshore Renewable Energy Technologies” (Mott MacDonald, 2011, p. 135-136).

*Table 8: Examples of expenditure support mechanisms.*

<b>Country</b>	<b>Tax Incentive</b>	<b>Grants</b>	<b>Loans/Loan Guarantees</b>
<b>Belgium</b>	- Tax deduction for investments in renewable energy by enterprises (1992): 13.5% tax deductions for renewable investments		
<b>Canada</b>	- Accelerated capital cost allowance (2007): allows accelerated write-off of RE assets - Canadian renewable conservation expenses (1996): allows corporations to class expenditures associated with start-up of RE projects as fully tax deductible		
<b>China</b>	- Preferential tax policies for renewable energy (2003): Income tax on foreign investment into wind projects reduced from 33% to 15%. - Reduced Value Added Taxes for renewable energy (2001): VAT for wind power cut from 17% to 8.5%		
<b>Denmark</b>		Subsidies for wind turbines and other RE generating plants	

<b>Finland</b>	Tax refund of EUR 6.9/MWh for wind	- Investment subsidy up to 40% depending on novelty of system for wind	
<b>France</b>	Flexible depreciation (2003): allows accelerated write-off of RE assets		* Government crediting a loan guarantee for RE investment (2001): covers up to 70% of loans from banks to Small Medium Enterprises in RE activities
<b>Germany</b>		Integrated climate change and energy Programme (2008): contains subsidies for offshore wind farm development	- KfW Bankengruppe RE programme (2009): offers preferential loans and grants for RE projects
<b>Ireland</b>	- Tax relief on corporate investment		
<b>Italy</b>		- €14 million funding for various projects including RE (2010)	
<b>Netherlands</b>	- Energy investment deduction (1997): allows up to 44 % of RE investment to be deducted from taxable profit	- production subsidy paid as a tariff on the basis of average production cost	
<b>Norway</b>	- CO2 Tax (1991): tax on combustibles and emissions from the petroleum industry	- Investment subsidy for demonstration projects	
<b>Portugal</b>		- 35% subsidy on investment up to €2.5 million and programme of 25% subsidy on technologies within Azores Region	- 100% reduction on interest of loans up to €750,000
<b>Sweden</b>	Energy, carbon and sulphur dioxide taxation (1991): complex taxation of CO2, NOx, and sulphur		

	emissions		
<b>United Kingdom</b>		£1 billion upgrade in grid network - Direct support in manufacturing facilities	- Plans to launch £2 billion “green investment bank
<b>United States</b>	American recovery and reinvestment act: tax-based provisions (2009): allows a 50% write-down on RE projects. Contains various tax credits for RE technologies - Modified accelerated cost recovery system (2008): allows recovery of investment into wind technology to be depreciated over accelerated timescales - Production Tax Credit and Investment Tax Credit	- Option to convert Production Tax Credits and Investment TaxCredits into treasury grants	- American recovery and reinvestment act: tax-based provisions (2009): offers clean RE bonds DOE Loan Guarantee Programme (2007) Guarantees loans for renewable projects

(Mott MacDonald, 2011).

In terms of actual financing, there are two main financing modes that have been identified for RE, balance sheet finance and project finance. Mott MacDonald (2011) explains:

Balance sheet finance using debt raised corporately is cheaper, involves less parties, and control of the project remains firmly with the owner; it is however capital intensive and the risk of failure lies entirely with the owner. On the other hand, project finance allows greater leverage from the available funds for sponsors equity investment; however, it is typically more expensive and complex and an element of control over the project is afforded to the lenders.

In Canada, some researchers have argued that the government takes a ‘hands-off’ approach to RE development by not providing supporting incentives (Jagoda et al., 2011). Not creating incentives for RE through, for example, placing stricter regulations on non-renewable resources, is due to concerns of losing international industry competitiveness (Jagoda et al., 2011). Regardless of available expense or revenue based mechanisms, there needs to be political weight behind RE projects of any sort if they are going to succeed (SQWenergy,

2010; Jagoda et al., 2011). To address this, “the creation of a government financing body for projects to support commercial bank financing and provide a further signal to the lending community that the government is strongly supporting this industry” is recommended (Mott MacDonald, 2011, p.vii).

## Accessibility and Scope of Funding

Government funding schemes have been key to the success of many RE strategies (Leary & Esteban, 2009; Carley et al, 2011). Funding can take a variety of forms, from providing money for legislated impacts studies, to community engagement processes. It is important to consider where funding can be applied to best meet the goals of a given policy objective. TISEC technology and deployment rates are at different stages across the globe, and each region has its own specific issues that need to be addressed.

In many jurisdictions, government funding schemes have been primarily focused on R&D of renewable technology. The usefulness of a primarily R&D approach has been called into question by some researchers (RenewableUK & SeaPower, 2011; SQWenergy, 2010) as it misses some of the other major barriers associated with projects, such as the difficulty many developers face, whether they be private or community-based, in getting past the permitting stage (Carley et al, 2011). There is a need to mix funding between R&D, capital construction and the required pre-permitting stages of development (RenewableUK & SeaPower, 2011).

In some cases the mere complexity of grant applications may preclude some smaller scale developers (in particular small communities) from being able to access funds (DTI, 2005). Regional approaches to providing funding (i.e. offering a type of funding in one area but not another) may also stifle development and the ability to gain valuable experience in renewable energy development (DTI, 2005).

Funding should be flexible in its accessibility and the scope should be allowed to span a variety of needs in the technology refinement, permitting, testing and pre-commercial phases of development (SQWenergy, 2010; Mott MacDonald, 2011). In cases where the how and when of funding is not in step with the status of the industry, funding may not be utilized. An example of this is the Marine Renewables Development Fund – which was developed in 2004 in the UK to support the deployment of the first MRE projects. The funding was not used extensively due to tidal technology not being at the project stage (MottMacDonald, 2011).

Therefore, providing funding for what the industry and technology can accommodate is an important strategy in designing funding schemes.

### Providing Project Assistance

As was mentioned in the previous sections some potential entrants to the renewable energy market may have limited ability to navigate financing and funding opportunities. In order to offset this difficulty and to encourage expansion of renewable technologies, some jurisdictions have established teams that are able to provide support to potential developers. In England, the Community Renewables Initiative programme, was set up in 2001 and established Local Support Teams (Walker & Devine-Wright, 2008). The Local Support Teams were able to provide expert advice on funding application and financing options amongst a variety of other issues related to renewable power development (Walker & Devine-Wright, 2008). The Community Renewables Initiative funded ten Local Support Teams which covered 70 percent of England (Walker & Devine-Wright, 2008). In the areas where Local Support Teams were accessible, applications to government capital funding programs for renewables were double that of areas without the teams (Walker & Devine-Wright, 2008).

#### **4.1.4 Community Benefits and Economic Development**

Renewable energy projects are often discussed in terms of the benefits they can provide to the communities where they are situated. RE resources such as wind, tidal, and wave energy, tends to be located in peripheral and rural areas. Wind and tidal energy need to be used at their source as opposed to biofuels, which can be transported to combustion facilities as necessary. The consequence of having to utilize some renewable energies in-situ, is that this necessitates the development of infrastructure around the resource itself, which in many cases is in small and rural communities. This suggests communities that are close to resources should be able to gain some level of benefit from the development of RE industries. However, gaining benefits for communities is not always straightforward. The amount of local content (workers and goods) in energy projects, community participation in siting decisions or simply whether communities are allowed to invest in projects can all determine the type and scale of benefits a community receives. Cash or parkland contributions are often used as a way for local benefits to be garnered from a given development (DTI, 2005). In the case of TISEC

technologies, understanding what types of contributions could be made, and to whom, is difficult to assess as in most regions marine environments fall under the purview of a number of agencies or are shared by a number of communities.

There are a wide range of potential community benefits to be had from renewable energy projects. In their article on wind farms in the UK, Munday et al. (2011) summarize many of them in Table 9 below:

*Table 9: Potential community benefits from renewable energy projects.*

Categories of ‘community benefit’	
Conventional economic benefits:	the use of locally manufactured content, and local contractors for construction, operation and maintenance
	land rental income to landowners and any royalties
	local business rates and/or taxes
Flows of financial benefits to local communities:	some form of ownership/investment in the project among local people, either as equity or a form of profit share
	some form of community fund, with lump sum and/or annual payments, either focused on specific purposes (such as energy efficiency) or more open-ended
	cheaper electricity
	sponsorship of local events
Contributions in-kind to local assets and facilities:	to landscape and ecological enhancement measures, perhaps that mitigate or compensate for any environmental costs caused by the wind farm
	to tourism/visitor facilities
Provision of other local services:	educational visits or other educational programmes
Involvement in the development process:	various forms of liaison activity (Based on Community Viewfinder, 2007; DTI, 2005; as quoted in Munday et al., 2011, p.3)

## Community Engagement and Control

In order to provide more significant and direct economic benefits to communities, some countries (e.g. Denmark and Germany) have sought to implement policy and provide technical and legal assistance to encourage increased local ownership of renewable energy projects (Munday et al., 2011). The goal of this policy is to ensure that a greater amount of benefits are channelled to rural areas. Other jurisdictions have designed policies that have

(although not intentionally), discouraged community ownership and as a consequence its associated benefits. For example in the UK, the Renewable Obligation legislation was more market oriented to support competition between technologies, which in turn resulted in primarily large companies being involved in the renewable energy industry, due to high entry costs and associated risk levels (Woodmann & Mitchell, 2011). This left most communities unable to enter the renewable energy industry (Woodmann & Mitchell, 2011). Consequently, smaller technologies and projects, which could have been designed around a bottom-up economic development model, were discouraged (Woodmann & Mitchell, 2011). Many reports and academic studies suggest that the best possible way to increase community engagement is to begin consultation at the outset of a project. This ensures that residents can feel as though they are part of the process rather than the recipients of decisions made elsewhere (Portman, 2009).

Many scholars have remarked that Denmark has made exceptional progress since the 1970's toward being less dependent on foreign energy and becoming a global exporter of renewable energy technology and devices, in particular wind energy (Sovacool, Lindboe & Odgaard, 2008; Agterbosch, Meertens & Vermeulen, 2009). While much focus has been on the financial mechanisms associated with the success in Denmark, some authors have suggested that some non-financial aspects are large contributors to this success. For example in countries like the United States, the production and consumption aspects of energy are separated, with power plants often placed at the periphery of communities (Sovacool et al., 2008). The opposite occurs in Denmark; where energy production is located near to the consumer (Sovacool et al., 2008; Agterbosch et al., 2009). In Copenhagen, wind turbines are located in urban areas where they are highly visible and people view them as being natural (Sovacool et al., 2008). In other countries (e.g. USA, Canada, UK), NIMBYism (Not in My Backyard) plays a major role in permitting decisions, and energy producing projects tend to be located at the periphery (Sovacool et al., 2008).

Having community and stakeholder participation in projects is typically seen as a best practice. However, some academics have pointed out that current permitting and approval processes entail lengthy and at times, ad hoc consultation procedures, which may not yield meaningful or focused results (Boettcher, Nielsen & Petrick, 2008). Others have suggested that consultation should be replaced with participatory approaches and be tied to action-based



research methodologies (Portman, 2009). Some communities may be willing to participate in more active and participatory ways than others; for example, rural residents may be more likely to get involved in public participatory processes than their urban counterparts because the project may represent a significant economic opportunity (Boettcher, Nielsen & Petrick, 2008).

A potential benefit to increasing community participation in a RE project is that the requirements for the creation of industry clusters may be more easily identified (Brun & Jolley, 2011). Although cluster analysis is typically led by consultant or academic activities, the article by Brun & Jolley (2011) suggests that it can be reframed to engage stakeholders in a collaborative process. Brun and Jolley (2011) suggest that the benefits to this process is increased accuracy regarding the specifics of industry capacities and linkages, however the down side is that the process may be more costly and will require more time than a traditional expert led approach.

### Community Decision Making Capacity

Numerous authors have discussed the importance of community decision making capacity in ensuring tangible community benefits (Walker et al., 2010; Portman, 2009). Functional issues such as tidal energy device location and type, and whether impact assessments are required, are largely external to community decision making as they are formally defined by legal parameters or by the bio-physical nature of the area. The impacts from development of tidal energy can be direct, indirect or induced as with any major development. In the instance where renewable energy development is driven and owned by a community, rather than a private developer, the understanding is that more of these benefits can be captured locally (Walker & Devine-Wright, 2008).

Many researchers acknowledge decision making capacity in smaller communities is an issue (Halcrow Group Ltd, 2009; DTI, 2005). Capacity problems may be due to a lack of human resources, community cohesion or simply inexperience in making project development or planning decisions. The literature on community capacity building is expansive, and is far beyond the scope of this thesis. Typically a lack of information is cited as a major barrier to increasing community decision making capacity. The use of Geographic Information Systems (GIS) has been proposed as a valuable tool for community decision making (Mari et al. 2011).

### **Box 5: Best Practice: Community Accessible Geographic Information Systems**

Geographic Information Systems (GIS) can come in a variety of forms from paper maps and physical models to interactive digital 2D and 3D maps. GIS applications, in particular web-based technologies, are becoming increasingly popular as a way to provide a tool to facilitate greater community participation in development decisions for energy and other projects (Mari et al. 2011; Van Hoesen & Letendre, 2010). Numerous municipalities have invested in developing GIS web-based applications that allow community members to overlay various data layers to analyze the spatial aspects of their community.

GIS systems allow community members to overlay a wide variety of data in configurations that make sense to them. It allows residents and stakeholders to question developers, and in some cases to add data layers that they feel are important (Mari et al. 2011; Van Hoesen & Letendre, 2010). Other project decision methods such as local ecological knowledge can be (if designed well) integrated into GIS models, which can be significant in providing legitimacy to local and aboriginal interests. Another potential consequence of using a community-based GIS model is a much more rapid and potentially accurate appraisal of sensitive areas, and identification of community concerns (Van Hoesen & Letendre, 2010). This may result in faster pre-approval study times and increased support from community for an energy project (Mari et al., 2011).

### **Community Ownership**

Germany, Spain, and Denmark have been able to establish strong buy-in regarding wind energy due to legislated benefits to communities through community compensations, pre-approval contributions, local taxes, and providing for community investment in projects (DTI, 2005). Several authors have suggested that increasing community ownership levels have a number of benefits to the community (Carley et al. 2011; Walker et al. 2010; Walker-Devine-Wright, 2008; Sustainable Development Commission, 2007). As Warren and McFadyen (2010) point out, community ownership has impacts on the development process timeline as higher levels of community ownership have been proven to reduce project opposition and NIMBYism. Walker (2008) echoes this point and suggests several other benefits to community ownership models:

- local income and regeneration;
- quicker local approval and planning permission;

- local control over issues like siting and orientation;
- energy security and lowered costs;
- meeting ethical and environmental commitment; and
- smaller scale projects allow for better load management.

There are a number of issues related to community ownership, in particular complete community ownership of a renewable energy project. The most significant is the limitations this places on accessing finance. Community owned projects can be limited in their ability to raise funds, as lending institutions may not be willing to lend to inexperienced project developers and management teams. Full community ownership also exposes the community to all the risks associated with development (Halcrow Group Ltd, 2009). A possible solution is connecting communities with private developers who can assist in accessing better financing options. A few reports have suggested that along with funds for private and community developers, a special fund for joint ventures should be established in recognition of the varying capacity of communities to invest in renewable energy projects (Halcrow Group Ltd, 2009; SAC Consulting, 2010). Both communities and private business can use advisory packages on all aspects of renewable energy development including the management of private and community partnerships (SAC Consulting, 2010). In general, flexibility is important when looking at community ownership possibilities. Some communities will be reluctant or unable to invest in a project at the outset but may wish to be more active in later stages.

## Measuring Impacts on Community Development

How RE developments could benefit, or regenerate communities, is currently under discussion. In most cases, benefits are defined in terms of direct economic gains such as jobs, local investment, and land rents. Two issues in measuring the impacts of tidal energy development (pre and post project) and RE in general are:

- a) having useful baseline data; and
- b) having a framework that effectively accounts for impacts.

Socioeconomic impact assessments are typically a part of most Strategic Environmental Assessments, or in some cases Environmental Impact Assessments. However, in many cases the socioeconomic data is not substantial. There may be a need for a more prominent role for socioeconomic impact studies (EquiMar, 2011c). A major limitation to socioeconomic impact analysis is the availability of data (EquiMar, 2011a). In many cases, such as in Canada, certain statistics which can facilitate analysis of socioeconomic impacts are not readily available. Having a clear idea of the socioeconomic status of a local population prior to the development of an energy project can serve as a guide on deciding the appropriate route for capturing community benefits (Regeneris Consulting & URS Scott Wilson, 2011).

### **Measuring and planning for direct benefits**

Several researchers have brought up the concern that direct community benefits from tidal and renewable energy projects in general, may be limited due to in-situ skills and workforce availability in small and rural communities (Munday et al., 2011; Dalton & Ó Gallachóir, 2010). The reality is that smaller communities may not necessarily have the required skills or number of workers necessary to complete projects.

Depending on the situation in a given community, the highly specialised employment opportunities could attract or demand labour from outside the region and would constitute economic benefit leakage (Regeneris & URS Scott Wilson, 2011). The scale of benefits accruing to the local area would only be maximised if workforce development and job matching programmes are introduced at an early stage, to ensure local people benefit from marine renewable development opportunities (Regeneris & URS Scott Wilson, 2011). Consequently, there is a need to have an understanding of what the local employment and skills situation is prior to a project, when seeking direct employment benefits from tidal energy development.

Another issue is that many socioeconomic impact assessments begin and end with the project permitting process. Measurements need to be ongoing in order to be useful in long-range impact assessment and planning (Neves & Leal, 2010). There is also a need to have an established concept of what will be counted as an impact. Will it be total jobs, percentage of new commercial development, baseline education levels, or a mixture of indicators? Having

an idea of what will be considered a “benefit” is an often overlooked issue in development studies (ADAS Consulting Ltd, University of Newcastle, 2003).

Some researchers (del Rio & Burguillo, 2009; Wei, Patadia & Kammena, 2010) have identified that job creation is valuable only to the extent that the jobs created are:

- stable;
- value as opposed to de-value workers;
- respect social and cultural norms in respect to the environment, economy and political structure; and
- create opportunity for those in the community who are left outside of the labour market, women, rural people, the long term unemployed.

Often, “jobs” and “job-years” are used interchangeably (Wei, Patadia & Kammena, 2010). Simply referring to “jobs created” without specifying duration can be misleading (Wei, Patadia & Kammena, 2010). Renewable energy jobs will very likely entail job losses from other sectors, in particular oil and gas (FREDs, 2009). Often reviews of employment impacts from renewable energy projects do not specify the duration, quality or the skills required for jobs, additionally the measure of direct, indirect and induced jobs vary widely (Wei, Patadia & Kammena, 2010). Transfers between industries are not often investigated, which provides an incomplete picture of the economic impact. Industrial sectors are not often grouped in similar fashion between nations, potentially leading to different results in estimated jobs impacts (Wei, Patadia & Kammena, 2010).

The insight derived from an employment impact assessment is largely determined by the impact model used. An analytical model simply counts direct jobs, whereas an input-output model, calculates direct, indirect and induced effects. Consequently, the model used will determine the scope of community benefits anticipated from a project (Mott MacDonald, 2011). Each model has its particular pros and cons. Input-output models can capture the widest range of job and economic impacts but the data required to develop them can be exceptionally difficult to collect as it requires businesses to specify information about their operations (Mott MacDonald, 2011). Additionally the time required to collect the data may mean that by the time analysis is completed, the assessment may be outdated (de Carvalho, 2011). The analytical model, while relatively simple to complete, does not provide an assessment of

indirect economic impacts (de Carvalho, 2011). The consequence being that the full scope of economic impact is not covered.

**Box 6: Toolbox: Accessible Economic Modelling**

The ability for communities to estimate and predict economic impact is a valuable decision making tool. However, many communities do not have the in-house human resources capable to complete economic impact studies, and the costs of having professional consultants complete the work can be prohibitive.

The Ministry of Tourism, Culture and Sport in Ontario, Canada developed a tool called the Tourism Regional Economic Impact Model (TRIEM) to allow communities and other groups to assess the potential direct, indirect and induced economic impacts of tourism development (hotels and other facilities) and cultural events. The model is essentially an input-output model, however, it takes into account time, and users can project future impacts with results reported in nominal dollars in the corresponding year of the impact (Ontario Ministry of Tourism, Culture and Sport, 2011).

## Community and Private Supports

Various governments in Europe and North America have established grants, funds and other financial mechanisms to support the development of community owned RE developments. While these are essential components of RE projects, there is also the need for expert guidance and advice on how to best proceed through the various stages of development. Many reports have pointed out that applications for project funding can be complicated, not to mention the impact assessment /permitting processes and that many communities have limited experience in project management (Halcrow Group Ltd, 2009). The report “Economic and Community Benefit Study Final Report” (2009) by the Halcrow Group Ltd, for the Scottish Government identifies the need for communities that wish to develop RE projects to have access to expert advice and support services. The Community Renewables Initiative (CRI) in the UK demonstrates the success of a system of Local Support Teams (discussed on page 62). Walker and Devine-Wright (2008) state:

By 2006, this service was dealing with over 2000 enquiries per year and had successfully delivered over 160 installations with 100 more in development. Evaluation data also showed that in the areas where the Local Support Teams were operating, applications to a government capital funding programme, Clear Skies, were

over double the rate of those in areas where there were no Local Support Teams (p. 500).

In the North American context, many tidal energy developments may occur in small or rural communities. If local communities are to be engaged in the development process, either through local administrators, the public, or both as has been promoted as a best practice (CANWEA, n.d.; BWEA, 2002; RenewableUK, 2011; Walker et al., 2010), then there may be some human resource shortages in development processing or for public input collection and interpretation.

Canadian communities are becoming more involved in local level energy planning due to a desire to reduce GHG emissions and to develop more local sources of energy (St. Denis & Parker, 2009). Local level energy management improves energy efficiency, conservation, and eases the transition to RE sources (St. Denis & Parker, 2009). As St. Denis and Parker (2009) point out, the majority of these planning exercises and decision making process are undertaken with minimal expert support.

## **4.2 Nova Scotia Context**

### **4.2.1 The TISEC Context in Nova Scotia**

Nova Scotia is uniquely positioned to develop a TISEC industry. Many supporting factors are already in place, including relevant legislation, a world-class testing facility, and excellent tidal conditions. An abbreviated timeline of tidal energy activities in Nova Scotia is provided in Table 10 below.

*Table 10: Timeline of tidal energy activities in Nova Scotia.*

<b>Date</b>	<b>Action</b>
1984	<ul style="list-style-type: none"><li>• Annapolis tidal barrage installed</li></ul>
2007	<ul style="list-style-type: none"><li>• The Offshore Energy Environmental Research Association (OEER) was commissioned by the NS Department of Energy to carry out a Strategic Environmental Assessment (SEA) focussing on tidal energy development in the Bay of Fundy</li></ul>
2008	<ul style="list-style-type: none"><li>• The Province commits to building tidal test centre, research, legislation, and selects three TISEC developers</li></ul>

	<ul style="list-style-type: none"> <li>• Major vessel survey identifies ideal site</li> <li>• Final SEA report submitted</li> <li>• Fundy Energy Research Network (FERN) formed by “members from academia and the government research sector” (FERN, n.d., webpage)</li> </ul>
2009	<ul style="list-style-type: none"> <li>• The Fundy Ocean Research Centre for Energy (FORCE) is created as a non-profit institute by means of a public/private partnership (FORCE, n.d.)</li> <li>• “Environmental Assessment approved”(FORCE, n.d., website)</li> <li>• “NS Power deploys OpenHydro (first large-scale device in North America)” (FORCE, n.d., website)</li> <li>• “Environmental monitoring begins” (FORCE, n.d., webpage)</li> <li>• The Province provided OEER Association with funding to contract Membertou Geomatics Consultants to perform a Mi’kmaq Ecological Knowledge Study related to MRE projects in the Bay of Fundy.</li> </ul>
2010	<ul style="list-style-type: none"> <li>• Province releases the 2010 Renewable Electricity Plan, which commits a target of 25% renewable electricity by 2015 into law, and sets of goal of 40% by 2020</li> <li>• Request for Proposal of 4<sup>th</sup> berth at FORCE announced</li> <li>• Province announces tidal FIT</li> <li>• FORCE research facility completed</li> <li>• OpenHydro retrieval from test site</li> </ul>
2011	<ul style="list-style-type: none"> <li>• Atlantis wins 4<sup>th</sup> berth at FORCE</li> <li>• FIT and ComFIT price announced</li> <li>• Acadia University launches Acadia Tidal Energy Institute</li> <li>• FORCE and the European Marine Energy Centre forge alliance by signing a strategic agreement to help advance marine renewable energy industry worldwide</li> <li>• FORCE Interpretive Centre Opens</li> </ul>
Upcoming	<ul style="list-style-type: none"> <li>• Subsea cable installation at FORCE</li> <li>• Transmission line for Parrsboro / FORCE</li> <li>• New legislation to clarify commercial path and public interests</li> <li>• Release of Mi’kmaq Ecological Knowledge Study</li> <li>• Alstom, Atlantis, Minas Basin Pulp and Power device installation</li> </ul>

(Nova Scotia Department of Energy, n.d.; FORCE, n.d.).



## 4.3 Gap Analysis

The purpose of a gap analysis is to measure the status quo relative to a desired state. A desired state with clearly defined goals has yet to be articulated for a TISEC and marine renewables industry in Nova Scotia. Gap analysis is often informed by strategic plans. While Nova Scotia has done a considerable amount of work on exploring the opportunities and barriers associated with TISEC and has also sought input from Nova Scotians on this emerging industry, there is still no strategic plan. Despite the absence of a strategic plan, using the insight and the goals and objectives developed in other jurisdictions, we can identify several features of a desirable end state in the tidal energy industry. Reports from Europe, the United States, Canada (federal level) and Nova Scotia (provincial level) highlight similar issues for efficient, equitable and economically sustainable deployment of tidal energy. These issues can be divided into the following seven themes:

- Legislation and Strategic Planning
- Financing and Investment Models
- Monitoring and Assessment
- Supply Chain and Infrastructure
- Community Support and Participation
- Analytical Tools, Requisite Data and Research
- Socioeconomic Impacts

This gap analysis highlights specific goals (e.g. developing legislative clarity on tidal resource rights and access) that have been identified elsewhere. These goals will be compared to what is currently *in situ* in Nova Scotia to identify if and to what extent a gap exists. Where applicable, a possible action to address the gap or compliment current activity will be proposed. The purpose of the gap analysis is not to comment on the quality or validity of what is currently available in Nova Scotia to support MRE and TISEC, but to identify what is available to support TISEC development in Nova Scotia.

Table 11: Gap Analysis

<i>Strategic Goal</i>	<i>Current State</i>	<i>Gap</i>	<i>Possible Action</i>
<b>Legislation and Strategic Planning</b>			
<b>Strategic and topical plans</b>	<ul style="list-style-type: none"> <li>• Renewable Electricity Plan,</li> <li>• Marine Renewable Energy Infrastructure Assessment,</li> <li>• Draft Coastal Strategy,</li> <li>• Marine Renewable Energy Legislation: A Consultative Process,</li> <li>• Fundy Strategic Environmental Assessment (Fundy SEA),</li> <li>• Mi'kmaq Ecological Knowledge Study (underway).</li> </ul> <p>All provide a base for a Strategic Plan.</p>	No overarching Strategic Plan for TISEC.	Develop a Strategic Plan as soon as possible to guide future investment in TISEC and marine renewables in a coordinated fashion.
<b>Legislative clarity</b>	<p>Discussion of legislative issues began in 2006 and has been ongoing.</p> <p>Changes to the Nova Scotia Energy Act and the Renewable Electricity Regulations have been completed to facilitate FITs and other reforms.</p>	Review of legislation is ongoing.	<p>Begin shaping legislation that integrates or combines the various legislative acts at the provincial and federal level to reduce uncertainty around TISEC.</p> <p>Legislation should be flexible and adaptive as the industry is still evolving.</p>
<b>Streamlined permitting process</b>	One window permitting process established.		A one window system has been identified

			internationally as a best practice –however, until the process has been proven overtime, attention should be paid to the experiences of large and small scale developers. Developing pre-permitted areas may reduce project permitting time and financial burdens, as development could be done as of right.
<b>Identification of potential TISEC deployment sites and tenure</b>	<p>Nova Scotia, Renewable Land Opportunities Directory.</p> <p>This allows people who own land and are willing to sell or lease it for renewable electricity projects to list their sites.</p>	All sites still unidentified	Spatial analysis of resources, the best sites to access them and their tenure would provide important project information for consultation, assessing cost of development and potential partnership options.
<b>User and jurisdictional conflict management tools, such as Integrated Coastal Zone Management (ICZM) and Marine Spatial Planning (MSP) in place</b>	<p>Eastern Scotian Shelf Integrated Management (ESSIM) Initiative – is an approximate to ICZM. Ecology Action Centre report, “Integrated coastal zone management in the Bay of Fundy: Implications for tidal power”.</p>	No known ICZM or MSP in Bay of Fundy Region	Investigate the possibility of ICZM in the Bay of Fundy based on the ESSIM initiative. Look to the Rhode Island Ocean Special Area Management Plan for guidance on implementing

			MSP
<b>Financing and Investment Models</b>			
<b>Reduction of Market Risk for TISEC</b>	<ul style="list-style-type: none"> <li>• Community Economic Development Investment Funds,</li> <li>• ComFIT,</li> <li>• Power Purchase Agreement with Nova Scotia Power Incorporated (NSPI),</li> <li>• Creation of a “Renewable Electricity Administrator to manage independent power producer competitions for medium and large-scale renewable electricity projects” (NS Legislature, 2010, website).</li> </ul>	The effectiveness of these mechanisms in terms of meeting renewables targets and to facilitate meaningful industry development has yet to be determined.	Collect information on industry growth and renewables targets as they progress.
<b>Multi-stakeholder investment and partnership models (Large and Small projects)</b>	Community Economic Development Investment Funds, ComFIT Guidelines.	Information may be inaccessible to potential investors, power producers, and stakeholders.	More information on how to engage and negotiate investments and partnerships, especially for smaller projects and project developers would be useful.
<b>Monitoring and Assessment</b>			
<b>Methodology for and timing of socioeconomic impact studies</b>	Fundy SEA has identified gaps in data and methodology. Currently, developments post Fundy SEA need to undergo site specific Environmental Assessments. Environmental	No specific process identified. Numerous gaps in data and no clear methodological standards identified.	Review in Nova Scotia practices and reports completed by provincial Departments and other agencies across Nova Scotia that have

	Assessments may leave socioeconomic impacts unaccounted for.		completed socioeconomic studies and select best approaches.
<b>Supply Chain and Infrastructure</b>			
<b>Transparent and fair access to electricity transmission infrastructure.</b>	<p>A Renewable Electricity Administrator to manage independent power producer competitions for medium and large-scale renewable electricity projects.</p> <p>Currently any producers over 100kW are subject to costs associated with:</p> <ul style="list-style-type: none"> <li>• Required studies,</li> <li>• Customer's interconnection facilities,</li> <li>• Nova Scotia Power Incorporated interconnection facilities, and</li> <li>• Distribution system upgrades.</li> </ul> <p>Nova Scotia Power Incorporated controls technical approval to connection to the electricity distribution network.</p>	Connections have not been mapped and overlaid with tidal resources and tidal access points. Also, some concern remains around how decisions around how ComFIT type projects will be affected by Nova Scotia Power Incorporated's control of interconnections.	Utilize available data to assess the location of current interconnection capacity and access points relative to tidal resources and access points to determine future strategic investments in grid connection infrastructure. Investigate the current standards outlined in the Power Purchase Agreement with Nova Scotia Power Incorporated to see if they are fair and feasible for different project scales.
<b>Marine and terrestrial short, medium and long term infrastructure needs identified</b>	Marine Renewable Energy Infrastructure Assessment.	Impacts of tidal energy industry on terrestrial transportation and	Infrastructure requirements should be reviewed regularly.

		potential infrastructure upgrades are largely unknown.	Information on planned infrastructure improvements and expansions should be available to project developers.
<b>Self-sustaining industry training in place</b>	Apprenticeship training and employer incentives available through the Department of Labour and Advanced Education for trades. Support for professional program is unknown.	No current industry specific training or financial supports for trades and professions.	Assess industry trade and professional needs and begin program, supports and curriculum development with the Nova Scotia Community College, universities and industry players as needed.
<b>Community Support and Participation .</b>			
<b>Standards of practice for public participation for project and industry development</b>	ComFIT proponents are expected to engage with the Mi'kmaq community in Nova Scotia as per Section 24(f) of the <i>Renewable Electricity Regulations</i> .	Detailed guidelines for public participation, specific to Nova Scotia for renewable energy are unknown.	Review best practices in renewable project development and other industries. Develop standards as required.
<b>Compensation mechanisms in place</b>	Fundy Strategic Environmental Assessment – recommended developing compensation protocol.	No known parameters.	Define who, how, and under what circumstances compensation should be allocated.
<b>Community Development Resources available</b>	ComFIT Guide developed.	Outside of the ComFIT Guide, few community resources are available specifically for TISEC.	Identify key informational needs for small (and large) scale independent power producers and community-based groups, and develop decision

			making and project development tools.
<b>Analytical Tools Requisite Data and Research</b>			
<b>Knowledge transfer among developers, researchers and public is regulated and encouraged</b>	<ul style="list-style-type: none"> <li>• Recommendations in Fundy SEA and Marine Renewable Energy Legislation.</li> <li>• A Consultative Process to establish a system of knowledge transfer.</li> <li>• MOU signed between Nova Scotia and the state of Maine.</li> <li>• Research agreement signed between Fundy Ocean Research Center for Energy and the European Marine Energy Centre.</li> </ul>	Research collaboration and sharing agreements are in place between governments and research bodies. No official process to share knowledge gained through project assessments and demonstration projects.	Follow up recommendations from the Fundy SEA and the Marine Renewable Energy Legislation to develop a system of knowledge transfer that respects the intellectual property rights of TISEC developers.
<b>Defining, locating or creating required data for socioeconomic research</b>	<ul style="list-style-type: none"> <li>• Creation of FERN Socioeconomic subcommittee</li> <li>• FERN Socioeconomic Scoping Study.</li> <li>• Fundy SEA.</li> <li>• Marine Renewable Energy Legislation: A Consultative Process.</li> </ul> <p>All these reports raised questions about availability of information for socioeconomic analysis.</p>	Requirements still largely unknown.	Review socioeconomic data needs and compare to currently available data.
<b>Establish short, medium and long-</b>	Key local research bodies:	Many recommendations	Create a research plan that

<b>term research goals and the organizations/institutions/departments to undertake them.</b>	<ul style="list-style-type: none"> <li>• Fundy Energy Research Network,</li> <li>• Offshore Energy Technical Research Association,</li> <li>• Offshore Energy Environmental Research Association,</li> <li>• Fundy Ocean Research Centre for Energy.</li> </ul>	have been made within Nova Scotia on what should be included in a research plan for TISEC, but no specific targets or plans have been defined as of yet.	provides targets that complement government and industry plans and actions for TISEC development. Define budgets, timelines and specific bodies to undertake research
<b>Engage coastal research organizations beyond those dealing primarily with Marine Renewables</b>	<ul style="list-style-type: none"> <li>• Provincial Oceans Network,</li> <li>• Coastal Communities Network,</li> <li>• Coastal CURA (Communities Managing Coasts ,</li> <li>• Bay of Fundy Ecosystem Partnership,</li> <li>• Ecology Action Centre.</li> </ul>	Several research bodies working in this area in Nova Scotia – the only gap is for TISEC.	Build upon knowledge and action based research already conducted in coastal Nova Scotian communities and involve current organizations active in coastal research and management.
<b>Socioeconomic Impacts</b>			
<b>Mitigation of negative impacts on low and medium income persons due to increases in energy costs</b>	Nova Scotia Poverty Reduction Strategy.	Strategy does not directly address energy costs.	Research socioeconomic impacts of TISEC (and potential increase in energy costs) on low and medium income persons
<b>Other Issues</b>			
<b>Adopt Occupational Health and Safety Standards</b>	Occupational Health and Safety for Offshore Oil and Gas developed	Unknown whether this is sufficient for TISEC.	Review practices in other jurisdictions for tidal and



	and in use.		adapt current standards as necessary.
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## 5 Discussion

### 5.1 Recommendations and Potential Actions

In order to reach many of the goals outlined in the gap analysis, additional research and work needs to be completed. Numerous academic and professional reports have identified a wide range of actions, research areas, and policy initiatives that could support rapid diffusion of TISEC and marine renewable technologies, to support socioeconomic benefits. Following from the gap analysis, below is a collection of these recommendations and actions that are pertinent to the Nova Scotia context, based on both Nova Scotia and international research.

Table 12: Recommendations and Potential Actions

<b><i>Priority/Recommendation</i></b>	<b><i>Report Citation</i></b>
<b>Development of a Strategic Plan for Tidal Energy</b>	<p>Fournier, R.O. (2011). Marine Renewable Energy Legislation: A Consultative Process.</p> <p>Carbon Trust. (2011). Accelerating marine energy: The potential for cost reduction – insights from the Carbon Trust Marine Energy Accelerator.</p> <p>Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.</p>
<b>Improve cooperation across provincial departments and other levels of government</b>	<p>Government of Nova Scotia (2011). Draft Coastal Strategy.</p> <p>Ryan, C. (2009). Workshop on Economic Opportunities, Challenges and Actions of Marine Renewable Energy: Final Report, Thackeray Consulting for Nova Scotia Department of Energy, 21 pgs.</p> <p>Electric Power Research Institute. (2008). Prioritized Research Development, Deployment and Demonstration Needs: Marine and Other Hydro Kinetic Renewable Energy.</p>
<b>Define jurisdictional boundaries and commercial rights</b>	<p>Nova Scotia Department of Energy. (2010). Marine Renewable Energy Legislation for Nova Scotia Policy Background Paper.</p>

	Offshore Energy Environmental Research Association. (2008). Fundy tidal energy strategic environmental assessment: final report. Prepared for NS Department of Energy.
<b>Investigate whether it is possible to provide any additional financial mechanisms, in particular for device testing and installation.</b>	Carbon Trust. (2011). Accelerating marine energy: The potential for cost reduction – insights from the Carbon Trust Marine Energy Accelerator.  Renewable UK and SeaPower. (2011). Sea Power: Funding the Marine Energy Industry 2011-2015.  Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.
<b>Reduction of redundancies between federal and provincial legislation</b>	Fournier, (2011). Marine Renewable Energy Legislation: A Consultative Process.  Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.
<b>Supply chain, skills inventory and labour availability assessment</b>	SLR – Environmental Consultants (2010). FINAL REPORT Renewable Energy Opportunities and Competitiveness Assessment Study, For: NS Department of Energy, Business and Technology Division.  Ryan, C. (2009). Workshop on Economic Opportunities, Challenges and Actions of Marine Renewable Energy: Final Report, Thackeray Consulting for Nova Scotia Department of Energy.  Electric Power Research Institute (2008) Prioritized Research Development, Deployment and Demonstration Needs: Marine and Other Hydro Kinetic Renewable Energy.  Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.  FREDS – Marine Energy Group (MEG) (2009) Marine Energy Road Map.
<b>Create a public education and outreach plan</b>	Robert O. Fournier (2011). Marine Renewable Energy Legislation: A

	<p>Consultative Process.</p> <p>Mott MacDonald (2011). Accelerating the deployment of offshore renewable energy technologies: final report.</p> <p>FREDS – Marine Energy Group (MEG) (2009) Marine Energy Road Map.</p>
<b>Create standards of practice for public participation</b>	<p>Robert O. Fournier (2011). Marine Renewable Energy Legislation: A Consultative Process.</p> <p>EquiMar. (2011c). Deliverable D5.8: Impacts upon marine energy stakeholders.</p> <p>BWEA. (2002). Best practices guidelines: Consultation for offshore wind energy developments. British Wind Energy Association, Renewable Energy House, London.</p>
<b>Continue to streamline permitting process based on applicant feedback</b>	<p>Robert O. Fournier (2011). Marine Renewable Energy Legislation: A Consultative Process</p> <p>Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.</p>
<b>Review interconnection to grid process, to ensure that it is clear and fair and does not present any exceptional risk to developers (small or large)</b>	<p>Ecofys International BV - David de Jager and Max Rathmann (2008). Policy instrument design to reduce financing costs in renewable energy technology projects.</p> <p>Adams, M., and Wheeler, D. (2009). Stakeholder Consultation Process for a New Renewables Energy Strategy for Nova Scotia: Final Report to the Government of Nova Scotia.</p> <p>Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.</p>
<b>Investigate future grid infrastructure upgrades</b>	<p>FREDS – Marine Energy Group (MEG) (2009). Marine Energy Road Map.</p>
<b>Define budgetary allocations from government for desktop and action based research/device testing research</b>	<p>Electric Power Research Institute (2008). Prioritized Research Development, Deployment and Demonstration Needs: Marine and Other Hydro Kinetic Renewable Energy.</p>

	FREDS – Marine Energy Group (MEG) (2009). Marine Energy Road Map.
<b>Create mechanism to provide for the transfer of information about tidal energy projects and define how and what type of information will be shared with the public, industry and other developers to encourage learning rates</b>	<p>Offshore Energy Environmental Research Association. (2008). Fundy tidal energy strategic environmental assessment: final report. Prepared for NS Department of Energy</p> <p>SQWenergy. (2010). Economic study for ocean energy development in Ireland: a report to sustainable energy authority Ireland and Invest Northern Ireland.</p> <p>Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.</p>
<b>Provide information and tools to assist communities in developing TISEC and to manage coastal issues themselves.</b>	<p>Adams, M., and Wheeler, D. (2009). Stakeholder Consultation Process for a New Renewables Energy Strategy for Nova Scotia: Final Report to the Government of Nova Scotia.</p> <p>Government of Nova Scotia (2011) Draft Coastal Strategy.</p>
<b>Ensure compatibility of Marine Renewable Energy plans with plans within other departments and levels of government</b>	<p>Carbon Trust (2011). Accelerating marine energy: The potential for cost reduction – insights from the Carbon Trust Marine Energy Accelerator.</p> <p>FREDS – Marine Energy Group (MEG) (2009) Marine Energy Road Map.</p>
<b>Develop local marine spatial plans, including guidelines, and if necessary training</b>	<p>Tym and Partners (2011) Marine Management Organisation : Maximising the socioeconomic benefits of marine planning for English coastal communities.</p> <p>FREDS – Marine Energy Group (MEG) (2009). Marine Energy Road Map.</p>
<b>Socioeconomic profile and SWOT assessment of community capacity for tidal energy development (Capacity assessment of small, large or array systems)</b>	<p>Collective Wisdom Solutions, Services Inc., Maritime Tidal Energy Corp (2011) Marine Renewable Energy Infrastructure Assessment.</p> <p>Tym and Partners (2011). Marine Management Organisation Maximising the socioeconomic benefits of marine planning for English coastal communities.</p>

<b>Establish mechanisms to ensure Strategic Environmental Assessments are revisited when needed.</b>	Nova Scotia Department of Energy (2010). Marine Renewable Energy Legislation for Nova Scotia Policy Background Paper.
<b>Define what, how, to whom, under what circumstances compensation from TISEC projects will be provided</b>	Offshore Energy Environmental Research Association. (2008). Fundy tidal energy strategic environmental assessment: final report. Prepared for NS Department of Energy.  Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.
<b>Understanding household impacts (in particular for low income households) of FIT programs and what if any support programs should be put in place.</b>	Adams, M., and Wheeler, D. (2009). Stakeholder Consultation Process for a New Renewables Energy Strategy for Nova Scotia: Final Report to the Government of Nova Scotia  Nova Scotia Sustainable Electricity Alliance (2010). Discussion Paper: Key Policy Elements for Nova Scotia to Achieve Stable and Equitable Renewable Electricity Growth.  Mott MacDonald. (2011). Accelerating the deployment of offshore renewable energy technologies: final report.

## 5.2 Opportunities and Barriers

The development of the TISEC industry in Nova Scotia as identified in the gap analysis has already made progress and has important features such as the Feed-in-Tariff for tidal arrays, ComFIT and Fundy Strategic Environmental Assessment in place. However, not all facets of the industry will or can be addressed currently. Table 13 identifies some opportunities and barriers present in Nova Scotia that may affect the growth of TISEC in Nova Scotia. The table does not include technical or environmental opportunities and barriers as this is beyond the scope of this thesis. The table is by no means comprehensive as many unknowns remain regarding TISEC and its impact on the socioeconomic landscape of Nova Scotia.

*Table 13: Opportunities and Barriers to TISEC development*

<b>OPPORTUNITIES</b>	<b>BARRIERS</b>
<p>The provincial government has demonstrated commitment to TISEC through the development of the:</p> <ul style="list-style-type: none"> <li>• FIT for developmental tidal arrays,</li> <li>• COMFIT and a commitment to have 100MW of renewable energy by 2015,</li> <li>• Facilitation support to help communities who want to better understand the “technical, financial and regulatory work needed to develop these projects” (NS Department of Energy, 2010, p.2),</li> <li>• The “appointment of a renewable electricity administrator to oversee independent power-producer competitions for medium- and large-scale renewable-electricity projects”(NS Legislature, 2010, website),</li> <li>• A review in 2012 to determine whether the regulations set out for COMFIT’s are appropriately supporting the target of reaching 25% renewable electricity supply by 2015.</li> </ul>	<p>Municipalities may have difficulty with COMFITs as they have to own 100% of the project to qualify. Given infrastructure deficits across the province, this situation is unlikely to change dramatically within the next few years.</p> <p>Other entities may have difficulty raising capital necessary to develop TISEC projects.</p>
<p>As identified in several documents, there is ample research and development capacity in Nova Scotia. However, lacking is a more comprehensive understanding of the specific areas like socioeconomic opportunities and challenges.</p>	<p>Knowledge sharing, especially regarding technical and engineering data may be problematic, especially in instances where intellectual property is an issue.</p>
<p>MOU signed with the State of Maine and the agreement between the European Marine Energy Centre and the Fundy Ocean Research Centre for Energy could result in much more rapid learning rates and the solving of key technical questions and other research issues.</p>	<p>Coordination across government departments, internally or externally, can require much time and effort.</p>
<p>Nearly all reports on developing marine renewable energy in Nova Scotia have identified jurisdictional rights as an issue and have proposed tools such as Marine Spatial Planning as a way to deal with this issue.</p>	<p>Jurisdictional boundaries and commercial rights are still unclear.</p>
<p>Recent naval ship contract awarded to Irving Shipyards could result in an influx of new</p>	<p>Ageing of the population and outmigration may create a tight labour market, and with</p>

workers to the area to mitigate labour shortages.	the recent naval ship building contract to Irving Shipyards there may be competition for key skills and trades.
	Access to onshore converters is not uniform throughout Nova Scotia or the Bay of Fundy, and the cost to access the grid can increase project costs substantially. Nova Scotia Power holds the power to provide technical approval for projects over 100kW, this should be investigated in terms of its impact on fair treatment of projects.

## 5.3 Research Priorities

Identifying research priorities at this stage of TISEC development is both essential and problematic. It is essential because as the Marine Renewable Energy Legislation: A Consultative Process (2011) points out, it is important to have a coordinated approach to research in order to avoid redundancies and to facilitate faster industry development. It is problematic because many unknowns remain, such as the feasibility of certain devices, the capacity and coordination within Nova Scotia's supply chain and the level of future investment and interest in TISEC-outside of government. Table 14 highlights several potential research priorities on socioeconomic issues associated with TISEC.

*Table 14: Suggested research priorities for TISEC development.*

<b>Research Priorities</b>	
<b>1</b>	Development of a Strategic Plan, which addresses research capacities and short, medium and long term research needs.
<b>2</b>	Review policy and legislation that may limit or block adaptive management, MSP, and ICZM in the Bay of Fundy.
<b>3</b>	Consult with Bay of Fundy users and map both spatially and temporally critical sites for user groups (e.g. traditional and commercial fishing places and seasons, high tourism sites, etc.).
<b>4</b>	Establish benchmarks for evaluating socioeconomic impacts of TISEC on coastal communities.
<b>5</b>	Collect information from current TISEC developers and their input (component parts) and service suppliers (installation, transport) regarding : a) current and projected labour and skills needs, b) production capacity and flexibility (is TISEC their primary activity?) and c) knowledge of local, regional and provincial supply chain – this should be compared to what is currently present in terms of skills inventory and labour availability, and what can be made available through current post-secondary and other programs.
<b>6</b>	Identify data and skills needed to implement a MSP for the Bay of Fundy.



<b>7</b>	Identify legislative, capacity and other barriers to community based investment and development of TISEC projects and develop appropriate information packages and tools to address these barriers.
<b>8</b>	Explore synergistic relationships between current, planned and future users (e.g. off season fishers providing back up and support roles for TISEC installation, operations and maintenance).
<b>9</b>	SWOT assessment of community capacity for tidal energy development (i.e. capacity assessment of small, large or array systems) to identify potential key development sites.
<b>10</b>	Research the relationship between Feed-In-Tariff programs, energy conservation and management programs and the socioeconomic impacts on energy costs to consumers – in particular low and medium income persons.

## 6 Conclusions

This thesis explores socioeconomic issues and opportunities of TISEC development in Nova Scotia and abroad. Despite the diversity in the legislative, geographic, and economic contexts of regions undertaking TISEC development, several key issues are common throughout, including the need for:

- Creating strategic plans that provide useful guidance on how to pursue TISEC industry development;
- Removing unnecessary barriers related to permitting and approval mechanisms and processes;
- Understanding supply chain sectors and capacity;
- Developing and fostering financial models that allow for TISEC deployment at various scales;
- Ensuring socioeconomic research on the impacts of TISECs is coordinated and funded,
- Allowing public based input and community buy-in to renewable energy projects; and
- Creating contexts that allow for substantial and sustainable community benefits.

Nova Scotia has demonstrated that it has paid attention to what has worked well in other jurisdictions, as evidenced in the policies and mechanisms that have been put in place to date. However, many issues still need to be better understood. Key areas recommended for research activity include:

- Strategic Planning;
- Coastal and user conflict management;
- Supply chain, technology and workforce development;
- Financial and investment models; and
- Community scale research on the impacts and potential of TISEC development.

This is by no means a complete list of all research and actions that need to be taken based on the gap analysis and the recommendations identified in other reports. These priorities

do, however, represent foundational work that needs to be completed. Some of these priorities are primarily desktop based research, while others will entail action and community-based research. In order to facilitate timely and durable socioeconomic benefits, a coordinated approach to research is essential. As MRE develops in Nova Scotia and on an international level, more information will become available on what can be expected from TISEC and other MRE technologies. As new information becomes available, research priorities should be amended to build upon new findings.

As demonstrated and discussed throughout this thesis, the socioeconomic issues and opportunities of TISEC development are diverse and far-reaching, affecting multiple jurisdictions, industries, and communities. In order to best develop this nascent industry, integrated planning and management schemes should be incorporated into an overarching strategic plan. This will help ensure that the industry is developed sustainably, incorporating economic, socio-cultural, and environmental factors into the development process, while working towards a secure and sustainable energy future for Nova Scotia.

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