BEACHHEAD MARKET SELECTION FOR A RENEWABLE ENERGY TECHNOLOGY COMPANY

by

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ABSTRACT

Company X is a young company specializing in ocean renewable energy. Their technology involves converting ocean energy into energy used for generating electricity or pumping water, among other applications. Company X is entering undeveloped markets where there are no commercially proven technologies. Hence, market selection for launching their first product is integral to the success of their technology and their business.

This report evaluates five markets identified by Company X as having potential as a strategic first market, or beachhead market. A strategic market selection process, utilizing the balanced scorecard, is conducted to select those markets with most potential as a beachhead. From the balanced scorecard selection process, three markets were selected as having greater potential than the others. Further analysis of these three markets was conducted, to identify customer-preferred product features and assess issues related to technology adoption. From this analysis, recommendations are made for Company X's market strategy.

This research project is dedicated to my soon-to-be wife Angie. I need to forever thank her for putting up with my "grumpiness" for two whole years during this MBA program. What was I thinking, going back to school in my mid-thirties! I would also like to dedicate this to my folks for raising me with the fundamental tools to stay focused and disciplined enough to achieve my goals.

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I would like to sincerely thank Company X's executive management team for providing me the opportunity to complete an interesting project in an exciting industry. The entire team at Company X are great visionaries with a promising technology and I wish them the best of luck. I would also like to thank the faculty and administration at Simon Fraser University for a high-quality education over the past two years. Particularly, Dr. Elicia Maine and Dr. Colleen Collins-Dodd for some valuable learning and helping me work through the details of this project.

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1 INTRODUCTION

Company X is a renewable energy technology company specializing in ocean renewable energy (ORE). Their technology involves converting ocean energy into energy that is useful to humankind, for applications such as driving electrical turbines or water pumps. The technology is extremely scaleable and can be used for a variety of applications, from producing utility-scale electrical power for a large community to pumping water through desalination equipment for an individual home. Producing electrical power and, to a slightly lesser degree, pumping ocean water for desalination are two applications discussed within the scope of this report.

Company X is a young company entering an undeveloped market. Both Company X and the ORE industry in general are at the research and development stage. There are currently no widespread commercially-viable ORE technologies. As such, with limited funding and resources, and unproven technology, the selection of a successful and strategic first market is integral to Company X's success.

This introduction section, Chapter 1, discusses the objectives and scope of the project, the key method of analysis, the definition of a beachhead market, general information about ORE, and some background information about incumbent technologies. Chapter 2 is an analysis of the potential beachhead market segments. Chapter 3 consists of the selection process for identifying the beachhead markets and a discussion of the selection results. Chapter 4 includes additional analysis of the top three selected beachhead markets. Chapter 5 presents the report conclusions, and Chapter 6 provides recommendations for Company X's sales and marketing strategy.

1.1 Objectives and Scope of Analysis

Choosing the best market(s) for launching Company X's first product is the overall objective and of integral importance to the company. There are no widespread commercially-viable ORE products yet in the world. Success in the first target market, or beachhead market, will allow Company X to prove their technology and provide a reference for subsequent markets. Ultimately, by gaining a first-mover advantage, Company X will be able to gain market share before competitors validate their technologies and enter the market.

This report consists of a market analysis of five market segments considered as potential markets for launching Company X's technology product. Through a selection process using the Balanced Scorecard method, the top three potential beachhead markets are identified. The top three market segments are further evaluated through identification of customer-preferred features and an analysis of technology adoption.

Methodologies used in this investigation include Kaplan and Norton's (1993, p.134) Balanced Scorecard and Rogers' Model of Adoption (Rogers, 1995). The balanced scorecard method is used to develop criteria to evaluate and select a short-list of potential beachhead markets. The Rogers' Model of Adoption is used to identify characteristics of the technology that may either facilitate or inhibit technology adoption in each market segment.

Information was collected by different methods, and through a number of sources. Primary data was collected through telephone interviews with possible customers and industry experts in each potential market, as well as through workshops held with the executive management team for Company X. The potential customers were interviewed about their market needs and product requirements. Workshops and interviews with the Company X executives were used mainly to develop the criteria used in market evaluation, complete the market selection process, and collect some industry and company information. Secondary data was collected from a variety of research databases and other public sources (see Reference List).

The two applications for Company X's technology that are discussed within the scope of this report include electricity power generation and seawater desalination. The electricity power generation is discussed as the more dominant application because the need for electricity is more ubiquitous. Seawater desalination is discussed to a lesser degree.

1.2 Method of Analysis – The Balanced Scorecard

The method used in this report for evaluating and selecting the short list of beachhead markets is Kaplan and Norton's (1993) Balanced Scorecard. This method is typically used in the business world for defining and communicating strategies and priorities throughout the organization (Grant, 1998, p.43). Extrapolating this method for Company X's purposes, it is useful for strategically evaluating and selecting priority markets. The scorecard method is useful, and is a good fit for an early-stage company like Company X, because it requires the organization to select critical indicators that help focus the strategic objectives of the beachhead market. Furthermore, based on the strategic objectives chosen, the scorecard identifies strategic measures (or criteria) that are used to compare the different markets being evaluated.

The balanced scorecard is based on four different perspectives from which to choose measures (Kaplan and Norton, 1993, p.134). These four perspectives represent components of a company's strategy and they include financial, customer, internal, and growth and learning. Strategic objectives are developed within each of the four perspectives. Once the strategic objectives are defined, specific strategic measures (or criteria) are developed that can quantitatively assess the strategic importance of each market. This method is more clearly presented in Section 3, where the balanced scorecard is used to evaluate the prospective beachhead markets.

1.3 A Beachhead Market

In general, a beachhead market can be defined as a strategic target market. The Merriam-Webster online dictionary defines beachhead as "a foothold", which can be further defined as "a position usable as a base for further advance" (Merriam-Webster Online, 2005). In addition, a beachhead market is a term that is much discussed by Geoffrey Moore in his book "Crossing the Chasm" (Moore, 2002). He uses the term in an analogy about WWII's D-Day to explain how a new technology product can gain a foothold in the mainstream market (Moore, 2002, pp. 63-87). The beachhead term, and the analogy for that matter, is relevant to Company X. The energy market can be considered very mainstream, and Company X's technology is trying to break into it and gain a foothold. This is the rationale for selecting the term "beachhead market" to describe the first market for Company X's ORE technology product.

Ultimately, the selected beachhead market for Company X is intended to establish a market presence and generate early revenues. The beachhead market should be a market where Company X's technology either delivers much better performance (i.e. cost, reliability) or makes something technically possible that wasn't before. It should also represent a market application that can be used as a reference by customers in subsequent markets.

1.4 Background on Ocean Renewable Energy[1]

The power of the ocean has long been considered an immense untapped energy resource. The ocean covers 70% of the earth and holds substantial energy in many forms, such as wave energy from the wind, tidal energy driven by the moon, and thermal energy from the sun. (Johnson, 2004, p.23). Harnessing this vast energy from the ocean could easily meet global electricity power demands.

[1] Specific information on Company X's technology is not included in this report, for confidentiality reasons. As a result, discussion about Company X's technology is purposefully ambiguous and simply described as an "ocean renewable energy source" for this report.

> "It has been estimated that if less than 0.1% of the renewable energy available within the oceans could be converted into electricity it would satisfy the present world demand for energy more than five times over." UK Marine Foresight Panel, 2000 (Stormy Weather, 2005).

Wave and tidal energy are two of the prominent sources of energy potential from the ocean. In terms of wave energy, it is estimated that up to 100 kilowatts (kW) of power is available for every 1m of wave front. Wave power densities are estimated at up to 17 MW of energy per mile of coastline off California's coast alone (Urban Ecology Australia, 2005). For tidal energy, water is nearly 1,000 times as dense as air "so you can get the same ocean energy from a machine much smaller than a wind turbine and much cheaper" (Johnson, 2004, p.23). A tidal turbine can generate huge amounts of power even at very slow rotation speeds. It is easy to imagine the efficiency advantages of a tidal turbine compared to a wind turbine. Furthermore, ocean energy is available in any coastal area twenty-four hours a day, seven days a week. This omnipresent availability provides huge advantages over other renewable energy sources such as solar and wind.

Although the potential for ORE is enormous and ORE research has been conducted for over two centuries, no widespread commercially viable technologies have yet been produced. The first techniques were patented by Girard & Son in 1799, and several hundred other patents have been filed since (Clement et al, 2002, pp.405-431). Clearly, the engineering involved in generating power from ocean energy has been neither simple nor cost-effective.

Interest in ORE technologies is quickly gaining in popularity. With world energy consumption estimated to rise significantly over the next few decades, fossil fuels becoming less available and more expensive, and with the increasing concerns over environmental pollution and climate change, there is rapidly increasing dependence on energy conservation and alternative energy production. At least 20 countries around the world are actively involved in research and development of ORE technologies, including Canada, USA, UK, Norway, Portugal, Australia, China, India, Israel, Japan, Mexico, Russia (Clement et al, 2002, pp.405-431). According to Clement et al, ORE is closer to commercial exploitation than ever before: performance of many techniques has improved substantially, different technologies have proven their abilities on a large scale, and a number of commercial plants are under construction in Europe, Australia, and Israel (Clement et al, 2002, p.405). The rate of growth for capital investment in ORE is forecast at upwards of 60% per year (Jones and Rowley, 2003, p.85).

Many countries have implemented policies to encourage the development of renewable energy. The UK committed to a target of 10% renewable energy by 2010 (Bellamy, 1999, p.132) along with specific funding for marine renewable energy (Cliff Funnell Associates, 2005, p.3). Such policies may have encouraged the recent flurry of development of a broad range of patents in ORE technologies. A quick search of the internet identifies many different technology designs all vying for the prize as the first widespread commercially-viable ORE product. In fact, there are over one thousand individual patented techniques worldwide.

1.5 Background on Incumbent Technologies

While ORE technologies will certainly not entirely replace currently-used power technologies, they have the potential to augment or supplement them in many markets. Some common incumbent power technologies that will be augmented by ORE include grid transmission infrastructure, diesel generators, and other renewable power technologies (including small hydroelectric, wind, photovoltaic solar, and hybrid systems). These incumbent technologies can be considered as competing with ORE because ORE technologies must be better in some attributes in order to gain adoption. A general understanding of these incumbent technologies is useful for comparison, and to provide context, thus a brief overview of each is given in this section. This is not a complete list of incumbent technologies, but it represents those that seem to be most common to the markets discussed in this report. Each overview includes a few common benefits and problems with the technology.

1.5.1 Grid Transmission Infrastructure

Transmission power grid infrastructure supplies the electrical power needs for much of the civilized world. The ultimate goal of grid infrastructure is to provide concentrated populations with less expensive, more reliable, and more convenient power than generating power individually or locally. Grid transmitted power benefits from the economies of scale gained from large power generation sources, the reliability gained from multiple and variable generation sources, and easy access for customers. Common problems with grid transmission infrastructure include power loss, the expense of initial construction, and ongoing maintenance. Examples of common benefits and common problems with grid power are included in **Table 1**.

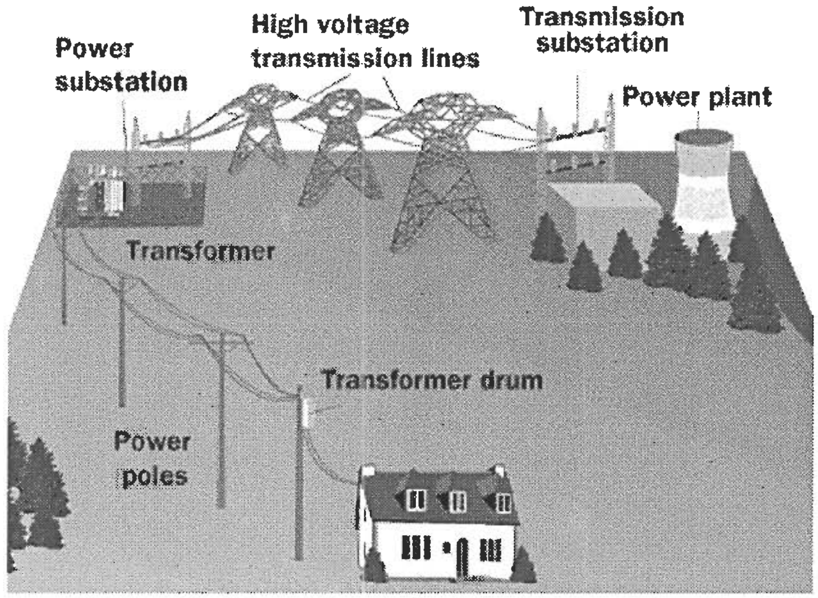
Table 1: Incumbent Technology Benefits and Problems – Grid Transmission Infrastructure

GRID TRANSMISSION INFRASTRUCTURE	
Common Benefits	**Common Problems**
Easy access if on or near the grid	Expensive to construct and maintain transmission line extensions to non-serviced areas (one estimate indicates that power delivery costs 50% more than power generation)
Generally less expensive than independent power generation	9% loss of power during power delivery (transmission)

Sources: Author, U.S. Department of Energy, 2005

A grid is made up of a series of electricity transmission lines that distribute electricity from power generation plants to end users (e.g. your house). Electrical power grids are generally fed by multiple power generation sources, which may include any combination of hydroelectric, gas turbine, diesel, coal, nuclear, renewables (wind turbines, solar PV, biomass, geothermal, etc.), or other sources. Power is distributed to individual homes and businesses via transmission power lines. Generally the power is inexpensive due to economies of scale. It is also usually reliable and easily scaled for varied power demand. **Figure 1** illustrates a power grid system with a single generation source.

Figure 1: Electricity Transmission Grid System



Source: How Stuff Works, 2005, by permission

1.5.2 Diesel Generators

Diesel generators have been used for generating power for more than a century. In fact, Rudolph Diesel first patented the diesel engine in 1893 (Alper, 1990, p.4). Since then, innovations have improved the diesel engine to a much more efficient and reliable technology. Therefore, diesel power is a very proven technology. Diesel generators are capable of generating power at all different scales, from a small generator to power a drill in the workshop to a large multi-megawatt utility-scale generator for a town or city. Diesel generators are probably the most common source of electrical power for distributed (off-grid) power needs.

The lifecycle of a diesel power generator varies greatly depending on a myriad of factors including design, quality, maintenance, usage. The general rule is that a well-maintained diesel generator will last up to 20 years.[2] A few common benefits of diesel power generators are their proven reliability, relatively inexpensive capital costs, and ubiquity. Common problems with diesel generators tend to be mainly associated with fossil fuel use. See **Table 2** for a more extensive list of benefits and problems with diesel generated power.

Table 2: Incumbent Technology Benefits and Problems – Diesel Generators

DIESEL GENERATORS	
Common Benefits	**Common Problems**
Proven technology	Combustible fuel risk (fire risk)
Common and ubiquitous, thus easily understood and familiar to most people	Fuel storage and transport
Reliable	High operation costs (ever increasing cost of diesel fuel and oil)
Portable and fixed designs	Noise
Inexpensive capital cost, relative to other technologies (e.g. extending grid transmission lines)	Environmental impact (GHG emissions, fuel spills)
Appropriate for both large and small applications	Dirty maintenance

Sources: interviews from Chapter 2, author

Diesel fuel is the most prevalent liquid petroleum fuel for generators that would compete with ORE; however, there are other petroleum fuels that are used in competing power generators. Other petroleum fuels include gasoline and bunker fuel. Generators employing other petroleum-based fuels are very similar to diesel generators and reflect similar benefits and problems as those listed above. For ease of discussion in this report, generators employing other liquid petroleum fuels are referred to as diesel generators.

1.5.3 Other Renewable Power Technologies

Many other types of renewable power technologies are being used in markets that could support ORE. Common types of renewable power technologies include small hydroelectric,

[2] Interview with Karl Brothers, Owner, Frontier Power Systems; June 3, 2005

wind, photovoltaic solar, and hybrid systems. Other less common renewable technologies are available but are not discussed here.

1.5.3.1 Small Hydroelectric

Hydroelectric technologies have been used by humans for meeting power needs for centuries. In fact, this renewable source of power, captured by converting the mechanical energy of falling water, was used by the Greeks more than 2,000 years ago. The Greeks used falling water to turn water wheels for grinding wheat into flour. By the 1700s, hydropower was widely used for milling and pumping applications (Green Nature, 2005). Today, hydropower of both large and small-scale is used around the world, generating a total capacity of over 67,121MW (Natural Resources Canada, 2005).

Large-scale hydroelectric plants, such as the Hoover Dam in the United States or the W.A.C. Bennett Dam in Canada, are most commonly known to the public. Large-scale hydropower is used for generating power to the transmission grid for wide-area power distribution. Roughly one tenth of all power generated in the United States is from hydropower, mostly from large-scale hydro plants (Green Nature, 2005).

Less common, but increasing in popularity, are small-scale hydroelectric technologies. These technologies can take advantage of smaller water flows in more rugged regions, where less elaborate civil engineering works are required (i.e. low dams or no dams) (Natural Resources Canada, 2005). Small-scale hydro systems are sometimes called "run-of-river" hydro because there are few alterations to the natural river. Small-scale hydropower includes small, mini, and micro hydro technologies, as defined in **Table 3**. For the markets discussed later in this report, small-scale hydropower systems (mini and micro hydro technologies), rather than large-scale hydro facilities, are likely to be augmented or replaced by ORE technologies.

Table 3: Small-Scale Hydroelectric - Definitions

Size of Hydroelectric Facility	Power Output
Small	1 MW to 30 MW – typical NUG development and low end of range for supply to a regional or provincial power grid
Mini	100 kW to 1 MW – typical supply for a small factory or isolated community
Micro	100 kW or less – typical supply for one or two houses

Source: Natural Resources Canada, 2005

Some common benefits of small-scale hydroelectric power include lack of environmental pollution, its low operating costs (no fuel), and its ability to generate variable capacity to meet varying demand. Common problems with small-scale hydroelectric include its lack of scalability, lack of mobility, and seasonal variations in power output. **Table 4** provides more detail on common benefits and problems.

Table 4: Incumbent Technology Benefits and Problems – Small Hydroelectric

SMALL HYDROELECTRIC	
Common Benefits	**Common Problems**
Hydroelectric energy is a continuously renewable energy source	Not easily scalable - there is always a maximum useful power output available from a given hydropower site
Small hydro is one of the most environmentally benign forms of energy available; it does not pollute - no heat or GHG emissions are released	It is a site specific technology and appropriate sites are not typically near to locations where the power can be economically exploited
Hydroelectric energy has no fuel cost and low operating and maintenance costs; it is essentially inflation proof	River flows can vary considerably with the seasons, especially where there are monsoon-type climates; this can limit the designed power output to quite a small fraction of the possible peak output
Hydroelectric energy is a proven technology that is reliable and flexible	Dams, even small ones, present migratory barriers
Hydroelectric stations have a long life; many existing stations have been in operation for more than fifty years and are still operating efficiently	Fish can be killed in the turbines
Hydropower can achieve efficiencies of over 90% making it the most efficient of energy conversion technologies	
Hydropower offers quick response to changes in load demand	

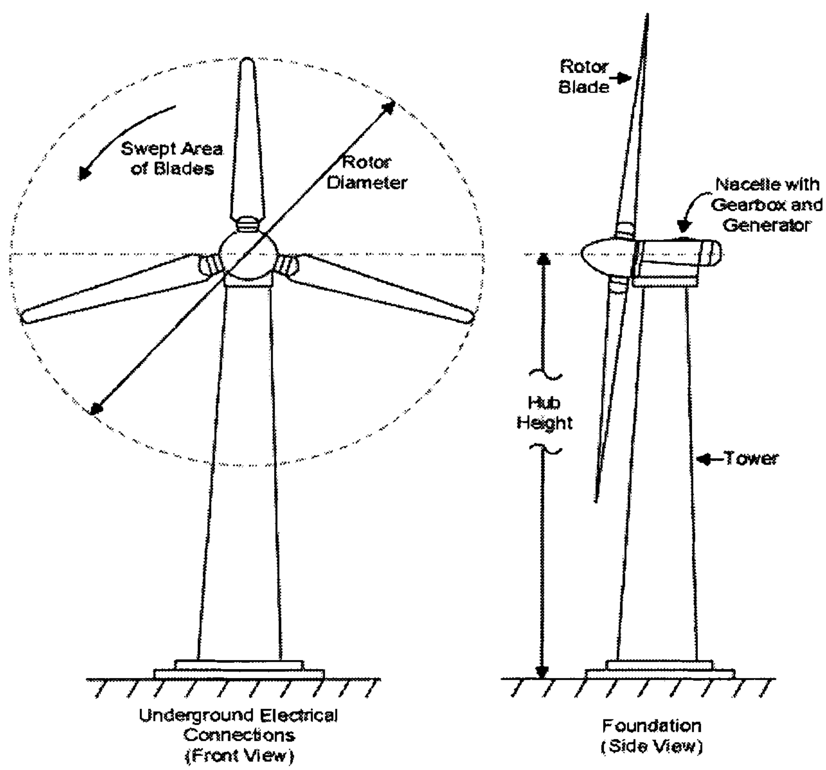
Sources: International Small-Hydro Atlas, 2005; Micro Hydropower Basics, 2005

1.5.3.2 Wind Turbine

Wind has been used for power since very early times. It has been used by many cultures for thousands of years to power ships and boats, and the Persians used wind energy to pump water at least two thousand years ago (Natural Resources Canada, 2005). Wind mills have been in existence since at least 200 B.C. for milling grain and pumping water (U.S. Department of Energy, 2004). The more recent interest in wind energy, with wind turbines, was spurred on by the need for clean and sustainable energy systems that can be relied on well into the future (Natural Resources Canada, 2005).

The modern form of wind energy technology is engineered wind turbines (see **Figure 2**). Wind turbines convert kinetic energy from the wind into more useful mechanical energy or electricity. They capture energy from the wind usually with either two or three propeller blades. The blades are mounted on a rotor that spins to generate electricity. The turbines sit on top of high towers, usually 30m or more above the ground, to take advantage of stronger and more consistent winds. Turbines can operate individually or a large number can be built close to each other (a wind farm) to operate on a utility scale (U.S. Department of Energy, 2004).

Figure 2: Typical Wind Turbine



Source: RETScreen, 2005, by permission

The wind turbine industry has reached more mature status over the past 15 or 20 years (RETScreen, 2005). The use of wind turbines is becoming more and more common (Natural Resources Canada, 2005). There was a 20% increase in global installed generating capacity in 2004 of 7,976MW, raising the global installed capacity to 47,317MW (Global Wind Energy

Council, 2005). This increased demand is largely due to improved engineering and cost efficiencies. In fact, the U.S. Department of Energy suggests that the cost of generating energy from wind has decreased by 85% since the mid-1980s (U.S. Department of Energy, 2004).

Some common benefits with wind turbine power generation include the lack of environmental impact, space-efficiency, and low maintenance. A few problems include high capital investment cost, intermittent power, and noise. A list of common benefits and problems is presented in **Table 5**.

Table 5: Incumbent Technology Benefits and Problems – Wind Turbine

WIND TURBINE	
Common Benefits	**Common Problems**
Pollution-free and infinitely sustainable form of energy	Wind power technology requires a higher initial investment than petroleum-fueled generators. Wind power may or may not compete with conventional generation sources on a cost basis.
No significant hazard to wildlife	Wind is intermittent and does not always blow when electricity is required, and wind energy cannot be stored unless batteries are used
Wind farms installed on farmland only require about 2% of the land area, the rest is available for farming, livestock, and other uses	Sites with appropriate wind supply are often located in remote locations, far from communities where the electricity is needed
Landowners who host wind turbines often receive payment for the use of their land	Some noise is produced by the rotor blades
Low cost renewable energy - It is one of the lowest-priced renewable energy technologies available, costing between US$0.04 and $0.06 per kWh, depending upon the wind resource and project financing	Establishment of wind power systems may compete with other uses for the land, which may be more highly valued than electricity generation
Low Maintenance - Wind turbines operate automatically and require little maintenance, thus can be left unattended for long periods	Aesthetic (visual) impacts
Simple and robust technology - resulting in life spans of greater than 15 years without major new equipment investments	Birds have been killed by flying into the rotors but this problem has been greatly reduced through technological development and proper siting

Sources: Natural Resources Canada, 2005; U.S. Department of Energy, 2004; Tele-Learning and Renewable Energy, 2005

1.5.3.3 Solar Photovoltaic

Solar energy simply involves harnessing the energy from the sun. Photovoltaic (PV) solar, in particular, converts the sun's energy directly into electricity using photovoltaic cells. PV solar cells are made of semi-conducting materials such as crystalline silicon, amorphous silicon, copper indium diselenide, among others. Each individual solar cell is small and produces only about 1 to 2 watts of power. To increase output, the cells are connected together into larger units called modules, and the modules can then be connected together into arrays to produce even more power (U.S. Department of Energy, 2004).

The photovoltaic effect was first discovered by French scientist Edmond Becquerel in 1839. Modern photovoltaic technology was born during the 1950s in the United States with a silicon solar cell that attained 6% efficiency. Current PV solar cell technologies have achieved greater than 30% efficiencies (U.S. Department of Energy, 2004).

The global installed capacity for solar PV by 2003 was nearly 2GW and increasing (International Energy Agency, 2004). World installations of PV cells reached 927MW in 2004, which represents growth of 62% over 2003 installations. Forecasts indicate that worldwide annual PV installation will reach 3.2GW by 2010, a threefold increase over 2004 market installations (Solarbuzz, 2005)

Common benefits with solar PV power include quick installation, scalability, and long operating life. A few common problems include higher cost, limited operating time, and power storage. See **Table 6** for a more detailed list of benefits and problems.

Table 6: Incumbent Technology Benefits and Problems – Solar Photovoltaic

SOLAR PHOTOVOLTAIC	
Common Benefits	**Common Problems**
Quick installation - Utility-scale PV plants can be built much more quickly than conventional fossil or nuclear power plants, because PV arrays are relatively easy to install and connect	Higher cost - PV-generated electricity still costs more than electricity generated by conventional plants in most places (using current utility accounting practices)
Utilities can build PV power plants where they're most needed in the grid, because siting PV arrays is usually much easier than siting a conventional power plant	Regulatory agencies require most utilities to supply the lowest-cost electricity
Easily scalable - PV installations are modular so can be expanded incrementally as demand increases	Limited operation - PV systems generate power only during daylight hours, and their output thus can vary with the weather
No fuel and no air or water pollution is produced, while they quietly generate reliable electricity	Battery storage is required if power is needed 24 hours
Inexpensive in the long-run - Energy from the sun is virtually free after the initial cost has been recovered, and the sun provides a virtually unlimited supply of solar energy	
Distributed power – no grid connection is required	
Solar modules live a long life; they are guaranteed for 25 years and require very low maintenance	

Sources: Natural Resources Canada, 2005; U.S. Department of Energy, 2004; interview with Dan Bue of Green Earth Alternatives; Tele-Learning and Renewable Energy, 2005

1.5.3.4 Hybrid Systems

Hybrid power systems utilize a combination of two or more power systems, including technologies such as those discussed in the previous sections. Typically, a hybrid system integrates a renewable system, such as a wind turbine or photovoltaic array, with a back-up diesel generator. Sometimes, the hybrid system may employ two renewable technologies, such as wind and solar PV. Hybrid systems are reliable and cost-effective methods of implementing renewable energy technologies, as alternatives to conventional methods of electricity generation.

A few common benefits and problems with hybrid systems are listed in **Table 7**. For specific benefits and problems related to the individual power technologies, see **Tables 2, 4, 5, and 6** in the previous sections.

Table 7: Incumbent Technology Benefits and Problems – Hybrid Power Systems

HYBRID POWER SYSTEMS	
Common Benefits	**Common Problems**
Greater reliability than using a single technology	High capital cost for investing in two or more systems
Lower environmental impact for systems integrating at least one renewable power source	

Source: author

2 MARKET SEGMENTS ANALYSIS

The following five market segments were selected by Company X as having potential for success as a beachhead market.[3] These five segments were selected from a longer list, based on discussions with Company X (see **Appendix A**). Chapter 2 includes an analysis of each of the five market segments selected. The analysis includes an overview of market characteristics, customer characteristics, incumbent power technologies commonly used in each market, and problems identified with those technologies.

Information for the analysis was collected from interviews with potential customers and industry experts from each market, as well as from the secondary sources referenced. In total, thirty-one interviews were conducted for these five market segments. An outline of the interview guide, with questions asked during interviews, is included in **Appendix B**.

2.1 Coastal Communities – Off-Grid

The off-grid coastal communities market segment can be defined as communities that are on or near the ocean and are responsible for generating their own power. The communities are not connected to regional power grid infrastructure. Power generated for such communities may be for either electricity or water desalination.

Interviews were conducted with a variety of potential customers and key people with knowledge of the off-grid coastal community market. Interview respondents included

[3] Source: a meeting May 22, 2005, and subsequent communications, with Company X's executive team.

representatives with Indian and Northern Affairs Canada (INAC),[4] First Nations' Emergency Services Society of Canada,[5] Kitasoo First Nation (Klemtu, BC),[6] Kerr Wood Leidel Associates,[7] Frontier Power Systems,[8] and Shetland Island Economic Development Unit.[9] Interviews focused on a few specific areas: the community of Kitasoo on the west coast of British Columbia; off-grid British Columbia west coast First Nations communities in general; Ramea, Newfoundland and other off-grid Canadian east coast communities in general; and islands off the west coast of Scotland. Both interview respondents and secondary sources are referenced where discussed.

Interviews for this market segment, and the other market segments, represent only a very small sampling of each overall potential market. The respondents' responses provide useful information for this report for market screening purpose only. Given the immense depth and breadth of this market segment, additional interviews would be useful in exploring sub-segments of the market.

2.1.1 Market Characteristics

In North America, Europe, and other countries in the more developed parts of the world, off-grid communities are typically small (less than 50 homes) and remote. In less developed nations, where transmission grid infrastructure is less ubiquitous, off-grid communities are more prevalent and may be much larger and less remote. An example of an off-grid coastal community in North America is Kitasoo, which is a First Nations' community just off the west coast of British Columbia, Canada near Prince Rupert. Some characteristics of the off-grid coastal

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[4] Paula Santos, Environmental Engineer, Public Works and Government Services Canada, for INAC; May 31, 2005
[5] Ananthan Suppiah, Environmental Engineer, First Nations' Emergency Services Society; May 30, 2005
[6] Chris McKnight, Community Maintenance and Power, Kitasoo First Nation; and Percy Starr, Band Manager and Chief Negotiator, Kitasoo First Nation; May 30, 2005
[7] Mike Dickens, Community Power Consultant, Kerr Wood Leidel Associates; May 30, 2005
[8] Karl Brothers, Owner, Frontier Power Systems; June 3, 2005
[9] Aaron Priest, Economic Development Unit, Shetland Island Council; June 13, 2005

communities market include: market location, market size, power demand, price of power, and water desalination.

2.1.1.1 Market Location

The location of the Coastal Communities – Off-Grid market is in communities that are near the ocean worldwide. Off-grid coastal communities may be considered adjacent to, or within a kilometer or two of the coast.

2.1.1.2 Market Size

The off-grid communities market is very large; it encompasses virtually any remote but inhabited region near an ocean. To consider islands alone, the market would include tens or hundreds of thousands of small but populated islands around the world. In fact, this market could and probably should be further segmented; however, this task must be completed as part of future work beyond the scope of this report. For example, off-grid communities could be segmented into different geographical regions, community sizes or types, or divided into product application (electricity generation or water desalination). Recommendations for further segmentation are discussed later in this document, in Chapter 6.

It is difficult to find accurate numbers on how many people live in coastal communities and have no access to grid power; however, it can be safely estimated that there are tens and possibly hundreds of millions across the globe. According to United Nations Environment Programme (UNEP) website, the worldwide coastal population in 2000 was roughly 950 million people (UNEP Geo-2000, 2005). In Canada, there are 302 remote communities, with a combined population of 200,000, that are not connected to a central electricity grid (Globe 2006 Conference Outline, 2005; and RETScreen, 2005). Many of these communities are adjacent to or near the ocean. In China, there are more than 76 million people living in 30,000 villages without any electrical power (World Energy Council, 2005). The same source states that there were over

140,000 small wind generators installed in off-grid locations in China by 1995, which implies that hundreds or thousands of off-grid communities in China purchase distributed renewable energy technologies.

For economic size of the market, assume the following conservative calculation: 50 million people at a median worldwide energy consumption of 4,980kWh per year (see **Table 8** below), times a conservative price of $0.20/kWh. The total estimated value of the market is $49.8 billion.

For trends in the number of off-grid communities, it may be assumed that the number is decreasing. In Canada, research indicates that the number of remote communities is decreasing due to ongoing grid extension (RETSreen, 2005). Similar grid extension efforts are assumed to be occurring in most other regions of the world.

2.1.1.3 Power Demand

Electricity demand for off-grid communities varies greatly across the world. For example, the average electricity consumption per person in Canada is 15,516 kWh per person per year (Nationmaster.com, 2005) In China, the average electricity consumption is 1,019 kWh per person per year. **Table 8** presents energy consumption data for the most and least energy consuming countries in the world, as well as the median consumption level.

Table 8: World Energy Consumption Data

Country	Energy Consumption (per capita)
Top 5 Energy Consuming Nations in the World	
1) Norway	25,205 kWh per person
2) Iceland	24,972 kWh per person
3) Canada	15,516 kWh per person
4) Finland	14,609 kWh per person
5) Luxembourg	13,119 kWh per person
Bottom 5 Energy Consuming Nations in the World	
1) Cyprus	0 kWh per person
2) Cambodia	8.27 kWh per person
3) Chad	9.16 kWh per person
4) Rwanda	17.60 kWh per person
5) Afghanistan	17.93 kWh per person
Median World Energy Consumption	**4,980 kWh per person**

Source: adapted from Nationmaster.com, 2005 (based on information from the CIA World Factbook, March 2005)

The demand for off-grid communities varies greatly as well, depending on the number of people, relative wealth of the community (i.e. how many appliances they use), industrial or recreational activities, etc). No information suggests whether off-grid individuals consume less or more power than the stated national averages for power consumption. However, electricity consumption in off-grid communities is assumed to be similar to that of the national averages.

Even in less developed regions where electricity is limited or unavailable, consumption is expected to be similar to the national average if power were to become available. Of course, the national averages of some less developed countries may actually increase if more affordable power supply was available. Such increased demand in less developed areas may occur in other markets, in addition to off-grid coastal communities.

2.1.1.4 Power Costs

Power costs also vary substantially for off-grid communities, from country to country and region to region. Costs largely depend on the generation technology utilized, its capital cost, and the cost of fuel. Some examples of electricity costs in off-grid communities include China, Fiji, and Canada. In China, the average price of diesel power generation for off-grid communities is $0.54[10] per kWh (World Energy Council, 2005). A study of off-grid villages in Fiji indicated the average cost for diesel power generation at $1.82 per kWh.

Costs vary widely for electricity in remote communities across Canada. For First Nations' communities in British Columbia, costs vary from an inexpensive $0.09 per kWh in Kitasoo (due to an efficient, small (600kW) hydroelectric plant)[11] to $0.35 to $0.40 or more for diesel generators at most other remote First Nations communities in British Columbia.[12] In other remote communities across Canada, power prices often exceed $0.40 per kWh. The most expensive power in Canada is reported to be $1.54 per kWh in the Northwest Territories in a RETScreen report from 1996/97 (RETScreen, 2005). It can be assumed that power costs for this area are even higher at today's diesel prices.

2.1.1.5 Fresh Water and Desalination

Sources of fresh water are highly variable in coastal communities. Fresh water sources may be surface water, ground water, rain water collection, or ocean water (desalinated).

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[10] Unless otherwise stated, all costs reported are in Canadian currency, based on the value of the Canadian dollar for currency conversion as of June 2005.
[11] Interview with Chris McKnight, Community Maintenance and Power, Kitasoo First Nation; May 30, 2005
[12] Interview with Paula Santos, Environmental Engineer, Public Works and Government Services Canada, for INAC; May 31, 2005

Desalination of ocean water is usually the most expensive option, chosen only when other fresh water alternatives are inappropriate (i.e. due to limited supply, contamination, or poor quality).

Off-grid community representatives contacted for this study did not identify a strong need for desalinated ocean water in their communities; however, desalination is an important source of fresh water for many communities in this off-grid market segment. Desalination is not so common in North America, but very common in other parts of the world where surface and ground water sources are limited or contaminated, such as the Middle East and Africa. The World Health Organization estimated in 2000 that 1.2 billion people around the world lack clean drinking water (Gleick et al, 2001, p.10). Even if only a fraction of these people live in off-grid communities near coastal regions, there are still millions and millions who could benefit from viable desalination technologies.

2.1.2 Customer Characteristics

Based on the interviews and other supporting information, some key customer characteristics were identified. They are discussed in the following sub-sections: identifying the customer, financial implications, and sophistication with renewable energy sources.

2.1.2.1 Identifying the Customer

Identifying the customer in the off-grid communities market is likely to be a difficult task. In general, off-grid communities are not as "plugged in" as urban and suburban communities so contacting people within the communities is not always easy. In addition, the decision makers for capital asset purchases in such communities tend to reside within governments at various levels. For example, in Canada many off-grid communities are First Nations villages. First Nations communities are generally governed internally or by a regional Tribal Council and are funded by the federal government. The customer (i.e. decision maker or economic buyer) may be within the community government, the federal government, a private partnership between the community and an independent company, or a consultant for any of the above or all of the above.

Third-parties, such as engineering consultants who represent communities in recommending or purchasing capital assets, can be a barrier in the process for acquiring power equipment in an off-grid community. Research indicates that third-party consultants are often barriers to adoption of innovative environmental technologies due to their negative view of regulatory barriers (Eggers, Villani & Andrews, 2000, p.274). They also perceive high regulatory barriers and high costs related to new environmental technologies. Consultants generally conduct feasibility studies with very small budgets, so usually recommend only proven conventional technologies.[13] The perception by consultants is that there is an expensive learning curve for accurately specifying, designing, and implementing new power technologies.

2.1.2.2 Financial Implications

A financial implication in this market includes government funding for capital projects. Capital funding is usually very limited for small communities, and typically comes from regional or federal government sources. Government funding agencies are risk-averse, thus new and unproven technologies are not usually supported.[14]

2.1.2.3 Sophistication with Renewable Energy

Most off-grid communities seem to employ diesel generators, based on interviews and various references cited throughout this report. Local operators in off-grid communities are thus most familiar with the operation of diesel generators. Interviews also indicate, though, that some off-grid communities are also familiar with the more common renewable energy sources such as solar PV and small wind turbines.

[13] Interview with Mike Dickens, Community Power Consultant, Kerr Wood Leidel Associates; May 30, 2005
[14] Interview with Karl Brothers, Owner, Frontier Power Systems; June 3, 2005

2.1.3 Incumbent Technologies

Power technologies commonly used in the Off-Grid Coastal Communities market include diesel generators, small hydro, wind turbine, and solar PV. A short discussion of findings about each is presented in the sub-sections.

The following discussion does not include efficiency of power generation capacity between the different technologies. The efficiency factor in generation leads to significant relative differences in overall lifecycle costs, and thus in advantages of one technology over another. Although this is an important consideration for Company X in pursuing the off-grid market (and all other markets), it would add an unnecessary level of complexity to the market selection process in Chapter 3. The lack of this information will not impact the conclusions of this study. Researching relative power generation efficiencies for the various incumbent technologies should be conducted as part of a subsequent study of lifecycle energy costs.

2.1.3.1 Diesel Generator

According to interview information and Natural Resources Canada's RETScreen database (RETScreen, 2005), diesel generators are most often used for supplying power to off-grid communities. The power capacity for generators in most west coast First Nations villages (20 – 60+ homes), is usually in the 250kW range. There is undoubtedly a wide variety of both smaller and larger generators used for power in other off-grid communities around the world; however, the 250kW order-of-magnitude is assumed to be common. Diesel generators were praised in interviews for their reliability and ubiquity; however, some problems were identified and are included in Section 2.1.4.

2.1.3.2 Small Hydroelectric

Although not likely common in off-grid communities, one small hydroelectric power system was identified during interviews. It is located at Kitasoo, BC. It is a 600kW system powered by dam-released water from a lake. The community is very happy with their hydroelectric system. The power is inexpensive ($0.09 per kWh) and reliable. The only complaints from the interview respondents were that access for maintenance is difficult and an expansion is needed to generate more power for the community. Estimated costs for replacing/expanding the system are $4.2 million.

2.1.3.3 Wind Turbine

Wind turbines seem to be gaining popularity in off-grid communities. Many interviewees had seriously considered wind as a power option. A hybrid wind/diesel system was recently installed by Frontier Power Systems in Ramea, an off-grid community in Newfoundland.[15] The wind turbine portion of the hybrid system is capable of generating roughly 600kW of power for the community. Mr. Brothers of Frontier Power Systems, suggested that the hybrid wind/diesel system has been successful but shared information on a few problems with a wind turbine installation. These problems are identified in **Table 9** in Section 2.1.4.

2.1.3.4 Solar PV

Photovoltaic solar, or solar PV, is commonly used as a distributed power source for off-grid communities around the world. An interview with a local supplier of solar PV equipment indicated that investment in solar PV technology by off-grid home-owners is quickly increasing in North America.[16] Other parts of the world, such as Europe and Japan, solar PV already represents a significant power source, as indicated in Chapter 1 (Section 1.5.3.3).

2.1.4 Problems Needing to be Solved

Some problems were identified with incumbent power systems in the coastal communities – off-grid market. Problems were identified specifically with diesel generators,

[15] From interview with Karl Brothers, Owner, Frontier Power Systems; June 3, 2005
[16] Dan Bue, Owner, Green Earth Alternatives; March 8, 2005

small hydroelectric, wind turbines, and solar PV. These problems are presented in **Table 9**, and are based on information from interviews only. For additional problems that may be more common to the individual technology, refer to the Background on Incumbent Technologies section in Chapter 1.

Table 9: Problems Needing to be Solved for Coastal Communities – Off-Grid

Problem Needing to be Solved	Comments
Diesel Generators - Environmental Impact	There is a widespread concern over environmental impacts from petroleum fuel use (both green house gas emissions and fuel spills).
Diesel Generators - Noise	Diesel generators can be noisy.
Diesel Generators - Operation and Maintenance	Operation and maintenance are difficult for inexperienced and unsophisticated users. In addition, operation and maintenance is dirty (exhaust and oil).
Diesel Generators - Reliability	Reliability can be poor if poorly maintained.
Small Hydroelectric - Scalability	Scalability is difficult and expensive.
Wind Turbine - Supply Issues	Smaller reliable wind turbines in the 600kW range are difficult to procure; many turbine manufacturers are concentrating on larger turbine designs in the 1MW to 5MW capacity
Wind Turbine - Economies of Scale	Economies of scale are difficult to achieve with smaller wind turbines.
Wind Turbine - Additional Common Problems	Intermittent operation due to wind supply.
Solar PV – Investment Cost	Up-front investment costs are high, relative to a portable diesel generator with equivalent power productivity.

Sources: interviews referenced in this section, author

2.2 Coastal Communities – Constrained and Non-Integrated

The Coastal Communities – Constrained and Non-Integrated market segment includes communities that are constrained by limited power infrastructure and communities that are not integrated with the main power grid system. The constrained communities are connected to a power grid but it is constrained by limited power generation capacity or distribution infrastructure. This market may also include communities with fresh water limitations, where desalination of ocean water may be an opportunity. Constrained communities may be any size. For example, the island nation of Fiji has a population of nearly one million people but its grid capacity is constrained due to insufficient generation capacity (PIRAP, 2004, pp.vii-x).

The non-integrated coastal communities are those that are not integrated with the main power grid and are supplied power by distributed generation sources, operated by the regional or local power agency or utility. Non-integrated communities are usually the size of a small town (i.e. less than 1,500 people). For example, Masset, BC is a non-integrated town with a population of about 1,200 people (Government of British Columbia, 2005). These communities are typically small and remote enough that costs are too high to extend the grid, but large enough so that power is supplied by the regional or local power agency or utility company.

Interviews were conducted with a variety of key people in the constrained and non-integrated coastal communities market. Respondents include representatives from: the Village of Masset, BC,[17] BC Hydro,[18] Indian and Northern Affairs Canada (INAC),[19] Frontier Power Systems (east coast of Canada),[20] the Shetland Island Council,[21] and Fiji Department of Energy.[22]

2.2.1 Market Characteristics

Specific market characteristics are discussed in the following subsections: market location, market size, power demand, price of power, and fresh water and desalination.

[17] Trevor Jarvis, Village Administrator, Village of Masset, BC; May 30, 2005
[18] Tom Gissell, Operations Manager, Non-Integrated Areas, BC Hydro; and Ben Sparrow, Construction Site Manager and Engineer, BC Hydro; July 7 and July 3, 2005
[19] Paula Santos, Environmental Engineer, Public Works and Government Services Canada, for INAC; May 31, 2005
[20] Karl Brothers, Owner, Frontier Power Systems; June 3, 2005
[21] Aaron Priest, Economic Development Unit, Shetland Island Council; June 13, 2005
[22] Iniyaz Khan, Senior Energy Analyst, Fiji Department of Energy; June 8, 2005

2.2.1.1 Market Location

The location of Coastal Communities – Constrained and Non-Integrated market encompasses any community, which meets the constrained or non-integrated criteria, that is located near the ocean. This description is somewhat ambiguous though, as an exact distance of a given community from the ocean varies based on that community's specific power infrastructure. The communities discussed in this study are typically adjacent to the ocean, but more inland communities may benefit from ORE technologies.

2.2.1.2 Market Size

Much like the off-grid communities market, the constrained and non-integrated market is very large. A clear quantification of the actual size of this market is difficult to ascertain. The number of people who live in constrained and non-integrated communities is difficult to calculate because definitions of constrained and non-integrated can vary significantly. In addition, little market information is available. Some data is given below to provide an order of magnitude for size of this market.

The worldwide coastal population is roughly 950 million people (UNEP Geo-2000, 2005). The island nation of Fiji, for example, has a population of nearly 1 million people (PIRAP, 2004, p.vii). Thus, an assumption can be made that the total number of people in the coastal communities – constrained and non-integrated market is well into the millions. As for economic size of the market, assume the following conservative calculation: 25 million people at a median worldwide energy consumption of 4,980kWh per year, times a conservative price of CAN$0.15/kWh, the total estimated value of the market is CAN$18.68 billion.

2.2.1.3 Power Demand

Power demand for constrained and non-integrated communities varies greatly around the world, as summarized in **Table 8** of Section 2.1.1.3. Similar to the coastal communities off-grid market, power demand in this market also varies greatly, depending on the number of people in the community, the relative wealth of the community, and the commercial and industrial activities. No information suggests power demand is less or more, so it is assumed that consumption for individuals in constrained and non-integrated communities is similar to their national averages.

2.2.1.4 Power Costs

Power costs also vary substantially within the coastal communities - constrained and non-integrated market, from country to country and region to region. Costs largely depend on the generation technology utilized, its capital cost, and the cost of fuel. Some examples of electricity costs in constrained and non-integrated communities are given for Fiji, Scotland, and British Columbia. Grid electricity in Fiji costs from $0.14 to $1.40[23] per kWh, depending on the region (PIRAP, 2004, p.24). Average electricity costs for non-integrated villages in Fiji, powered by diesel generators, were estimated in 2002 to be $2.00 per kWh[24] (PIRAP, 2004, p.29). Electricity retails in the non-integrated Shetland Islands, off the coast of Scotland, UK at about $0.16/kWh to $0.18/kWh.[25] Electricity in non-integrated communities British Columbia retails at $0.10/kWh[26] (BC Hydro, 2005). Although the retail prices are inexpensive, the actual cost to generated power in these regions is usually much higher. Electrical power in both the UK and Canada, and probably many other countries and regions, is subsidized for many non-integrated communities. For example, the Shetland Islands are supplied by an aging diesel plant that has operating costs exceeding the retail price of power.[27] In BC, the average cost for producing electricity in non-integrated communities is $0.22;[28] more than double the retail price. Furthermore, this quoted

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[23] All costs reported are in Canadian currency, based on the value of the Canadian dollar as of June 2005, except where indicated otherwise
[24] Average cost of electricity includes capital costs and estimated transmission losses
[25] Interview with Aaron Priest, Economic Development Unit, Shetland Island Council; June 13, 2005
[26] Price for non-integrated power over the first 3,000kWh (at $0.0605)
[27] Interview with Aaron Priest, Economic Development Unit, Shetland Island Council; June 13, 2005
[28] Interview with Tom Gissell, Operations Manager, Non-Integrated Areas, BC Hydro; July 7, 2005

cost of $0.22 excludes the capital cost of equipment; most of BC's non-integrated generating equipment is 25 years old and fully amortized.[29]

2.2.1.5 Fresh Water and Desalination

Sources of fresh water are highly variable in coastal communities, as mentioned in the off-grid market section (Section 2.1). Fresh water sources may be surface water, ground water, rain water collection, or ocean water (desalinated). In this market segment, entire countries and regions can be considered constrained with respect to fresh water supply. The entire state of California experienced a seven year drought in the late 1980s, early 1990s (McCarthy, 1996). It is widely recognized that the Middle East and much of Africa suffer from a lack of fresh water. Groundwater aquifers which offer safe fresh water in many areas of the world are being depleted or contaminated.

Desalination of ocean water is important to communities within this market segment. Desalination is common in other parts of the world where surface and ground water sources are limited, contaminated, or of poor quality. For example, an interview with Mr. Priest of the Shetland Island Council suggested plans for a desalination plant project in Skerries, in the Shetland Islands off Scotland.[30]

Although desalination is common in some regions of the world, desalination equipment requires significant energy thus is very costly. Currently, only wealthier communities can afford desalination. The Middle East, which has the tightest supply of fresh water, only has two countries that can afford desalination technologies: Saudi Arabia and the Gulf Emirates (McCarthy, 1996).

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[29] Interview with Nigel Protter, President, Sieber Energy Inc., based on discussions with BC Hydro; July 7, 2005

[30] Interview with Aaron Priest, Economic Development Unit, Shetland Island Council; June 13, 2005

2.2.2 Customer Characteristics

Based on the interviews and other supporting information, some key customer characteristics were identified for the coastal communities – constrained and non-integrated market. They include identifying the customer, financial implications, and sophistication with renewable energy sources.

2.2.2.1 Identifying the Customer

From interviews, identifying the customer for ORE technologies in the constrained and non-integrated market would be very similar to that in the off-grid market. The customer may reside in many places: a private utility company (i.e. independent power producer or treated water supplier), a crown corporation utility, or a department within a government body (i.e. municipal, regional, or federal government). An energy or water supply consultant, or a contractor to the consultant, may represent a potential customer for ORE technologies.

2.2.2.2 Financial Implications

Two financial implications in this market include government funding and renewable power incentives. Funding for capital power projects will vary depending on the wealth of a given community and its relative need for investing in a renewable power technology. Constrained and non-integrated communities are likely to have larger populations than the average off-grid community so government funding sources may be more generous. Many federal and regional governments around the world offer tax incentives and special funding for investing in renewable energy. For example, the UK offers funding to support renewable power, to help meet the country's aggressive targets of generating 18% of the country's energy by 2010 and 40% by 2020 (Web Newswire, 2005). An example of ORE funding by the UK:

> "In August 2004 the DTI announced a new £50 million Marine Renewable Deployment Fund. The new scheme will allocate up to £42 million towards supporting a number of larger scale pre-commercial demonstration wave and

> tidal farms. DTI has already committed over £15m towards wave and tidal energy technologies R&D over the last 5 years." (Cliff Funnell Associates, 2005, p.3)

The United States represents another example of a country that offers government incentives for renewable energy investment. In fact, there is an entire website dedicated to information about state incentives for renewable energy (Database of State Incentives for Renewable Energy, 2005).

2.2.2.3 Sophistication with Renewable Energy

The potential customers within this market are probably more sophisticated with renewable energy than in many other markets. All respondents interviewed for this market indicated a high level of interest and knowledge in renewable energy sources. Mr. Priest, of the Shetland Island Council, indicated that the Shetland Islands are looking into wind, wave and tidal power as possible solutions. Mr. Jarvis of the Village of Masset, BC suggested that wind and biomass is being considered. Mr. Khan of the Department of Energy in Fiji forwarded a comprehensive report outlining previous experience and experiments with biomass, wind, wave, tidal, solar, hydro, and geothermal.

2.2.3 Incumbent Technologies

Incumbent power technologies used in the coastal communities - constrained and non-integrated market include most existing types of power systems. From interview information, they include grid supplied power, petroleum fuel generators, hydroelectric, wind turbine, solar, and likely many others not identified in the interviews. Grid supplied power, petroleum fuel generators, and hydroelectric are assumed to be the most common sources of power for communities in this market, so comments about each of these are presented below.

2.2.3.1 Grid Power

Constrained communities are usually on a power grid but power supply is constrained by various factors. For example, the island nation of Fiji is constrained by limited generation capacity, Prince Rupert, British Columbia is constrained by its distribution system[31], and many British Columbia First Nations communities are constrained by distribution line reliability issues.[32]

2.2.3.2 Diesel Generator

By definition, non-integrated communities are not supplied power by a regional grid, but they are typically supplied by diesel (or other petroleum fuel) generators. For example, BC Hydro supplies power to all non-integrated areas in British Columbia. Nearly all non-integrated communities in BC, including the Village of Masset[33] and Bella Coola (CentralCoastBC.com, 2005) are supplied by diesel generators for most or all of their power.[34] Mr. Brothers of Frontier Power Systems indicated that most non-integrated communities on the east coast of Canada are powered by diesel generators.[35]

Diesel generators are usually the power technology of choice for non-integrated communities because of their good reliability. Mr. Gissell at BC Hydro suggested that "dependability is key for a non-integrated system" and diesel generators provide reliability.[36] In addition, many of BC Hydro's non-integrated diesel systems are designed as mobile units that can be moved or towed, to allow for offsite maintenance or rebuilding.[37] BC Hydro has explored renewable energy alternatives for non-integrated communities, such as wind, biomass, and hybrid

[31] Interview with Nigel Protter, CEO, Sieber Energy; June 17, 2005
[32] Interview with Paula Santos, Environmental Engineer, Public Works and Government Services Canada (for Indian and Northern Affairs Canada); May 31, 2005
[33] Interview with Trevor Jarvis, Village Administrator, Village of Masset, BC; May 30, 2005
[34] Interview with Tom Gissell, Operations Manager, Non-Integrated Areas, BC Hydro; July 7, 2005
[35] Interview with Karl Brothers, Owner, Frontier Power Systems; June 13, 2005
[36] Interview with Tom Gissell, Operations Manager, Non-Integrated Areas, BC Hydro; July 7, 2005
[37] Interview with Ben Sparrow, Construction Site Manager and Engineer, BC Hydro; July 3, 2005

solutions, but hasn't yet found a technology that meets their reliability and cost performance needs.[38]

2.2.3.3 Hydroelectric

Non-integrated communities are also supplied by hydroelectric systems, although probably to a lesser degree than diesel power generation. Examples of non-integrated communities using hydroelectric power in British Columbia include Ocean Falls, which has a 1.5MW small hydro system (in addition to a diesel plant), and Bella Coola has a 2.0MW (in addition to its 7.5MW diesel system) (CentralCoastBC.com, 2005).

2.2.4 Problems Needing to be Solved

From interviews, some problems were identified with power systems in the coastal communities – constrained and non-integrated market. Problems were identified specifically with grid power and diesel generators. These problems are presented in **Table 10**, with comments.

[38] Interview with Tom Gissell, Operations Manager, Non-Integrated Areas, BC Hydro; July 7, 2005

Table 10: Problems Needing to be Solved for Coastal Communities – Constrained and Non-Integrated

Problem Needing to be Solved	Comments
Diesel Generator – maintenance	Aging diesel plants require substantial costly maintenance.
Diesel Generator – cost of operation	Due to high maintenance and fuel costs, the plant in the Shetland Islands relies on a government subsidy to continue operating. Similar problem in British Columbia.
Diesel Generator – not environmentally sustainable	A common complaint from interview respondents was that diesel systems are not environmentally sustainable.
Grid Power – distribution line outages	Many constrained communities are located in more remote locations at the end of the transmission grid. Storms commonly disrupt distribution lines and response time to repair the lines is slow.
Grid Power – limited distribution capacity	Many constrained communities have limited power due to insufficient grid distribution line capacity. Replacement of distribution lines is very costly.

Sources: interviews referenced in this section

2.3 Coastal Resorts

The coastal resorts market includes commercially-operated recreational properties with onsite hotels, resorts, "villages", or lodges. Generically, they will be referred to as resorts in this report. Interviews for this market focused on large international hotel and resort chains. Some information on fishing lodges in British Columbia was also collected.

Interview respondents for the coastal resorts market include representatives from Club Med Resorts,[39] Wyndham Resorts,[40] Fairmont Hotels and Resorts,[41] Hilton Hotels,[42] the Gallows

[39] Alain Ibanes, Regional Maintenance Manger, Club Med Resorts; June 13, 2005
[40] George Gordon, Manager of Power Plant, Wyndham Resorts; and Kenneth Williams, Power Plant Supervisor, Wyndham Resorts; June 8 and June 10, 2005

Point Resort in St. Thomas Virgin Islands,[43] Queen Charlotte Lodge,[44] and Langara Fishing Adventures in the Queen Charlotte Islands.[45]

2.3.1 Market Characteristics

Specific characteristics discussed for the coastal resort market include market location, market size, power demand, price of power, and water desalination.

2.3.1.1 Market Location

The location of the coastal resorts market is worldwide and obviously near the ocean. Research for this report focused on coastal resort areas in British Columbia and in tropical regions such as the Caribbean and Mexico; however, some of the hotel chains contacted have properties all over the world.

2.3.1.2 Market Size

Much like the coastal communities market segments, the coastal resorts segment is also huge. There are obvious difficulties in assessing the actual size of this market. Coastal resorts exist across the globe in any country with a coastline, and the resorts themselves are all different sizes with different power needs. No estimate was available indicating the number of coastal resorts worldwide. However, the Caribbean Hotel Association website lists nearly one thousand island resorts in the Caribbean islands alone (Caribbean Hotel Association, 2005). There are probably another thousand resorts in the Caribbean that are not members of the association. It can be conservatively estimated that there are tens to hundreds of thousands of coastal resorts worldwide.

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[41] Karl Pinault, Executive Regional Director of Design and Construction, Fairmont Hotels and Resorts; June 3, 2005
[42] George Neeson, Engineering, Head Office for Operations, Hilton Hotels; June 6, 2005
[43] Akhil Deshwali, Utilities Manager, Gallows Point Resort, St. Thomas, Virgin Islands; June 8, 2005
[44] Brian Higgs, Operations Manager, Queen Charlotte Lodge; March 10, 2005
[45] Richard Taggart, Operations, Langara Fishing Adventures; March 10, 2005

To estimate the economic size of the coastal resorts market, the following conservative assumptions can be considered:

1. For electrical power generation, assume 50,000 resorts worldwide, times an average of 30 people per resort at any given time, times the median power consumption of 4,980kWh per person, times \$0.20/kWh = \$1.49 billion per year.
2. For water desalination, assume \$3 per cubic meter, times 50 cubic meters per person per year, times 1.5 million people = \$225 million per year.

The coastal resorts market is also a growing market. According to research, an "increasing demand by international tourists for beach holidays has resulted in a rapid increase of the number of coastal resorts worldwide" (Andriotis, 2003, p67).

2.3.1.3 Power Demand

Power demand for resorts varies substantially. Of course, a small resort in Mexico with ten rooms and no air conditioning will not need the power capacity that a five hundred room resort on the coast of Norway in the winter would require. A couple of examples to indicate the orders of magnitude for power demand, would be the Wyndham Sugar Bay resort in St. Thomas, U.S. Virgin Islands and the Langara Fishing Lodge in the Queen Charlotte Islands, British Columbia. The Wyndham Sugar Bay resort is a reasonably large three hundred room resort with air conditioning. Its average power requirement is roughly 1,300kW (or 1.3MW).[46] By contrast, the Langara Fishing Lodge has about thirty rooms and consumes about 165kW of electricity (heat is generated by a diesel furnace).[47]

[46] Interview with George Gordon, Manager of Power Plant, Wyndham Resorts; June 8, 2005
[47] Interview (by Company X) with Richard Taggart, Operations, Langara Fishing Adventures; March 10, 2005

2.3.1.4 Power Costs

Based on information collected during interviews with resort representatives, costs varied from $0.09/kWh[48] to $0.26/kWh;[49] however, these costs are from resorts that use grid-supplied power. Respondents who generated their own power were not able to supply cost data. It is suspected that costs for resorts that generate their own power are much higher. Assuming similar costs from diesel power generation in other markets, $0.40/kWh or more would be a reasonable estimate.

2.3.1.5 Fresh Water and Desalination

Water desalination appears to be widely used for generating fresh water in the coastal resorts market, particularly on islands and in tropical regions. Islands and tropical regions are commonly victim to scarce or poor quality ground water and surface water sources. Most resort chains contacted indicated that at least some of their coastal hotels use desalinated water. However, based on interview information, few resorts operate their own desalination systems. One hotel chain contacted for an interview owned and operated a reverse osmosis desalination plant,[50] but most resorts seem to purchase their fresh water from municipalities or private companies.

Municipalities and private utility companies in the Caribbean commonly operate desalination facilities for producing fresh water. Two private companies that produce and supply fresh water via desalination technologies in the Caribbean include Ionics (previously Aqua Designs)[51] and Consolidated Water, (Simpson, 2005).

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[48] Regarding a resort in France, based on the interview with Alain Ibanes, Regional Maintenance Manger, Club Med Resorts, June 13, 2005

[49] Regarding a resort in St. Thomas, U.S Virgin Islands, based on the interview with Akhil Deshwali, Utilities Manager, Gallows Point Resort; June 8, 2005

[50] Interview with Karl Pinault, Executive Regional Director of Design and Construction, Fairmont Hotels and Resorts; June 3, 2005

[51] Regarding a resort in St. Thomas, U.S Virgin Islands, based on the interview with Akhil Deshwali, Utilities Manager, Gallows Point Resort, June 8, 2005

Fresh water costs for coastal resorts range from nearly free for resorts in locations with plentiful fresh water, such as British Columbia where some resorts extract water from nearby streams,[52] to almost $9 per cubic meter for desalinated water from a reverse osmosis plant in the Turks and Caicos islands.[53] Resorts in other parts of the world may pay even higher rates. Typical costs for desalinated fresh water in the Caribbean islands and Mexico range between $2.50/m^3$ and $3.75/m^3$.[54]

2.3.2 Customer Characteristics

Based on the interviews and other supporting information, some customer characteristics include identifying the customer, financial implications, and sophistication with renewable energy sources.

2.3.2.1 Identifying the Customer

The customer is relatively simple to identify in the coastal resorts market segment. Resorts are typically operated as businesses, where the purchasing decision makers are rather easy to identify, compared with communities and their government funding procedures. Based on interviews, the customer would generally be the owner or a manager within the organization. Larger hotel chains may have a purchasing department that facilitates the purchase of capital assets (i.e. power or water treatment equipment).

2.3.2.2 Financial Implications

Resorts are operated as businesses so an investment must have financial merit and justification. Interview respondents suggested a few reasons that would justify purchase of ORE equipment. Reasons include: a favourable return on investment, better performance, and green

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[52] Interview (by Company X) with Brian Higgs, Operations Manager, Queen Charlotte Lodge; March 10, 2005

[53] Interview with Alain Ibanes, Regional Maintenance Manager, Club Med Resorts; June 13, 2005

[54] Interview with Alain Ibanes, Regional Maintenance Manager, Club Med Resorts; June 13, 2005

marketing. There was consensus that if the ORE technology is cost-competitive with the current power or fresh water supply systems, then investment would be likely. If ORE can supply better performance, in terms of more reliable power or higher quality water than what is currently available, then there is added value for their customers. It was suggested that resorts would even pay higher prices for better power performance and water quality.[55] Resorts also attach value to being an environmentally responsible, or "green", business for marketing opportunities, meeting company values, and preserving the beautiful natural environments where they are usually located. All interview respondents indicated some interest in having renewable power for their electricity or fresh water systems. Some indicated they would pay more for green technologies, but most were concerned that additional costs must be justified.

2.3.2.3 Sophistication with Renewable Energy

The sophistication of potential customers in the coastal resorts market varies depending on the individual resort and its staff. It is apparent from interviews, though, that large resort chain organizations are more "tech" savvy due to the availability of in-house technical experts. From interviews, some resorts operate their own power and fresh water systems, while most do not. Large resort chains employ specialists knowledgeable with utility systems and small independent resorts may be much less knowledgeable and rely on external experts for their utility systems. All interview respondents seemed to have some knowledge, but none had actually invested in any renewable power systems.

2.3.3 Incumbent Technologies

Power technologies currently used in the coastal resorts market include grid power and diesel generators. Resorts typically use grid power where possible. Factors such as accessibility

[55] Interview with Alain Ibanes, Regional Maintenance Manager, Club Med Resorts; June 13, 2005

and reliability of the grid require some resorts to generate their own power usually with diesel generators.

2.3.3.1 Grid Power

In general, where grid power is accessible, resort representatives are pleased with the services. Respondents indicated it is reliable and cost-effective. Although resort representatives seemed happy with grid power, many indicated an interest in green power sources as an alternative. Many resorts claim to have considered renewable power sources, including wind turbines and solar; however, no renewable power equipment was installed at the resorts contacted.

2.3.3.2 Diesel Generators

Off-grid resorts generally supply their own power by diesel generators. Interviewees indicated that the generators reasonably met their needs. They are reliable and familiar. Resorts also usually have backup power systems to ensure the safety and comfort of guests. Backup power is usually supplied by diesel generators.

2.3.4 Problems Needing to be Solved

Some problems were identified with both power technologies and fresh water supply in the coastal resorts market. Problems with power technologies included grid power, diesel generators, as well as other renewable energy technologies considered for use in the market. These problems are presented in **Table 11**, with comments.

Table 11: Problems Needing to be Solved for Coastal Resorts

Problem Needing to be Solved	Comments
Fresh Water Supply – poor water quality	Poor water quality from external water suppliers (municipal and private operators) was reported. Mr. Ibanes of Club Med Resorts indicated that their sources for fresh water "do not meet their needs at all" with respect to water quality for many of their villages.
Fresh Water Supply – high cost	High costs were reported for fresh water, particularly in Mexico and the Caribbean. Up to \$9 per m^3 was reported by a Caribbean resort (from an externally-operated reverse osmosis plant).
Fresh Water Supply – maintenance	High maintenance and related costs for operating desalination facilities was reported.
Diesel Generator - maintenance	It was suggested by an interview respondent that less maintenance of the generators would be preferred.
Wind Turbine – noise and aesthetics	Club Med reviewed the possibility of wind turbines for power, but did not invest due to potential problems with noise and the unsightly turbine tower.
Solar PV - cost	Club Med reviewed the use of solar PV, but perceived the productivity insufficient and the costs uncompetitive with current power supply.

Sources: interviews referenced in this section

2.4 Disaster Relief

The disaster relief market can be defined by the potential customers who respond to international disasters on an international scale. They would include organizations that provide emergency electric power supply and desalination for drinking water, such as the Red Cross, World Bank, and United Nations.

Interviews conducted for this market included a variety of key organizations in the disaster relief market: Red Cross,[56] UN High Commission for Refugees,[57] World Bank,[58] and Canadian International Development Agency (CIDA).[59]

2.4.1 Market Characteristics

The disaster relief market appears to be a very promising market for ORE technologies. The following references paint the picture.

> "Globally, statistics gathered since 1969 show a rise in the number of people affected by disasters. Since there is little evidence that the actual events causing disasters are increasing in either intensity or frequency, however, the only conclusion is that vulnerability to disasters is growing. Possible causes mentioned include the increasing population density in many areas, the increased vulnerability of societies and the more sophisticated, hence more vulnerable in many aspects, urban infrastructure." (World Health Organization, 2005)

> "Over the past ten years around 7,000 'natural' disasters have occurred, killing more than 300,000 people and resulting in over US$800 billion in economic losses. Increasing interest in global warming has provoked intense debate on the issue of climate change and its implications for more frequent and intense extreme weather events, placing more people at risk than ever." (Briceño, 2004, p. 234)

Specific market characteristics are discussed in subsections: market location, market size, power demand, cost of power, and fresh water and desalination.

2.4.1.1 Market Location

The technology is needed in disaster-stricken communities near the ocean, anywhere in the world; however, the market itself is in organizations that provide relief for these communities. Initially the market was assumed to be within large international relief organizations such as the Red Cross, World Bank, and United Nations; however, interviews suggest that the actual market

[56] Jonathan Baker, Logistics Services, Red Cross Canada; June 3, 2005
[57] Abdi Egeh, Logistics, UN High Commission for Refugees; and Dinesh Shreshta, Logistics, UN High Commission for Refugees; June 1-6, 2005
[58] Param Iyer, Senior Water and Sanitation Specialist, World Bank; June 15, 2005
[59] Joe Knockert, Regional Director, CIDA; May 30, 2005

is located more within the countries' governments themselves. More information is provided in the Customer Characteristics section (Section 2.4.2).

2.4.1.2 Market Size

The article referenced above by Briceño, provides a fair assessment of the size of the disaster relief market: 7,000 natural disasters in past ten years and over US$800 billion in economic losses (Briceño, 2004, p. 234). Although these numbers include disasters in all locations, a significant portion would be represented by coastal disasters. For example, the recent tsunami in Southeast Asia on December 26, 2004 caused widespread damage, leaving millions of people without power and fresh water. In Indonesia alone, the estimate to rebuild damaged power and telecommunications networks is US$150Billion (Dennis, 2005, P.20).

2.4.1.3 Power Demand

The power demand for both the relief mission crews and the civil communities is reasonably low. According to the Red Cross, relief crews use small generators (up to 125kW) for supplying power for permanent and temporary field offices.[60] The Red Cross also indicated that power for the civil communities, affected by the disaster, is not a high priority and typically supplied by the relief organizations. Electrical power is not as important in an emergency as is energy for heating and cooking, which is usually supplied by heating and cooking fuels. Electric power for the civil communities is usually supplied by the local government, or perhaps the military.

[60] Interview with Jonathan Baker, Logistics Services, Red Cross Canada; June 3, 2005

2.4.1.4 Power Costs

As expected, power costs are not important for disaster relief operations based on interviews with the Red Cross and the UN High Commission for Refugees.[61] Electric power demand is not significant, yet it is crucial for emergency operations. Thus, costs are not important when compared with reliability and convenience attributes. Interviews did suggest that low power costs are more important for long-term or permanent operations. Current costs are assumed to be typical of a small to medium sized diesel generator operating in a remote location, likely in the $0.40/kWh range (depending on the difficulty for transporting fuel).

2.4.1.5 Fresh Water and Desalination

Interview respondents indicated that most disaster sites in their experience are far from the coast, thus fresh water is usually sourced from ground water or nearby surface water. However, both suggested that desalination has been used on a few occasions. Representatives for the UN High Commission for Refugees had used reverse osmosis desalination plants but found them unsuitable.[62] In an emergency, when equipment operation is crucial, cost is not a factor but ease of operation and low maintenance are important factors. Desalination equipment was found to require specially trained and skilled individuals and costly maintenance. For long-term fresh water supply infrastructure, the UN tends to pursue other options, such as pipelines from existing but distant sources.

Although those interviewed for this report did not provide positive experiences for water desalination equipment, other information suggests desalination may be important for coastal disaster relief activities. For example, the relief efforts in Iraq after the latest war with the United States involved successful implementation of portable desalination equipment (Ehrenman, 2003).

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[61] Interviews with Abdi Egeh and Dinesh Shreshta, Logistics, UN High Commission for Refugees; June 1-6, 2005

[62] Interviews with Abdi Egeh and Dinesh Shreshta, Logistics, UN High Commission for Refugees; June 1-6, 2005

In addition, the US military supplied desalination equipment for relief purposes in Indonesia shortly after the tsunami in December 2004 (US Department of Defense, 2005).

2.4.2 Customer Characteristics

Potential customers in the disaster relief market are difficult to identify. From interviews, it appears that the large relief organizations purchase minimal or no power equipment. They purchase diesel generators for their own field operations. They are not generally responsible for purchasing large-scale power or water treatment equipment for civil use. Mr. Baker of the Red Cross suggested "we don't provide power for civil communities, not for towns or villages; we only provide more basic needs and first response. The local governments generally provide power and capital projects."

Actual customers in this market are anticipated to consist of utilities, government agencies, and military forces in the disaster-stricken areas. Therefore, customer characteristics are assumed to be similar to those of government agencies in the coastal communities markets and military customers in the military market. There appears to be some overlap with disaster relief applications in these markets. In fact, upon researching the US Department of Defence 2006 military budget, there is US$61million allocated for "Overseas Humanitarian Disaster and Civic Aid" (US Department of Defence, 2005, p.24).

2.4.3 Incumbent Technologies

From interviews, the primary power technology used in the disaster relief market is diesel generators. Some information on diesel generator use in this market is included below in Section 2.4.3.1.

2.4.3.1 Diesel Generators

Disaster crews usually supply their own power from diesel generators for field operations, as mentioned in interviews. Diesel generators are used because crews are familiar with them, and find them to be reliable and convenient. Reliability and convenience are key factors for power technologies in this market. To ensure good performance, generators are replaced often.[63]

2.4.4 Problems Needing to be Solved

A problem was identified with fresh water supply in the disaster relief market. The problem is presented in **Table 12**, with comments.

Table 12: Problems Needing to be Solved for Disaster Relief

Problem Needing to be Solved	Comments
Fresh Water Supply – difficult and costly operation of reverse osmosis desalination equipment	Emergency equipment must be easy to operate and maintain. An interview with the UN suggested that reverse osmosis desalination equipment is not used due to operational complexity. Costly maintenance was also mentioned. An article in The Engineer journal quotes that reverse osmosis desalination "is massively power hungry and currently requires an engineering infrastructure akin to that of an oil refinery to support it." It also quotes a water engineering expert who suggests "a lot of money is spent on research into desalination worldwide, but I haven't seen anything that is applicable to a situation like this (the Asian tsunami)."

Sources: interview with Dinesh Shreshta, Logistics, UN High Commission for Refugees; and The Engineer, 2005, p.16-17.

[63] Interview with Jonathan Baker, Logistics Services, Red Cross Canada; June 3, 2005

2.5 Military

The military market can be defined as potential customers who would purchase ORE equipment for coastal military and naval operations. Military operations may include, but are not likely limited to, supplying electrical power or fresh water supplies for permanent and field defence operations, search and rescue, and disaster relief.[64] Another example of a possible military application may be in the US Navy's interest in developing an all-electric warship (Littlefield and Nickens, 2005, p.46). ORE technologies could be relevant to the US Navy, at least in researching such an application.

Information sources more heavily on secondary research for this market. Interview information is limited due to difficulties getting responses from key military personnel. The Canadian, United States, and British military forces were contacted but no comprehensive responses were available for this report. An interview was conducted with NGrain Corporation,[65] a supplier of technology products to both the Canadian and US military forces.

2.5.1 Market Characteristics

Overall, technology adoption in the military market is a slow and onerous process, according to interview information. Specific topics on market characteristics include market location, market size, power demand, price of power, and fresh water and desalination. These topics are discussed in the following subsections.

2.5.1.1 Market Location

The military market could include any military force in the world with coastal or off-coast operations. New technologies, such as ORE, would be of more interest to the more technologically-advanced forces in more affluent nations.

[64] This represents some overlap with the Disaster Relief market
[65] Interview with Paul Halmshaw, Senior Technology Advisor, NGrain Corporation; June 1, 2005

2.5.1.2 Market Size

There is large potential for ORE technologies in the military market. Very little data was available for military spending on renewable energy technologies. Thus, much of this assumption is based on the number of US naval stations and various data on military spending.

There are 92 permanent naval stations, both domestic and foreign, in the US Navy (Answers.com, 2005) that could have potential applications for ORE technologies. In addition, field operations would represent more opportunities for ORE technologies. Extrapolate these numbers to include other military forces and this could represent a large market.

Beyond the US naval stations, a search of the US Federal Business Opportunities database indicates a number of requests for proposal (RFPs) for renewable energy purchases, particularly in the form of renewable energy certificates (Federal Business Opportunities, 2005). One RFP from the Defense Logistics Agency requested proposals for certificates for the equivalent of 18,000,000 kWh, for transfer to various facilities. The database also contains RFPs and awarded contracts for solar PV and wind turbines.

The US military's proposed budget for 2006 is US$441 billion (Pasztor, 2005, p. A.5), which accounts for nearly half of the world's military spending combined (Skons et al, 2004, p.10). The US military's 2006 budget includes a budget line item for "Generators and Associated Equipment" of US$43 million (US Department of Defense, 2005, p.A27), which indicates significant spending on off-grid power systems. A few more interesting military spending data from Skons et al:

- World military spending has been increasing significantly, over 18% in the two years prior to 2003
- Total world-wide military spending was US$956 billion in 2003

- High income countries account for roughly 75% of world military spending, but only 16% of world population

2.5.1.3 Power Demand

Power demand largely depends on the application needed for the technology. It can be assumed that a large naval station would require several megawatts of power capacity, similar to a town or small city. Small field operations or a search and rescue base, on the other hand, might only require a few kilowatts of power, similar to what could be supplied by a small portable diesel or gas generator.

2.5.1.4 Power Costs

Due to lack of available information in this market, power costs in the military market are not available. It is uncertain which technologies are used for military applications; however, it can be assumed that many permanent military stations use grid power and remote or temporary stations/operations use diesel generators and a variety of other power technologies. Costs for grid and diesel-generated power are probably as variable as other markets that utilize these technologies.

2.5.1.5 Fresh Water and Desalination

Water treatment technologies such as desalination are used by military forces. As discussed in the disaster relief market, the US military supplied desalination equipment for relief purposes to Indonesia shortly after the tsunami in December 2004 (US Department of Defense, 2005). Information in the US Federal Business Opportunities database indicates a number of purchases of desalination equipment by the US military; one contract awarded nine reverse osmosis desalination units (Federal Business Opportunities, 2005). The 2006 US Department of Defense budget includes US$8.2 million for water purification equipment (US Department of Defense, 2005, p.A26).

2.5.2 Customer Characteristics

Some characteristics of potential customers in the military market that require discussion include: identifying the customer, adoption of technologies, funding implications, and sophistication with renewable energy sources. Information in these subsections was supplied primarily from interview information with NGrain Corporation.[66]

2.5.2.1 Identifying the Customer

Much like the disaster relief and coastal communities markets, potential customers in the military market are difficult to identify. Based on the effort spent finding knowledgeable interview contacts for this market, finding the customer is probably even more difficult. Mr. Halmshaw at NGrain confirmed that the purchase process in both the Canadian and US forces is very procedural and difficult. He recommended finding a champion within the organization who can help create "pull" for the technology.

2.5.2.2 Adoption of Technologies

Adoption of technologies by military forces obviously varies substantially depending on the technology's value to the organization and the timing (e.g. an advanced weapons technology creating a strategic advantage during war-time would be of more interest to the military than a high tech training tool). However, NGrain offered key suggestions relating to adoption of technologies by the US and Canadian military forces.

One key suggestion from NGrain's experience in landing a military contract was to prove the technology first in the consumer market. The military forces are more interested in technologies that are more validated. The other suggestion was to strategically approach the Canadian forces before the US forces. NGrain found it procedurally easier to first get their

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[66] Interview with Paul Halmshaw, Senior Technology Advisor, NGrain Corporation; June 1, 2005

technology into the Canadian military. Once the Canadian military supported their technology, the US Military was more interested.

2.5.2.3 Funding Implications

Funding for technology purchases in the military largely depend on how much funding is available and how the procurement process operates. The US spends far more on military than other countries. In fact, the US spends nearly one half of all other countries combined (Skons et al, 2004, p.10). As mentioned above, the US military's annual budget is an enormous US$441 billion (or CAN$553 billion). By contrast, the Canadian Forces budget is substantially smaller, at only CAN$13 billion (CBC News Online, 2005). Like most government budgets, military budgets are typically allocated in advance and require onerous procurement approvals to receive a budget line item. According to the NGrain interview, the US military requires a return on investment (ROI) study to be completed before they can even begin the approval process. It took NGrain two and a half years to encourage the US military to complete an ROI study and then another year or more to get approved for the following year's budget. In total, it typically takes three to five years before the US military will pay for a new product. The good news is that once a product receives approval for a budget line item, it is relatively simple to sustain the funding for subsequent years.

2.5.2.4 Sophistication with Renewable Energy

Military forces are widely known to be at the leading edge of technologies; therefore, it is safe to assume that most military forces are very sophisticated with renewable energy technologies. In fact, the US Navy has an alternative energy section specifically for Naval Research. This US Navy Office of Naval Research was contacted for an interview for this study;

however, no response was received.[67] According to a Financial Times article, the US Navy is already working with ORE technologies (Blackwell, 2004). Less developed nations' military forces may be less tech savvy with respect to renewable energy, due to limited funding for researching new technologies.

2.5.3 Incumbent Technologies

A detailed assessment of incumbent technologies used by militaries in coastal regions is difficult, due to limited information. It is assumed that military forces need power for many coastal or off-coast applications, such as permanent, temporary, or field operations (offices, housing, and equipment maintenance), naval ships, equipment installations, search and rescue, and relief missions. From various US military data sources, it is clear that the US military uses grid-supplied power wherever possible and purchases diesel generators (US Department of National Defense, 2005). Based on contract information in the Federal Business Opportunities database, the US military purchases a number of other power sources that may be used in coastal or off-coast locations, including: solar PV systems[68] and wind turbines[69] (Federal Business Opportunities, 2005). It is assumed that military forces also use various other conventional power technologies as well as experimental power supplies.

2.5.4 Problems Needing to be Solved

Due to lack of available information in this market, few specific problems with incumbent power technologies were identified by interviews. Based on the author's basic knowledge of the military market, a couple of additional problems are presented in **Table 13**.

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[67] Preliminary interview with Richard Kikla, Alternative Fuels Section, US Office of Naval Research; June 6, 2005

[68] The US Army purchases solar PV systems for such applications as charging batteries in remote locations

[69] The US Navy purchases wind turbines for powering remote radio repeater stations

Table 13: Problems Needing to be Solved for the Military

Problem Needing to be Solved	Comments
Military Purchasing Process – barrier to adoption	The onerous procurement process for new technologies may create a high barrier to adoption, according to the interview with NGrain.
Diesel Generator – heat signature	Diesel generators (combustion engines) produce significant heat. Heat can represent a strategic disadvantage if enemy forces are using infrared (thermal) spectrum reconnaissance technologies or heat-seeking weapons.
Diesel Generator – fuel supply	Supplying fuel for generators may be difficult or dangerous during foreign battle operations.

Sources: author, interview with Paul Halmshaw, Senior Technology Advisor, NGrain Corporation, June 1, 2005

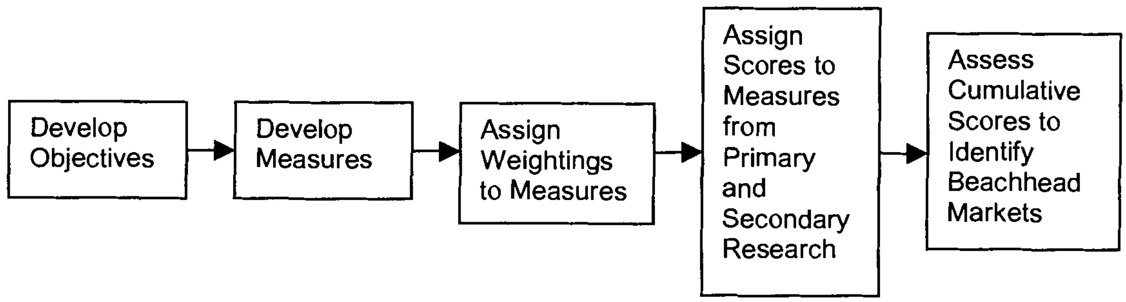
3 BEACHHEAD MARKET SELECTION

This section summarizes the beachhead market evaluation and selection process. The process utilizes Kaplan and Norton's (1993, p.134) Balanced Scorecard method, as introduced in Chapter 1. A discussion of results follows the summary of Company X's balanced scorecard market selection.

3.1 Balanced Scorecard for Company X's Market Selection

The overall objectives of the balanced scorecard are to effectively define the priorities of Company X's beachhead market and then select the best potential markets. To accomplish this objective, the scorecard process involves developing strategic objectives within the context of the four market perspectives (financial, customer, internal, and growth and learning). Specific strategic measures are then developed to reflect the objectives and a weighting is assigned to each of the measures. Actual semi-quantitative scores are assigned for each market segment being assessed. Based on interpretation of the scores, a priority list of potential beachhead markets is created. The process is more clearly illustrated in **Figure 3**.

Figure 3: Balanced Scorecard Process for this Analysis



Source: author

3.1.1 Development of Strategic Objectives

Strategic objectives were developed within the four market perspectives: financial, customer, internal, and growth and learning. Each of these perspectives is important for selecting a beachhead market, as explained in the subsections below. The strategic objectives developed for each perspective are identified. The objectives were developed in collaboration with Company X's executive team. The objectives chosen are strategically significant to Company X for a beachhead market.

3.1.1.1 Financial

The financial perspective answers the question "How do we look to owners and shareholders (in this market)?" (Grant, 1998, p.43). For evaluating and selecting a beachhead market, key strategic objectives can be developed that help identify the potential it has to meet the company's financial goals. Financial objectives important to Company X include potential revenues, profitability, financial risk, and cost competitiveness. Financial objectives, and the other objectives discussed below, are included in **Table 14**.

3.1.1.2 Customer

The customer perspective answers the question "How do customers see us (in this market)?" (Grant, 1998, p.43). For evaluating and selecting a market, customer objectives help indicate how well the technology will meet the customer's needs and expectations, and how well the customer fits with the technology. Key customer objectives include how well the technology solves the customers' problems, how well it can compete with incumbent technologies, speed of adoption, and technological sophistication of the customer.

3.1.1.3 Internal

The internal perspective answers the question "What must we excel at (in this market)?" (Grant, 1998, p.43). Internal objectives can be generated to identify the key characteristics of the market that are important to the company. Internal objectives defined by Company X include technology validation, market dominance, shareholders' and board's support, observability, and market accessibility.

3.1.1.4 Growth and Learning

The growth and learning perspective answers the question "Can we continue to improve and create value (in this market)?" (Grant, 1998, p.43). Growth and learning objectives can assist in evaluating and selecting a market by identifying characteristics for future market strategies. The key growth and learning objectives for Company X include market referencing and market growth.

Table 14: Strategic Objectives

	Strategic Objectives of Company X
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility
Growth & Learning	• Reference market • Growth within market

Sources: author, interviews with Company X, scorecard adapted from Kaplan and Norton, 1993 p.135

3.1.2 Development of Strategic Measures

Strategic measures were developed to assess the strategic performance of the markets, relative to each other. They represent a list of key criteria that are most important to Company X in a beachhead market and they are aligned with the strategic objectives in Section 3.1.1. They were developed in collaboration with Company X's executive team and are presented in **Table 15.** A detailed explanation of each strategic measure is included in the generic balanced scorecard in **Appendix C.**

Table 15: Strategic Measures

	Strategic Objectives	Strategic Measures
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness	• Revenue estimates for the market
		• Profitability o Expected profitability o Range/volatility
		• Ability to pay
		• Willingness to pay
		• Cost competitiveness
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market
		• Ability to compete with incumbent technologies
		• Estimated speed of adoption
		• Level of technological sophistication of the customer
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation
		• Potential for market dominance
		• Total market demand
		• Internal support for the market
		• Observability
		• Market accessibility
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets
		• Market growth potential

Sources: author, interviews with Company X, scorecard adapted from Kaplan and Norton, 1993 p.135

3.1.3 Market Evaluation and Selection

The evaluation and selection process of potential beachhead markets consisted of a workshop with Company X's executive team (the President and CEO, and the Director of Market Research and Commercialization) on June 17, 2005. It involved two separate activities: assigning strategic importance weightings to each of the measures in the balanced scorecard, and then assigning scores to each measure for each market under consideration. Weightings and scores are presented in the generic balanced scorecard in **Appendix C**.

3.1.3.1 Assigning Weightings to the Strategic Measures

Importance weightings were assigned to each of the strategic measures during the workshop. The purpose for this step is to recognize those metrics with higher or lower relative importance to Company X; not all metrics have equal importance. The weighting scale is based on a quantitative system, outlined in **Table 16**, where:

Table 16: Weightings for Balanced Scorecard

1 = Low Importance
2 = Medium Importance
3 = High Importance

Source: author

3.1.3.2 Scoring the Strategic Measures

Following the task of assigning weightings to each metric, scores were assigned for each metric within each market. The scoring system used in this market evaluation and selection process consisted of a semi-quantitative approach. Each score reflects the level of potential that the market will meet that individual metric. **Table 17** outlines the scoring values.

Table 17: Scoring System for Balanced Scorecard

+ +	High Potential
+	Potential
0	Neutral (or Insufficient Data)
-	Poor Potential
- -	Very Poor Potential

Source: author

Weighted scores for each metric are calculated in the scorecard by multiplying the weighting of the individual metric by the score for that market. Total scores are calculated by adding up the total number of "pluses" (+) versus the total number of "minuses" (-) for each market.

An individual scorecard was completed for each of the five markets evaluated.[70] Scores were assigned to the scorecard based on the information collected and presented in Chapter 2 (from interviews and secondary research), and interviews with Company X's executive team. Many of the scoring decisions were made during the workshop on June 17, 2005. Rationale and assumptions for each score are included in a "Scoring Rationale and Assumptions" column in each scorecard. All completed balanced scorecards are included in **Appendix C**.

The results of the scoring exercise identify the markets with the highest potential as beachhead markets, relative to each other. A detailed discussion of the results is included in the following section. A balanced scorecard summary is included as **Table 18**.

[70] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, Coast Resorts, Disaster Relief, and Military.

Table 18: Balanced Scorecard Summary

	Potential Markets Evaluated		Coastal Com. – Off-Grid	Coastal Com. – Constrained and Non-Integrated	Coastal Resorts	Disaster Relief	Military
	Strategic Objectives	**Strategic Measures**	**Weighted Score**				
Financial	• Revenues • Profitability • Manage risk • Cost competitive-ness	• Revenue estimates for the market	6 +	6 +	3 +	6 -	3 +
		• Profitability o Expected profitability o Range/volatility	2 +	1 +	1 +	1 +	0
		• Ability to pay	1 -	1 +	0	0	0
		• Willingness to pay	0	3 +	3 +	6 +	3 +
		• Cost competitiveness	3 +	3 +	0	0	0
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market	6 +	3 +	3 +	0	0
		• Ability to compete with incumbent technologies	2 +	0	0	0	0
		• Estimated speed of adoption	3 -	3 +	6 +	6 -	3 -
		• Level of technological sophistication of the customer	1 -	1 +	1 +	0	2 +

Potential Markets Evaluated			Coastal Com. – Off-Grid	Coastal Com. – Constrained and Non-Integrated	Coastal Resorts	Disaster Relief	Military
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation	4 +	2 -	4 +	4 -	4 -
		• Potential for market dominance	0	0	0	0	0
		• Total market demand	2 +	2 +	1 +	0	0
		• Internal support for the market	0	0	0	0	0
		• Observability	0	0	0	0	0
		• Market accessibility	0	0	0	0	0
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets	4 +	4 +	2 -	4 +	4 +
		• Market growth potential	0	0	3 +	3 +	3 +
Total Weighted Score			24	25	23	- 2	8

Sources: author, interviews with Company X, market information from Chapter 2, scorecard adapted from Kaplan and Norton, 1993, p.135

3.2 Discussion of Results and Findings

Results of the market selection exercise indicate three of the potential beachhead markets with very similar scores and the other two with much lower scores. Specifically, both coastal communities markets and the coastal resorts market are very close. Based on the subjectivity of many of the metrics, these three markets can be interpreted as virtually in a three-way tie. The disaster relief and military markets scored much lower than the other three. The following subsections provide some general findings and interpretation of the scorecard results for each market.

3.2.1 General Findings

In general, the markets evaluated in this study are found to be very broad, probably too broad to be effective as beachhead markets. In addition, many assumptions needed to be developed in order to attach scores to the measures. Some measures were found difficult to attach scores to at all.

A key finding from this market selection exercise is that the markets assessed are extremely broad. The top three ranked markets do not represent appropriate beachhead markets, given the breadth of each. For example, the coastal communities – off-grid market includes communities of any size, from around the world, with a wide variety of possible customers (e.g. governments, consultants, contractors). A more appropriate beachhead may be a sub-segment of one of the top three markets. As an example, instead of all off-grid coastal communities, it may be more useful to identify only off-grid communities in the Maldives with less than two hundred homes. Further segmentation of the selected markets is necessary. Discussion and suggestions for additional segmentation are included in the recommendations section.

Many assumptions were used to establish scores for the balanced scorecards. For example, to estimate revenues in the Coastal Resorts market, an assumption that there are 50,000 coastal resorts in the world is loosely founded on data in the Caribbean region only. It is important to understand that many assumptions in this study were developed to make order-of-magnitude estimates. Some assumptions may be questionable so Company X should revisit the scorecard in the future, upon gaining additional information on these markets.

Some measures were found to be inappropriate for scoring at this time, so neutral scores were applied across all markets. Neutral scores were applied to the following strategic measures: Potential for Market Dominance, Internal Support for the Market, Observability, and Market Accessibility. Using the measure Potential for Market Dominance as an example, neutral scores were assigned because Company X determined it to be too early to score; their technology is not yet close enough to commercialization. Rationale for the other metrics is included in the scorecards.

3.2.2 Coastal Communities – Off-Grid

The coastal communities – off-grid market scored as one of the highest, at 24 points. It is a top candidate as a beachhead market for Company X. Some key considerations can be interpreted from the scorecard, as follows.

3.2.2.1 Financial Measures

Financial measures scored very high in this market, with the exception of the "ability to pay" measure. Ability to pay for expensive capital costs may be difficult for small, financially-strapped off-grid communities. Such communities may be dependant on government funding, which represents risk from political priorities in the area.

3.2.2.2 Customer Measures

Customer measure scores for off-grid communities are much lower than the other two high-scoring markets. Although there were many “problems to solve” identified for this market, this score was off-set by poor ratings in the estimated speed of adoption and technological sophistication of the customer measures. Interviews suggest that most off-grid communities rely on diesel generators for electric power. The product lifecycle of a diesel generator is about 20 years, thus adoption of new technologies in this market may be slow. It should be noted though that the off-grid market is so large that there will always be a community with an old generator, so perhaps speed of adoption does not represent such a barrier. As for the technological sophistication metric, consulting engineers often represent the potential customers in this market. Research indicates that third-parties tend to be risk-averse and are less likely to recommend investments in new environmental technologies.

3.2.2.3 Internal Measures

Many of the internal measures were given neutral scores because the measures were either perceived as equal across all markets, or that it was considered too early to develop a meaningful score. One high-scoring metric was the potential for technology validation in the off-grid market. Company X claims that smaller-scale ORE installations are preferable to larger-scale installations for early-market technology validation. The off-grid communities’ power needs are typically on a smaller scale than some other markets, thus the smaller installation scale is considered a key benefit in this market.

3.2.2.4 Growth and Learning

Growth and learning measures in the off-grid market compare well with the other markets. This is mainly because of a high score for the market reference metric. Communities often reference other communities for information on technologies and infrastructure.

3.2.3 Coastal Communities – Constrained and Non-Integrated

The coastal communities - constrained and non-integrated market was given the highest score, 25 points, in the balanced scorecard exercise. Based on these results, it is the top candidate as a beachhead market for Company X. The following key results were extracted from the scorecard.

3.2.3.1 Financial Measures

This market indicated the highest score for financial measures of all the scorecards. Constrained coastal communities represent a very large market, with individual communities reaching hundreds of thousands to possibly millions in population. All other financial measures indicated good potential in this market. Economically, this translates into a very favourable market for Company X.

3.2.3.2 Customer Measures

The customer measures scores are the second highest, next to the coastal resorts market. Problems related to constrained communities indicated good opportunities in this market. Constrained communities need greater power capacity now, thus there is greater market pull and no waiting time for replacement of existing generation equipment. Speed of adoption is assumed to be much quicker.

3.2.3.3 Internal Measures

As with the other markets, many internal measures were given neutral scores. Neutral scores were assigned to those measures that were either perceived as equal across all markets, or that the technology was considered too early stage for developing a meaningful score. A high-scoring metric was total market demand for power because of the large potential size of the market. However, this score was off-set by the assumption that equipment installations in this market would need to be utility-scale. Company X prefers a beachhead market with smaller-scale demands for validating their technology.

3.2.3.4 Growth and Learning

Growth and learning measures scored the same as in the coastal communities – off-grid market, and for the same reason. Communities often reference other communities for information on technologies and infrastructure.

3.2.4 Coastal Resorts

The coastal resorts market is the third top-ranked market, with a score of 23, and can be interpreted as a potential beachhead for Company X. Some interesting results are discussed below.

3.2.4.1 Financial Measures

The score for financial measures is not as high as the coastal communities markets. This is because coastal resorts is a much narrower market, thus it cannot represent the same revenue potential as coastal communities around the world. However, estimated revenues are still in the hundreds of millions of dollars range and water desalination is assumed to represent high revenues in this market. Return on investment is a key motivator for customers in this market.

3.2.4.2 Customer Measures

The customer measures in the coastal resorts market scored the highest of all the markets assessed. This is mostly due to the "ability to solve a problem" and "speed of adoption" measures. Interview information indicates that many resorts have a high interest in producing better quality fresh water, possibly through cost-effective desalination technologies. In addition, resorts in areas with unreliable power supplies are interested in better technologies to improve guest services. Storms were identified as a key problem with reliability of existing power supplies. Perhaps this represents an opportunity for ORE, for technologies that can capitalize on ocean energy during a storm.

3.2.4.3 Internal Measures

A high score for internal measures in the coastal resorts market was the "potential for technology validation" measure. This measure was given a high score because most coastal resorts would require relatively small-scale installations for water desalination equipment or backup electrical power. Also, resorts are typically very diligent with respect to operation and maintenance of equipment, another benefit for technology validation. Resort owners would be motivated to ensure the performance of the equipment is optimized for business reasons.

3.2.4.4 Growth and Learning

Growth and learning measures did not score particularly high in this market. This is mainly due to the assumption that resorts are not a credible reference market for new technologies. It is doubted that other markets would reference resorts for new power technologies. However, the coastal resort market is documented to be growing.

3.2.5 Disaster Relief

The disaster relief market was given the lowest overall score of -2. To clarify though, potential customers for this market were not exactly within the organizations contacted for this study. Interviews suggested that the actual significant customers for this market are within governmental agencies and military forces. These organizations were not contacted regarding disaster relief applications for this study. Regardless, information collected is sufficient to rank this market as a lower priority as a beachhead for Company X.

3.2.5.1 Financial Measures

Financial measures for the disaster relief market indicated the lowest score for all markets assessed. This is mainly due to very poor potential for revenues in the organizations contacted for interviews, such as the Red Cross and the UN. Of course, significantly greater revenues may be available in the market from government or military customers. Additional research must be completed to confirm.

3.2.5.2 Customer Measures

Scores for customer measures are very low for the disaster relief market. The most significant factor is that disaster relief customers require proven performance of technologies in emergency relief situations. A new technology requires significant operating data, and familiarity with operators, to ensure that it will perform to expectations during an emergency. The requirement for this level of proven performance is not appropriate for a beachhead market.

3.2.5.3 Internal Measures

As most internal measures were given neutral scores across all markets, the technology validation score heavily impacted the disaster relief market. A "very low potential" score was given to this metric because of the high reliance on performance requirements. High performance could represent high risk for a new technology in a beachhead market.

3.2.5.4 Growth and Learning

The only significant positive score in the disaster relief market came from the growth and learning measures. Both "market reference" and "market growth" metrics were given high scores. It was assumed that technologies used in disaster relief operations are highly referenced due to the importance on reliability and convenience in difficult operating conditions. Growth for power technologies in the disaster market is a probable result of increasing vulnerability of humans and their reliance on infrastructure.

3.2.6 Military

The military market indicates a relatively low score on its balanced scorecard. The score may be lower due to a larger number of neutral scores granted, due to limited market information. Although information is limited for this market, it is sufficient to represent it as a poor beachhead for Company X. As a beachhead, it does not appear appropriate mainly due to slow procurement processes in the military. It may be a good subsequent market, though, for a number of reasons discussed in the remainder of this section.

3.2.6.1 Financial Measures

Many financial measures were given neutral scores due to insufficient information. It was assumed that the military's willingness to pay for the technology would be high if it had potential strategic benefits.

3.2.6.2 Customer Measures

Scores for customer measures are somewhat competing. A low score for "speed of adoption" is offset by a high score for "sophistication of the customer." Speed of adoption can be slow in the military due to a three to five year procurement process. The technological sophistication of the typical military customer is assumed to be very high. Military forces, particularly the US, are on the leading edge of technology to ensure strategic competitive advantage.

3.2.6.3 Internal Measures

As mentioned in the discussion for other markets, many internal measures were given neutral scores because the measures were either perceived as equal across all markets, or that it is too early in the development of Company X's technology to develop a meaningful score. For the military market, the internal measures scored low because of a low score for the "potential for technology validation" metric. It was given a low score because Company X perceives market validation in the military difficult due poor information flow from the military organization.

3.2.6.4 Growth and Learning

Growth and learning measures scored relatively high for the military market. The military is a good reference market for technology products. In addition, worldwide military spending is increasing.

4 ADDITIONAL ANALYSIS OF TOP THREE SELECTED MARKETS

Chapter 3 identified three markets with roughly equal potential to be Company X's beachhead. This chapter further explores these three markets, to uncover possible opportunities and barriers for the technology. In particular, two additional analyses are conducted for each of the three selected markets. The first analysis involves identifying customer-preferred product features. The second analysis examines factors that may influence or inhibit the adoption of ORE technologies in each market.

4.1 Customer-Preferred Product Features[71]

Identifying and understanding customer-preferred product features is very important to Company X at this stage in the development of their ORE technology. For the product to be successful it must meet the needs and solve the problems of the market. Several product features were identified from interviews with potential customers in the top-ranked three markets. These features are summarized in **Table 19**, and discussed in detail in the following subsections.

Interview respondents were given a brief physical description of Company X's technology and then asked what features would be of key interest or concern to them. The features in Table 19 include only those that are market-specific, as identified from the interviews. Table 19 does not include general features that are obviously common to all markets. Such general features include: cost-competitiveness, low maintenance, high performance, high reliability, and safety.

[71] From interviews referenced in Chapter 2

A product feature identified in one market may be relevant to other markets. Company X should consider each product feature presented for whichever market they ultimately plan to pursue. In addition, this is not an exhaustive list; it only represents a few features that came to the minds of the interview respondents.

Table 19: Product Features Summary Table

Coastal Com. – Off-Grid	Coastal Com. – Constrained and Non-Integrated	Coastal Resorts
Vessel Navigation	Vessel Navigation	Vessel Navigation
Aesthetics	Aesthetics	Aesthetics
Coastal Fishing	Coastal Fishing	Resistance to Extreme Weather
Training	Grid Connection Capability	Beach Access and Recreation
Level of Sophistication	Qualification for Government Incentives	
	Mobility	

Sources: interviews referenced in Chapter 2

4.1.1 Coastal Communities – Off-Grid Market

Interviews were conducted with several people with knowledge of the off-grid coastal community market, as discussed and referenced in Chapter 2, Section 2.1. A few product features identified during these interviews include vessel navigation, aesthetics, training, level of sophistication, and coastal fishing. Details on each of these features are discussed below.

Sea-going boats and vessels are an integral part of life in coastal communities. Design of ORE systems for coastal communities must respect navigation of all such vessels. Location selection may be the most important factor in designing a system that addresses this issue.

Another factor may include electronics or communications devices in the system that could foul navigation systems.

Aesthetics of the product are important to people in the off-grid coastal communities market. This is particularly true for systems that will be installed in scenic natural settings and touristy areas. An unsightly system was the most common concern among interview respondents in all markets.

Training for properly using and maintaining the technology is an important issue, particularly for First Nations communities in British Columbia. According to interviewees, inadequate training for community-level operators and maintainers seriously inhibits the performance of existing power technologies.[72] Designing an effective training program for end-users will be an important product feature for all markets, but particularly for remote, off-grid communities.

The same interviews regarding First Nations communities in British Columbia recommended a low level of sophistication for power technologies used in First Nations communities. Although, this comment was specific to First Nations communities, it is valid for typical off-grid coastal communities. Typical off-grid coastal communities are small and may not have a resident power system expert. Designing an ORE system that is less sophisticated, or even perceived as less sophisticated, is an advantage for this market.

Many off-grid communities rely on fishing and shellfish harvesting for subsistence and/or economic sustainability. ORE technologies must be designed to not disturb or threaten fishing activities. Perhaps the technology can be designed to enhance the marine environment for fishing by providing a substrate for growing or protecting shellfish environments.

[72] Interviews with Paula Santos, Environmental Engineer, INAC, May 31, 2005; and Mike Dickens, Community Power Consultant, Kerr Wood Leidel Associates, May 30, 2005

4.1.2 Coastal Communities – Constrained and Non-Integrated

Interviews were conducted with several people with knowledge of the coastal communities - constrained and non-integrated market, as discussed and referenced in Chapter 2, Section 2.2. Some product features identified during interviews for the constrained and non-integrated market include grid connection capability, qualification for government incentives, vessel navigation, aesthetics, mobility, and coastal fishing. Discussion is included for each of these features.

Interviews recommended that an ORE power system would need to be connected to the local transmission grid. Particularly for constrained communities, an ORE technology would commonly need grid-connection. Although power could be generated for specific off-grid applications to alleviate usage of a constrained grid, grid connection would increase the value of an ORE power system. Of course, such a capability would likely be addressed by simply including a DC-AC inverter in the system design.

The interview with Mr. Priest, of the Shetland Island Council in the UK, identified a key element for new ORE technologies. It is to qualify for the UK Renewable Obligations Certificates. By qualifying for these certificates, a marine renewable energy technology can command a premium price for selling power in the UK. Beyond the UK, considering government requirements for financial incentives may make the difference between viable and not-viable in any given geographic market. Consideration of qualifying features for government incentives should be conducted during the design and planning phase of the ORE technology.

Mobility of diesel generation systems, for offsite maintenance or rebuilding, is a characteristic that has value for BC Hydro.[73] This preference is likely for many other non-integrated community power suppliers. If significant onsite maintenance or frequent rebuilding

[73] Interview with Ben Sparrow, Construction Site Manager and Engineer, BC Hydro; July 3, 2005

of an ORE system is required, future customers may prefer a system that can be easily moved to a more convenient service location.

Vessel navigation, aesthetics, and coastal fishing were identified and discussed in the off-grid communities section, Section 4.1.1. Information for these features is very similar for the coastal communities – constrained and non-integrated market. No additional discussion is required.

4.1.3 Coastal Resorts

Interviews were conducted with knowledgeable people in the coastal resorts market, as discussed and referenced in Chapter 2, Section 2.3. Product features identified during interviews for the coastal resorts market include resistance to extreme weather, beach access and recreation, vessel navigation, and aesthetics. Details are included for each of these features.

Many coastal resorts are located in tropical regions of the world where hurricanes and extreme storms are almost regular events. Even coastal resorts in less tropical regions may be exposed to extremely rough water and high winds. Interview respondents recommended for any ORE technology to operate successfully in a tropical region, it would have to withstand the forces of extreme weather systems.

Beach access and recreational activities such as surfing must not be impacted by the design or location of an ORE power generator, according to a representative from Fairmont Hotels and Resorts. Coastal resorts rely on the recreation offered by their beach locations. Therefore, beach access must not be limited by power infrastructure. In addition, system installation should avoid sacrificing recreational activities (e.g. installing the technology in a location that may foul good surfing waves).

Similar to coastal communities, coastal resort areas are also host to sea-going vessels and particularly recreational vessels such as jet-skis. In designing an ORE power system, consideration should include the safety of all vessel traffic. The design should also include security features to prevent damage from curious boating tourists.

Aesthetic issues were a key concern in the coastal resorts market. In fact, Mr. Ibanes of Club Med suggested that appearance, combined with noise issues, were key reasons for cancellation of a proposed wind turbine project at one of their villages. An unsightly installation could easily impact the sea views that resort guests pay high prices to enjoy.

4.2 Analysis of Technology Adoption

This section analyzes each of the three potential selected beachhead markets with respect to adoption of ORE technology, Company X's technology in particular. It is based on Everett Rogers' Model of Adoption, which identifies characteristics that may facilitate or inhibit technology adoption (Rogers, 1995). Rogers' model explores technology characteristics for six factors relating to adoption:

1. **Relative Advantage** – the advantage of the new technology as perceived by the customer.
2. **Compatibility** – compatibility of the technology with what customers already know and how they already do things.
3. **Complexity** – complexity of the technology and its adoption process.
4. **Observability** – how observable, noticeable, demonstrable, communicable is the technology.
5. **Risk** – how risk averse is customer and the product (physical risk, financial risk (product failure), technological risk).
6. **Divisibility/Trial** – the ability to try the technology, to lower the risk before buying it.

Tables 20, 21, and **22** apply Rogers' analysis to each of the three potential beachhead markets.[74] Each table includes facilitators and barriers to adoption, for each of the six adoption factors.

[74] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

Table 20: Adoption Characteristics for Coastal Communities – Off-Grid

COASTAL COMMUNITIES – OFF-GRID		
	Facilitators	**Barriers**
Relative Advantage/ Disadvantage	• Relative to diesel generators, no fuel transport or handling requirements • No electricity costs for powering water desalination equipment • No fuel costs; waves and tides are free • Renewable energy • No polluting emissions	• Power generation from ocean waves is inconsistent, thus may be limited to use as backup or supplemental power supply
Compatibility	• Uncertain - technology is still at research and development stage • Compatible with environmental values in many communities • "Plug and play" design would be more easily compatible with installed electrical infrastructure • End-user (home owner) sees little difference in use	• Ocean-based systems may be incompatible with system operators and maintainers familiar with land-based power systems, such as diesel generators
Complexity	• Uncertain – technology is still at research and development stage o Design must be simple to use	• New "discontinuous" power innovations may be perceived as too complex for rural, off-grid customers/users
Observability	• See balanced scorecards for "Observability" measure: media transparency offers high observability in all markets • Final product appearance is yet uncertain – buoy look or distinct look? • Technology will be visible from the shore	• Aesthetic issues (visibility in a natural setting may annoy people) – seek local knowledge for best locations • Off-grid communities are generally remote, thus technologies are less observable to the public
Risk	• Lower risk of fuel spills, fuel shortages and fuel price fluctuation, when compared with diesel generators • Lower risk of environmental impact from fuel emissions	• High financial risk for investment by small off-grid communities • Service risk – difficult to access remote locations for providing after-sales service • Possible risk of impact to the marine environment • Risk to early adopters: product failure, dissolution of Company X • Risk averse third party consultants

Divisibility/ Trial	• Uncertain – technology is still at research and development stage
	  o Visits to a demonstration system would be beneficial
	  o Demonstration materials are essential
		• On-site trials of the technology would be particularly costly and difficult in off-grid locations
		• Difficult to try without installation

Source: author

Table 21: Adoption Characteristics for Coastal Communities – Constrained and Non-Integrated

COASTAL COMMUNITIES – CONSTRAINED AND NON-INTEGRATED		
	Facilitators	**Barriers**
Relative Advantage/ Disadvantage	• Power generation is easily scalable, relative to a constrained grid • No fuel transport or handling requirements, relative to diesel generators • No electricity costs for powering water desalination equipment • Waves and tides are free • Renewable energy • No polluting emissions	• Power generation from ocean waves is inconsistent, thus may be limited to use as backup or supplemental power supply
Compatibility	• Uncertain - technology is still at research and development stage • Compatible with environmental values in many communities • End-user (home owner) sees little difference in use	• Ocean-based systems may be incompatible with system operators and maintainers familiar with land-based power systems, such as diesel generator or hydroelectric power plants

Complexity	• Uncertain – technology is still at research and development stage
	  o Design must be simple to use
	  o Customers in this market may be more technologically sophisticated than Off-Grid customers
		• Added complexity of new skills required for operating an ocean-based system may be difficult for constrained and non-integrated communities – ocean-based maintenance may present an issue for union labour workers

Observability	• See balanced scorecards for "Observability" measure: media transparency offers high observability in all markets • Final product appearance is yet uncertain – buoy look or distinct look? • Technology will be visible from the shore • Larger and more accessible constrained communities offer greater opportunities for observing the technology	• Aesthetic issues (visibility in a natural setting may annoy people) – seek local knowledge for best locations • NIMBY (Not in My Back Yard) issues may be more prevalent in the constrained communities market
Risk	• Lower risk of fuel spills, fuel shortages and fuel price fluctuation, when compared with diesel generators • Lower risk of environmental impact from fuel emissions	• Uncertain returns from technology • Service risk – difficult to access remote non-integrated locations for providing after-sales service • Possible risk of impact to the marine environment • Risk to early adopters: product failure, dissolution of Company X • Risk averse third party consultants

Divisibility/ Trial	• Uncertain – technology is still at research and development stage
	  o Visits to a demonstration system would be beneficial
	  o Demonstration materials are essential
		• On-site trials of the technology would be costly and difficult, particularly in remote locations
		• Difficult to try without installation

Source: author

Table 22: Adoption Characteristics for Coastal Resorts

COASTAL RESORTS		
	Facilitators	**Barriers**
Relative Advantage/ Disadvantage	• Excellent marketing potential for resorts as "environmentally sustainable" businesses • No fuel transport or handling requirements, relative to diesel generators • No electricity costs for powering water desalination equipment • No fuel costs; waves and tides are free • No polluting emissions	• Power generation from ocean waves is inconsistent, thus may be limited to use as backup or supplemental power supply • Capital costs may be prohibitive for some resorts, particularly those with grid power
Compatibility	• Uncertain - technology is still at research and development stage • Compatible with environmental values for many resort organizations and their customers • "Plug and play" design would be more easily compatible with installed electrical infrastructure • End-user (resort guest) sees little difference in use	• Ocean-based systems may be incompatible with system operators and maintainers familiar with land-based power systems, such as diesel generators
Complexity	• Uncertain – technology is still at research and development stage o Design must be simple to use	• New "discontinuous" power innovations may be perceived as too complex for typical resort maintenance personnel.
Observability	• See balanced scorecards for "Observability" measure: media transparency offers high observability in all markets • Final product appearance is yet uncertain – buoy look or distinct look? • Technology will be visible from the shore • Resorts offer high visibility to guests from all over the world, good opportunity promoting the technology across international boundaries.	• Aesthetic issues (visibility in a resort setting may annoy people) – seek local knowledge for best locations
Risk	• Lower risk of fuel spills, fuel shortages and fuel price fluctuation, when compared with diesel generators • Lower risk of environmental impact from fuel emissions	• High financial risk for investment by lower income resorts • Risk to water recreational areas • Service risk – difficult to access remote resort locations for providing after-sales service • Possible risk of impact to the marine environment • Risk to early adopters: product failure, dissolution of Company X

Divisibility/ Trial	• Uncertain – technology is still at research and development stage
	    o Visits to a demonstration system would be beneficial
	    o Demonstration materials are essential
		• On-site trials of the technology would be costly and difficult, particularly in remote resort locations
		• Difficult to try without installation

Source: author

4.2.1 Adoption Characteristics - Summary of Findings

Tables 20, 21, and **22** outline all the facilitators and barriers for each of the three top-ranked markets. The following sub-sections synthesize the information contained in the tables and outline the key differences and commonalities, categorized within Rogers' six factors. In general, most of the facilitators and barriers are common for all three markets.

4.2.1.1 Relative Advantage/Disadvantage

A common facilitator is that Company X's technology is a renewable energy source, so there is no pollution and the "fuel" (i.e. waves, tides) is free. Coastal resorts may benefit from the marketing potential of an "environmentally sustainable" resort. Company X's technology can be easily scaled up or down in capacity to meet fluctuating power needs of different sized communities, which may of particular benefit for growing coastal communities.

A common barrier for ORE technologies that are dependant on wave action is that waves are inconsistent. As waves are inconsistent, so is the power generating capability of the technology. ORE technologies that employ tidal action are not as exposed to inconsistent power generation issues.

4.2.1.2 Compatibility

Two compatibility facilitators include environmental values and end user behaviour. A facilitator common to all three markets is that the ORE technologies are compatible with environmental values in most communities. Another facilitator is that the end user of the power will not need to change his/her behaviour. For example, end users can still plug in their TVs to a power outlet in the same manner as before.

A barrier for ocean-based systems may be that they are not compatible with power system operators and maintainers. For example, people who are familiar with operating diesel generators may have neither the knowledge nor the desire to operate an ORE system located offshore. They may not even have the skills to operate a boat to check on power equipment installed offshore.

4.2.1.3 Complexity

The complexity of the technology is still uncertain at this stage in its development so design of Company X's final product should facilitate simple operation and easy maintenance. Regardless of how simple the design, people's perceptions in the markets may still represent a barrier to adoption. Such a new innovation in power technology may be perceived as too complex for many potential customers; specifically for small communities where customers may be less sophisticated. Also, in larger constrained communities, power utilities may employ union labourers who require special training and new procedures for operating and maintaining new technologies. Such requirements may act as significant barriers to unionized organizations.

To address this potential barrier of complexity, customers in Company X's beachhead market must be keen to adopt new technologies. According to Moore (2002, pp.9-13) people will adopt technologies at different times, dependent on which group they fit into on the *Technology Adoption Life Cycle.* For Company X's technology, a beachhead market must contain customers who are in the "innovators" and "early adopters" groups on the technology adoption life cycle. Innovators actively pursue new technologies simply for the intrigue and pleasure of exploring a new device (Moore, 2002, p.12). Early adopters are similar to innovators except they are less technical but can envision the benefits of new technologies early in their life cycle (Moore, 2002, p.12). It should be noted that innovators and early adopters are less likely to work in governments and more likely to own or work for private companies.

4.2.1.4 Observability

Facilitators for observability of ORE technologies transcend all three markets. For example, media coverage of such a new technology will be ubiquitous regardless of the market. On the other hand, if people find the installed system to be unsightly, the visibility of it may be a barrier. This may be particularly relevant for larger communities in the constrained communities market. To best address the risk of community backlash, Company X should seek local knowledge on preferred locations for installation.

4.2.1.5 Risk

Common risk facilitators for ORE technologies are related to fuel, when compared with diesel generators. The environmental risks associated with fuel handling, fuel storage, and fuel emissions are removed entirely. In addition, ORE is not affected by fuel shortages or price fluctuations.

A number of other common risks may represent barriers for Company X. Such risks include the risk of technology failure or company failure, the risk associated with servicing the technology in remote areas (e.g. remote off-grid communities), risk of impact to the marine environment, and financial risk of the investment. A risk that is more relevant to the coastal communities markets may be third party consultants, who are more risk averse to adoption of new environmental technologies.

4.2.1.6 Divisibility/Trial

The ability for a potential customer to try the technology is uncertain given the current stage of development; however, it can be assumed that trial will be difficult and costly. Inability to try, or effectively watch the technology working, may lead to a high barrier to adoption. To lower this barrier, it is important for Company X to offer potential customers the opportunity to see a live demonstration. Alternatively, a high quality video production with additional demonstration materials should be provided.

5 CONCLUSIONS

Key conclusions from the report findings are summarized in this chapter. In particular, it includes overall conclusions of findings and methods used, the individual markets analysed (potential beachhead markets and subsequent markets), the product features analysis, and the technology adoption analysis.

5.1 Overall Conclusions

A key finding from this market selection exercise is that the markets assessed are extremely broad. As a result, no one single market analysed is entirely appropriate as a beachhead market. For example, the coastal communities – off-grid market includes communities of any size, from around the world, with a wide variety of possible customers (e.g. governments, consultants, contractors). Establishing a foothold in such a broad market, as defined, could take decades. Although Company X's technology may deliver better performance[75] than incumbent technologies in some parts of this market, it certainly wouldn't for the entire market. Hence, suggestions on how to further segment the markets selected, and ultimately identify a beachhead, will follow in the recommendations section.

Another key overall conclusion is that three of the five markets evaluated in this report have much higher potential as a beachhead market than the other two. The coastal communities – constrained and non-integrated market scored the highest, but all three top-scoring markets[76] were very close in scoring. Although no clear winner was identified, the market selection process

[75] Or make something technically possible that wasn't before, as dictated by the definition of a beachhead market in the introduction.
[76] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

successfully narrowed the markets. The three top-ranked markets can be further segmented and assessed in the future by Company X.

The balanced scorecard method was used successfully for narrowing the potential markets, and should be used again. This is a key advantage of the balanced scorecard market selection process; Company X can revisit it in the future upon further segmentation of the markets. The process may be used to identify an appropriate beachhead segment from the markets already selected, or for evaluating new and subsequent markets in the future. Changes in company strategies can also be reflected in the scorecard by changing the strategic objectives and measures or altering the strategic weightings.

5.2 Potential Beachhead Markets

Some conclusions are included for each of the three markets[77] selected as having the highest potential as a beachhead for Company X. Although each of these markets has the potential to contain a beachhead, additional segmentation is needed first. This is mentioned in Section 5.1 as an overall conclusion. Conclusions specific to each of the three markets are included in the following sub-sections.

5.2.1 Coastal Communities – Off-Grid

The coastal communities – off-grid market has many positive attributes for a first market. There are good financial opportunities in such a large market, and communities offer good referencing of the technology for subsequent markets. In addition, installations would typically be on a smaller scale thus preferable for Company X. However, selling such a new technology to community government decision makers may be difficult. The decision process may be slow,

[77] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

funding for small communities may be limited, and third-party consultant representatives are more risk averse to new environmental technologies.

5.2.2 Coastal Communities – Constrained and Non-Integrated

Overall, the constrained and non-integrated coastal communities market rated the highest of those assessed. Even more than non-integrated communities, the constrained communities seem to have the biggest problems and most pull for the technology. Communities that are constrained by limited power or fresh water infrastructure need the resources now. There is no waiting time for an incumbent system to get old or fail, thus adoption may be quicker in this market.

Financial opportunity is also a positive attribute for constrained and non-integrated communities. There are huge potential revenues in such a large market. Also, costs for generating power in non-integrated and constrained communities can be very high.

A negative issue though may be the assumption that larger, utility-scale systems are needed in this market. Larger systems are more expensive and difficult for technology validation. They require more complex financing, they are more high profile thus highly scrutinized, and likely have a higher risk of failure for a small technology company such as Company X.

5.2.3 Coastal Resorts

The coastal resorts market also has many excellent attributes for a beachhead market. Although perhaps not to the same degree as the coastal communities markets, this is still a very large potential market with excellent revenue opportunities. In fact, many resorts would pay higher prices for better power reliability and fresh water quality. Fresh water seems to represent a larger opportunity in this market than the others, based on the interviews.

5.3 Subsequent Markets

The disaster relief and military markets were assessed but not selected as potential beachhead markets. However, they may be considered by Company X in the future as subsequent markets. A few conclusions regarding the assessment of these two markets are included for each.

5.3.1 Disaster Relief

The disaster relief market was not selected as a potential beachhead market. It actually achieved the lowest overall score from the market selection process. The main reason for such a low score is that the disaster relief organizations contacted (e.g. Red Cross, UN, World Bank) are not where the disaster relief market lies for Company X's product. Based on the assessment findings, actual customers are more likely to be within military forces and governmental agencies of disaster-stricken countries.

Large international relief organizations purchase minimal to no power equipment. They may purchase small diesel generators for their own field operations but are not generally responsible for purchasing large-scale power or water treatment equipment for civil use. National and regional governments and military forces more typically supply power equipment and large-scale water treatment for disaster relief.

There is some overlap with disaster relief applications in other markets assessed. For example, the military market supplies relief equipment to stricken countries and regions. Governments that represent coastal communities would also make purchase decisions about disaster relief equipment for their communities.

5.3.2 Military

A number of attributes identified from the market analysis indicate that the military market is not a good beachhead for Company X; however, it may be a good subsequent market. Very slow technology procurement processes, from three to five years, is unacceptable for a small technology company with limited financing. The military is also a poor platform for technology validation, given the lack of information flow from military agencies.

As a subsequent market, the military offers some promising possibilities. If approved for purchase, military forces offer long-term purchase commitments. They also provide very good market referencing, as plenty of other markets look to the military for advanced technologies.

Market information, particularly interviews, was limited for the military organizations contacted. If the military is chosen as a subsequent market for Company X's product, additional market information should be collected. Specifically, interviews with key military decision-makers would provide good information.

5.4 Customer-Preferred Product Features

Identifying customer-preferred product features is important to Company X at this stage in the development of their ORE technology. The product must ultimately meet the needs of the customer in the market selected. The interviews conducted for this report identified several preferred product features.

There are a few key customer-preferred product features that are rather obvious for meeting the needs of virtually all markets. They include features such as cost-competitiveness, low maintenance, high performance, high reliability, and safety. Beyond these obvious features, several more were identified that seem important to the three top-ranked markets.[78] A couple of notable features include vessel navigation and aesthetics. Coastal fishing is also a common concern. It is important for Company X to meet the needs of customers and design their ORE technology with consideration for features that are valued in the market.

5.5 Analysis of Technology Adoption

From the technology adoption analysis in Chapter 4, it was found that facilitators and barriers to adoption are similar across the three top-ranked markets.[79] There are no significant advantages or disadvantages for one market over another, with respect to adoption. The reason for such insignificant differences is probably due to the broad markets assessed.

Upon further segmentation, more significant differences in technology adoption between markets should arise. For example, an external factor such as the political environment cannot be considered either a facilitator or a barrier for the current definition of the coastal resorts market. This is because the coastal resorts market encompasses the entire world. If the coastal resorts market were to be segmented into different geographical regions, the political environment may represent a large facilitator in one region and a high barrier in another. Hence, many differences in technology adoption will surface between markets once the markets are further segmented.

Some key facilitators and barriers that are common to the three top-ranked markets are summarized below:

Key Facilitators for Technology Adoption:

- ✓ Company X's technology can be easily scaled up or down in capacity to meet fluctuating power needs of different sized communities, which may of particular benefit for growing coastal communities.

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[78] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

[79] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

- ✓ "Fuel" (i.e. waves, tides) to operate the technology is free.
- ✓ No environmental risks associated with fuel handling, fuel storage, and fuel emissions.

Key Barriers for Technology Adoption:

- Complexity, or the perception of complexity, of the technology may be a key barrier for customers adopting the technology.
- Ocean-based power systems may not be compatible with power system operators and maintainers familiar with land-based systems.
- Providing for a potential customer to try the technology will likely be difficult and costly. Inability to try, or effectively watch the technology working, may lead to a high barrier to adoption.

6 RECOMMENDATIONS

Ocean renewable energy is a much undeveloped market and Company X is a young company with an as-yet unproven technology. A successful and strategic beachhead will allow Company X the chance to prove their technology and generate revenues to further develop the product for subsequent markets. As such, a successful beachhead market is integral to the growth plan of Company X. The recommendations in this chapter are intended to help Company X achieve their goal of finding a successful beachhead. A few recommendations for subsequent markets beyond the beachhead are also included. Specific recommendations sections include: overall recommendations, further segmentation of potential beachhead markets, recommendations for potential subsequent markets, customer-preferred product feature recommendations, technology adoption recommendations, and beyond the beachhead.

6.1 Overall Recommendations

Company X is recommended to focus future marketing efforts on the top three selected markets in this study. They include the coastal communities – constrained and non-integrated, coastal communities – off-grid, and coastal resorts markets. These three markets have the highest potential to contain a beachhead market segment, based on findings from the market selection process in this report.

Although these top three markets have high potential, they were found to be too broad to be effectively targeted as beachhead markets. Hence, a key recommendation is to further segment these markets. A more appropriate beachhead may be a sub-segment of one of the top three markets. For example, off-grid communities in the Maldives with less than two hundred homes may be an appropriate beachhead. A number of recommendations are included in the following section to help Company X further segment the selected markets and identify an actual beachhead market.

The balanced scorecard process was found to be a successful method for narrowing and selecting markets for this project. Use of balanced scorecard process is recommended for future segmentation exercises, for finding an appropriate beachhead, analyzing subsequent markets, or evaluating entirely new markets. It is also recommended that Company X continue to revisit its strategic objectives, strategic measures, and weighting of the measures upon future uses of the scorecard process. For example, the scorecard may be expanded to include more specific measures like external factors (such as political stability) that could impact the selection of a new geographic market. To be effective, the strategies embedded in the market selection process must evolve in parallel with Company X's overall strategies.

6.2 Further Segmentation of Potential Beachhead Markets

Recommendations in this section are associated with further segmentation of the three selected markets,[80] to help find an actual beachhead. They include general recommendations for segmenting the selected markets and specific recommendations for each of the selected markets.

6.2.1 General Recommendations for Beachhead Markets

General recommendations for the potential beachhead markets include a few suggestions for segmentation. Segments that may be considered for the top-three markets include: water desalination, geographical location, incumbent power technology, and technology adoption life cycle profile. Other general recommendations involve confirming the beachhead market selection and completing additional interviews.

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[80] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

6.2.1.1 Water Desalination Segment

Water desalination is recommended as a separate segment within each of the three top-ranked markets. In fact, the water desalination market may be considered a separate market altogether, not limited to within these three markets. For example, private utility companies, such as the Caribbean utilities[81] mentioned in the Coastal Resorts market section, represent one such separate market segment for water desalination.

Water desalination, as a separate market segment, should be considered by Company X as a beachhead market. Many regions have high demand for fresh water. Desalination systems (e.g. reverse osmosis) have very high energy costs, thus are not affordable in many areas where fresh water is needed the most. Fresh water is a more basic human need than electrical power; therefore, people who need it the most are likely to be more price elastic. There is clearly significant demand and profit potential for lower cost desalinated fresh water.

Should Company X pursue water desalination as a segment, additional research should be conducted to identify regions where opportunities for fresh water supply are the highest (e.g. highest demand, highest willingness to pay). Utility companies in these regions should be approached for information. Additional research should also explore popular desalination technologies and how Company X's technology can reduce their cost of operation. Strategic alliances with such desalination technology companies should be considered.

6.2.1.2 Geographical Location Segments

Company X should consider focusing on different geographical locations as potential market segments. Specifically, markets may be segmented into locations where power and fresh water supply costs are the highest. Geographical segments may also focus on locations where government incentives for renewable energy are most favourable. From the preliminary research

[81] Ionics and Consolidated Water

in this report, the UK seems to offer some excellent incentives and has set substantial goals for installed renewable power.[82] However, much more research should be completed to assess the most opportunistic regions for power costs and associated incentives. Company X may consider including government incentives as a new strategic measure in the balanced scorecard for subsequent iterations.

6.2.1.3 Incumbent Power Technology Segments

Further segmentation of the markets should be conducted, based on overall lifecycle costs of the incumbent technologies in the market. For the electrical power supply application of Company X's technology, different incumbent power technologies have different efficiency factors for capacity (as considered in Section 2.1.3). This leads to significant relative differences in overall lifecycle power costs, and thus in advantages of one incumbent technology over another. In order to further segment the markets by incumbent power technology, additional research will be needed. Such research should include compiling data on power generation efficiency, amortized capital investment costs, operating and maintenance costs, decommission costs, and may include environmental and social costs for each of the various incumbent technologies. This research could be conducted as part of a subsequent study of lifecycle energy costs.

Two different power technology market segments that may be considered by Company X may be "main power" and "backup power" segments. As discussed in Chapter 1, ORE technologies will likely never entirely replace incumbent power technologies. Therefore, the backup power supply market will probably be the most successful for Company X (given the obvious limitations of the generating consistent power). Company X must be clear for future

[82] The UK committed to 18% renewable energy of the country's total energy by 2010 and 40% by 2020 (Web Newswire, 2005)

marketing efforts whether their technology will be marketed as a source for main power or backup power supply.

6.2.1.4 Technology Adoption Life Cycle Profile Segments

The beachhead market ultimately selected Company X should be well represented by Moore's "innovator" and "early adopter" categories, as discussed in Section 4.2.1.3. Hence, market sub-segments should be screened to confirm that they contain innovators and early adopters. An example of a simple method for finding out whether there are innovators and early adopters in the market being evaluated: peruse industry magazines or news clips for information about whether other new technologies are actively being adopted in the industry. Additional recommendations on issues that may influence technology adoption are in Section 6.5.

6.2.1.5 Confirming the Beachhead Market Selection

Findings from the beachhead market selection process should be revisited and confirmed prior to product launch. These markets are dynamic and external factors may change. Company X must minimize the delay between selecting a beachhead market and launching their product.

6.2.1.6 Additional Interviews

Interviews conducted for this report represent only a small sampling of the individual markets. They were successful for screening the broader markets. Once more appropriate sub-segments are identified; it is recommended that substantially more interviews be conducted for accurate representation.

6.2.2 Recommendations for Selected Markets

6.2.2.1 Coastal Communities – Off-Grid

Given the vast size of the off-grid market, it should be further segmented into geographic regions, community sizes or types, product application (electricity generation or water desalination), customer, or a combination of these. Based on Company X's strategies, it is recommended to begin the next stage of segmentation of this market by pursuing more information on smaller communities, in geographic regions where power and fresh water prices are the highest.

6.2.2.2 Coastal Communities - Constrained and Non-Integrated

This equally large market should be further segmented similar to the off-grid market; into geographic regions, community sizes or types, product application, customer, or a combination of these. Further segmentation should focus on small-sized (lesser power needs) constrained communities in geographic regions with the highest costs for power and fresh water supply.

6.2.2.3 Coastal Resorts

Coastal resorts may be further segmented by geographic region, product application, and customer. It is recommended that future efforts in the coastal resort market focus on research for water desalination opportunities. Coastal resort companies seem keen on technologies that offer higher quality and more reliable fresh water. As for customer market segments, resort chains or franchises may offer better opportunities than individually owned resorts. Resort chains may negotiate for the purchase of multiple installations for separate resort properties, with obvious economic benefits.

6.3 Recommendations for Potential Subsequent Markets

A few recommendations are included for the two markets that were not selected as appropriate beachheads. These two markets are the disaster relief and the military markets. The recommendations are presented in case Company X plans to consider these markets as subsequent markets.

6.3.1 Disaster Relief

If Company X plans to eventually launch their product in the disaster relief market, further research efforts should pursue federal government departments for budgets for emergency power and water equipment for emergencies in coastal regions. Particularly government agencies in areas where recent disasters have struck should be contacted for information. Also, discussions with military organizations should include questions about their emergency relief involvement and purchases.

6.3.2 Military

The military market may be a good subsequent market for Company X's technology. It provides a good reference market for more mainstream markets. Additional research recommended for this market includes continuous effort following up contacts identified in the US, Canadian, and British military forces.[83] Contacting other military forces, such as those in other countries with significant coastal and navy operations (such as Japan), would also be beneficial. As mentioned above, disaster relief may be explored as a sub-segment of the military market.

6.4 Customer-Preferred Product Feature Recommendations

The design of Company X's ORE technology product should consider the customer-preferred features identified in this report. Customer-preferred features identified for each of the top three selected markets[84] are presented in Section 4.1. Company X should also consider conducting additional effort into identifying customer preferences once an appropriate beachhead is identified.

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[83] Contact information was provided to Company X but is not included in this report.

[84] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

Customer preferences identified in this report, including aesthetic and vessel navigation features, should be addressed during the product design process. It should be clarified that customer-preferred features identified in this report do not represent an exhaustive list; they only represent those features that came to the minds of the interview respondents. More customer input should be solicited from the selected beachhead market once Company X's technology is closer to commercialization.

Company X should consider conducting a more thorough customer analysis, prior to final design of the product. Such an analysis may include focus groups from the chosen beachhead market. It is recommended that focus groups experience a demo of a full-size prototype, to encourage more and better responses. Their comments should be included in the final design process, to ensure the final product meets the customers' needs.

6.5 Technology Adoption Recommendations

Section 5.5 concluded that there are few differences in adoption factors between the top three markets[85] assessed. Further segmentation of these top three markets is recommended so that the segments with the most adoption facilitators and fewest barriers can be identified. For example, in a given geographic segment within the constrained communities market, there may be more government financial incentives that could facilitate adoption. It is also recommended that Company X complete an external analysis of the beachhead market, once selected, to further identify such specific facilitators and barriers to adoption.

Some recommendations are included that are associated with adoption facilitators and barriers identified in this report. All those listed below are relevant to all three top-ranked markets. These recommendations are: address incompatibility with land-based power system

[85] Coastal Communities – Off-Grid, Coastal Communities – Constrained and Non-Integrated, and Coastal Resorts

operators, minimize complexity, lower financial risk, conduct on-site trials, consider product appearance in design, provide training, and avoid third-party representatives. Each technology adoption recommendation is elaborated on in the sub-sections below.

6.5.1 Address Incompatibility with Land-Based Power System Operators

A solution is needed to address the incompatibility of power system operators who are unfamiliar with ocean-based power systems. Possible solutions may include designing the system so maintenance can be conducted with relative ease on-shore, or the purchase/lease agreement includes a service contract with quick-response capabilities.

6.5.2 Minimize Complexity

To ensure complexity of the technology is minimized, Company X should ensure their power system is designed to facilitate simple operation and easy maintenance. Operators in many markets may not be sophisticated with respect to power generation technologies. They may be in remote locations where access to experts is difficult; therefore, the design of a simple to use and maintain system is crucial to reduce complexity.

6.5.3 Lower Financial Risk

Company X must develop methods to lower the financial risk of investment by customers. Particularly, financial risk must be addressed for customers with limited funds such as those in small off-grid communities and small resorts. Consider lease-to-own or power/water supply contracts with pricing per unit of power or water.

6.5.4 Conduct On-Site Trials

On-site trials by potential customers of the technology are recommended; however, such trials will likely be difficult and costly for Company X. Visiting an existing installation or demo site may also be too costly for potential customers (i.e. too far to travel); therefore, it is recommended that Company X utilize the best technology available to provide information to potential customers. For example, a well-produced video of an existing installation, including testimonials and unbiased evangelists promoting the benefits of the technology. A scaled-down demonstration system would be beneficial if it's feasible for potential customers to visit conveniently.

6.5.5 Consider Product Appearance in Design

Aesthetics of the final product was identified as a key concern by potential customers contacted for information on preferred product features. As such, appearance will be a key concern for the adoption of Company X's technology. Most markets will probably prefer it to be as invisible as possible, such as integrated into an existing marine-based structure. Assuming the design cannot be totally invisible, a distinct "look" is recommended for Company X's product. A distinct appearance will offer greater observability to the public for Company X's product, thus good branding potential for Company X.

Different markets may demand different looks for the final product. Some markets may prefer the ORE product to look like a typical marine object (e.g. a buoy), while other markets may prefer a more low-profile look. To maximize adoption potential, Company X should question potential customers about product appearance in future customer-preferred product feature analyses. Company X should also seek local knowledge on preferred locations for installation, to build trust and address the risk of potential community backlash.

6.5.6 Provide Training

Learning to use the technology will be a key facilitator in a beachhead market, and all subsequent markets for that matter. Prior to launching its product in the selected beachhead market, Company X should develop an effective training program for operators and maintainers of the ORE system.

6.5.7 Avoid Third-Party Representatives

Third party consultants are considered a barrier to adoption of new environmental technologies, from research findings presented in Section 2.1.2.1. Company X is recommended to avoid, or at least be wary, of markets where third party consultants represent the customer. Communicating directly with the actual customer (e.g. community decision-makers) may be a good strategy.

6.6 Beyond the Beachhead

Once a beachhead market segment has been selected for initial product launch, or perhaps even before, Company X should start thinking beyond the beachhead to subsequent markets. A strategic marketing plan should be developed to offer the best chance for ongoing growth and success of the company. This report provides a basis for such a strategic marketing plan.

APPENDIX A

INITIAL LIST OF MARKETS

Appendix A – Initial List of Markets

This list represents the initial list of markets suggested by Company X for possible evaluation. As the scope of the project required a short list of five markets for evaluation, this initial list of nine markets was reduced based on discussions with the Company X executive team. The first five markets in the list are those that were selected for evaluation. The remaining markets are those that did not make the cut. Some comments are included for those that were not chosen for evaluation in this report.

1. **Coastal Communities – Off-Grid**

2. **Coastal Communities – Constrained and Non-Integrated**

3. **Coastal Resorts**

4. **Disaster Relief**

5. **Military**

6. **Industrial – Ocean-Based Oil and Gas Rigs**

This potential market includes oil and gas companies and contractors who design, build, or operate offshore oil and gas rigs. Company X suspected that companies in this market would be less keen on ocean renewable energy (ORE) technologies, but wanted to confirm their suspicion. Clearly, why would a natural gas producing offshore rig use anything other than natural gas or other petroleum fuels for producing power? In addition, renewable energy may be considered a threat to this industry. Regardless, the assumed power requirements for offshore rigs may be a feasible application for Company X's technology.

To confirm the suspicion that companies in this market may not be keen on ORE, an interview was conducted with an expert in the oil rig industry.[86] Findings from the interview indicated that offshore rigs require an incredible amount of power: from 5 megawatts (MW) for an exploration drilling rig to greater than 100MW for a large production rig. Reliability requirements are also highly important for uninterruptible power, for safety reasons. To meet these two main power criteria, the industry employs large diesel generators. According to the interviewee, current renewable power alternatives do not adequately meet these two criteria and do not have sufficient power storage capabilities. Based on the interview information, Company X and the author decided that the interest level in ORE technologies in this market would be insufficient.

7. Science Stations

This potential market includes remote coastal scientific research stations. Company X and the author decided that this market may be inappropriate as a beachhead for a few reasons. Reasons included: small market size, transient nature of science stations, and general lack of significant funding. In addition, this market is unlikely to provide significant observability for the technology (i.e. it is not mainstream).

8. Industrial – Aquaculture

This potential market includes fish hatcheries and related aquaculture facilities. These facilities require pumping and power for a steady supply of fresh water for rearing tanks. Company X decided that this market may be inappropriate as a beachhead because of poor financial resources in the industry.

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[86] Ed Bourgeau, Power Systems Engineer, TransOcean Inc. (a contractor that designs deep ocean oil and gas drilling and production vessels); June 1, 2005

9. Industrial – Coastal Agriculture

This potential market includes coastal farming and green housing. The most likely application for Company X's technology in this market would be for desalination, to generate fresh water for irrigation. Company X executives decided that this market is a lower priority and may be a good subsequent market.

APPENDIX B

INTERVIEW GUIDE

Appendix B – Interview Guide

Market Segment: ____________
Organization: ____________
Contact Name: ____________
Telephone: ____________
Date: ____________

QUESTIONS

<u>Introduction</u> Who I am and how the information will be used. I am a researcher from SFU looking at the potential for ORE technologies in various markets, including yours. I am trying to find out where Company X's technology is situated in relation to currently-used power systems in communities/industries such as yours. The information will help ORE technology companies focus on the best markets for which to develop their products. Your feedback at this stage is valuable to me and hopefully, eventually, to your community/industry/organization.
First Question: We'd like to know what attributes of renewable energy production would be useful to you? (e.g. "green-ness", self-reliant power production, no fuel, cost-efficiency, etc.)
<u>Electrical Power Supply Questions</u>
What is(are) the current source(s) of electric power for your community/operation?
Does your current source(s) meet your power demand needs now/future? **(Do you know your power demand (how much per year)?)** **(Do you know your current costs for power?)** **If you own the power generation assets, how often do they need replacement? When must they be replaced next? (Approx. cost?)**
How well does your power system perform? (Reliable? Cost-effective? Maintenance?)
What would you change about your current power supply if you could? (The largest problems?)
Have you looked into other ways of supplying energy? If so, what types? What happened?
How important is it for you to have a sustainable power source for your community/business (on a scale of 1-10)? Is your current system in line with the values of your community/business?
Do you have any policy on purchasing renewable energy? Any problems finding appropriate sources/technologies?
What % above current power costs would you pay for green power?

How satisfied are you with your current power system (on a scale of 1-10)?
<u>Desalination Questions</u>
What is your current source of fresh water?
Does it meet your needs now/future? (Do you know your demand in L/yr now/future?) (Do you know the cost (per litre/gallon)?)
How well does your system perform? (Reliable? Cost-effective? Maintenance?)
What are the largest problems with your current system?
Have you looked into any solutions? If so, what types?
How important is it for you to have a sustainable power source for your desalinated water system (on a scale of 1-10)? Is your current system in line with the values of your community/business?
How satisfied are you with your current fresh water system (on a scale of 1-10)?
<u>General Questions</u>
What is your purchase process for new power equipment/assets?
Describe Company X's system in general. What do you see as a barrier to using this technology in your community/operation/industry?
Would you consider participating in a trial of the technology?
Wrap up: • Do you mind if I contact you again? • Do you want more information? • Do you want to be on an email list?

APPENDIX C

BALANCED SCORECARDS

Generic Balanced Scorecard

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness	• Revenue estimates for the market	3	Estimated revenues based on assumptions of total energy consumption and estimated price for market.			
		• Profitability • Expected profitability • Range/volatility	1	Expected profitability is based on assumptions of relative price (relative cost of incumbent power) minus cost to service the market. Range/volatility of profits depends on location, price variability, range in cost to service the market.			
		• Ability to pay	1	Ability for customers to invest in the technology (to secure payment to Company X).			
		• Willingness to pay	3	Willingness for customers to pay. How badly do they want the technology?			
		• Cost competitiveness	3	Cost competitiveness with incumbent technologies. What is the current estimated cost of energy in the market (per kWh)?			
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market	3	The degree to which the market is underserviced by incumbent sources and how well the ORE technology will solve the problem. (e.g. cost performance, reliability, noise, mobility, space-efficiency, environmental risk). Includes electricity and water desalination.			
		• Ability to compete with incumbent technologies	2	Competition is based on factors excluding cost, but including reliability, maintenance, fuel supply, ease of use, etc.			
		• Estimated speed of adoption	3	The estimated speed of adoption in the market. How quickly will the customer adopt, based on purchasing process, existing capital assets, lifecycle of assets?			
		• Level of technological sophistication of the customer	1	Similar to adoption above, but specifically refers to the technological sophistication of the customer. How tech savvy is the customer? Will the customer understand it or will they view it as too complicated and risky? How familiar are they with renewable power systems?			

Generic Balanced Scorecard

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation	2	How well the market provides for technology validation. Smaller equipment installations will provide for better and easier solutions to early-stage construction and maintenance problems.			
		• Potential for market dominance	3	The degree to which customers in the market pull for the technology, such that it may become the dominant source of power.			
		• Total market demand	1	Total estimated energy consumption per year.			
		• Internal support for the market	1	Shareholders' and board member's support. Are there any special interest factors from internal stakeholders that may influence the selection?			
		• Observability	1	Observability of the technology in this market. How visible is the equipment (i.e. physical location)? The geographical size of market; is it a global or wide-reaching geographical market?			
		• Market accessibility	2	Ability or difficulty to service the market. Considers enablers and barriers with respect to policies/regulations, technical, cultural.			
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets	2	How well the market can be used as a reference for subsequent markets. Do others look to this market for new ideas and technologies?			
		• Market growth potential	3	What are the trends or assumptions for growth of this market? How large? How fast?			
						TOTAL WEIGHTED SCORE:	

Balanced Scorecard – Coastal Communities – Off-Grid

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness	• Revenue estimates for the market	3	Estimated revenues based on assumptions of total energy consumption and estimated price for market.	+ +	Large potential due to global-scale market demand. A conservative estimate of 50 million people at an average energy consumption of 4,980kWh per year, times a conservative price of CAN$0.20/kWh, the total estimated value of the market is CAN$49.8 billion per year.	6 +

		• Profitability
		  • Expected profitability
		  • Range/volatility
			1	Expected profitability is based on assumptions of relative price (relative cost of incumbent power) minus cost to service the market.
				Range/volatility of profits depends on location, price variability, range in cost to service the market.
					+ +	High costs for power in most off-grid communities. Assumed to be higher cost than constrained communities.
						Volatility may be high, depending on geographical region and currency.
							2 +

		• Ability to pay	1	Ability for customers to pay for the technology (to secure payment to Company X).	-	Varies greatly, but typically a convoluted funding process, and small communities themselves generally have very limited funding.	1 -
		• Willingness to pay	3	Willingness for customers to pay. How badly do they want the technology?	0	Highly variable depending on individual need and alternatives. From interviews, most are not likely to pay more than current costs, but some have a high desire for renewable power though.	0
		• Cost competitiveness	3	Cost competitiveness with incumbent technologies. What is the current estimated cost of energy in the market (per kWh)?	+	Costs for off-grid power are substantially higher due to poor efficiencies of scale and high fuel costs. From interviews, costs for off-grid power reached $1.82/kWh	3 +

Balanced Scorecard – Coastal Communities – Off-Grid

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market	3	The degree to which the market is underserviced by incumbent sources and how well the ORE technology will solve the problem. (e.g. cost performance, reliability, noise, mobility, space-efficiency, environmental risk). Includes electricity and water desalination.	+ +	Many opportunities to solve problems related to generator use, and problems with other renewable power options. More problems identified in this market than others.	6 +
		• Ability to compete with incumbent technologies	2	Competition is based on factors excluding cost, but including reliability, maintenance, fuel supply, ease of use, etc.	+	Difficult to assess until the technology is closer to commercialization, and it will depend on the individual situation. However, based on assumed costs for incumbent technologies alone (costs are higher in this market) the ability to compete is assumed to be higher than in some other markets.	2 +
		• Estimated speed of adoption	3	The estimated speed of adoption in the market. How quickly will the customer adopt, based on purchasing process, existing capital assets, lifecycle of assets?	-	Likely to be slow, due to convoluted purchase process and 20 year life cycle of diesel generators.	3 -
		• Level of technological sophistication of the customer	1	Similar to adoption above, but specifically refers to the technological sophistication of the customer. How tech savvy is the customer? Will the customer understand it or will they view it as too complicated and risky? How familiar are they with renewable power systems?	-	Situation-dependant. Depends if customer is local, regional, federal government level. 3rd party consulting engineers are usually involved, which may be a detriment.	1 -

Balanced Scorecard – Coastal Communities – Off-Grid							
	Strategic Objectives	**Strategic Measures**	**Weight**	**Explanation of Measures**	**Score**	**Scoring Rationale and Assumptions**	**Weighted Score**
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation	2	How well the market provides for technology validation. Smaller equipment installations will provide for better and easier solutions to early-stage construction and maintenance problems.	+ +	Smaller-scale installations will meet needs of most off-grid communities. If an installation is approved, it will likely be well-supported and provide good validation opportunity.	4 +
		• Potential for market dominance	3	The degree to which customers in the market pull for the technology, such that it may become the dominant source of power.	0	All markets are given a neutral score. It is too early in the development of the technology to score the markets on this criterion. Revisit this criterion once technology performance is determined.	0
		• Total market demand	1	Total estimated energy consumption per year.	+ +	Difficult to estimate, but given conservative assumptions above, total consumption for 50 million people @ 1,500kWh/person = 75GWh/year.	2 +
		• Internal support for the market	1	Shareholders' and board member's support. Are there any special interest factors from internal stakeholders that may influence the selection?	0	All markets are given a neutral score. Internal stakeholders are united in supporting the selected market with the best potential, at this time.	0
		• Observability	1	Observability of the technology in this market. How visible is the equipment (i.e. physical location)? The geographical size of market; is it a global or wide-reaching geographical market?	0	All markets are given a neutral score. It is assumed that transparency in the media creates no advantage in one market over another for renewable energy technologies.	0
		• Market accessibility	2	Ability or difficulty to service the market. Considers enablers and barriers with respect to policies/regulations, technical, cultural.	0	All markets are given a neutral score. This metric cannot be accurately scored against the other markets at this time, given breadth of the market segment. This metric should be revisited upon further market segmentation.	0

Balanced Scorecard – Coastal Communities – Off-Grid

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets	2	How well the market can be used as a reference for subsequent markets. Do others look to this market for new ideas and technologies?	+ +	Many communities look to other communities for sharing information and finding ways to solve problems. Also, higher level governments involved may apply the same solution to multiple communities.	4 +
		• Market growth potential	3	What are the trends or assumptions for growth of this market? How large? How fast?	0	No evidence found to support growth trends in the Off-Grid market; however, the ever-increasing global population suggests more people need more power.	0
						TOTAL WEIGHTED SCORE [29(+) + 5(-)]:	**24**

Balanced Scorecard – Coastal Communities – Constrained and Non-Integrated

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness	• Revenue estimates for the market	3	Estimated revenues based on assumptions of total energy consumption and estimated price for market.	+ +	Huge potential due to global-scale market demand. A conservative estimate of 25 million people at the median worldwide energy consumption of 4,980kWh per year, times a conservative price of CAN$0.15/kWh, the total estimated value of the market is CAN$18.68 billion.	6 +
		• Profitability • Expected profitability • Range/volatility	1	Expected profitability is based on assumptions of relative price (relative cost of incumbent power) minus cost to service the market. Range/volatility of profits depends on location, price variability, range in cost to service the market.	+	Power prices are high in this market, but assumed not as high as the Off-Grid market. Volatility is significant due to different locations and currencies.	1 +
		• Ability to pay	1	Ability for customers to pay for the technology (to secure payment to Company X).	+	Communities in this market are generally larger and may have greater financing ability than many small off-grid communities.	1 +
		• Willingness to pay	3	Willingness for customers to pay. How badly do they want the technology?	+	Variable depending on individual need and alternatives, but the level of interest seems high from interviews.	3 +
		• Cost competitiveness	3	Cost competitiveness with incumbent technologies. What is the current estimated cost of energy in the market (per kWh)?	+	Costs for power in this market are high. From interviews, costs for off-grid non-integrated power reached $1.40/kWh.	3 +

Balanced Scorecard – Coastal Communities – Constrained and Non-Integrated

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market	3	The degree to which the market is underserviced by incumbent sources and how well the ORE technology will solve the problem. (e.g. cost performance, reliability, noise, mobility, space-efficiency, environmental risk). Includes electricity and water desalination.	+	Some big problems with grid power reliability and limited distribution in some constrained communities. A few other problems with diesel generators in non-integrated communities.	3 +
		• Ability to compete with incumbent technologies	2	Competition is based on factors excluding cost, but including reliability, maintenance, fuel supply, ease of use, etc.).	0	Difficult to assess until the technology is closer to commercialization, and it will depend on the individual situation. However, based on assumed costs for incumbent technologies alone (they are lower than in the Off-Grid market), the ability to compete is neutral.	0
		• Estimated speed of adoption	3	The estimated speed of adoption in the market. How quickly will the customer adopt, based on purchasing process, existing capital assets, lifecycle of assets?	+	Adoption is likely slow in non-integrated communities, if replacing existing power assets. Adoption may be much quicker in constrained communities that need to invest quickly in new equipment.	3 +
		• Level of technological sophistication of the customer	1	Similar to adoption above, but specifically refers to the technological sophistication of the customer. How tech savvy is the customer? Will the customer understand it or will they view it as too complicated and risky? How familiar are they with renewable power systems?	+	Depends if customer is a private utility or local, regional, federal government level. Consulting engineers may also be involved. In general though, it is assumed that customers would be reasonably tech savvy in this market.	1 +

Balanced Scorecard – Coastal Communities – Constrained and Non-Integrated

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation	2	How well the market provides for technology validation. Smaller equipment installations will provide for better and easier solutions to early-stage construction and maintenance problems.	-	Larger-scale installations would be needed for most communities in this market. Higher expectations and greater scrutiny perhaps. This adds level of difficulty.	2 -
		• Potential for market dominance	3	The degree to which customers in the market pull for the technology, such that it may become the dominant source of power.	0	All markets are given a neutral score. It is too early in the development of the technology to score the markets on this criterion. Revisit this criterion once technology performance is determined.	0
		• Total market demand	1	Total estimated energy consumption per year.	+ +	Difficult to estimate, but given conservative assumptions above, total consumption for 25 million people @ 1,500kWh/person = 38GWh/year.	2 +
		• Internal support for the market	1	Shareholders' and board member's support. Are there any special interest factors from internal stakeholders that may influence the selection?	0	All markets are given a neutral score. Internal stakeholders are united in supporting the selected market with the best potential, at this time.	0
		• Observability	1	Observability of the technology in this market. How visible is the equipment (i.e. physical location)? The geographical size of market; is it a global or wide-reaching geographical market?	0	All markets are given a neutral score. It is assumed that transparency in the media creates no advantage in one market over another for renewable energy technologies.	0
		• Market accessibility	2	Ability or difficulty to service the market. Considers enablers and barriers with respect to policies/regulations, technical, cultural.	0	All markets are given a neutral score. This metric cannot be accurately scored against the other markets at this time, given breadth of the market segment. This metric should be revisited upon further market segmentation.	0

Balanced Scorecard – Coastal Communities – Constrained and Non-Integrated							
	Strategic Objectives	**Strategic Measures**	**Weight**	**Explanation of Measures**	**Score**	**Scoring Rationale and Assumptions**	**Weighted Score**
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets	2	How well the market can be used as a reference for subsequent markets. Do others look to this market for new ideas and technologies?	+ +	Many communities look to other communities for sharing information and finding ways to solve problems. Also, higher level governments involved may apply the same solution to multiple communities.	4 +
		• Market growth potential	3	What are the trends or assumptions for growth of this market? How large? How fast?	0	No evidence found to support growth trends in the Constrained and Non-Integrated market; however, the ever-increasing global population suggests more people need more power.	0
						TOTAL WEIGHTED SCORE [27(+) + 2(-)]:	**25**

Balanced Scorecard – Coastal Resorts

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness	• Revenue estimates for the market	3	Estimated revenues based on assumptions of total energy consumption and estimated price for market.	+	Insufficient data is available to calculate an estimate **for this market. However, it is a large, global-scale** market. An accurate estimate is difficult. For an order of magnitude, assume the following conservative estimate for power revenues: 1) 50,000 coastal resorts worldwide x 2) average of 30 people per resort 3) the median 4,980kWh per year per person 4) CAN$0.20/kWh, Total estimated value of the market = 1x2x3x4 = CAN$1.49billion per year. Water desalination may represent additional significant revenues in this market. Assuming $3/cu.m x 50cu.m/person/year x 1.5million people = CAN$225million per year.	3 +
		• Profitability • Expected profitability • Range/volatility	1	Expected profitability is based on assumptions of relative price (relative cost of incumbent power) minus cost to service the market. Range/volatility of profits depends on location, price variability, range in cost to service the market.	+	Insufficient data is available to accurately estimate profitability; however, costs for power are assumed to be similar to off-grid communities. Therefore, profitability is assumed to be similar. Volatility may be high, depending on geographical region and currency.	1 +
		• Ability to pay	1	Ability for customers to pay for the technology (to secure payment to Company X).	0	Depends on the individual resort, it's availability of cash and financing procedures. Large chains may have greater ability to finance capital assets than small independent resorts.	0
		• Willingness to pay	3	Willingness for customers to pay. How badly do they want the technology?	+	High willingness to pay for better ROI and competitive advantages related to green marketing and increased guest comfort (i.e. more reliable power, better quality water).	3 +
		• Cost competitiveness	3	Cost competitiveness with incumbent technologies. What is the current estimated cost of energy in the market (per kWh)?	0	Very situation dependant. For electric power, costs will vary substantially between on-grid vs. off-grid resorts. For fresh water, costs also vary greatly (from free to $9/m^3$ from interviews).	0

Balanced Scorecard – Coastal Resorts

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market	3	The degree to which the market is underserviced by incumbent sources and how well the ORE technology will solve the problem. (e.g. cost performance, reliability, noise, mobility, space-efficiency, environmental risk). Includes electricity and water desalination.	+	The greatest problems seem to be with fresh water supply. For electric power, there are some problems with other renewable technologies possibly slowing adoption of those technologies in the resort market. Also, reliability of power during storms is a common problem.	3 +
		• Ability to compete with incumbent technologies	2	Competition is based on factors excluding cost, but including reliability, maintenance, fuel supply, ease of use, etc.	0	Difficult to assess until the technology is closer to commercialization, and it will depend on the individual situation. This metric should be revisited later in the technology development process.	0
		• Estimated speed of adoption	3	The estimated speed of adoption in the market. How quickly will the customer adopt, based on purchasing process, existing capital assets, lifecycle of assets?	+ +	For some resorts where electric grid power is unreliable ORE may represent viable backup power, thus quicker adoption. For off-grid resorts with diesel generators, adoption is likely to be slow, due to the 20 year life cycle of diesel generators. For water desalination, adoption could be quick in areas with poor water quality.	6 +
		• Level of technological sophistication of the customer	1	Similar to adoption above, but specifically refers to the technological sophistication of the customer. How tech savvy is the customer? Will the customer understand it or will they view it as too complicated and risky? How familiar are they with renewable power systems?	+	Larger resort organizations seem to be more technologically sophisticated; however, all resorts contacted had some knowledge of renewable power systems.	1 +

Balanced Scorecard – Coastal Resorts

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation	2	How well the market provides for technology validation. Smaller equipment installations will provide for better and easier solutions to early-stage construction and maintenance problems.	+ +	Smaller-scale installations would be common for resorts, particularly for backup power and desalination applications. Resorts typically stress good maintenance in their organizations so an ORE installation would be well-supported and maintained.	4 +
		• Potential for market dominance	3	The degree to which customers in the market pull for the technology, such that it may become the dominant source of power.	0	All markets are given a neutral score. It is too early in the development of the technology to score the markets on this criterion. Revisit this criterion once technology performance is determined.	0
		• Total market demand	1	Total estimated energy consumption per year.	+	Accurate data was not available for this market. It is assumed that total consumption in this market is significant, but less than the coastal communities markets.	1 +
		• Internal support for the market	1	Shareholders' and board member's support. Are there any special interest factors from internal stakeholders that may influence the selection?	0	All markets are given a neutral score. Internal stakeholders are united in supporting the selected market with the best potential, at this time.	0
		• Observability	1	Observability of the technology in this market. How visible is the equipment (i.e. physical location)? The geographical size of market; is it a global or wide-reaching geographical market?	0	All markets are given a neutral score. It is assumed that transparency in the media creates no advantage in one market over another for renewable energy technologies.	0
		• Market accessibility	2	Ability or difficulty to service the market. Considers enablers and barriers with respect to policies/regulations, technical, cultural.	0	All markets are given a neutral score. This metric cannot be accurately scored against the other markets at this time, given breadth of the market segment. This metric should be revisited upon further market segmentation.	0

Balanced Scorecard – Coastal Resorts

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets	2	How well the market can be used as a reference for subsequent markets. Do others look to this market for new ideas and technologies?	-	Uncertain. The hospitality industry is not widely known as a "hotbed" for new energy technologies.	2 -
		• Market growth potential	3	What are the trends or assumptions for growth of this market? How large? How fast?	+	Research indicates an increasing demand for coastal resort holidays.	3 +
						TOTAL WEIGHTED SCORE [25(+) + 2(-)]:	**23**

Balanced Scorecard – Disaster Relief

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness	• Revenue estimates for the market	3	Estimated revenues based on assumptions of total energy consumption and estimated price for market.	- -	Very poor potential for large revenues based on potential customers researched in this study (Red Cross, UN, etc). Power assets and water desalination equipment for disasters are purchased by governments and the military. ***Much larger potential for revenues within governments and military forces. Per the report, in Indonesia alone the estimate to rebuild tsunami-damaged power and telecommunications networks is US$150Billion. Additional research is required in this market! Re-score this metric once the actual customers are identified.	6 -
		• Profitability • Expected profitability • Range/volatility	1	Expected profitability is based on assumptions of relative price (relative cost of incumbent power) minus cost to service the market. Range/volatility of profits depends on location, price variability, range in cost to service the market.	+	Interviews suggest that costs in emergencies are not as important as other considerations, such as convenience and reliability; therefore, profitability is potentially high.	1 +
		• Ability to pay	1	Ability for customers to pay for the technology (to secure payment to Company X).	0	Assuming that the key customers will be within governmental organizations around the world, their ability to pay is highly variable.	0
		• Willingness to pay	3	Willingness for customers to pay. How badly do they want the technology?	+ +	Willingness to pay in an emergency, or shortly after an emergency is very high.	6 +
		• Cost competitiveness	3	Cost competitiveness with incumbent technologies. What is the current estimated cost of energy in the market (per kWh)?	0	Diesel generators are the main competing technology in this market, so costs are assumed to be similar to off-grid communities. However, costs are not as important in this market, so a lower score is appropriate here.	0

Balanced Scorecard – Disaster Relief

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market	3	The degree to which the market is underserviced by incumbent sources and how well the ORE technology will solve the problem. (e.g. cost performance, reliability, noise, mobility, space-efficiency, environmental risk). Includes electricity and water desalination.	0	Where needed, electricity generation in this market seems well-serviced by diesel generators. Interviews suggest water desalination equipment is too complex and costly to operate in relief situations, so other options are used for fresh water supply. Neutral score given; however, this metric should be revisited once the ORE technology is further advanced.	0
		• Ability to compete with incumbent technologies	2	Competition is based on factors excluding cost, but including reliability, maintenance, fuel supply, ease of use, etc.	0	Difficult to assess for this market until the technology is closer to commercialization, for both electric power and desalinated water supply applications.	0
		• Estimated speed of adoption	3	The estimated speed of adoption in the market. How quickly will the customer adopt, based on purchasing process, existing capital assets, lifecycle of assets?	- -	Difficult to assess until potential customers are better identified, but assume the following: 1) Customers are governments and military forces. 2) Government and military purchasing processes are slow. 3) Time needed for proving reliability of technology in emergency applications is long. Therefore, adoption is likely very slow.	6 -
		• Level of technological sophistication of the customer	1	Similar to adoption above, but specifically refers to the technological sophistication of the customer. How tech savvy is the customer? Will the customer understand it or will they view it as too complicated and risky? How familiar are they with renewable power systems?	0	Assuming that customers may be either in governments or military forces, their levels of sophistication are highly variable. Assume a neutral score for this metric.	0

Balanced Scorecard – Disaster Relief

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation	2	How well the market provides for technology validation. Smaller equipment installations will provide for better and easier solutions to early-stage construction and maintenance problems.	- -	Size of installations in this market is variable. A more important factor for this metric is the high risk of a new ORE technology not working properly and causing additional difficulties in an emergency situation. Also, level of operator skill is less controllable in this market.	4 -
		• Potential for market dominance	3	The degree to which customers in the market pull for the technology, such that it may become the dominant source of power.	0	All markets are given a neutral score. It is too early in the development of the technology to score the markets on this criterion. Revisit this criterion once technology performance is determined.	0
		• Total market demand	1	Total estimated energy consumption per year.	0	Data is not easily available nor would it be consistent for energy demand for disaster-stricken areas. Electric power consumption for relief organization operations is low (they use small generators for field operations). Assume neutral score, given uncertainty.	0
		• Internal support for the market	1	Shareholders' and board member's support. Are there any special interest factors from internal stakeholders that may influence the selection?	0	All markets are given a neutral score. Internal stakeholders are united in supporting the selected market with the best potential, at this time.	0
		• Observability	1	Observability of the technology in this market. How visible is the equipment (i.e. physical location)? The geographical size of market; is it a global or wide-reaching geographical market?	0	All markets are given a neutral score. It is assumed that transparency in the media creates no advantage in one market over another for renewable energy technologies.	0
		• Market accessibility	2	Ability or difficulty to service the market. Considers enablers and barriers with respect to policies/regulations, technical, cultural.	0	All markets are given a neutral score. This metric cannot be accurately scored against the other markets at this time, given breadth of the market segment. This metric should be revisited upon further market segmentation.	0

Balanced Scorecard – Disaster Relief

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets	2	How well the market can be used as a reference for subsequent markets. Do others look to this market for new ideas and technologies?	+ +	It is assumed that disaster relief technologies would be highly referenced, given the importance for reliability and convenience in such operating conditions. In addition, military customers may support it for this market which provides positive referencing.	4 +
		• Market growth potential	3	What are the trends or assumptions for growth of this market? How large? How fast?	+	Research indicates that human populations and their infrastructure are increasingly more vulnerable to disasters. This trend suggests growth for power technologies in the market.	3 +
						TOTAL WEIGHTED SCORE [14(+) + 16(-)]:	**-2**

Balanced Scorecard – Military

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Financial	• Revenues • Profitability • Manage risk • Cost competitiveness	• Revenue estimates for the market	3	Estimated revenues based on assumptions of total energy consumption and estimated price for market.	+	Insufficient data is available to estimate revenues. Assume potential revenues would be in the $millions. Additional research is required.	3 +
		• Profitability • Expected profitability • Range/volatility	1	Expected profitability is based on assumptions of relative price (relative cost of incumbent power) minus cost to service the market. Range/volatility of profits depends on location, price variability, range in cost to service the market.	0	Insufficient data is available to estimate profitability. Range/volatility is probably lower, due to less potential customers in this market than others. Additional research is required.	0
		• Ability to pay	1	Ability for customers to invest in the technology (to secure payment to Company X).	0	Depends on the military force. Generally a long and onerous process to get funding approval, but once on a military budget, the money is usually secure. Neutral score due to variability and difficulty.	0
		• Willingness to pay	3	Willingness for customers to pay. How badly do they want the technology?	+	Insufficient data available. It is assumed that military forces in more developed nations are keen to test new technologies (e.g. US Navy). If technologies offer strategic advantages, willingness to pay would be high.	3 +
		• Cost competitiveness	3	Cost competitiveness with incumbent technologies. What is the current estimated cost of energy in the market (per kWh)?	0	Uncertain, but assume energy costs are similar to other markets that use grid power and portable diesel generators. Neutral score due to uncertainty.	0

Balanced Scorecard – Military

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Customer	• Solves a problem • Competes with incumbent technologies • Speed of adoption • Technological sophistication of customer	• The ability to solve a problem in the market	3	The degree to which the market is underserviced by incumbent sources and how well the ORE technology will solve the problem. (e.g. cost performance, reliability, noise, mobility, space-efficiency, environmental risk). Includes electricity and water desalination.	0	Insufficient information available. Additional research is required.	0
		• Ability to compete with incumbent technologies	2	Competition is based on factors excluding cost, but including reliability, maintenance, fuel supply, ease of use, etc.	0	Insufficient information available. Additional research is required.	0
		• Estimated speed of adoption	3	The estimated speed of adoption in the market. How quickly will the customer adopt, based on purchasing process, existing capital assets, lifecycle of assets?	-	According to interview information, military procurement procedures are very slow, from 3-5 years. Adoption may be quicker if the technology has potential strategic advantages.	3 -
		• Level of technological sophistication of the customer	1	Similar to adoption above, but specifically refers to the technological sophistication of the customer. How tech savvy is the customer? Will the customer understand it or will they view it as too complicated and risky? How familiar are they with renewable power systems?	+ +	Although procurement can be slow, military forces in developed nations tend to be at the leading edge of technology.	2 +

Balanced Scorecard – Military

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Internal	• Technology validation • Market dominance • Internal support • Maximum observability • Market accessibility	• Potential for successful technology validation	2	How well the market provides for technology validation. Smaller equipment installations will provide for better and easier solutions to early-stage construction and maintenance problems.	- -	Company X's perception is that the military is a poor platform for tech validation due to poor information flow from the military organization.	4 -
		• Potential for market dominance	3	The degree to which customers in the market pull for the technology, such that it may become the dominant source of power.	0	All markets are given a neutral score. It is too early in the development of the technology to score the markets on this criterion. Revisit this criterion once technology performance is determined.	0
		• Total market demand	1	Total estimated energy consumption per year.	0	Insufficient information available. Neutral score due to uncertainty. Additional research is required.	0
		• Internal support for the market	1	Shareholders' and board member's support. Are there any special interest factors from internal stakeholders that may influence the selection?	0	All markets are given a neutral score. Internal stakeholders are united in supporting the selected market with the best potential, at this time.	0
		• Observability	1	Observability of the technology in this market. How visible is the equipment (i.e. physical location)? The geographical size of market; is it a global or wide-reaching geographical market?	0	All markets are given a neutral score. It is assumed that transparency in the media creates no advantage in one market over another for renewable energy technologies.	0
		• Market accessibility	2	Ability or difficulty to service the market. Considers enablers and barriers with respect to policies/regulations, technical, cultural.	0	All markets are given a neutral score. This metric cannot be accurately scored against the other markets at this time, given breadth of the market segment. This metric should be revisited upon further market segmentation.	0

Balanced Scorecard – Military

	Strategic Objectives	Strategic Measures	Weight	Explanation of Measures	Score	Scoring Rationale and Assumptions	Weighted Score
Growth & Learning	• Reference market • Growth within market	• Reference potential for subsequent markets	2	How well the market can be used as a reference for subsequent markets. Do others look to this market for new ideas and technologies?	+ +	The military is widely referenced by others for new technologies.	4 +
		• Market growth potential	3	What are the trends or assumptions for growth of this market? How large? How fast?	+	Research indicates the global military market is growing, mainly due to increased spending by the US military.	3 +
						TOTAL WEIGHTED SCORE [15(+) + 7(-)]:	**8**

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