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Oceanography
EIS Project
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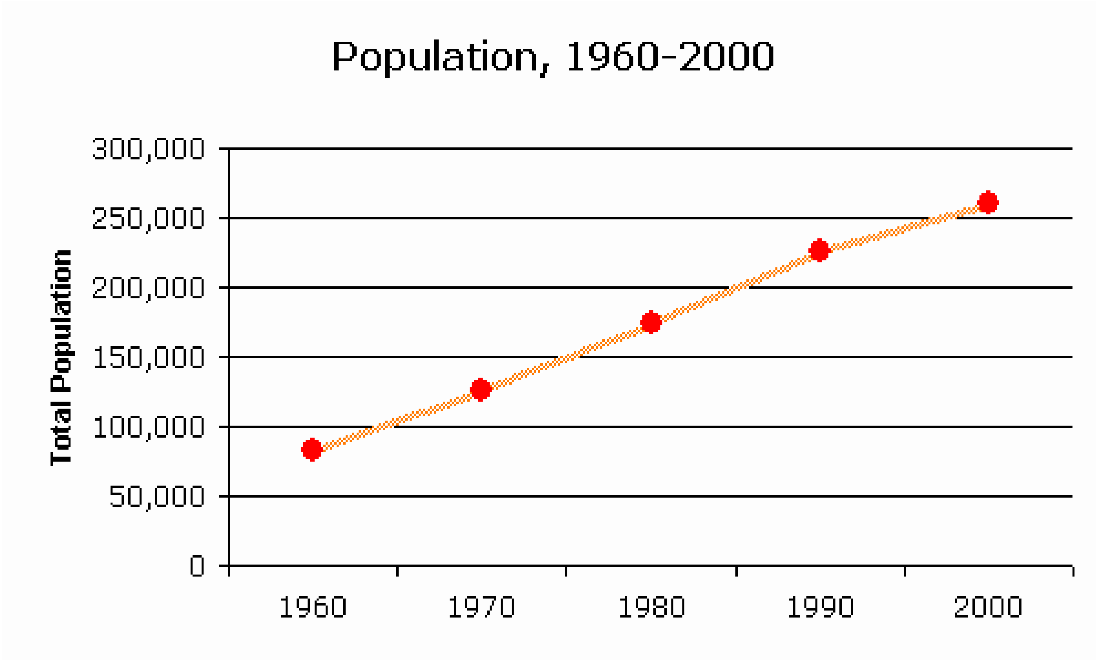
EIS- Tides Could Be Changing Energy Output Source

I. Introduction: New Sources of Energy

Consumption and demand of energy is increasing worldwide. As demand increases, humans need to establish new and reliable sources of energy that can carry the population into the future. The main sources of energy used now are finite natural resources such as, coal and oil. These resources cause severe environmental problems and continued use could cause devastating long-term effects to many important ecosystems. An alternative to these finite resources is renewable energy. There are many sources of renewable energy that have the potential to produce a large percent of the world's energy. Many of these resources could come from the movement of water within oceans and rivers. The oceans have vast amounts of untapped energy that could be harnessed to supply cities around the world. Tides are one possible source of energy from the movement of water. Landscapes that have large tidal ranges are perfect areas to access the large amount of energy available within the ocean. A specific site that offers possible energy capture from tides is Alaska's Cook Inlet.

Alaska's population has been increasing significantly since 1960. As the population grows, especially in Anchorage, there is a need for more energy to support the growth of the economy and population. The Kink Arm of Cook Inlet possesses massive potential for tidal power production. During Spring tides, there is a tidal range of over 30 feet. A non-profit organization, The Electric Power Research Institute estimated, that the Knik Arm could produce an average of 116 megawatts of electric power. Tidal Power is a potential energy source that Anchorage could add to their energy portfolio. Creating a balanced and diversified energy

Figure 1- Steady Increase of Anchorage Population



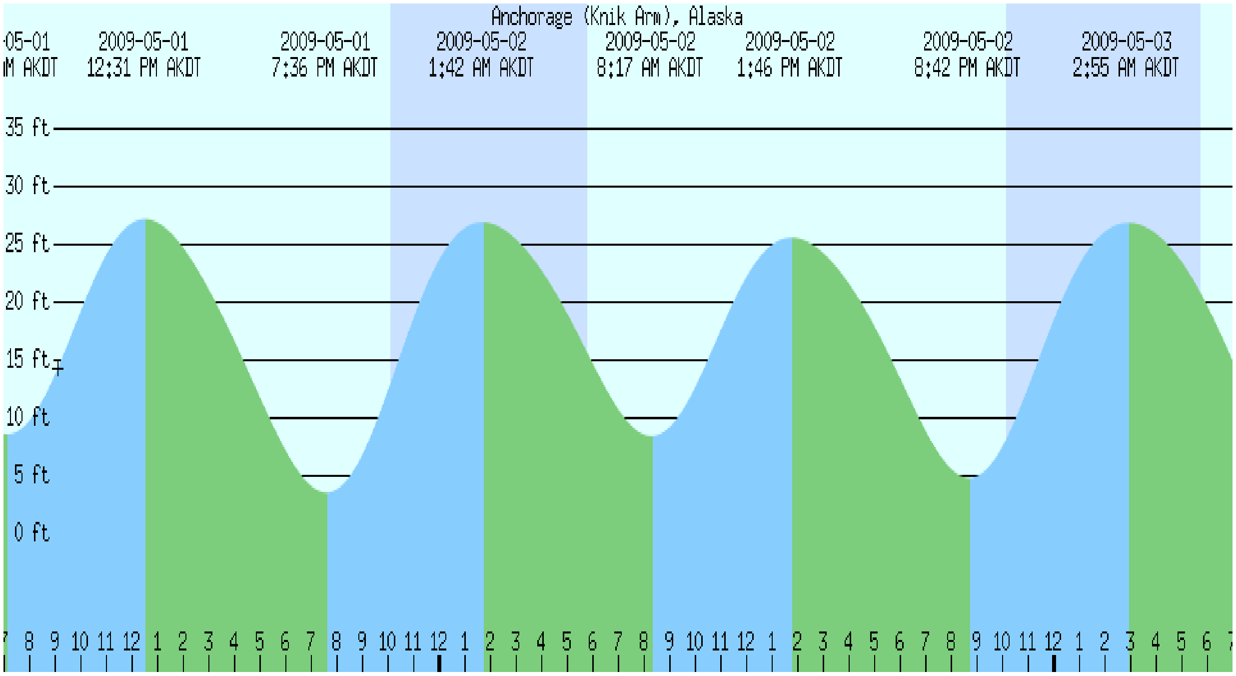
portfolio would stabilize the electric grid and bring numerous benefits to the area. By producing local tidal energy, Alaska would alleviate the demand for non-renewable resources, use a sustainable CO2 free energy source, create jobs, and provide a local long-term energy supply. There are many different technologies and approaches that could be used to capture the untapped energy of tides.

II. Implementation and Device/Site Selection

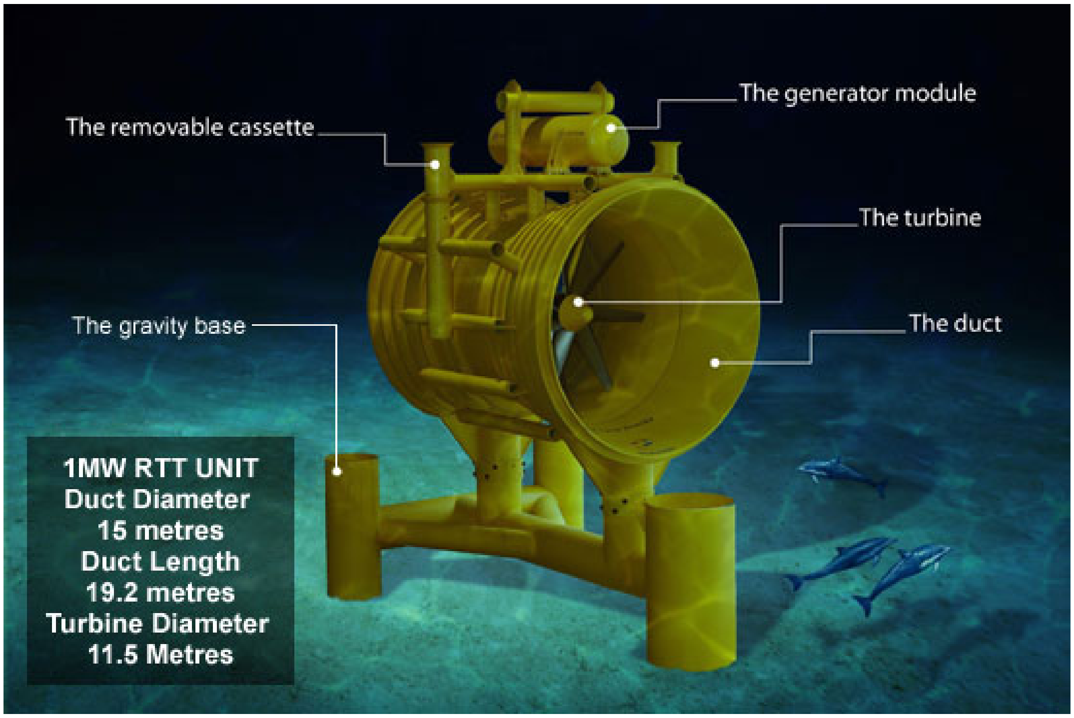
This report will evaluate the project feasibility, environmental impacts, and economical implications of inserting a commercial size in-stream tidal power plant in the Knik Arm of the Cook Inlet. The most feasible implementation for tidal energy in the Knik Arm is a tidal in-stream energy conversion device (TISEC). Several independent companies are designing and producing these devices. Each company has a different design and some are better for specific sites. Many variables come into play when deciding which device will work best in the Knik

Arm such as, water depth, strength of currents, and cross sectional area of the channel. One potential device that could be used is Lunar Energy's RTT 2000.

Figure 2- Tidal Oscillation Near Anchorage, Alaska. Semidiurnal Cycle (2 lows 2 highs per lunar day)

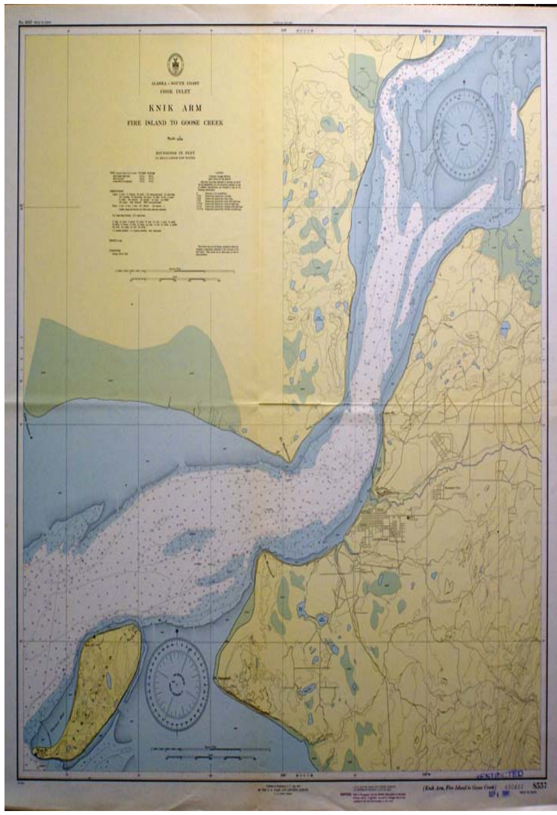


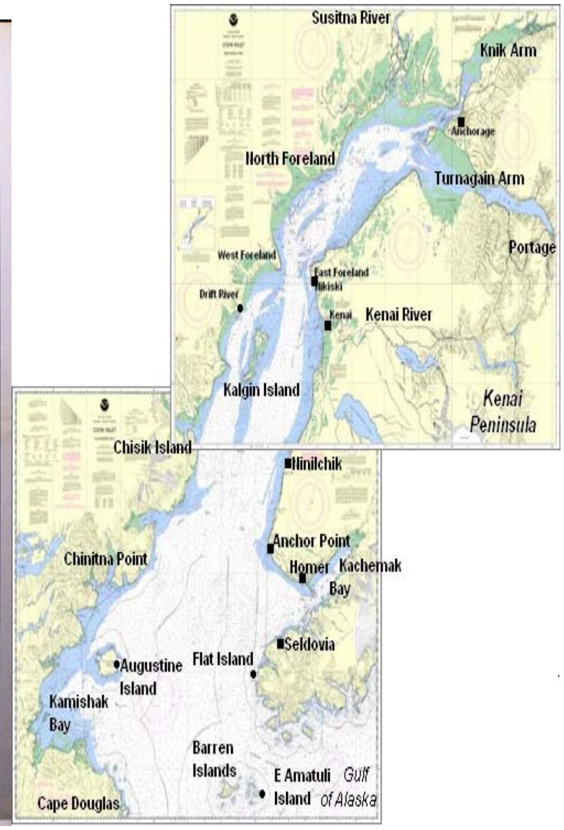
Lunar Energy's RTT TISEC device is a bi-directional horizontal axis turbine housed in a venturi symmetrical duct. The duct draws existing ocean currents into the turbines in order to capture and convert energy into electricity. Once in position the bi-directional ducted rotor with its symmetrical turbine blades uses the venturi shaped duct to accelerate tidal flows through the turbine and increases the energy that can be captured by the turbine. The electricity gained from each turbine would run through subsea cables and eventually reach the power circuit on land. A Diagram of the RTT 2000 can be seen below.



For tidal power in the Knik Arm to be feasible and efficient many criteria need to be satisfied. The site must have a strong tidal energy resource, low-cost of connecting to power-grid, and have close proximity to a major port. The specific location that satisfies these criteria is Cairn Point, which is just north of Anchorage on the East side of the Knik Arm. Many areas of Knik Arm are very shallow however, water depths off of Cairn Point exceed 50 (m). Due to Cook Inlet's large tidal range and the convergence at Cairn Point, the diurnal tidal exchange creates high flow velocities. Tidal currents at Cairn Point are reported to be 1.1 m/s. The proximity of Cairn Point to Anchorage is ideal because the energy produced could be easily connected to the energy circuit.

Figure 4- Map of Knik Arm (left) and Cook Inlet (right)





The Electric Power Research Institute (EPRI) has laid out a potential array of turbines for Cairn Point. The array consists of 69 RTT turbines arranged in six transects. On average, the turbines would produce 17 MW of power, which is 15% of the average channel power. The 15% energy production is a maximum energy output that is constrained by environmental factors. If more than 15% of the energy was taken out of the system, environmental problems could occur. Six main cables would be required to bring the power on shore. All the devices would be attached to the sea floor and approximately 9500 m of cable would be used. Several spacing elements would have to be followed. The tip of each rotor would have to be at least 12m below the water surface to ensure the rotor would not come into contact with sea ice. Each device would have to be 10.5 meters apart to prevent lateral interaction between the rotors. Also, each transect would have to be 210m apart downstream to allow turbulent dissipation of the rotor wake. Seabed composition is an important factor because the devices would have to be attached to this substrate. Geological surveys of Knik Arm characterize the seabed as 100 feet of dense, silty sand and overlaying hard clay. The dense sand would be the foundation of the support system. If this project were put into action, there would be several other site-specific issues that need attention.

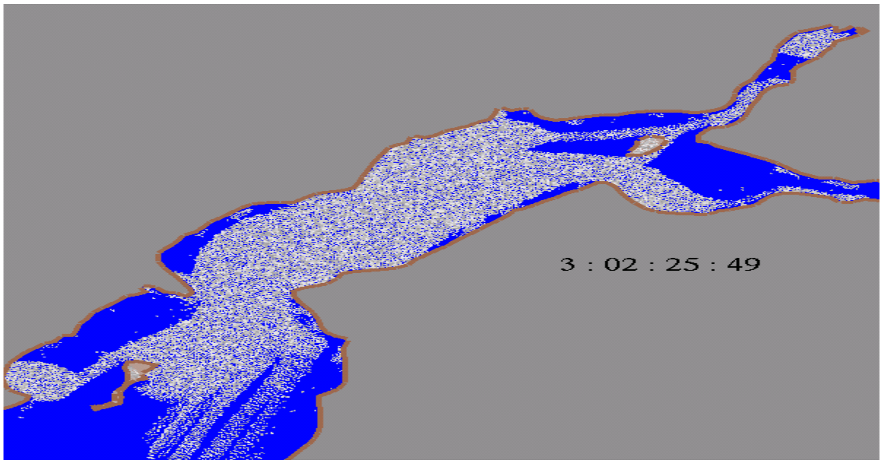
III. Evaluating Concerns

There are always going to be obstacles when trying to start a new project. Often, these problems are put aside and the project starts before proper research has been evaluated. To continue assessing the possible tidal power plant in the Knik Arm this report will attempt to identify the potential problems and negative side-effects that could occur by building the power plant. Once the issues are found, research can provide information on how to diminish negative impacts. Several issues are present that hinder turbine development. Seasonal ice pack, shifts in seabed, high sediment levels within the channel, and concern for fish and marine mammals are just some of the legitimate concerns within the Knik Arm.

-Sea Ice

Sea Ice is a major concern. In order to ensure that sea-ice does not interfere with the turbines a study around Cairn Point would need to be completed that measures average sea ice depth. There have been reports of sea ice of up to 12(m) within the kink arm. Ice depths are uncertain and should be the subject of detailed study prior to turbine deployment. From the estimates of sea ice, it does not appear that sea ice would not interfere with the turbines within the TISEC devices.

Figure 5- Sea ice diagram in Cook Inlet.



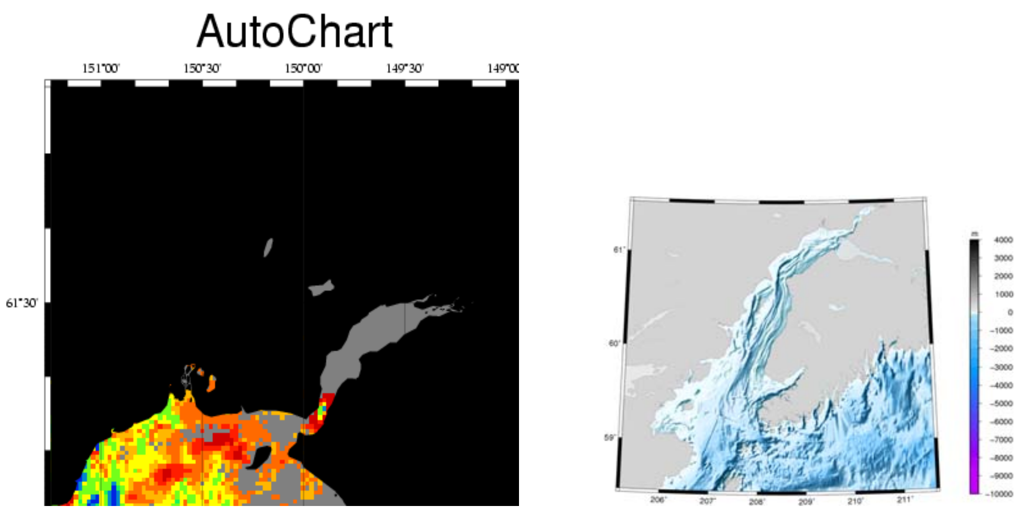
-Bathymetry Changes

In order for the TISEC devices to be stable the ocean floor needs to be relatively flat and have a stable surface layer. Although the area proposed is currently flat there are concerns that geologic adjustments from earthquakes could alter bathymetry in the future. From 1992 to 2001 the seabed surface dropped more than 3m in some areas. A survey of changes of bathymetry should be put in place around Cairn Point. Bathymetry changes will be important for the design of turbine foundations. Many areas in the Knik Arm are very shallow which means the turbines could only be put in a restricted area with a depth of over 40 (m).

-High Sedimentation

A potential environmental impact from the turbines could be the buildup of sediment near the turbines. If sediment were to build up, this could change nutrient transport as well. As velocity decreases near the turbines, some of the suspended sediment would drop out of the flow. Although the twice-daily reversal of tides would partially cure this problem ebb and flow currents are not the same. Depending on the flow strength lots of sediment could build up on and around the turbine device. Also, burying pipelines and attaching the devices could cause significant damage to the coastal seafloor.

Figure 6- Bathymetry Map of Cook Inlet (Blue/Green Shades are 50-60 m deep Yellow 20- 30 m deep and red shades are 0-20 m deep)



-Animal Life

There are many animals that use Cook Inlet as part of their habitat. Several species of salmon use the Knik Arm as migratory breeding grounds. Also, the endangered Beluga Whale resides near the Knik Arm. If individual fish or whales came into contact with the turbines the result would be devastating. The noise produced by the device could interfere with whale communication. In order to eliminate destruction of animals and their habitat many precautions would be needed to ensure their safety. Protective screens would need to be used around the devices. Also, the noise made by the turbines would need to be decreased by using some sort of acoustic casing.

Figure 7- Beluga Whale habitat

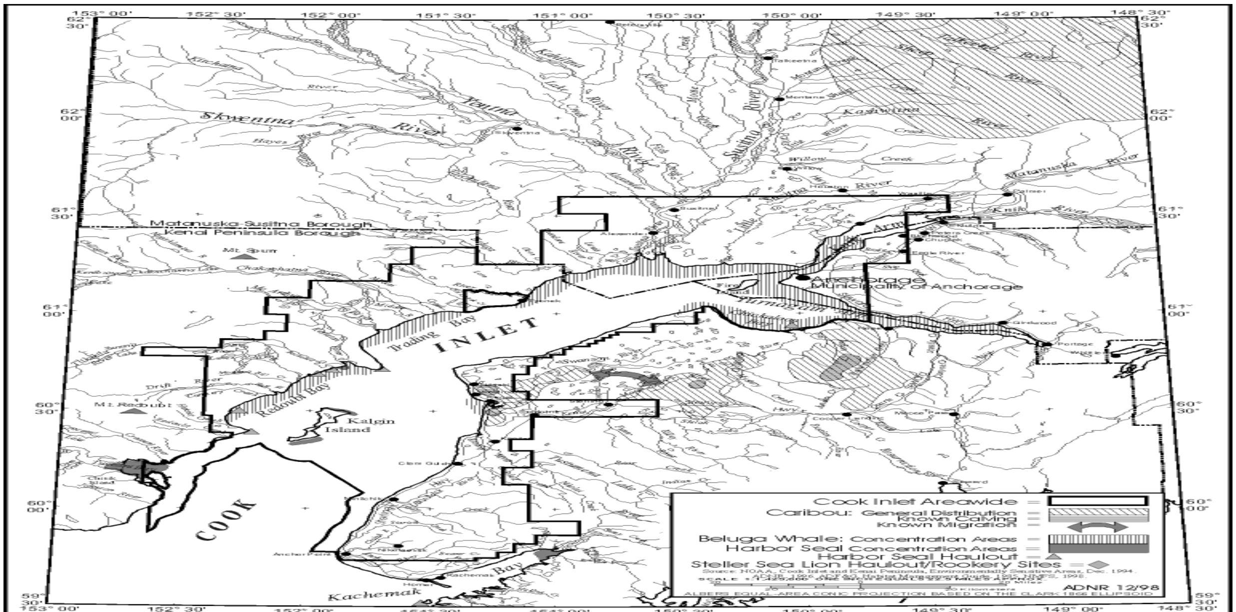


FIGURE 3.5 Important Wildlife Habitat

IV. Economic Considerations:

A commercial size power plant in the Knik Arm would be an extensive monetary demanding project. Compared to other energy alternatives a TISEC power plant is comparable in price. The cost per kW would be a little higher than coal or wind energy. EPRI created an estimate for implanting a TISEC power plant at Cairn Point. They found an estimated total investment of $110 million and a levelized cost of electricity to be 7.1-8.4 cents/kWh. If the government provided incentives for renewable energy this cost would be reduced. The commercial scale tidal power plant would create a significant amount of energy and is a viable source for creating alternative energy. One limitation that could hold back private investors is; that tidal power is a relatively new technology. In stream tidal power has no production experience and therefore, the costs, uncertainties, and risks are relatively high compared to other renewable energy sources such as wind power.

V. Conclusions: Public Release Statement

A TISEC power plant in Knik Arm is a plausible and efficient project however; further research and technological advancements are needed before installation can begin. Research on sea ice, current velocities, and marine life need to be established before further consideration is given to a commercial power plant. Also, a study of the ocean floor movement would have to be explored. One of the biggest advantages of a TISEC power plant compared to many other energy alternatives including a tidal barrage power plant is; TISEC devices cause significantly less environmental harm compared to tidal barrages. This report believes that creating a TISEC power plant would not create devastating damage to the surrounding ecosystems. The power plant would not cause huge interference with ecosystem development. Further research is needed before all environmental impacts can be minimilized. It is also a suggestion that a pilot turbine be put in place before a full-scale power plant. A pilot turbine would be able to give actual measurements of energy output and determine other impacts on the environment that may not be visible from the surface. Currently, there are many TISEC devices being explored and determining which one is the best is difficult. With this technology developing rapidly, it is a good idea to wait until companies have perfected their designs. TISEC devices have the potential to be much less expensive than solar or wind energy. A tidal machine is converting a much more concentrated form of energy compared to wind and solar machines. Overall an TISEC power plant appears to be a project that could be implemented in the future. At this point in time the technology is too young to have reliable data that could ensure all environmental factors are protected.

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