

Harnessing Tidal Power as Alternative Energy in Alaska

Seward High School

2100 Swetmann Ave, Seward, AK 99664

Team Fatheads

Authors: Alex Estes, Justin Croft, Roma Hammer, Ali Katsma, Joevahnta Weddington

Coach: Shoshannah Brasher (sbrasher@kpbsd.org, (907) 224-9057 / (907) 362-2033

This paper was written as part of the Alaska Ocean Sciences Bowl high school competition. The conclusions in this report are solely those of the student authors.



Harnessing Tidal Power as Alternative Energy in Alaska

Abstract

Our objective is to propose a plan for and research tidal energy as a renewable source of energy for Alaska. We choose this topic because of the need we have for a cleaner, local, renewable, and cost efficient source of energy. In our research we found Seward would cut its power bill in half for the year. In addition, tidal energy has a positive effect on the environment. There are no carbon dioxide emissions, no oil spills or nuclear waste.

The world and our oceans are changing in a variety of ways. Many of these changes present significant challenges for the future. One of the most pressing challenges is the need for clean, local, renewable energy sources. As current energy sources are depleted, and the availability of technology to harness tidal energy grows, we can adapt to this by developing projects to harness the potential energy created by the ocean's tidal fluctuations.

We chose to research tidal power because we believe it to be a viable option for obtaining clean, renewable energy throughout Alaska and other parts of the world. Alaska is a prime location for this technology because tide strength increases with increasing proximity to the magnetic poles. Use of traditional nonrenewable energy sources can be reduced by using tidal energy as a renewable alternative power source.

In Seward we spend millions of dollars to heat homes, businesses, and other buildings. In terms of current alternative energy sources, Seward currently has a single wind turbine that was created as part of AVTEC's Institute of Technology program. This turbine was put up last year and has provided some energy through wind power. However, Seward and many other cities and towns throughout Alaska, the US, and the world are primarily dependent on non-renewable energy sources such as diesel fuel and natural gas.

Our planet's CO₂ emissions have increased substantially as new technologies have been developed. Emissions have increased by over 16 times between 1900 and 2008, and by approximately 50% between 1990 and 2008. (EPA, 2010)

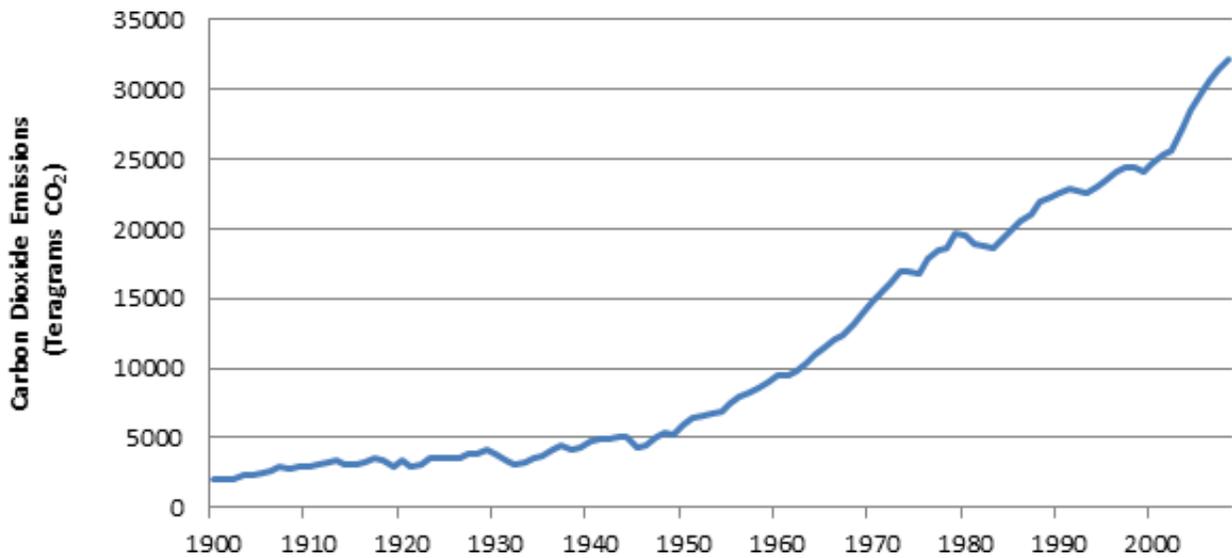


Figure 1: CO₂ Emissions Trends Worldwide (EPA, 2010)

In 2008, the United States produced 19% of the CO₂ emissions worldwide. In comparison, China, another highly industrialized country has 4 times the population of the United States. Yet the US produces 15.25% more per capita (based on population). 19% of the CO₂ produced worldwide originates from industrial facilities used in energy production. (EPA, 2010)

Carbon dioxide does not just affect the air we breathe, but also affects the oceans we depend on. CO₂ bonds with water in the ocean to make carbonic acids, which are destroying ecosystems on a global scale. Carbonic acid is a type of acid that tends to dissolve the compound calcium carbonate. Calcium carbonate makes up most aquatic animals shell and the acids make the shells weak and brittle.

We are proposing incorporating the use of tidal power as an economically viable and green alternative energy source to help solve this problem. Traditional energy sources such as oil and natural gas are being depleted, and it is becoming increasingly

difficult and harmful to the environment to exploit them. The current lack of available economically viable and green alternative energy is a big problem.

We believe that developing renewable energy sources such as wind, solar, and tidal power can present a possible solution to this issue.

From our research we have determined several prospective locations conducive to a potential tidal power generator. The location we chose closest to Seward is located in Resurrection Bay, near Fox Island. This area would make a good site because it is out of the way of most people and it would be the right depth (most tidal power generators require a minimum depth of 150 feet).

Resurrection Bay is good potential location for tidal power to be harnessed. At its mouth, Resurrection Bay has clean clear water with a constant strong tide. It is outside the Kenai Fjords National Park boundary, and reaches depths of approximately 1,000 feet because it is part of a fjord.

The Resurrection Bay area has an average of a twelve-foot tidal change, which is more than enough to power a five MW tidal power generator. Such a generator could be situated 4 miles from Caines Head where the cable from the generator could be attached.

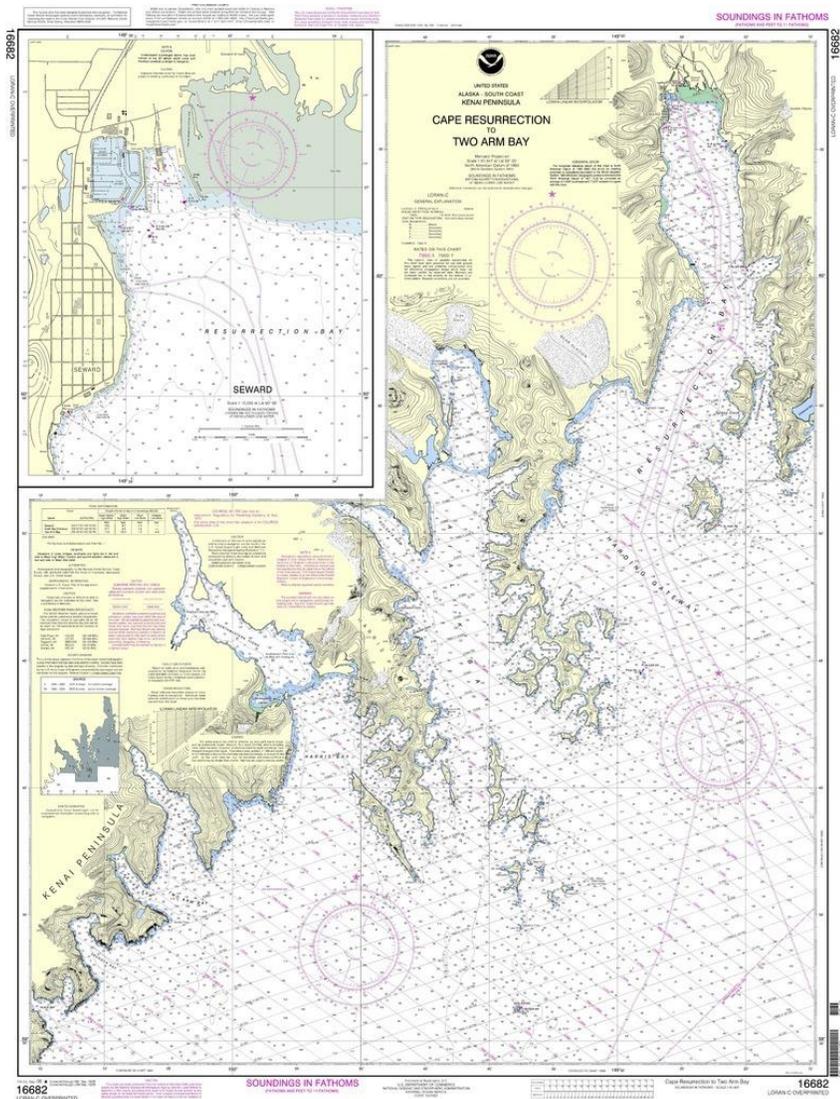


Figure 2: NOAA Chart (2012)

Turnagain arm has been considered by multiple agencies as a location for a tidal power generator due to the extreme tides the area experiences. However, Turnagain Arm's unstable ocean floor and possible habitat interactions with whales such as the Cook Inlet Belugas, and icebergs present significant challenges to building in this area.

Resurrection bay does not have as extreme of tides as Turnagain Arm. This does not however, disclude it from being a potential location for a tidal power generator. As a city, Seward uses \$2.5 million of energy a year.

"We'll create a federal Renewable Portfolio Standard (RPS) that will require 25 percent of American electricity be derived from renewable sources by 2025, which has the potential to create hundreds of thousands of new jobs on its own." (President Obama, 2009)

This projection could become a possibility if we start using these prime locations like Resurrection Bay to generate tidal power. Resurrection Bay has an average tidal range of almost five meters (16 feet) of water displacement.

Tidal generators are a fairly new renewable energy source. Some people say there are approximately 20 possible sites around the world (Darvill Clara, 2013).

There are 7 existing major generators, and they are spread out all over the world. They are located in France, Nova Scotia, China, and Russia. All of those are over 20 MW and are very successful. These numbers are expected to increase as resources on land become fewer. (Green World Investor, 2013)

A tidal generator works by harnessing the natural ocean tides. Tides are a very powerful force caused by the moons gravitational pull. The generator lets the water flow over the metal blades causing them to spin. The spinning blades attach to a central metal rod that spins the actual generator, creating clean renewable energy.

The generator then converts the kinetic motion of the turbines to electricity by using magnets. Inside, there are wires passing by two magnets. One of which has a north charge, and the other has a south charge. When the wires pass by the magnets AC

current is created. Once the energy is created, it is transported through a cable to land where it is stored in a battery.

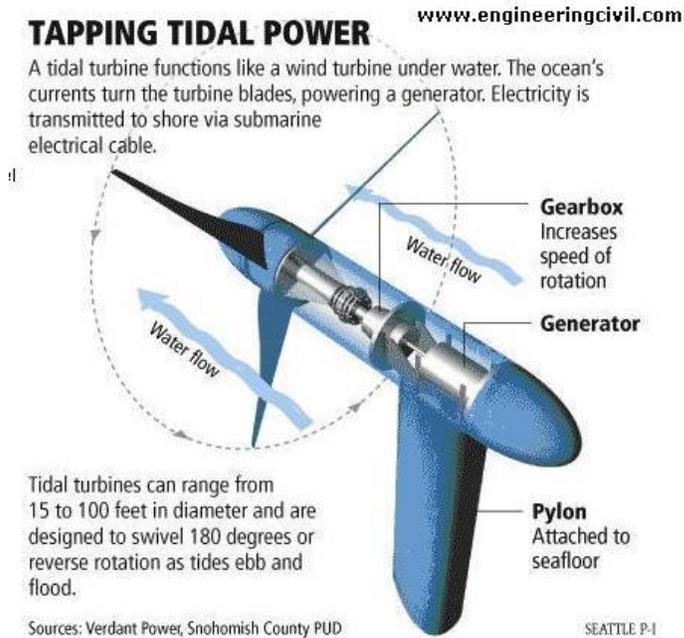


Fig 2.1.2.1 Tidal Stream Turbine

Figure 3: Tidal Stream Turbine, Verdant Power

There are a variety of different tidal power generator models. Specific structure varies depending on depth conditions, the speed of tides, and desired energy output. Most models include four main objects; turbines, generator, main barrage, and sluice gates (to let the water in and out).

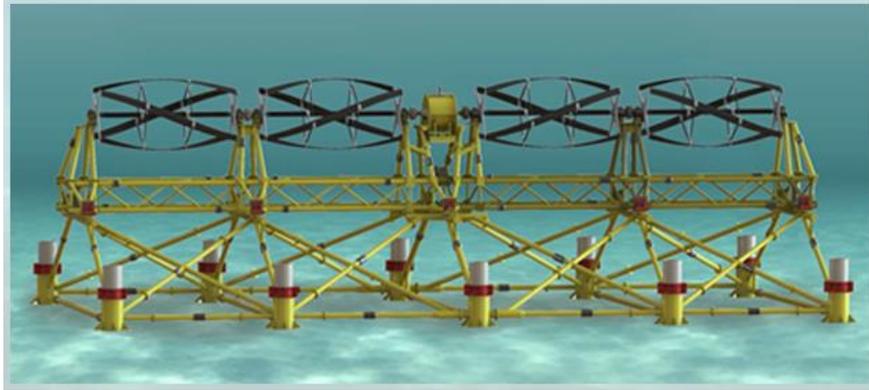


Figure 4: TidGen™ Power System

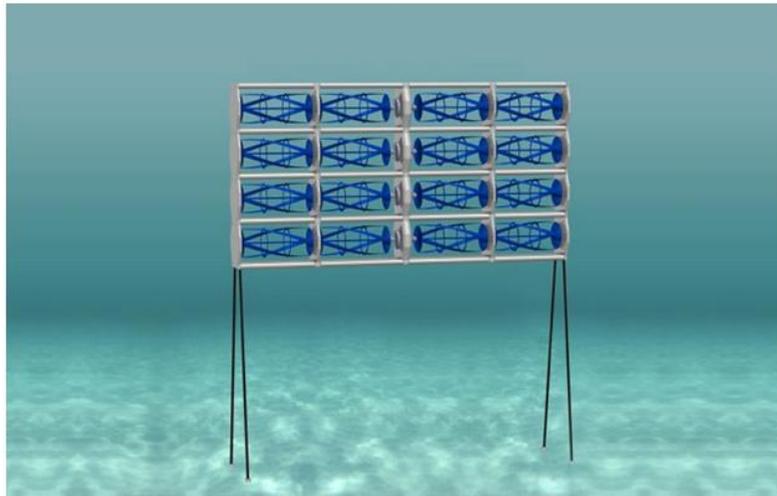


Figure 4: OCGen™ Model - Deep Water

There is an enormous variation of metals and other substances used for tidal power generators. Some of the metals used include Manganese, Lead, Nickel, Zinc, Cadmium, Chromium, Copper, and Iron. These metals are good for underwater use because they will deteriorate slowly and are prone to very little erosion due to oxidation by the seawater. There are additional substance that have similar structural properties

such as gold. However, Gold would be obsolete because the amount of material needed for a tidal plant would be far too costly.

Construction and maintenance of a tidal power program will also bring numerous quality jobs to the Kenai Peninsula area ranging from planning, construction, and maintenance. Whereas total cost of such a generator is unknown due to the lack of fully developed projects, it is estimated that by 2020 the average levelized cost of energy (LCOE) will be 12.5 cents per kilowatt hour for a tidal power generator. (ORCP, 2013)

Seward Alaska uses 4,934,529 kwh/month, which equals almost 60 million kwh/year. (Jeff Estes, 2013) This is 2,455,385.64 dollars a year, which can be reduced by half with a 5 MW turbine. So, over a five \$6,000,000 could be saved over a five year period. This may be enough to fund the five megawatt Tidal turbine installation.

The positive environmental effects of tidal power is no carbon dioxide emissions, no oil spills or nuclear waste, and for people who oppose the use of wind farms because of aesthetic appeal, the generators are primarily underwater, and not seen by land. Tidal power energy is also very predictable unlike other forms of renewable energy like solar and wind energy, which are intermittent in nature. The electricity supply is much more uniform and reliable in case of tidal power (Abhishek Shah, 2011).

The negative environmental effects of tidal power generation are very similar to the effects of wind power generation. There are a number of indirect environmental effects such as alteration of currents and waves, alteration of substrates and sediment transport, alteration of habitats, noise during construction, emission of electromagnetic fields, toxicity of paints, lubricants, and antifouling coatings, interference with animal movements and migrations, and strike by rotor blades. (Polagye, 2010)

From past and present tidal power plants there has been incidents in which specific animals have been killed; such as Basking shark, Blue fin tuna, Billfish, Brittle star, copepod, crabs, and the Lemon shark. Most are small animals that live on the bottom of the shores or live on rocks. This problem is avoidable by adding a cage around the OCGen module, which will prevent most of the problems with the surrounding habitat.

The ocean is an important factor in helping sustain life on Earth. Tidal power is helps us harness the energy from the ocean to turn it into renewable energy. It also helps make the environment a cleaner place by helping reduce Carbon Dioxide emissions and other pollutants that come from nonrenewable energy. Tidal power is also an advantage over other renewable energy sources, like wind and solar, because it is a predictable source of energy. There are many benefits in using tidal energy, both for people and the environment.

References

Alaska Energy Authority. (2013) Retrieved from

<http://www.akenergyauthority.org/EnergyPolicyTaskForce/AKEnergyTaskForceSewardBrief.pdf>

EPA. (2013) Retrieved from

<http://www.epa.gov/climatechange/ghgemissions/global.html>

Green Rhino Energy. (2013). Retrieved from

http://www.greenrhinoenergy.com/renewable/marine/tidal_range.php

Luoma, J. (2008). Capturing the Ocean's Energy. Yale Environment 360. Retrieved

from http://e360.yale.edu/feature/capturing_the_oceans_energy/2093/

Marine Current Turbines. (2013). Retrieved from <http://www.marineturbines.com/tidal-energy>

Mobile Geographics LLC. (2005). Retrieved from

<http://tides.mobilegeographics.com/locations/5752.html?y=2013&m=11&d=11>

NOAA / National Ocean Service. (2013). Retrieved from [http://www.co-](http://www.co-ops.nos.noaa.gov/faq2.html#26)

[ops.nos.noaa.gov/faq2.html#26](http://www.co-ops.nos.noaa.gov/faq2.html#26)

Obama, Barack. Retrieved from http://change.gov/agenda/economy_agenda/2025/

Ocean Energy Council. (2013) Retrieved from

<http://www.oceanenergycouncil.com/index.php/ /Tidal-Energy.html#4>

Ocean Renewable Power Company. (2013). Retrieved from

<http://www.orpc.co/default.aspx>

Polagye, B., B. Van Cleve, A. Copping, and K. Kirkendall (editors). 2011.

Environmental Effects of Tidal Energy Development. U.S. Dept. Commerce,
NOAA Tech. Memo. F/SPO-116, 181 p.

Personal interview by email. Johnson, D. (2013). Ocean Renewable Power

Personal interview in person. Estes, J. (2013).

Shah, Abhishek. (2011). List of Tidal Power Plants and Future Tidal Stations – Facing

Difficult Times. Green World Investor. Retrieved from

<http://www.greenworldinvestor.com/2011/03/13/list-of-tidal-power-plants-and-future-tidal-stations-facing-difficult-times/>

Whiticar, M. (2012). Tidal. Energy BC. Retrieved from

<http://www.energybc.ca/profiles/tidal.html#teconomics/>