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OCEAN THERMAL ENERGY CONVERSION

1. IPCC. Ocean Energy. Rep. Intergovernmental Panel on Climate Change, 2011. Web. <http://srren.ipcc-wg3.de/report/IPCC_SRREN_Ch06.pdf>.

2. "Ocean Thermal Energy Conversion Basics." Energy.gov. US Department of Energy, 16 Aug. 2013. Web. 28 Apr. 2015. <http://energy.gov/eere/energybasics/articles/ocean-thermal-energy-conversion-basics>.

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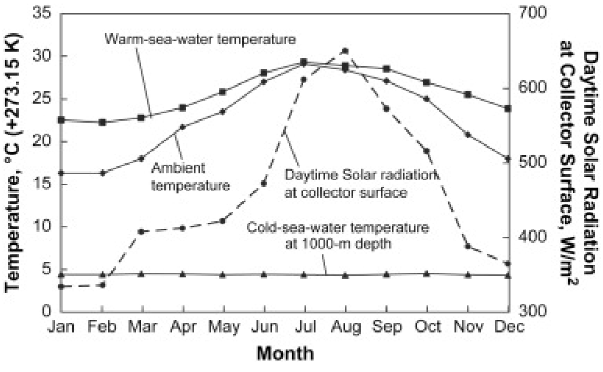
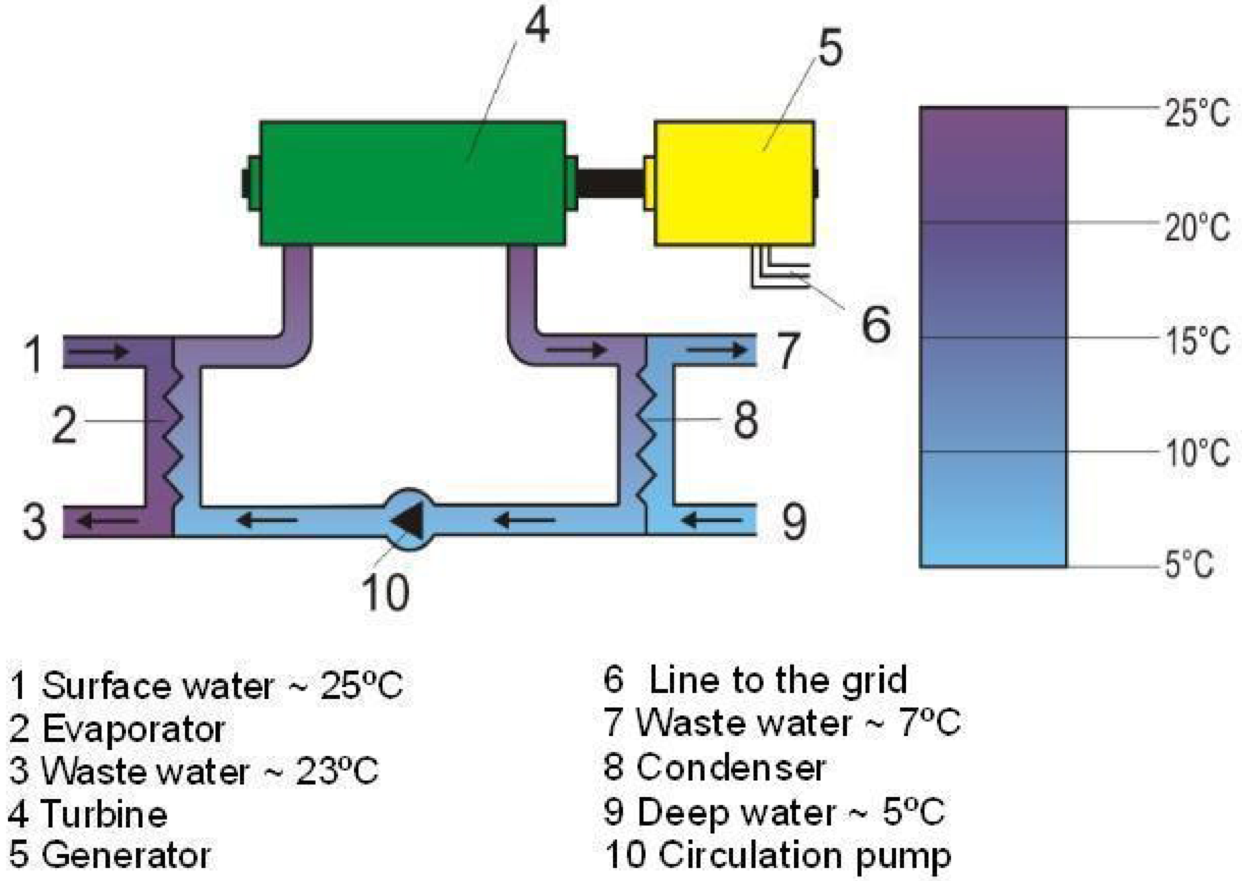
Ever since the 1973 Oil Crisis hit the United States, Ocean Thermal Energy Conversion (OTEC) technology has been proposed as a solution for clean, renewable alternative energy. The U.S. federal government has since poured hundreds of millions of dollars into this nascent technology, with the hope of generating electricity with nothing but the thermal differences in ocean depths. In a nutshell, OTEC uses warmer ocean surface water to evaporate water, and cooler, deeper water to condense it. This heat differential is used to power a similar generator to various other coal or nuclear power plants.



Many scientists regard OTEC as a viable alternative energy source. One of its strengths is that it is not reliant on any unpredictable sources. The Intergovernmental Panel on Climate Change (IPCC) report on Ocean Energy notes that, "OTEC is one of the continuously available renewable resources that could contribute to base-load power supply."[1] This is because OTEC generates a stable and constant amount of power from the ocean temperature gradient, giving it a crucial advantage over other alternative energy sources, and freeing it from the classic argument against renewables. By contrast, many of the renewable energy sources in use today depend on unpredictable



factors which are extremely intermittent. Solar power, for example, can only generate electricity when there is ample sunlight, which changes both with time and season. This has been one of the major problems plaguing renewable energy sources, since intermittent generation does not provide for a workable electric utility.

Monthly variation of ambient temperature, the temperatures of the warm sea surface water and cold sea-water, and mean solar irradiation incident on a tilted solar-collector surface at Kumejima island in Japan.

Although OTEC could theoretically be an excellent supplier of base-load power, it has significant limitations. Two major issues with OTEC are its high upfront cost and expensive kilowatt-hour production rates. Building the OTEC facility itself is extremely costly.[2] Vicki Bruch of the Energy Policy and Planning Department of Sandia National Labs states that "ocean energy technologies require the use of expensive equipment. OTEC in particular requires large turbines and a cold water pipe with a diameter of at least four feet."[3] Energy gradient conversion is only feasible when the gradient is at least 20°C and when the ocean floor is deep enough, leading to the requirement for large and lengthy pipes coupled with equally bulky turbines. Large upfront investments discourage capital investment from the private market and are difficult to front for projects that come with significant risk.

In terms of economic feasibility, the average cost for electricity is 12 cents per kWh in the United States, and estimates for average OTEC power cost rates vary from 7 to 22 cents per kWh, erring on the higher end.[4] With the average American household using 908 kWh per month, this additional cost premium adds up to around $100 extra every month.[5] To cap it off, the maintenance costs for OTEC threaten to raise that variable cost further still in the future, with the harsh environment of the ocean causing issues with "maintenance of vacuums, heat exchanger bio-fouling, and corrosion issues."[6]

In addition to concerns about the economic feasibility of OTEC, many studies have also taken a critical look at the technology's effect on the marine environment. A report published by the University of Hawaii studying the feasibility of implementing OTEC claims that the technology could pose "unprecedented environmental modification that must be rigorously evaluated."[7] Marietta DiChristina explains in her Popular Science article that, "The flow of water from a 100-megawatt OTEC plant would equal that of the Colorado River ... some 6°F above or below the temperature it was when it was originally drawn into the plant. The resulting changes in salinity and temperature could have unforeseen consequences for the local ecology."[8] Because OTEC is fundamentally a system based on heat transfer, it will require the displacement of massive amounts of warm surface water to cooler ocean depths, and vice versa.

Thus OTEC, like with every other energy generation source, has its benefits and drawbacks. Overall the decision to implement this technology is a value judgement of whether the baseload supply of renewable, carbon free energy is worth the disadvantages of high cost and potential environmental issues.

Matthew Chan is senior in Wharton and SEAS with a passion for technology. He hails from the San Francisco Bay Area and loves to dance and run in his free time.

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