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Ocean Thermal Energy Conversion: The Cost Challenge

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Abstract

This paper describes the analysis and conclusions from an Office of Naval Research SBIR study entitled “Integration and Optimization of Hydrogen Production with Ocean Thermal Energy Conversion Technology in Offshore Floating Platforms.” This 2005-2008 study commenced with defining a future large offshore OTEC industry and comparing that industry to alternative sources for hydrogen (or ammonia) fuel. OTEC is a renewable technology based on an immense resource, it has a low environmental impact, produces 24/7, and does not compete with other resources such as land, water and food; OTEC on a very large scale was found to be an economically and environmentally viable candidate for future hydrogen production. This technology will be available tomorrow only with investment today.

The OTEC process is straightforward, is technically feasible, and has been demonstrated several times. However, OTEC has not been commercialized due to high capital costs and competition from cheap fossil fuel. As the study progressed, energy costs became extremely volatile and that together with global warming and national security issues have made firm renewable energy like OTEC desirable. OTEC is a first choice renewable for firm, large-scale electrical power at island communities such as Hawaii, Guam and Puerto Rico; at these locations the gap between the willingness to pay and the cost of OTEC energy has considerably narrowed if not disappeared. This point of entry for commercialization is sufficiently large for OTEC to evolve and be poised for the next step of providing ammonia or hydrogen for the US mainland. The technical challenge for the engineer today is perfecting and testing “low cost” options for the more challenging OTEC components, and the challenge for the developer is financing these first critical steps.

Introduction

During the energy crisis of the 1970-80’s, there was a tremendous interest in Ocean Thermal Energy Conversion (OTEC) and the Department of Energy (DOE) invested significantly in OTEC technology. Several programs concentrating on heat exchanger performance, cold-water pipeline development, overall plant design, and both open and closed-cycle development were completed. OTEC appeared to be a very attractive renewable energy source: the global resources suitable for OTEC are huge; OTEC is a continuous and steady source of energy; and OTEC is among the most environmentally friendly alternate energy sources. At the end of this era, OTEC remained an exciting but expensive technology and DOE refocused on different technologies.

Public awareness of peak oil, energy security, and environmental issues has elevated to a new high. There is now a new national willingness to come to terms with energy; this is a new age for renewables.

In 2005, the Office of Naval Research (ONR) awarded Makai a Small Business Innovative Research (SBIR) study to investigate the role of OTEC for hydrogen production in offshore floating platforms. OTEC had traditionally been too expensive to be a near-term energy provider at a moderate scale. However, in a future world without oil and on a massive scale, would OTEC be a viable contender when compared to other available and acceptable energy sources? A technical and cost model was developed of a floating OTEC plant which was expanded to include a massive OTEC industry supplying hydrogen (via ammonia) to the US. For validation of this model, a conceptual design and cost estimate of a 100MW plant was completed and costs were included based on similar offshore structures built today. The study concluded that OTEC is attractive; the background on this study and conclusions are provided in this paper.