A Strategy for Promoting a Commercial OTEC Power Plant in Taiwan

Tar Zen Su, National Taiwan Ocean University, Taiwan, R.O.C.
Jin Chung, Industrial Technology Research Institute, Taiwan, R.O.C.
Jonathan Chen Fan Su, Lin-Zhi International, Inc, U.S.A.

Taiwan's ocean topography always has great potential to develop the first commercial OTEC power plant. Ten years ago some effort were organized but failed. In addition to the political problems when governmental policy is mixed with engineering and science, insufficient confidence in engineering and economics capital return were the major reasons that finally refrained the Taiwanese government to actually take the initiative first ground breaking step to build the first commercial OTEC power plant in Taiwan.

Today, as the oil price is soaring, the environmental problems are severe enough that the alternative of renewable energy seems to be a promising alternative solution for the world energy resources in the near future, how to construct a commercial OTEC power plant in Taiwan becomes an important issue with top priority once again.

Many new engineering concepts of the OTEC power plant had been proposed during the past 10 years. There are wide spread consensuses that with correct engineering competency that a commercial OTEC power plant can be build in the East Coast of Taiwan where typhoons and earthquakes frequently occurred. Given the right conditions, the efficiency of the size of the OTEC power plant as small as 10MW could be competitive with the conventional power plant.

Therefore, a step-by-step strategy must be implemented to promote an international OTEC power plant project in Taiwan.

1、Introduction

Among renewable energies: solar, wind, hydro, biomass, geothermal, ocean waves, currents, and thermal; wind energy is the only one that have been successfully developed and commercialized. Today, many wind driven power plants are operating worldwide. The construction cost and the unit power price of most of the wind power plants are cheaper than most of the conventional non-renewable power plants, even without governmental supports in any aspects (note 1).

OTEC (Ocean Thermal Energy Conversion) power plant could follow the development track of the wind energy power plant and become the second successful renewable energy case. Strategy to develop commercial OTEC power plants had been proposed by many researchers for many years before (note 2), (Ref. 1.2). By comparing OTEC power plant to wind energy power plant, there are two major differences. And it is these two difficulties that hold back the OTEC power plant to go forward.

(1) OTEC power plant must be 50MW or larger to be economically feasible, while wind energy power plant can be as small as a few kWh, usually no bigger than 1MW.

(2) OTEC power plant is a capital intense power plant. The initial investment for the construction of the power plant is much larger than the wind energy power plant.

For these two differences, even if there is a governmental passes for a protection law to guarantee buying OTEC power at a favorable fixed price for a period of time (for instance, say about 12US cents/kWh guaranteed for 10years), there are still two major problems waiting to be solved.

(1) How to integrate all the infrastructure of OTEC technology into an OTEC enterprise, and

(2) How a developing plan can be formulated so as to get a loan from venture capitalist or banks (note 3).

2、Technology Issues

The sub-systems of an OTEC power plant include at least as follows:

(1) Heat exchanger manufacture
(2) Turbine manufacture
(3) Electric generator manufacture
(4) Cold water pipe design, manufacture, and deployment,
(5) Platform design, manufacture, and deployment,
(6) Mooring system
(7) Electricity transmit system design, manufacture, and deployment,
(8) Clean energy product from OTEC
(9) By-products such as fresh water, air conditioning, and etc.
(10) OTEC power plant operation/maintenance/management

Since the design of an OTEC power plant is very site specific, an engineering maximization to get the most efficient and cost-effective subsystem can not be reached before the site is decided and the ocean data is fully investigated, as well as the environmental, social, and political situation are somewhat evaluated. For instance:

(1) If OTEC power plant is decided to be build at some tropical island country where fresh water is important, air cooling system is important, no big typhoon or major earthquake will likely to occurred, and comparatively expensive import oil is the only source of energy at the present time, optimization showed that a commercial OTEC power plant could be build at a size as small as 10MW (ref.3).

(2) If OTEC power plant is decided to be build at areas where thermal temperature difference is largely enough so that a very efficient but also very expensive titanium heat exchanger is not the only heat exchanger to be chosen, the cost of

the heat exchanger apparatus could be reduced dramatically (ref. 4).

(3) If an old decommissioned oil drilling platform could be obtained very cheap or even free of charge, it can be used as a platform for a floating OTEC power plant (ref.5).

(4) If a marine ship or an oil tanker can be used as a platform for a floating OTEC power plant where it is not too far from the shore, along with a design of detachable cold water pipe, the ship can sail back and forth from the power produce site to the harbor for unload the product or simply to avoid the possible severe ocean conditions. And the cold water pipe can be detached and simply remain sitting on the ocean floor as mooring at one end and floating below ocean surface without suffering the severe waves and currents at the other end. The cost of designing, manufacturing, and deploying this cold water pipe could be very inexpensive. In addition that the marine ship has its propeller system to move itself, cargo spaces for installing heat exchangers and other equipment, and accommodation ready for the workers.

A site with all the merits above could be optimized to engineering the OTEC power plant down to smaller size, lower cost, higher efficiency per power generated, and more valuable by-products.

3、A Potential Site

As early as in 1979, after the successful demonstration of the "Mini-OTEC" project in Hawaii, a thorough survey on "Where is the best potential site for commercial OTEC power plant in the Pacific Ocean area" had been conducted. In this survey, the East Coast of Taiwan had been concluded as the best potential site for building commercial OTEC power plants.

The characteristics and necessity that make the East Coast of Taiwan the best place to build an OTEC power plant are as follows:

(1) Geographically available, located in the tropical zone by the ream of Pacific, with large thermal gradient difference (more than 20 degree Celsius all year round, and Steep Ocean bottom slope (reach the 1,000m depth at only about 4km from the shore).

(2) Technologically competent, Oceanography and fishery industries continue to maintain strong marine on going businesses, and many pipe manufacturers.

(3) Economical Incentive, 10% increase of electricity consumption annually, 97% energy imported, less than 3% renewable energy produced, mostly hydro energy, desperate need for renewable energy.

(4) Politically ready, eagerly to participate with international programs.

(5) Environmentally and demographically, highest population density of the world (note 4), almost impossible to construct any new power plant (conventional or renewable) on land, energy from the ocean is the best option.

In fact, in the 90s, many researches and development projects such as " The Multiple Purposes OTEC Project of Taiwan", " Master OTEC Plan for the Republic of China"(ref. 6), " A Conceptual Design of An Ocean Energy Park at the East Coast of Taiwan" (ref.7), and etc. were aimed to invite world's OTEC expertise to participate in the commercialization of OTEC. The famous International OTEC Association, or IOA, was organized under the support of the Taiwanese government.

Insufficient confidences in engineering and economical feasibility were the major reasons and set back that finally refrained the Taiwanese government to actually take the first initiative step to build the first commercial OTEC power plant. As the limited resource of oil price continue to rise, and with all the engineering improvements, there is sufficient assurance that in building an OTEC power plant in the East Coast of Taiwan is a priority with many beneficial returns.

With the changing dynamical global economy, newly established engineering principle and rapidly changing governmental policy. A new implementation strategy that is ideal for the current time period that different from all those previously suggested must be implemented.

4、Conclusions

The future utilization of renewable and environmentally friendly energy resources by OTEC is assured. However, to achieve this paradigm shift, it is not proper to link the engineer, the government officials, investor, businessmen, and venture capital banker all together as an operation team. The assembling of people from different fields will be too large and conflict of interest will lead to hardly putting any task forward.

A better strategy could be as dividing them into three teams. Each team consists of the same expertise with its own limited task to overcome, while all these three teams commit to each other with some kind of agreements that will keep motivating them heading to the same goal. These three teams and their tasks are divided as follows:

Team 1, an OTEC consortium combines with only international OTEC experts. It aims only how to engineering ways to maximize a most efficient and lowest cost OTEC power plan design specifically for a potential site. This team considers neither how to gather the construction money nor how to get a governmental agreement for buying the electricity.

Team 2, an OTEC promoter deals with the government of that specific potential site. It aims only how to persuade the government to sign an agreement with the OTEC consortium. The agreement could be as simple as that the government is willing to purchase electricity at a fixed price for how many kWh for how long (note 5). There is no capital commitment in signing the agreement as yet.

Team 3, an OTEC enterprise, or the venture capitalist, deals with how to get a loan from either the World Bank, the Asian Development Bank, the UNESCO, and so forth. With the proposal from the consortium with experts in team 1 and the agreement from the team 2, a loan for the construction fee of OTEC power plant is very likely to be

granted (Note 5). With this monetary issue taken care of, the team three people can now go back to deal with team 1 and team 2 to have a "go ahead".

5、Notes

Note 1: With a steady increase rate of 35% for consecutive 5 years, today, the sum of the wind power generated is estimated around 40,000MW world wide, where about 4,000MW in Denmark, and about 5,000MW in German. In the early 80s, many countries pass electricity law to ensure wind power price be 8 US cents/kWh and with other favorable terms. Today, most of the wind power plant can produce electricity at the price around 6 US cents/kWh or even lower. It is cheaper than the conventional non-renewable power. The investor is now making profit even without governmental protection.

Note 2: According to previous proposals by either Joseph R. Vadus and Patrick K. Takahashi, or James G. Wenzels, a joint venture program by a "private-public partnership" should be integrated to perform the realization of a commercial OTEC power plant. This is a right concept, but it is not an easy task. It does not seem to be an adequate proper fit to assemble the engineers, the government officials, businessmen, venture capital investors, and banker all together as an operating team. The team will be too large and too much clashes from inner conflict of interests. This was probably why after the strategy had been proposed and some extended promotion had been done, there is still hardly any substantial action or measurable progress being taken.

Note 3: The construction of the OTEC power plant could be very site specific, and varied from different methods of estimation. In some case, the total cost could be as big as 1billion US dollars. And it is very unlikely that this loan can be obtained from any government.

Note 4: Some environmental issues of Taiwan comparing to United States are shown from the data below:

Density	Taiwan	United States
Density of population	587/km2	1/21, as compare to Taiwan
Density of vehicle	129/km2	1/6
Density of motor-bike	330/km2	1/330
Density of factories	2.7/km2	1/65

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Note 5: For example, 15US cents/kWh for the first 5 years, 10 US cents/kWh for the next 5 years, and 5 US cents/kWh for the third 5 years term.

Note 6: For example, to finance a 50 MW OTEC power plant to be constructed for the first 5 years, and a total of 500 MW power plants for the next 5 years, and 5,000 MW power plants for the third 5 years term.

6、References

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