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Ocean Thermal Energy Conversion: Call for European Revaluation

The solar energy that falls on earth is largely absorbed by tropical oceans. The resulting surface heating induces a temperature difference with deep ocean water that OTEC process converts into useful energy.
At first glance, developed countries may not seem concerned by the concept since it is only applicable where the sea surface temperature reaches 24°C at least. In reality, their support in the short term is necessary to initiate the OTEC market and will benefit the world as well as their industries. More particularly, European Union should feel concerned given that some of the best OTEC sites are within its territory, that millions of European citizens are directly concerned and that it could reduce global greenhouse effect as well as its energy dependence in the long term.
Today, the Japanese and Indians are working on a 1 MW floating plant while Americans are exhibiting strong interests. At the same time, current European decision makers do not have enough available information about OTEC concept and especially the elements that have favourably evolved for the past 15 years. The lack of communication makes it impossible to implement a project within EU.

The paper will focus on the reason why European decision makers should pay more attention to OTEC, and then it will highlight the steps forward accomplished outside and without EU.

European OTEC

1. OTEC background within European Union:

In 1928, the French engineer Georges Claude demonstrated the feasibility of the OTEC concept at Ougree-Marhaye, Belgium. From 1973 to 1986, the oil embargo led to renewed OTEC interest and the implementation of several European projects: French worked on a 5 MW project to be located in Tahiti. The Netherlands completed a feasibility study for a 100 kW closed-cycle plant for the island of Bali. Searchers from Norway studied the feasibility of a self-sustained diffusive pump. Candidate countries to EU such as Croatia and Romania respectively worked on the piping system optimization and on potential new OTEC components. In 1986, the sharp drop in the price of crude oil made the projects collapse.
Three years later, the International OTEC/DOWA Association (IOA) was established in a planner meeting held in Taiwan by a group of more than 50 professionals on OTEC and related activities from many countries, including Finland, France, Italy, the Netherlands, Sweden and the United Kingdom. In 1992, with the financial support of the European Community Commission, the IOA organised a workshop in Brussels to inform the Commission about OTEC and DOWA development and potential. Despite the workshop success, it did not lead to anything concrete.
In short, European countries were the first to develop the OTEC concept and European searchers remained involved in the topic until the early 1990's. For the last 15 years, the OTEC development continued outside Europe, mostly in Japan, Indian and USA.

2. Concerned European territories and citizens:

European citizens and territories are directly concerned by OTEC via Overseas Countries and Territories (OCTs) and French Overseas Department (DOM). OCTs association's purpose is to promote their economic and social development and to establish close economic relations between them and the Community as a whole. OCTs are not European territories but people living in OCTs are (mostly) European citizens, while DOMs are part of European territory.
In the short term, several OCTs and DOMs could be considered as very adequate places to develop OTEC technology. More than 2 millions of European citizens are concerned.

Potential OTEC sites linked to EU

	Name	Population	Comments: offshore or onshore plant, external difficulties* or not.
British OCTs	Anguilla	12,000	-
	Cayman Is	40,000	Offshore/Onshore
	Montserrat	4,000	Offshore
	Pitcairn	47	-
	Ascension Is	1,150	Offshore/Onshore, external difficulties
	British Indian Ocean Territory	-	-
	Turks and Caicos Is	21,000	Offshore/Onshore
	British Virgin Is	23,000	-
French OCTs	Mayotte	160,300	Offshore/ Onshore, external difficulties
	New Caledonia	228,000	Offshore/Onshore
	French Polynesia	244,000	Offshore/Onshore
	Wallis & Futuna	15,000	Offshore/Onshore, external difficulties
Dutch OCTs	Aruba	100,000	Offshore
	Netherland Antilles	221,000	Offshore/Onshore, external difficulties
DOMs	French Guyana	157,213	Offshore
	Guadeloupe	440,000	Offshore/Onshore
	Martinique	393,000	Offshore/Onshore
Total		2,059,710	

Sources: FAO website for the population, comments adapted from OTEC SITES (Richard Crews, 1997).
* political or financial difficulties

3. Potential benefit of OTEC investment

Arguments of OTEC detractors have been largely debates for a long time. They underline important technical points: thermal efficiency is low (7%) and pipes are wide (10m). Promoters indicate that first, converting only 0.07% of the available thermal energy would produce 8000 TWh/year. Second, pipes are wide precisely to compensate the efficiency; the indicated number would correspond to 50 to 100 MW plants that are full of promise but not ready yet for commercialisation. Third, 10 MW installations that could be built and operated today could achieve economic viability through the cogeneration of fresh water, air-conditioned and aquaculture.
Another point of digression concerns the environmental aspect: so far, simulations mostly confirmed the weakness of the global impact if the resource is rationally used. (Current pilot plants are two orders of magnitude below commercial size though, extrapolations might be incorrect.)

Then, there is a good chance that OTEC will become a very satisfactory source of energy. The following potential benefits could justify an OTEC investment:

OTEC Market: Tropical islands are current applicable locations; in the long term, ocean widespread large plants could produce electricity and fresh water for tropical countries as well as synthetic fuel (e.g. hydrogen) for the whole world. According to Japanese preliminary prediction, 1,000MW of Multi-OTEC station are expected to be built in Japan annually in near future. At that time, it means that a new industry having approximately €10 billions annual production amount and 10,000 employments will arrive in Japan. As well, India plans to, if things would turn positive as planned, construct some 1,000 OTEC power plants throughout Indian coast lines, according to their grand design.

Energy dependence: In Europe, the current dependence on energy imports is around 50%. If no action is taken, it is expected to rise to 70% by 2030. The European Commission's White Paper for a Community Strategy sets out a strategy to double the share of renewable energies in gross domestic energy consumption within the European Union by 2010.
OTEC plant could substantially participate to European energy needs: in the long term, the energy produced on open sea OTEC platforms could be transformed under transportable forms (e.g. H2 or NH3). It will allow EU to benefit from this renewable and abundant source of energy. Large use of synthetic fuels may occur at the same time as important OTEC platforms will be deployed. At this time, instead of getting oil in Middle East H2 would be available on the Atlantic Ocean.

Greenhouse effect: The Kyoto Protocol requires 38 industrial countries to reduce their emissions of greenhouse gases an average of 5.2% below 1990 levels in the 2008-2012 time frame. In the long term, OTEC could participate to the reduction of EU greenhouse gas emission.
EU investment could as well help tropical countries to reduce their emission: it might be even more efficient and cheaper to limit growing CO2 emissions in those countries (by helping them to develop OTEC) than to reduce the same quantity of CO2 emission within Europe.

For the time being, an OTEC project could theoretically be funded by the sixth Framework Programme, as a research activity having an impact in the medium to long term. But European industrials need a stronger political OTEC position before considering such a project.

OTEC outside Europe

As mentioned above, for the past 15 years, European countries did not exhibit any OTEC interest. On the contrary, Japan and USA, that have a relatively poor access to adequate OTEC sites, are still currently involved in different OTEC projects. India is more directly concerned by the resource and is also one of the three main OTEC actors.

1. Japan

The OTEC Japanese program starts in 1973; 30 years later, the construction works of the Institute of Ocean Energy, Saga University (IOES), was completed in Imari city.
IOES is one of the most advanced facilities of its kind in the world and includes OTEC experimental system (30kW), ocean thermal energy desalination experimental system (10m3/d), hydrogen production experimental system, lithium extraction experimental system and water tank experimental system modelling ocean environment.
During the last 15 years, IOES developed new patent technologies such as Kalina and Uhera cycles. According to IOES, those cycles improve thermodynamic efficiency from approximately 3% (Rankine cycle) to approximately 5%.
IOES signed several agreements with interested organisms, including the National Institute of Ocean Technology of India, the Japanese firm Xenesys, the Japanese National Fisheries University and the republic of Palau.

2. India

Indian government put strong emphasis on earth-friendly natural power generation. Established in 1993, the National Institute for Ocean Technologies (NIOT) is in charge of ocean energy technical development.
In 2001, a floating vessel, the Shagar Shakti was dedicated to OTEC R&D, in partnership with the IOES. According to Indian and Japanese sources, a 1 MW plant is onboard. The project might have had some troubles with the cold water pipe deployment but is still ongoing.

3. USA

- The Natural Energy Laboratory of Hawaii Authority (NEHLA) was initially mandated to provide a support facility for research on OTEC. For the last 15 years, the laboratory has been mostly involved in deep ocean water applications. Based at Keahole Point, 30 enterprises are developping their business with deep seawater.
- SeaSolarPower is a private company which designed a 10MW and is planning to implement it by 2007.
- Makai has been working with deep water pipelines since 1979. In 2001, it designs and manages the construction of a 55" diameter, 3000' deep and 2 miles long pipeline.

As a conclusion, with or without EU, the OTEC development will continue, as it did for the last 15 fifteen years. Recent elements tend to prove that OTEC will be part of the renewable energy cocktail of the future. Despite appearance, EU has many internal reasons to invest this technology and the ability to accelerate OTEC maturity. Common efforts with Americans, Indians and the Japanese will benefit everyone.

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