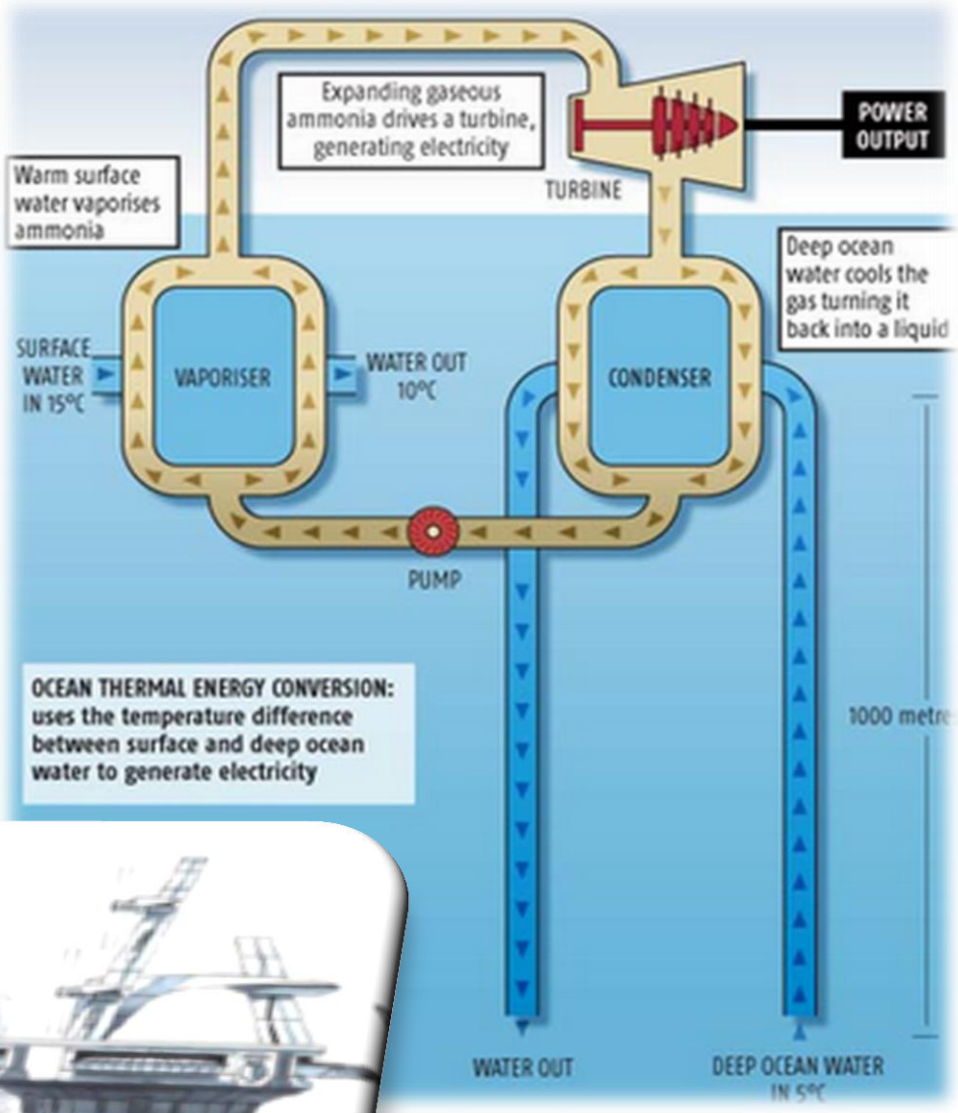
CIS 31223 - Networks and Telecommunication - Assignment

Ocean Thermal Energy Conversion (OTEC) & Sri Lanka



NAME :WIMALASOORIYA C.U.

REG. No. : 07/AS/CI/049

INDEX No.: EP610

DEPT. OF COMPUTING AND INFORMATION SYSTEMS

Oceans, the principal component of the earth's hydrosphere, covers approximately 71% of the Earth's surface, making them the world's largest recipient of solar energy. Each day, the oceans absorb enough heat from the Sun to equal the thermal energy contained in 250 billion barrels of oil. Most of this energy is absorbed by oceanic bodies in the tropical belt.

As Sri Lanka is an island nation well within the tropical belt having claims to an Exclusive Economic Zone (EEZ) 27 times the country's land area and deprived of any exploited indigenous petroleum resource, if we can extract a portion of this energy, it will greatly improve our energy independence and energy security.

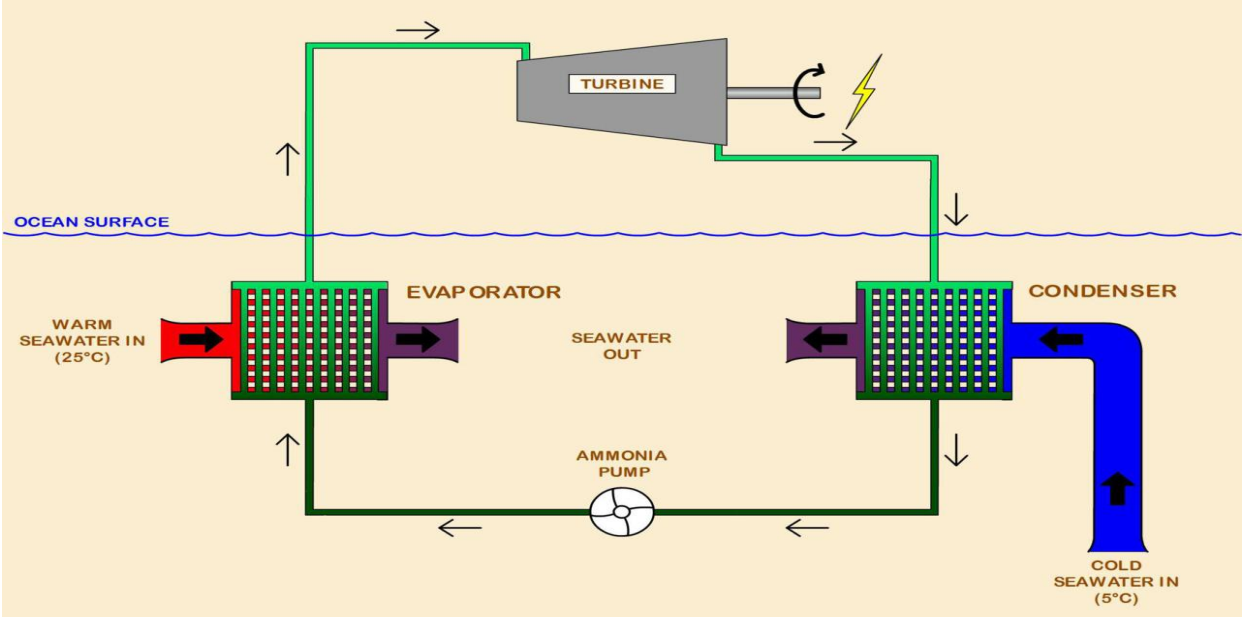
Ocean Thermal Energy Conversion Systems (OTEC) is an emerging power generation method which converts this thermal energy into electricity.

Ministry of power and energy of the government of Sri Lanka in its policy has mentioned that it is targeting a carbon neutral economy by 2020[1].

As a part of this drive, the government is considering OTEC or ocean thermal energy conversion power plant, in the deep-water harbour of Trincomalee[2].

What is OTEC ?

Ocean thermal energy conversion (OTEC) uses the difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity.



The most commonly used heat cycle for OTEC is the Organic Rankine cycle using a low-pressure turbine. This will be a closed cycle operation. In simple terms it operates the same as an ordinary steam turbine found in a coal power plant. Yet as the temperature different in which this plant operates is very

low (around 20 ^{0}C) steam cannot be used as the working fluid in the turbine. Therefore an organic compound with a low boiling point is used as the working fluid.

A basic closed-cycle OTEC plant is shown in the figure above. Warm seawater passes through an evaporator and vaporizes the working fluid, an organic substance such as ammonia, propane, refrigerant gases etc. This vapour which is at a higher temperature and pressure is fed into the turbine. The vapor expands as it passes through a turbine which turns a generator making electricity. The lower pressure vapor leaves the turbine and condenses in the condenser connected to a flow of cold seawater pumped from the deep ocean bed. The liquid ammonia leaves the condenser and is pumped to the evaporator to repeat the cycle.

OTEC has long been challenged by high capital costs in a world of cheap energy. Recently, however, higher electricity costs, increased concerns for global warming, and a political commitment to energy security have made initial OTEC commercialization economically attractive in tropical island communities such as ours where a high percentage of electricity production is oil based.

Why is it important for us?

Interest regarding OTEC power plants emerged in Sri Lanka in early 80's. At a request of His Excellency the President, the Solar Energy Group of the National Science council carried out a feasibility study on ocean thermal energy conversion in Sri Lanka[3]. Yet due to the economic situation and unrest prevailed in the country during last few decades these projects did not go beyond the feasibility study level.

Now with the push from the government policy decisions regarding renewable energy, energy security and carbon neutrality, OTEC has again showing signs of future dominance in Sri Lanka energy sector.

There are several key factors behind this drive…..

- Need of an indigenous energy source.

The hydro power potential of our country is almost fully exploited. And now the country is heavily depended on imported fossil fuel for its growing energy demand. Which has an adverse effect on the countries energy security and economic. OTEC power plants can operate as base load power plants. Which means it can generate a decided amount of power through-out the required time period. Thus they will be a candidate to replace fossil fuel fried base load power plants. Thus saving a large amount of foreign reserves of our country.

- Readily available resource

In Sri Lankan territorial waters average temperature of surface sea water is around 25 ^{0}C. At a depth of around 1000 m, the temperature goes down to about 5 ^{0}C. Therefore a temperature gradient of about 20 ^{0}C is there to be exploited for an OTEC project.

Also the continental Slope from continental shelf ends with a very high gradient is only several miles off shore in most parts of the island. Specially it is nearest to land in places such as Kalpitiya, Panadura, Deundara and Trincomalee. Therefore a higher temperature gradient can be achieved at a very short distance.

As such the viability of OTEC as an energy source in Sri Lanka is truly great.

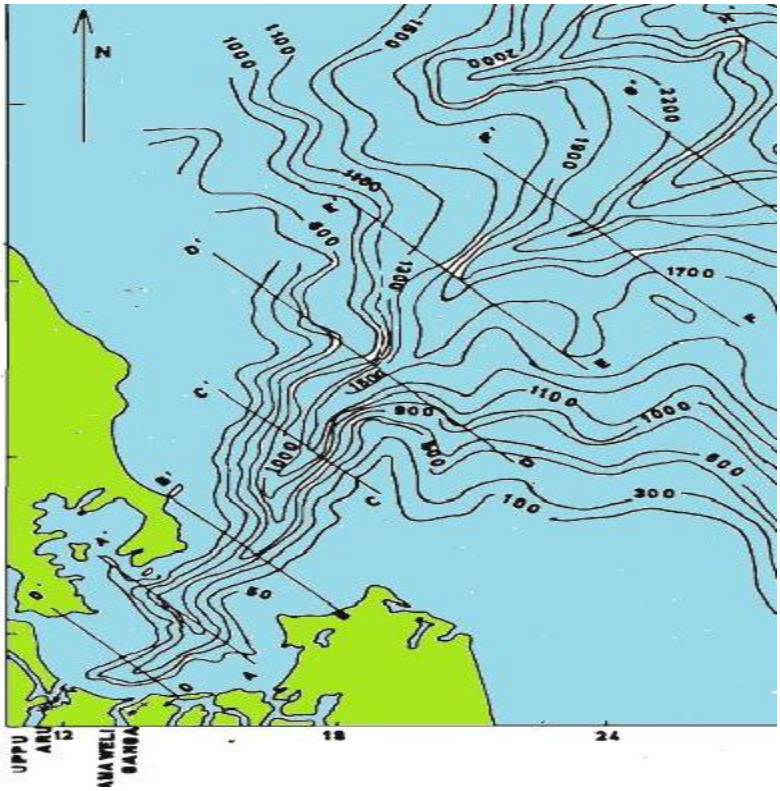
- Clean Energy

OTEC is a 100% clean energy source with zero emission in green-house gases.

Where to begin?

The Minister of power & energy mention in November 2010 that Sri Lanka will construct its first OTEC power plant around Trincomalee[2]. As Sri Lanka has no prior experience of off-shore installation, building a shore based OTEC power plant as the first OTEC power plant will be the most suitable path. Shore base power plant is less in complexity and also in operational cost.

Panadura is situated close to the capitol of Colombo and within 3 km from the coast reaches a depth of 1500 m where the temperature difference is 20 ^{0}C. Dondra canyon, located in the southern part of the island, is a valuable place for an OTEC plant because the necessary temperature difference is within 20km from the coast[4].



Top: conceptual drawing of an on-shore OTEC facility
Left: bathymetric chart of Trincomalee Canyon

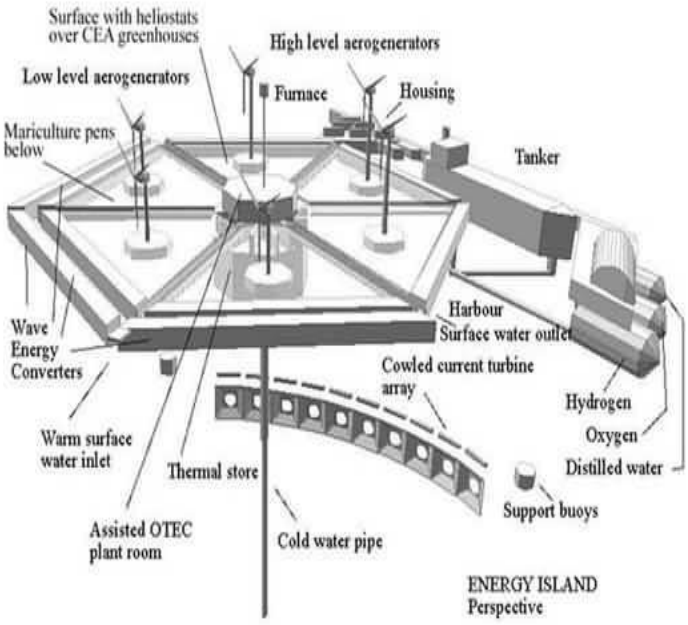
Under the natural harbour of Trincomalee runs extraordinarily deep under water canyon known as Trincomalee Canyon as shown in the bathymetric chart below[3]. The very steep canyon of Trincomalee is the most attractive and is called one of the most suitable sites for OTEC in the world. This canyon attains a depth of 1500 m only 1.5km from the coast Experiments done by research vessels, German R/V SONNE in 1994 and Sri Lankan R/V Samudra Maru found that the temperature difference in Trincomalee canyon is around 21 ^{0}C [4]. Thus Trincomalee is an ideal place to build an experimental on-shore OTEC power plant.

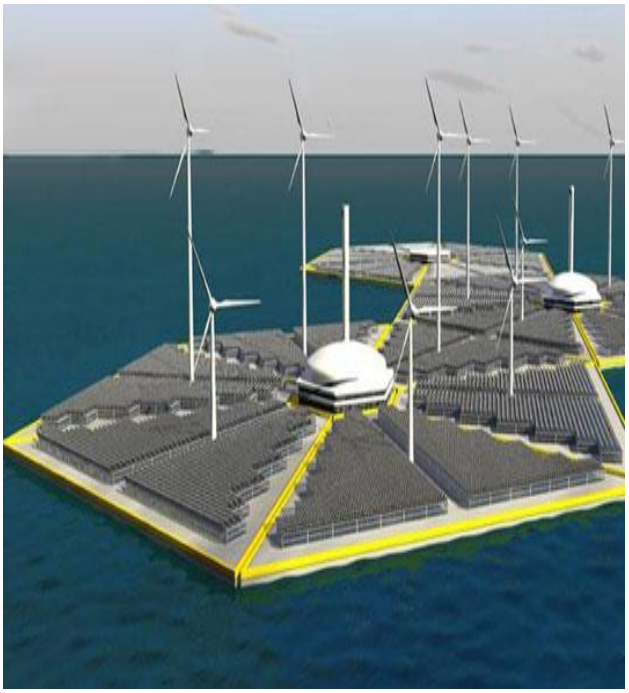
Future it holds……

With the maturing OTEC technology and building up local expertise we can venture in to off-shore mega scale OTEC power plants which will generate a considerable portion of the counties energy demand.

Also these OTEC facilities can be used to generate hydrogen, the future fuel for vehicles. Provide coastal cities with fresh water distilled from the sea. This technology can be used for air conditioning and refrigeration purposes.

As renewable energy technologies matures, we can set up energy islands in our territorial waters, which will combine several renewable energy technologies such as OTEC, wind, tidal power, solar thermal etc.. These energy islands will generate electricity for our households and industries and hydrogen for fuel-cell driven vehicles to meet our transportation needs.





Conceptual Drawings of Energy Islands

Referance:

1. Ministry of Power & Energy: National Energy Policy and Strategies of Sri Lanka, 2006

2. Lanka Business on-line ; Sri Lanka mulls ocean thermal energy option, 13/11/2010

3. Dr. P.D.C. Wijayathuga, former Professor of Electrical Engineering, Department of Electrical Engineering, University of Moratuwa; Energy Supply, Demand and Research; Journal of the National Science Foundation of Sri Lanka 1999 27(1): 65-71

4. Dr. T. K. D. Tennakoon, Oceanography Division, National Aquatic Resources Agency (NARA); Prospects for the OTEC Plant at Sri Lankan Coastline, International OTEC/DOWA Association (IOA) newsletter, Vol. 4, No. 6/winter 1995

On line Resources used :

Lockheed Martin Corporation: 10 MW OTEC power plant

http://www.lockheedmartin.com/products/OTEC/

Lockheed Martin Videos : Ocean Thermal Energy Conversion (OTEC)

http://www.youtube.com/watch?v=bSFp6WXyOU4&feature=related