OCEAN THERMAL ENERGY DEVELOPMENT: PROSPECTS OFF SABAH TROUGHS, MALAYSIA

by
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OPENING REMARK

• 22 April – EARTH Day
• 5 June – World Environment Day
• 8 JUNE – WORLD OCEAN DAY
• 21 October – Malaysia Environment Day
OUTLINE OF PRESENTATION

Part I: INTRODUCTION
Part II: OCEAN THERMAL ENERGY
Part III: PROJECT SITE: SABAH TROUGH
Part IV: THE NEXT STEPS FORWARD
PRIMARY & secondary SOURCES OF ENERGY
(In "Greening" Order)

1. SOLAR: PVs, Heat, Wind, Wave, Ocean Thermal
2. EARTH-MOON GRATIVATIONAL PULL: Tidal
3. HYDROPOWER
4. GEOTHERMAL: Heat
5. BIOMASS: Biogas
6. FOSSIL FUELS: Coal, Oil, Oil Shale, Gas, Gas hydrate
7. MASS-2-ENERGY: Nuclear Fission, Fusion

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A.Bakar Jaafar@MIMA-CETDEM RE-Seminar
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THE EARTH
(formed 4.6 billion years ago)
(as part of the Solar System)
“God is He who created **seven firmaments** and of the Earth a similar number. Through the midst of them (all) descends. His command that you may know that God has power over all things and in (His) **knowledge**”.

(Ref: *Al-Quran Surah Al-Talaq 65-12, the meaning of. Translated by Abdullah Yusuf Ali*)
“A proto-planet, by the size of Mars, crashed into the Earth about 50 my after the formation of the solar system … this cataclysmic event seems to have a stabilizing effect on the Earth, preventing its rotation axis swinging chaotically, and making our ONLY planet Earth a more amenable home to life” (Redfern, 2003:34)
EARTH SCIENCES

- GEODESY
- METEOROLOGY
- HYDROLOGY
- HYDROGRAPHY
- GEOCHEMISTRY
- GEOPHYSICS
- GEOLOGY
- OCEANOGRAPHY
- GEOGRAPHY

1. AIR
2. FRESH WATER
3. SOIL
4. SEA-BED
5. THE OCEAN
6. The MOON
7. (The non-LIVING THINGS)
THE OCEAN AND ITS ORIGIN

• Created some 3.3 billion ya [based on the fossils, dated from the Precambrian, of bacteria and cyanobacteria (blue-green algae)]

• Covering 363 million square km or some 72 per cent of the earth's surface;

• Containing 1.37 billion cubic km of water;

• Stabilized at the present sea-level only in the last 11,500 years ago.
EMERGING ISSUES, OPPORTUNITIES, AND INTERESTS AT SEA

1. OCEAN THERMAL ENERGY (OTEC);
2. MORE FOODS AND WATER FROM THE SEA;
3. MORE TRANSPORT BY WATER, THAN BY COASTAL HIGHWAYS; and
4. MARINE RESOURCES WITHIN AND BEYOND NATIONAL JURISDICTIONS.
RENEWABLE ENERGY & FRESHWATER FROM THE SEA

• At sea and by the sea, there will be more opportunities to develop various forms of renewable energy than on limited lands: from solar, wind, wave, tide-tidal, current, to ocean-thermal.

• With in-situ generation of such renewable energy, it would be more feasible than in the past to produce “freshwater” from the abundant “seawater”;}
RENEWABLE OCEAN-ENERGY

The world’s oceans provide two forms of energy powered by the sun: (1) Thermal energy: offshore wind and ocean thermal/OTEC; and (2) mechanical energy: waves, currents and tides. Only OTEC, currents and tides are consistent and predictable 24/7.

Areas highlighted above indicate locations of major ocean energy activities today.

To learn more about the various types of ocean energy, visit www.oceanenergycouncil.com
GLOBAL OCEAN ENERGY POTENTIAL

• The oceans 70 percent of the Earth’s surface, the world’s largest solar energy collector and energy storage system, 60 million sq km of tropical seas absorbing solar radiation equal in heat content to about 250 billion barrels of oil ($US 13 trillion @$50/bbl). If 0.1 percent converted into electric power = over 20 times the total amount of electricity consumed in US per day.
OCEAN THERMAL ENERGY CONVERSION

First conceived of by the French engineer, Jacques D’Arsonval in 1881
History of OTEC

- Georges Claude, d'Arsonval's student, in 1930 built the first OTEC plant in Cuba, producing 22 kW of electricity with a low-pressure turbine.
- In 1935, Claude constructed another plant aboard a 10,000-ton cargo vessel moored off the coast of Brazil. Weather and waves destroyed both plants before they became net power generators.
IN THE TROPICAL ATLANTIC

• In 1956, French scientists designed another 3-MW OTEC plant for Abidjan, Ivory Coast, West Africa. The plant was never completed, however, because it was too expensive??
DEVELOPMENT IN USA

The United States became involved in OTEC research in 1974 with the establishment of the Natural Energy Laboratory of Hawaii Authority. The Laboratory has become one of the world's leading test facilities for OTEC technology.
THE SECOND? DEMO-OTEC PLANT

Demonstrated in 1979 a small plant mounted on a barge (Mini-OTEC) produced 50 kW of gross power, with a net output of 18 kW.
Mini-OTEC (1979)
NEAR-SHORE OTEC
Some experimental systems, such as Ocean Thermal Energy Conversion (OTEC), are being developed. OTEC depends on the temperature differential between warm, surface water and the considerably cooler water of the deep ocean. The difference may be as much as 36°F (20°C). The cold, deep water is used to condense ammonia or similar liquid chemicals, which are then passed through evaporators warmed by the surface waters. The cycling of the gas through the condensation cycle is used to drive turbines that generate electricity. Although the efficiency of such systems is relatively low, alternative uses for this thermal grade include the Claude Condensor, which can be used for generating freshwater supplies in coastal areas of arid countries.
OTEC: How does it work?
(Ref: Maria Bechtel and Erik Netz)
Closed Cycle System

“KALINA CYCLE”

OCEAN THERMAL ENERGY CONVERSION: uses the temperature difference between surface and deep ocean water to generate electricity.
OTEC RANKINE CYCLE
Open-cycle OTEC Plant

Close-cycle OTEC Plant
MORE ADVANCED “UEHARA” CYCLE
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GLOBAL OCEAN THERMAL ENERGY POTENTIAL
PROSPECTS OF MARINE RESOURCES IN THE SOUTH CHINA SEA
TEMPERATURE-DIFFERENTIAL
(Beyond 20 °C)

Off Sabah, the Sabah Trough with very low water temperature of about 3 °C at a depth of 2900 m proves to be of potential site for the development of ocean thermal energy, sustainable resource for the future
(Ref: MyMRS, 2008)
Project X: RENEWABLE OCEAN THERMAL ENERGY POTENTIAL

- By pumping 1000 cubic metres/sec of the bottom cold sea water to the surface, the energy potential would be about 2500 MW, larger than the biggest coal-fired power plant of TNB Janamanjung of 2100 MW
PART IV: THE NEXT STEPS FORWARD

• To carry out Techno-Enviro-Economic Studies on OTEC off the Sabah Trough;

• To carry out Ocean Thermal Energy Conversion (OTEC) Technology Assessment;

• The explore the prospects of alternative means of OTEC energy storage and distribution, including conversion metal-lithium hydride; and

• To solicit potential stakeholders, including pioneer investors.
1. U.S. Navy and Lockheed Martin developing technology for an OTEC plant off Guam by 2013 at a cost of $1.5 billion.

2. DEEP Ocean Power Philippines Inc. targets to generate 3,600 MW in 36 prospective sites.

3. 10 MW Pilot OTEC Plant, off Kahe Point on Oahu’s western shore, Hawaii 2b Built by 2013, Scaled to 100 MW by 2015: Lockheed Martin
LARGEST OTEC PLANT TO DATE, 2006?

@ US Naval Support Facility Diego Garcia (NSFDG), Indian Ocean, the minimum size facility practical and capable of generating 7-9 MW of electricity and 1.25 million gallons of fresh water per day (i.e. 25,000 people)
TERIMA KASIH
شكر (shukran)
谢谢 (xìe xìe)
Thank You
Merci
Gracias
Спасибо