IEM-3rd International Green Workshop & Exhibition (IGWE 2016)

"Ocean Thermal Energy Conversion (OTEC) to Power or Hydrogen-Fuel & Other Spin-Offs for Sustainability"

by

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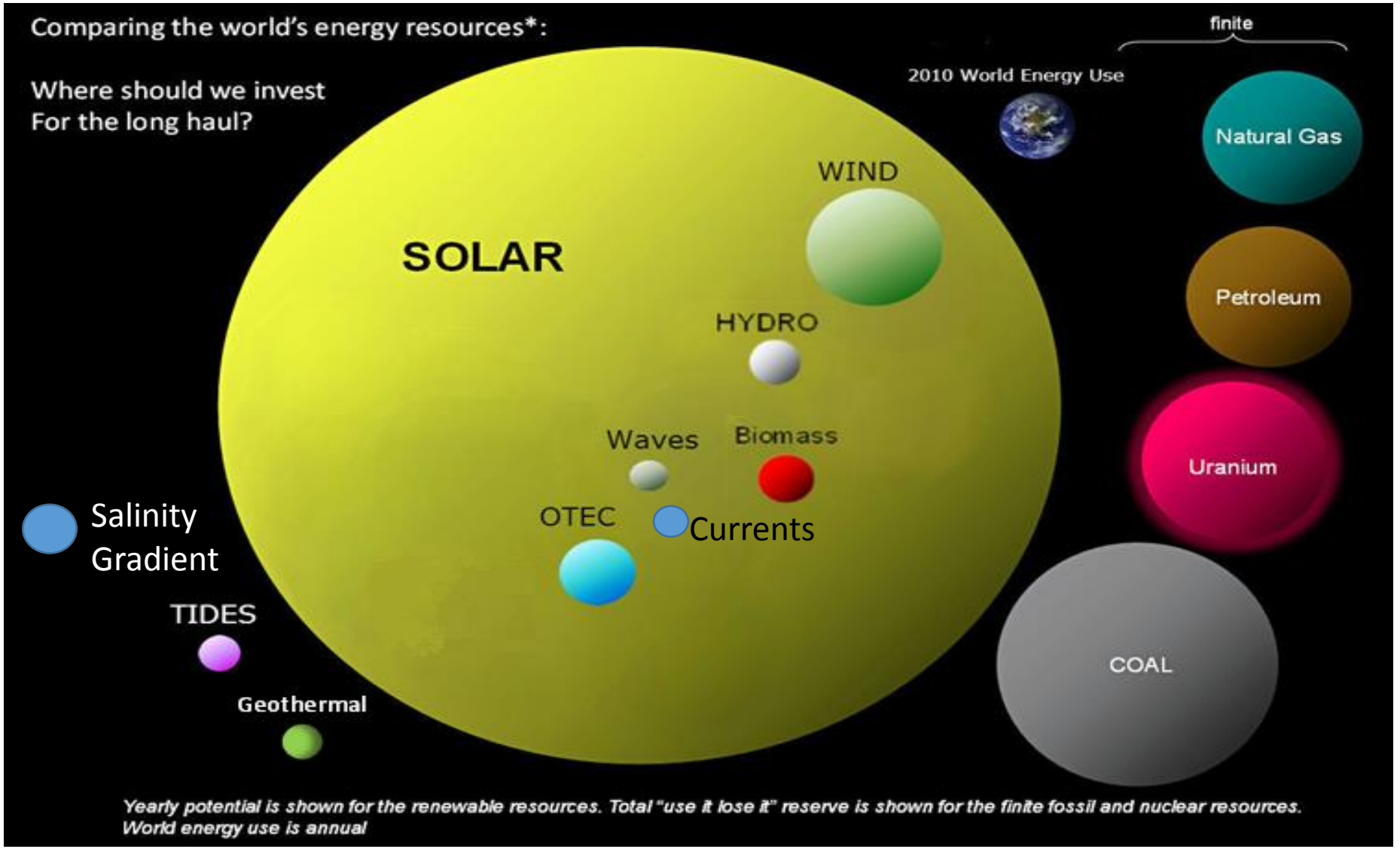
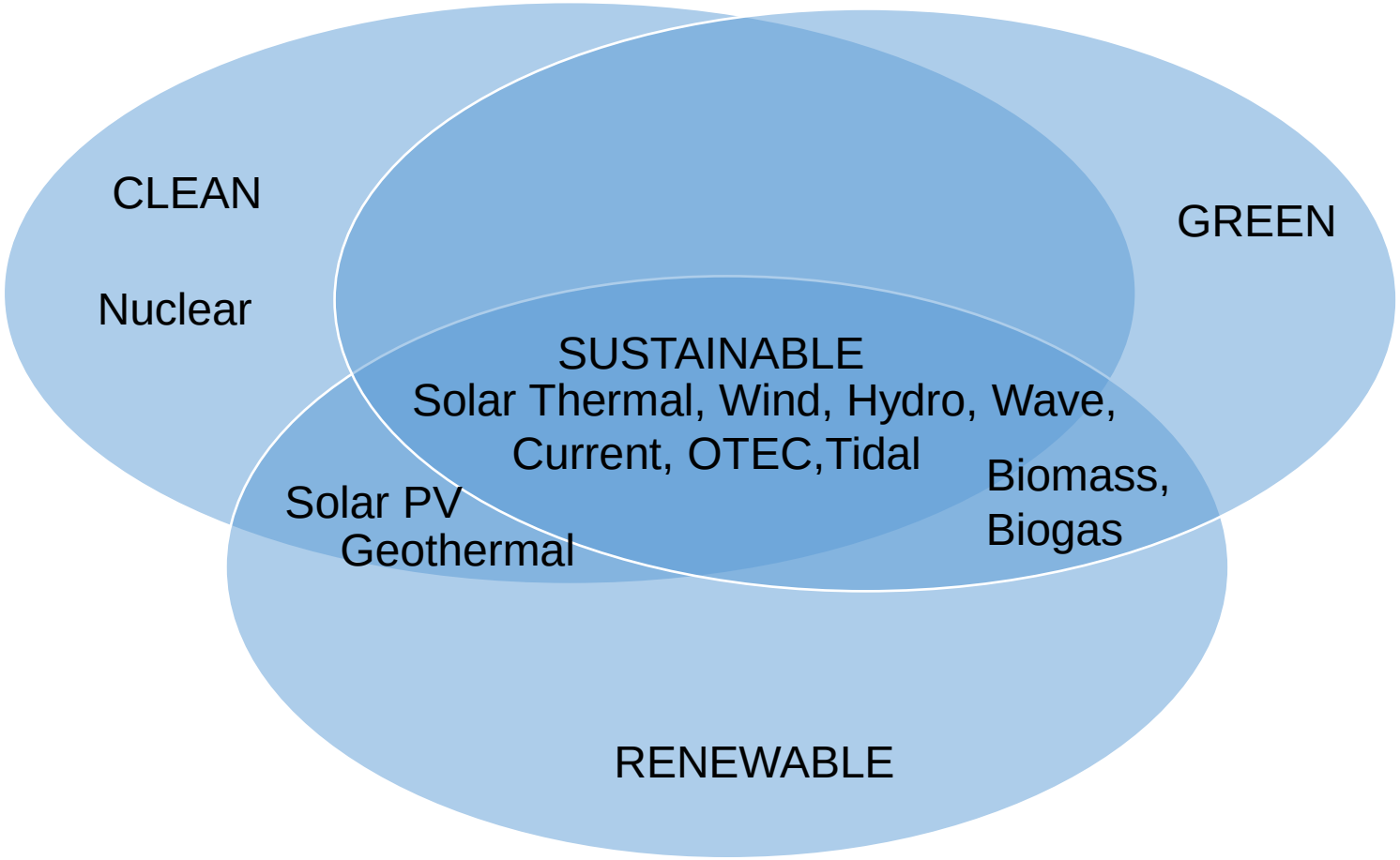
OUTLINE OF PRESENTATION

1. Introduction: Energy Resources in Perspective and OTEC Potential
2. OTEC Definition, Principle & Potential OTEC Project Sites
3. OTEC Production Cost and Spin-Offs
4. Way Forward for Sustainability

1. GLOBAL SOURCES OF ENERGY, RENEWABLE & NON-RENEWABLE, IN PERSPECTIVE



FORMS OF ENERGY & CLASSIFICATION



2. OTEC Legal Definition:

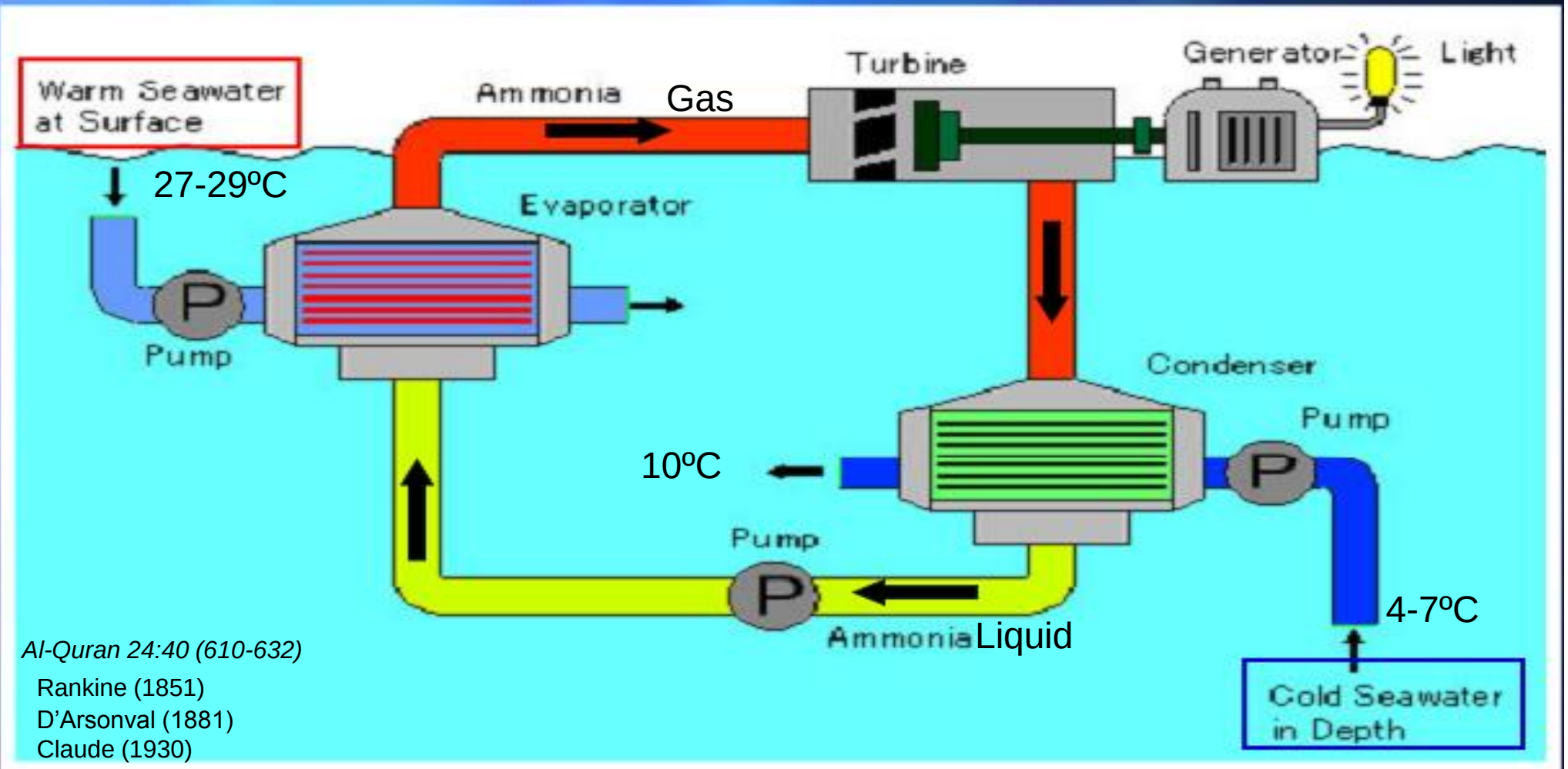
"OCEAN THERMAL ENERGY CONVERSION"

"... a method of converting part of the heat from the Sun which is stored in the surface layers of a body of water into electrical energy or energy product equivalent";

[Pub. L. 96-310, Sec. 9, July 17, 1980, 94 Stat. 946.]

Ref:
http://uscode.house.gov/download/pls/42C98.txt

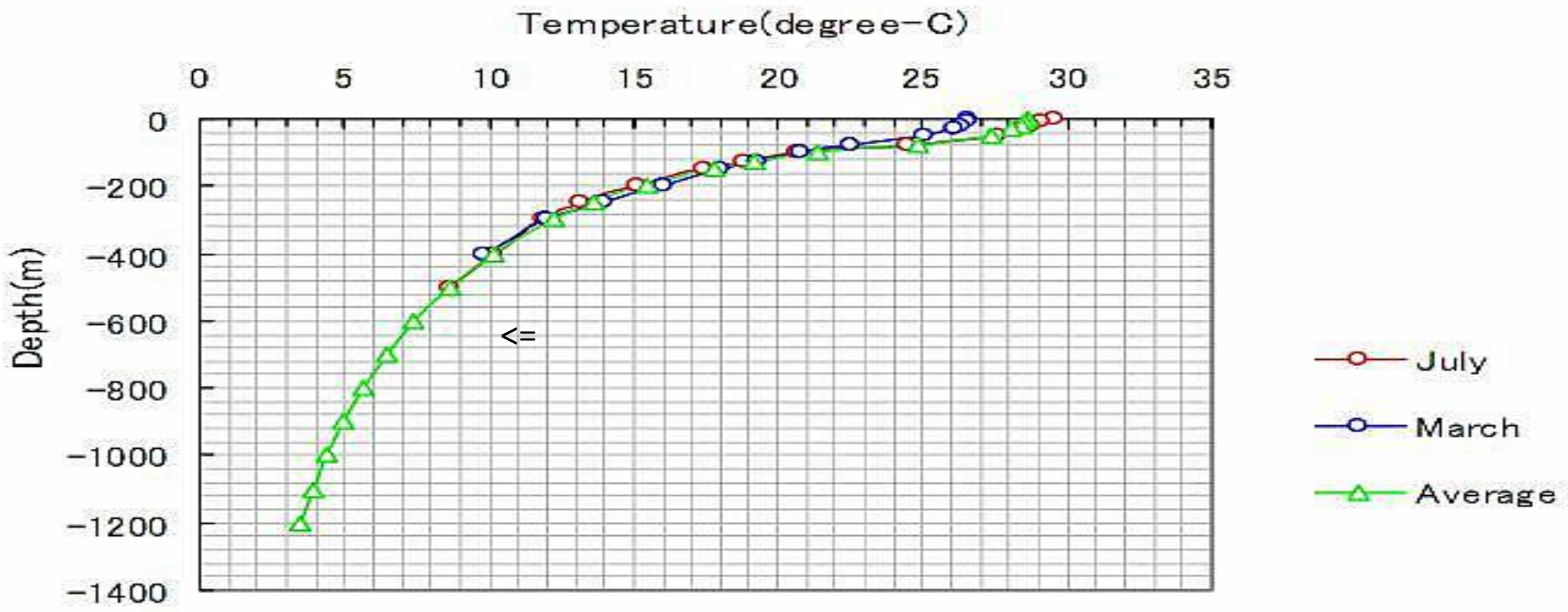
Principle of OTEC



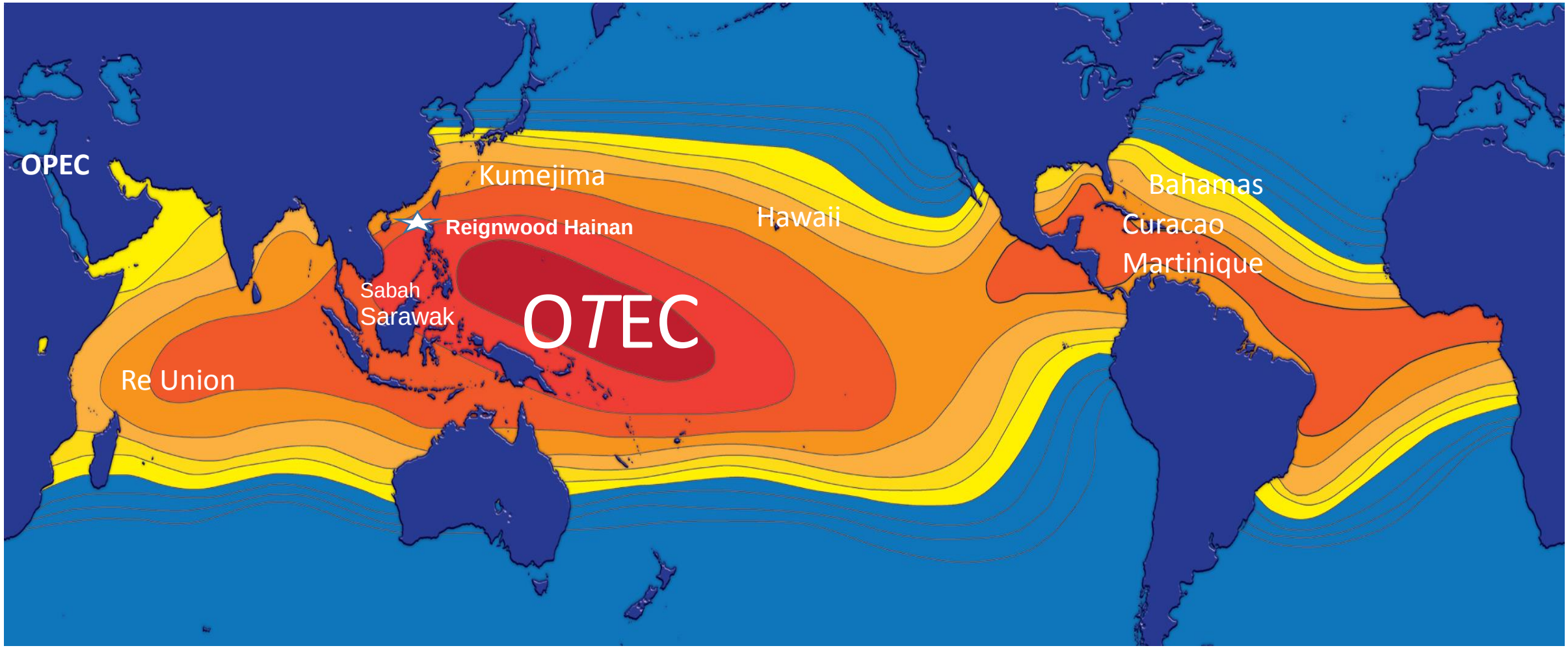
Al-Quran 24:40 (610-632)

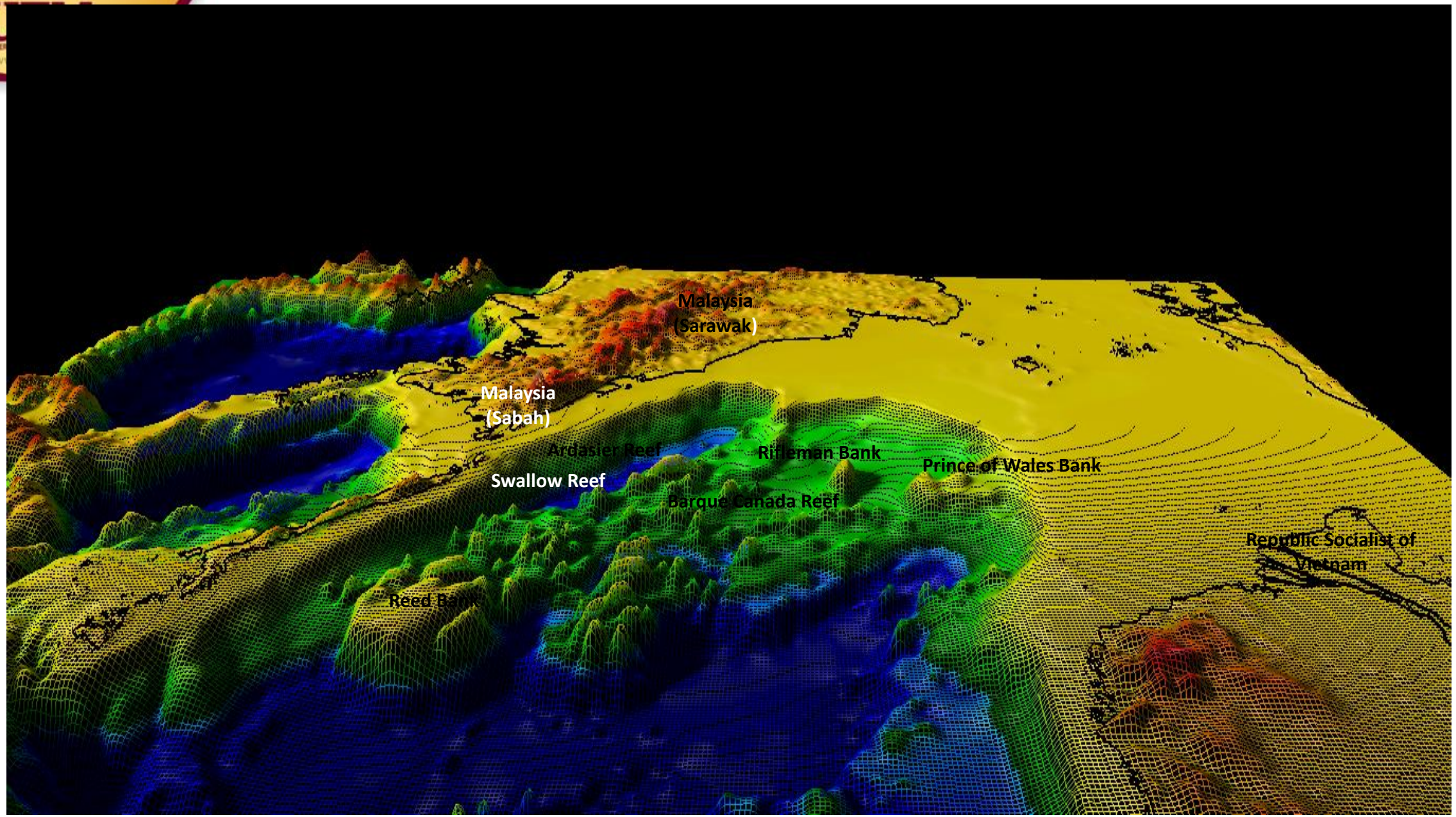
Rankine (1851)
D'Arsonval (1881)
Claude (1930)

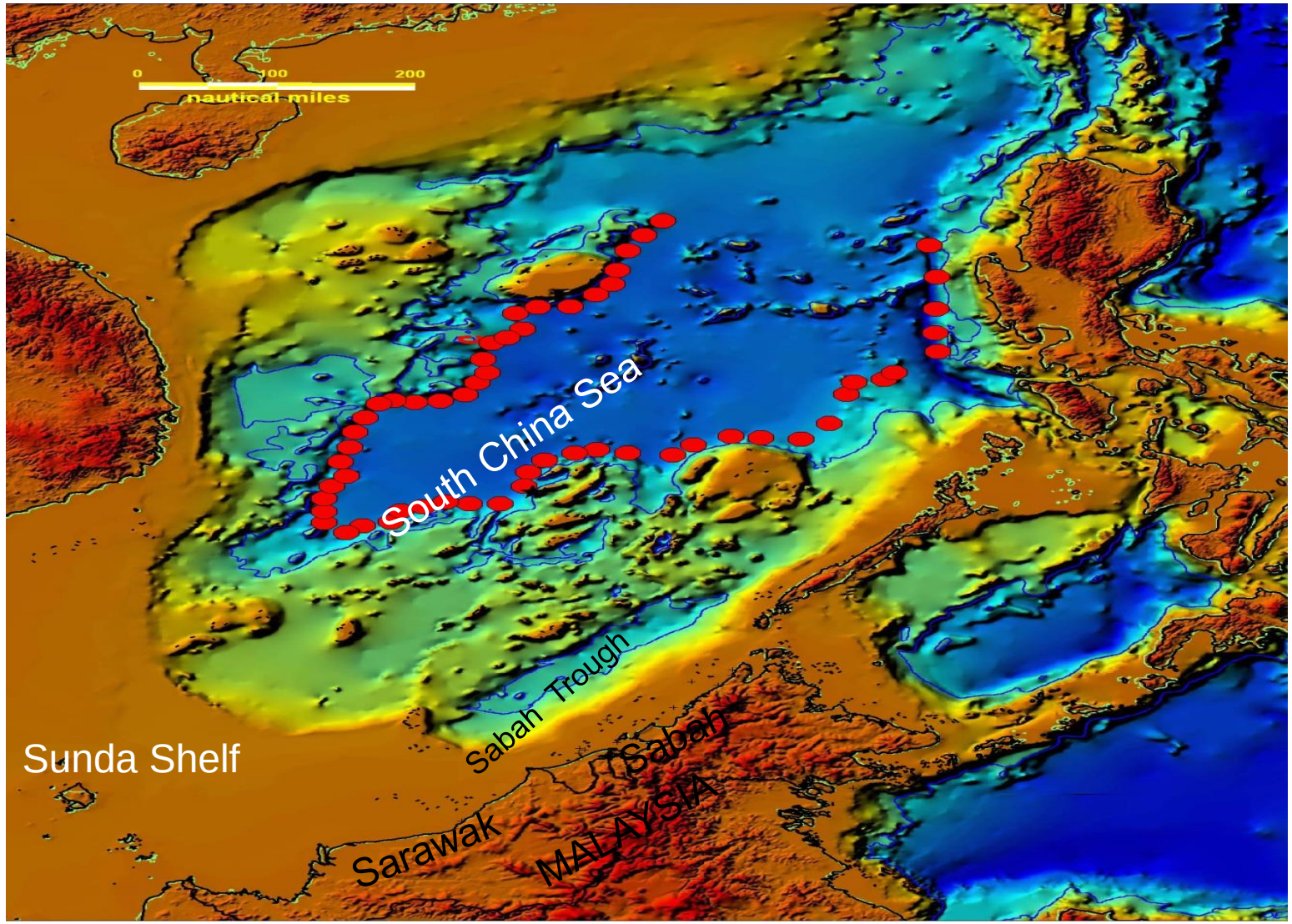
Off Sabah:


Temperature-Depth Profile
Temperature(degree-C)
0
5
10
15
20
25
30
35
Depth(m)
0
-200
-400
-600
-800
-1000
-1200
-1400
<=
July
March
Average

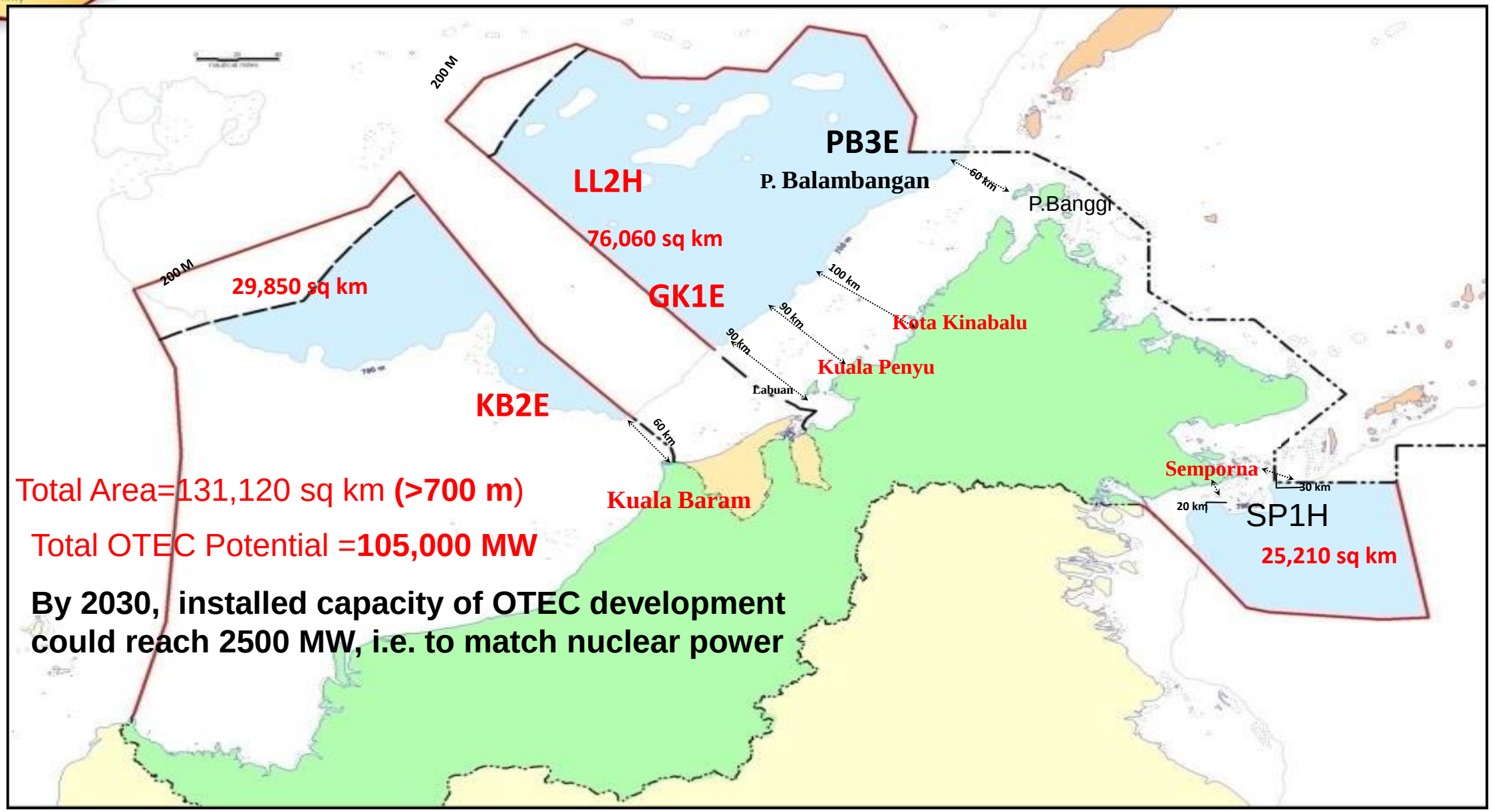
Global OTEC Potential & Development: From OPEC to O*T*EC

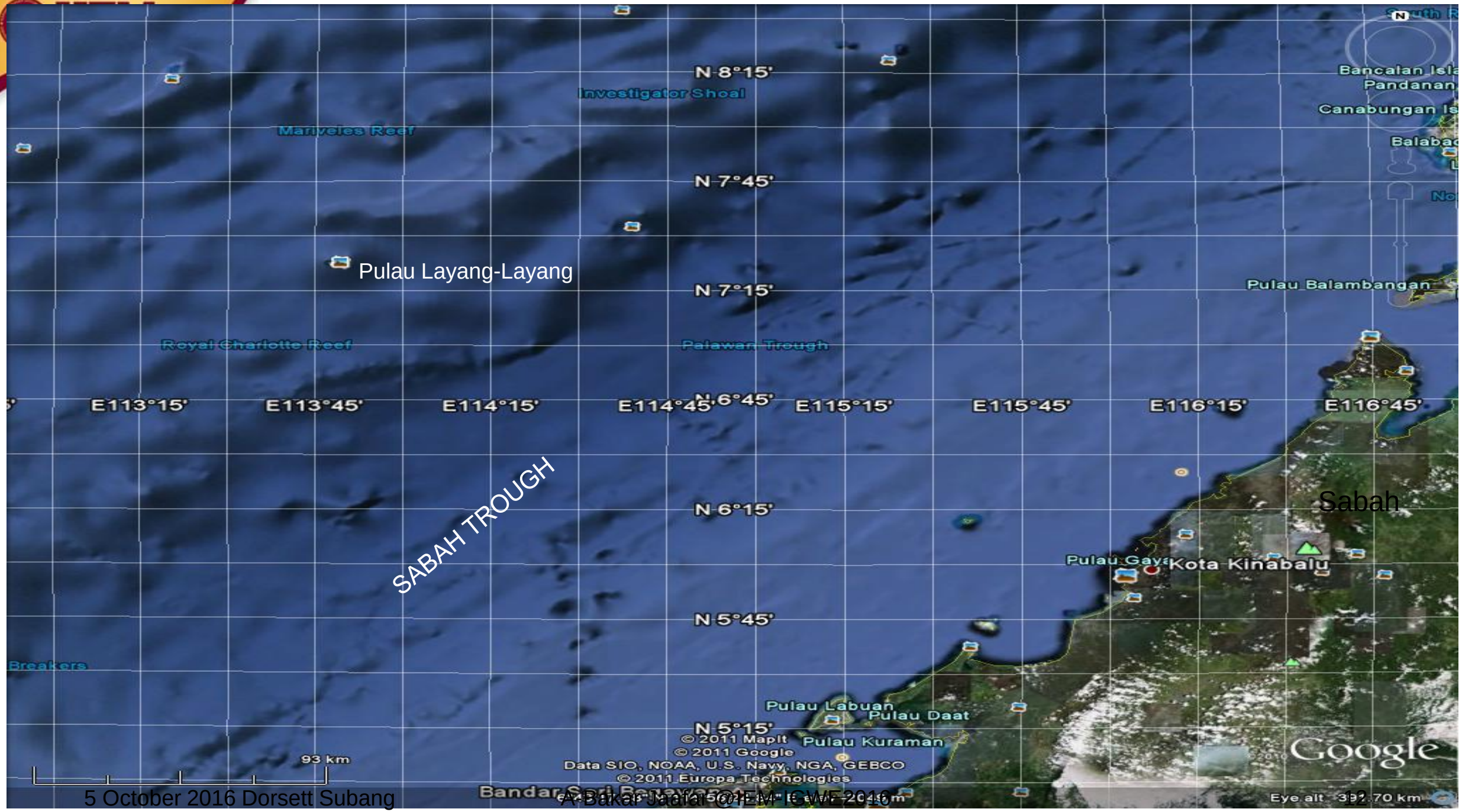



Malaysia
(Sarawak)
Malaysia
(Sabah)
Ardasier Reef
Swallow Reef
Rifleman Bank
Prince of Wales Bank
Barque Canada Reef
Republic Socialist of
Vietnam
Reed Bank


0
100
200
nautical miles
South China Sea
Sunda Shelf
Sabah Trough
Sabah
MALAYSIA
Sarawak

OTEC POTENTIAL IN MALAYSIA &THE FIRST FIVE OTEC POTENTIAL SITES




N 8°15'
Investigator Shoal
Mariveles Reef
N 7°45'
Pulau Layang-Layang
N 7°15'
Royal Charlotte Reef
Palawan Trough
E113°15'
E113°45'
E114°15'
E114°45'
N 6°45'
E115°15'
E115°45'
E116°15'
E116°45'
SABAH TROUGH
N 6°15'
Sabah
Pulau Balambangan
Kota Kinabalu
N 5°45'
Breakers
Pulau Labuan
Pulau Daat
N 5°15'
Pulau Kuraman
© 2011 MapIt
© 2011 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2011 Europa Technologies
93 km
Google
Eye alt 392.70 km

A PRE-FS being conducted @Pulau Layang Layang funded by DCNS 10.4 million Euro Offset Programme for the 1st Pioneer OTEC Plant in Malaysia

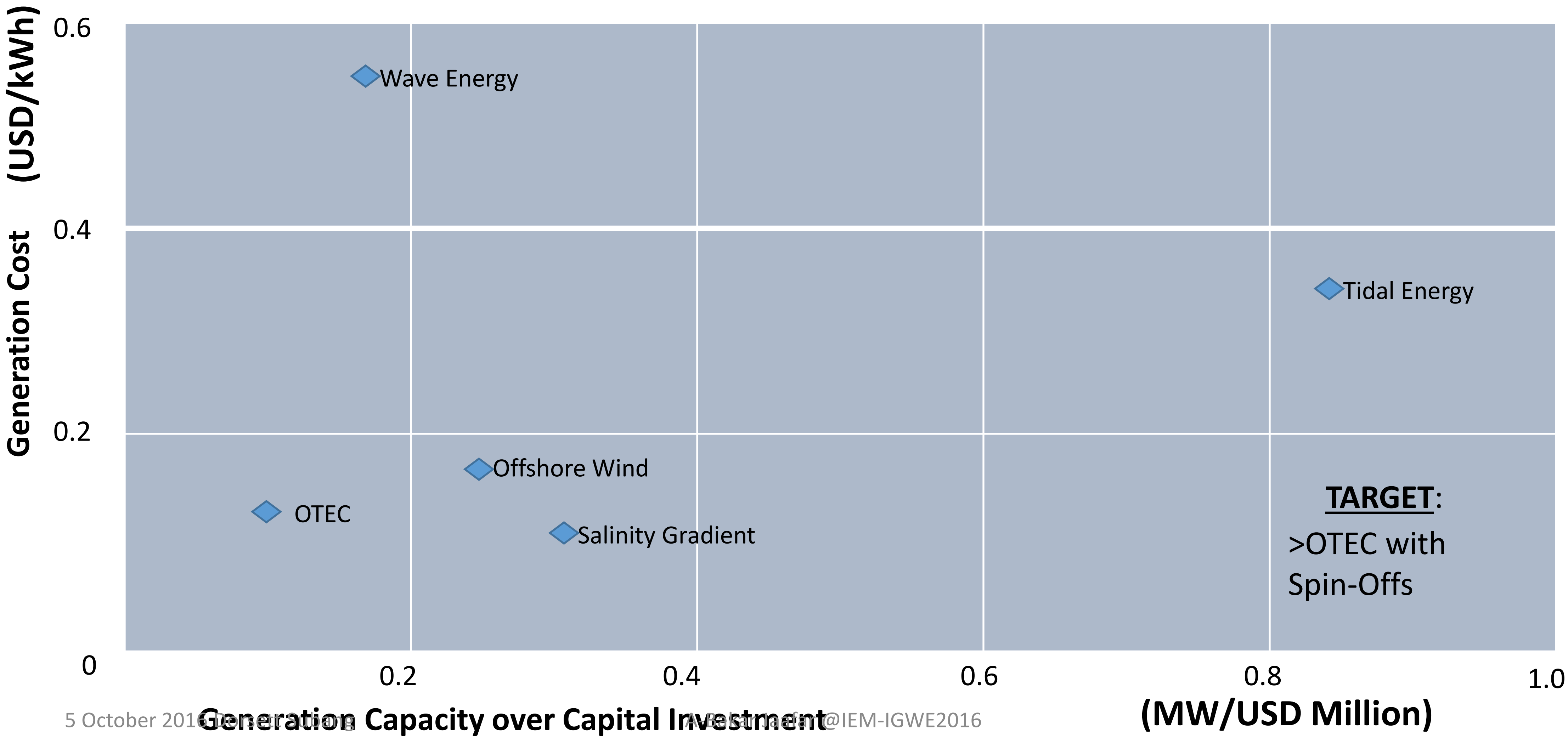
OTEC-Power Generation

Ocean Energy	Input			Output Cost of Ocean Energy (USD/KWh)
	Generation Capacity (MW)	Capital Investment (Million USD)	MW/Million USD	
Wave Energy	10	62.75	**0.16**	**0.561**
Tidal Energy	254	298	**0.85**	**0.28**
Offshore wind	10	40	**0.25**	**0.165**
OTEC	53	451	**0.12**	**0.13**
Salinity gradient	200	600	**0.33**	**0.09**

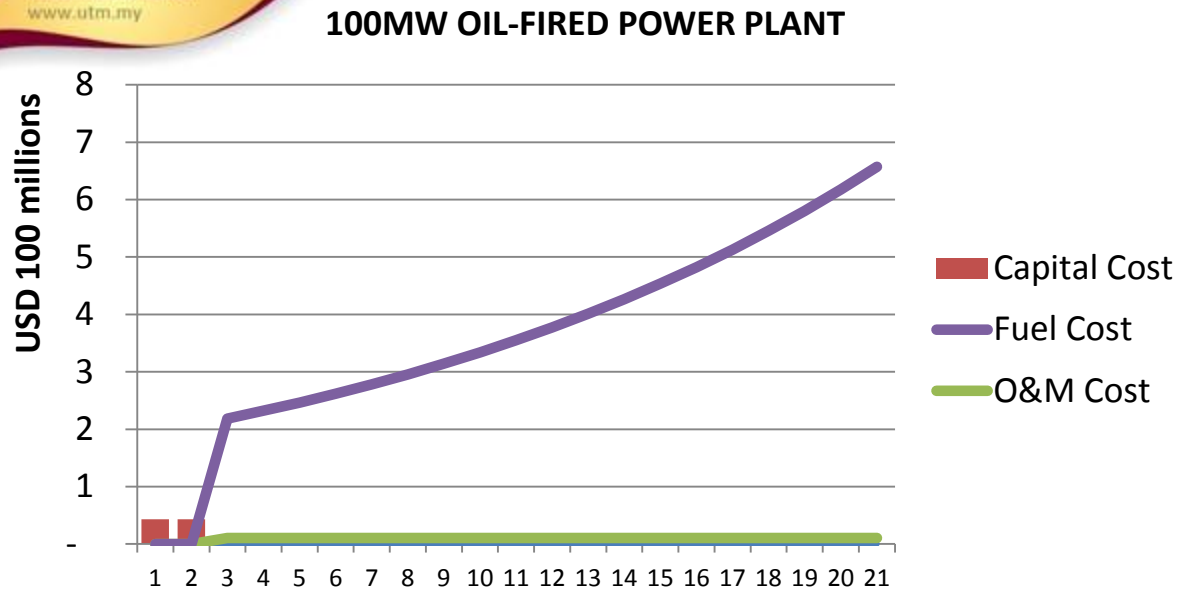
kWh = kilowatt-hour, MW =megawatt

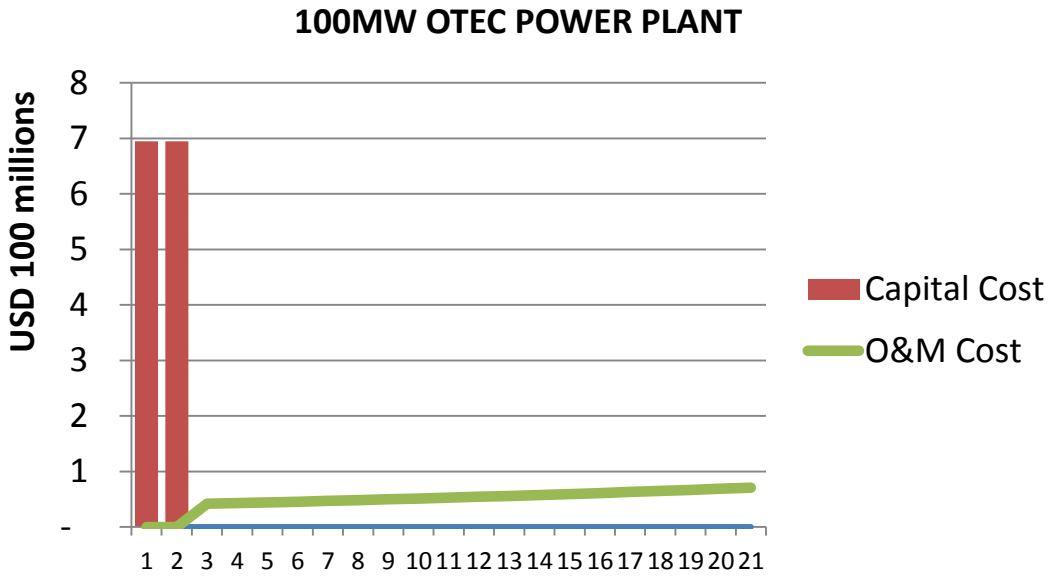
Source: Asian Development Bank Report & IRENA Technology Brief

3. Ocean Energy Production Cost & Generation Capacity over Capital Investment



COMPARATIVE CAPITAL & OPERATING COSTS OVER PROJECT LIFE CYCLE





Total costs (USD) over 21 years of operation

OIL-FIRED POWER	OTEC-POWER
USD 7.5 billion	USD 1.5 billion

5
4. WAY FORWARD FOR SUSTAINABILITY

- Ocean Energy & 11th Malaysia Plan, Already in Place;
- OTEC addressing all the 10 Impactful Focus Areas outlined by National Council for Science & Research
- OTEC-H2 & Fuel-Cell would contribute about one-third of the total power generation capacity by 2050 [Ref: ASM TF-CFE]

11th MALAYSIA PLAN & OCEAN ENERGY

- The subject of "ocean energy" has been incorporated in 11th Malaysia Plan (2016-2020):

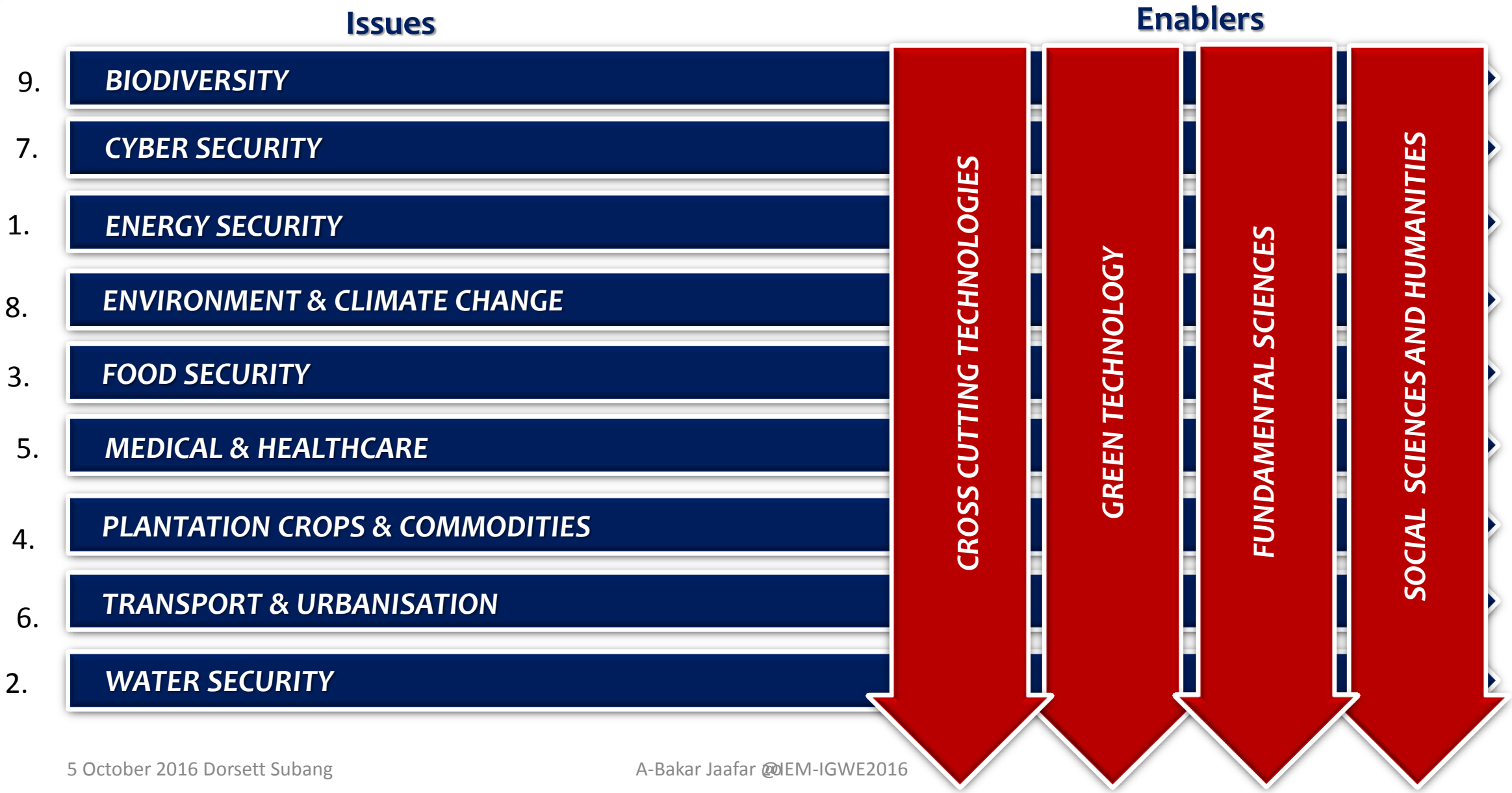
Exploring New Renewable Energy Sources

17.78 Studies will be conducted to identify new RE sources to diversify the generation mix. In the Eleventh Plan, new RE sources such as wind, geothermal and ocean energy will be explored. Currently, the national wind mapping exercise is underway and it is expected to be completed by 2016. The exercise will further enable a study on the feasibility of wind energy to be developed. Geothermal potential will also be further explored with the discovery of a 12 square kilometres geothermal field in Apas Kiri, Sabah. Viability of ocean energy will be explored to take advantage of Malaysia's geographical position of being surrounded by sea.

"Ocean Energy"=>

- Ocean thermal energy;
- Offshore wind energy;
- Tidal movements;
- Oceanic current;
- Wave energy; and
- Salinity gradient

IMPACTFUL FOCUS AREAS



OTEC SPIN-OFF INDUSTRIES FOR WATER, FOOD, & RENEWABLE ENERGY FOR SUSTAINABILITY

Temperate Produce

"Import Substitutions"

High Value Produce

Capture-Fisheries

Health & Cosmetics

Ms Earth Japan, 2012

Lithium Production

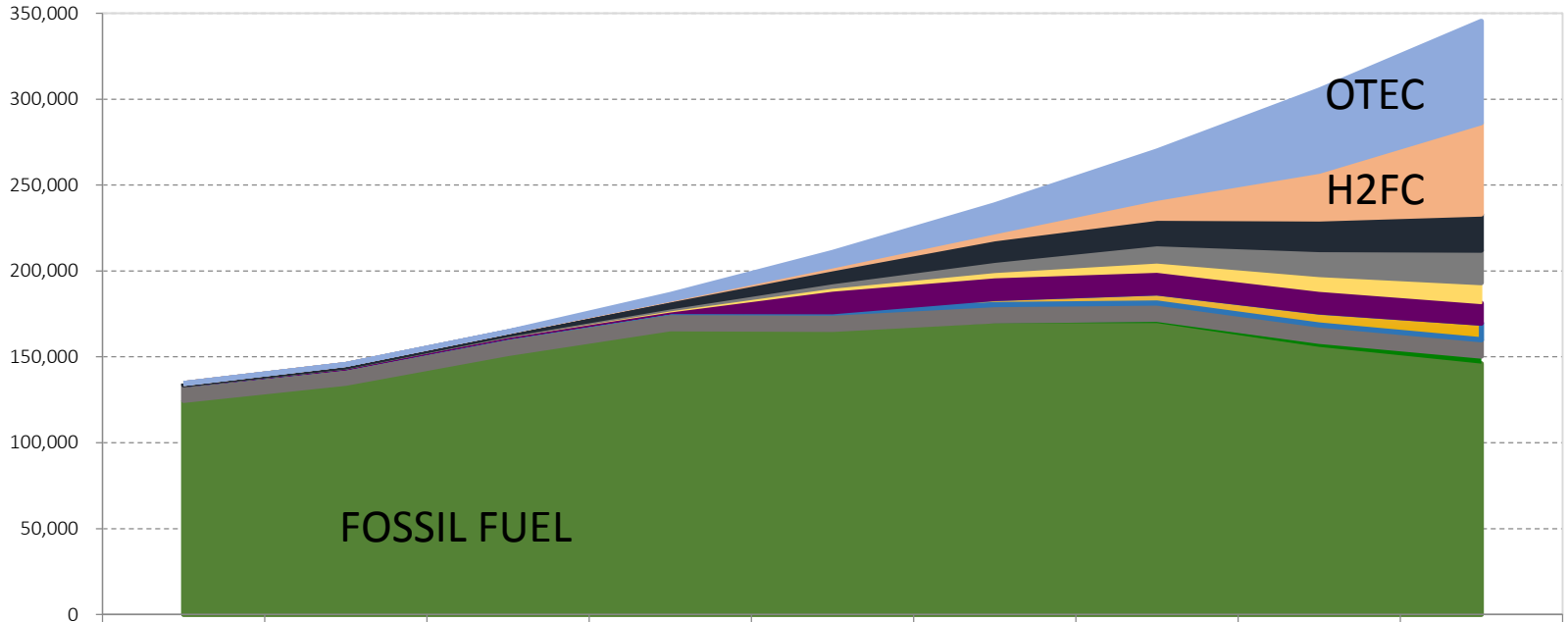
Mineral H_20

Smart-Grid

With all Renewables

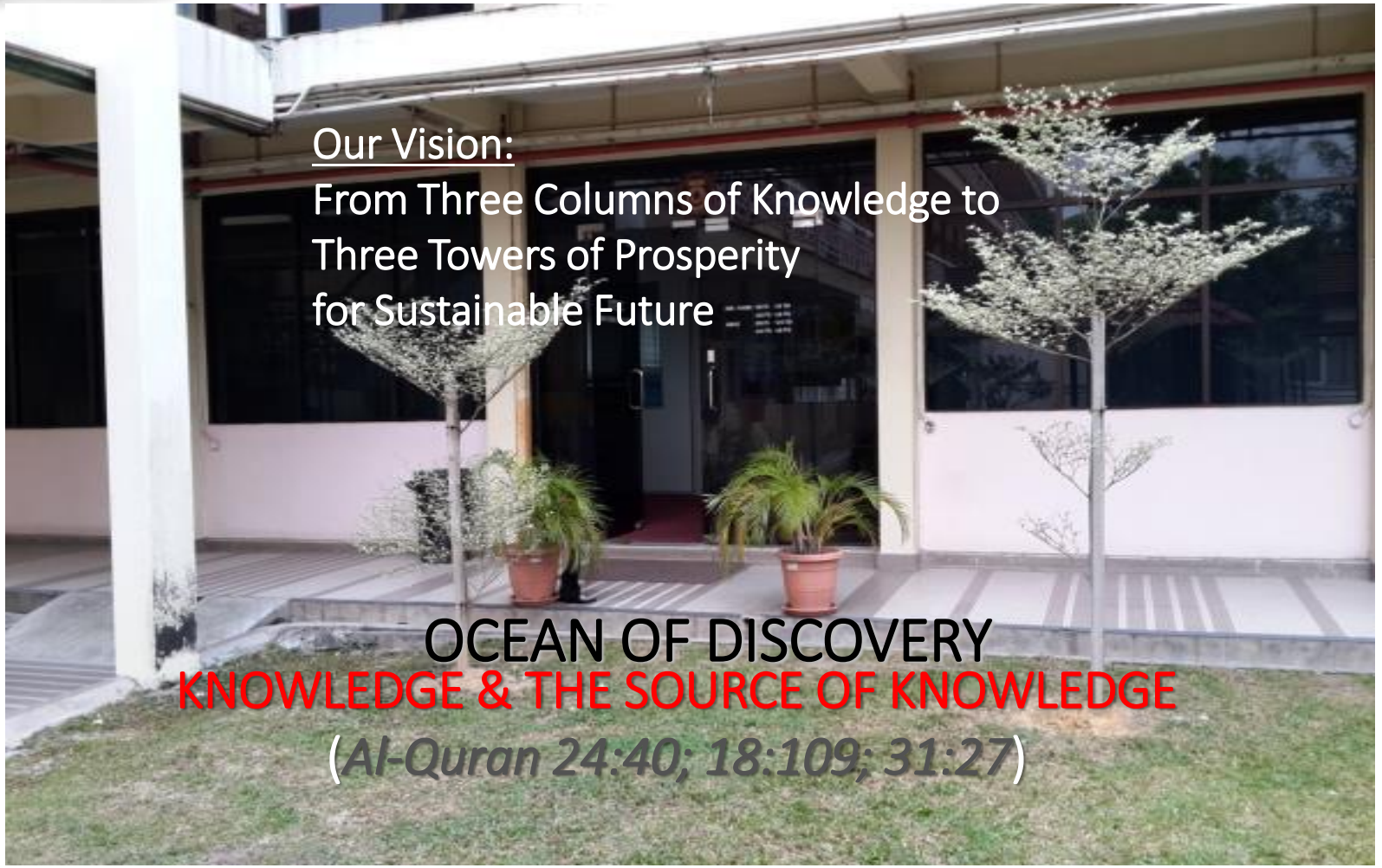
OTEC-H2

Malaysia: Projected Electricity Generation by Energy Source (GWh) 2012-2050



	2012	2015	2020	2025	2030	2035	2040	2045	2050
OTEC	0	0	134	2,848	7,884	15,768	27,594	47,304	59,129
Fuel Cell	0	0	16	354	1,665	4,054	11,603	27,782	53,194
Bioenergy	809	1,455	1,567	4,088	7,553	12,535	14,832	17,823	21,049
Wind Energy	0	0	547	1,095	2,601	5,913	10,052	14,520	18,922
Solar PV	7	437	790	1,579	2,631	3,999	6,314	9,502	11,913
Nuclear	0	0	0	0	12,264	12,264	12,264	12,264	11,650
Wave/ Tidal/ Current	0	0	219	548	751	3,548	5,868	7,603	9,662
Hydropower	9,056	9,084	9,531	9,531	9,531	9,531	9,531	9,531	9,531
Geothermal	0	0	216	382	531	1,264	2,122	3,174	4,318
Fossil Fuel	124,596	134,571	151,656	165,891	165,388	169,623	169,661	155,798	146,047
Total	134,468	145,547	164,675	186,316	210,800	238,500	269,841	305,300	345,417

Source: ASM Task Force on Carbon Free Energy (2015)



TERIMA KASIH

GRACIAS
MERCI
SPASBO
SYUKRAN
THANK YOU
XIE-XIE

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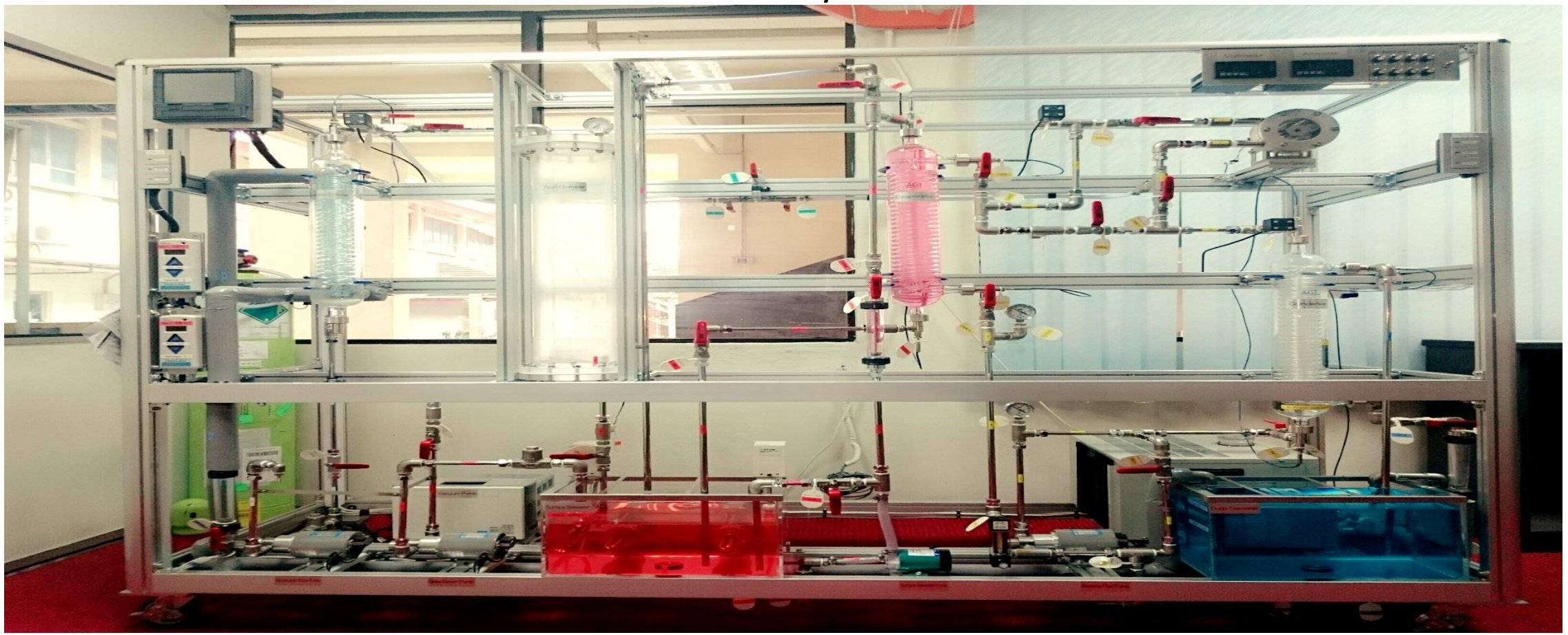
3W Micro-OTEC @UTM OTEC Block Q Commissioned on 22 May 2015



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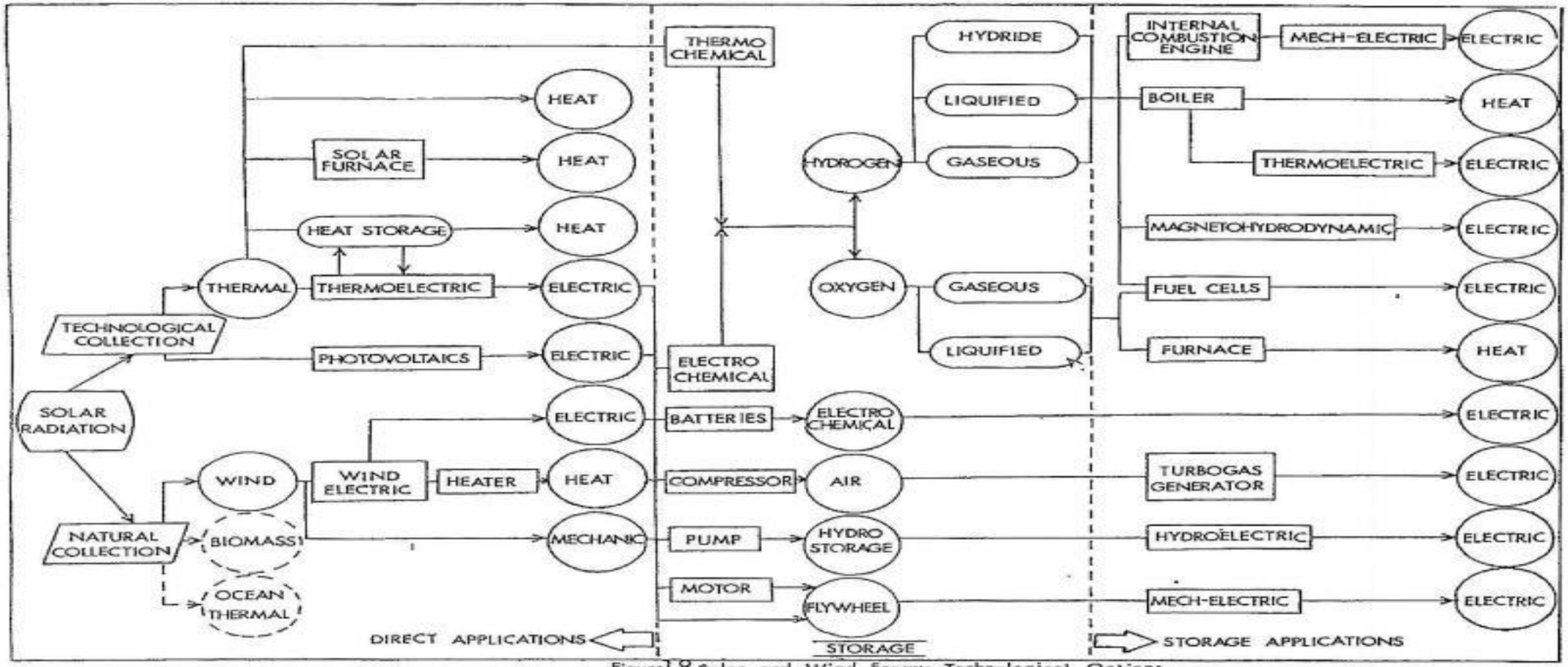

Figure 18 Solar and Wind Energy Technological Options

[Ref: Abu Bakar Jaafar (1976). "Applicability of Solar Energy Technology for Industrial Pollution Control and Production: The Case of the Primary Copper Smelting Industry". An Internship Report. Submitted to the Faculty of Miami University in par tial fulfillment of the requirements for the degree of Master of Environmental Science Institute of Environmental Sciences. Oxford, Ohio. P.82]

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