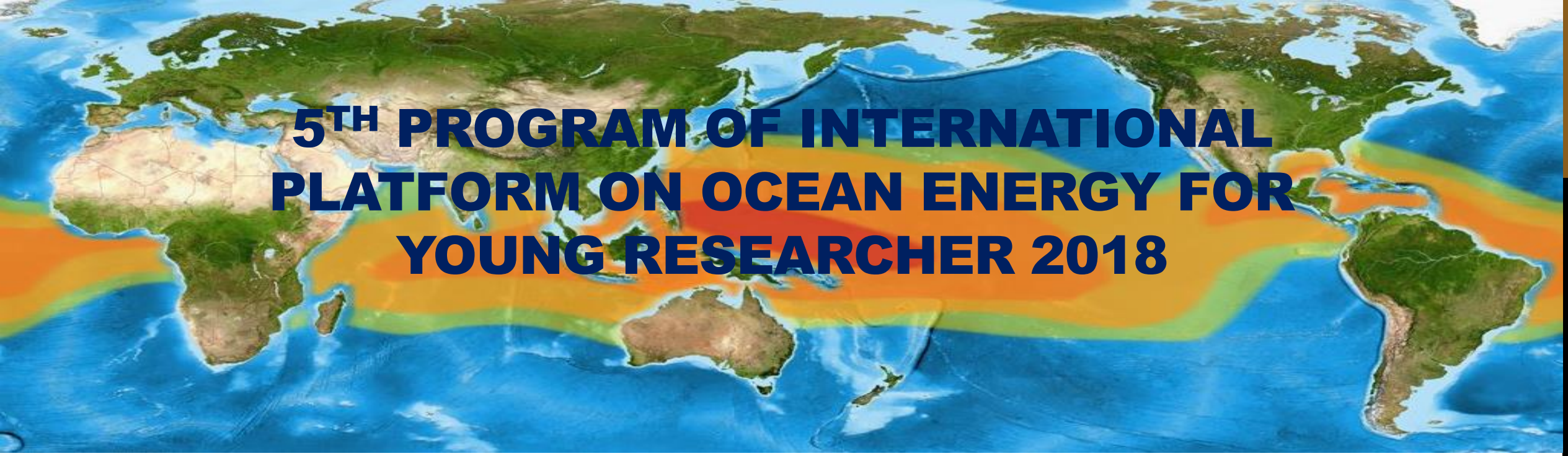


5TH PROGRAM OF INTERNATIONAL PLATFORM ON OCEAN ENERGY FOR YOUNG RESEARCHER 2018

"BATHYMETRY DATA ANALYSIS OF THE OCEAN THERMAL ENERGY CONVERSION (OTEC) RESOURCE"

by

M Shafiq Rahmat

UTM Ocean Thermal Energy Centre

E-mail: mshafiq11@utm.my

Mobile: +601137040793

innovative • entrepreneurial • global

OUTLINE OF PRESENTATION

1. Introduction to OTEC
2. Consideration Factors in Choosing OTEC Sites
3. Choosing OTEC Site
4. Method to determine OTEC potential site
5. Case Study 1: Kume Island
6. Case Study 2: Sri Lanka
7. Conclusion

INTRODUCTION TO OTEC

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.]

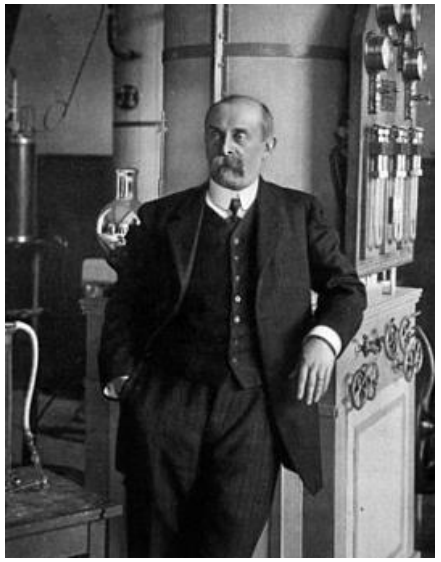
Ref:
http://uscode.house.gov/download/pls/42C98.txt

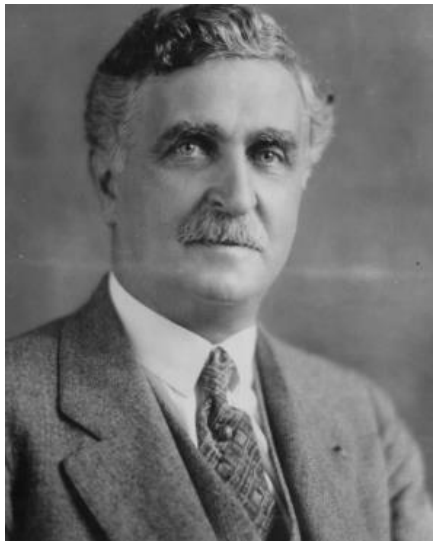
INTRODUCTION TO OTEC

UTM UNIVERSITI TEKNOLOGI MALAYSIA

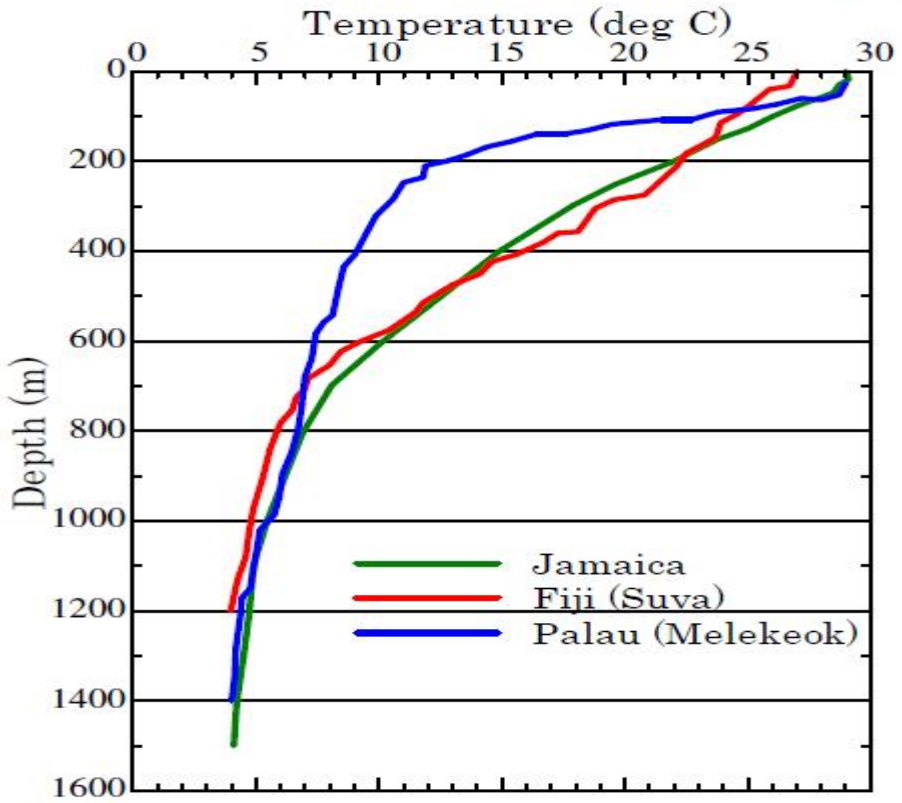
HISTORY OF OTEC

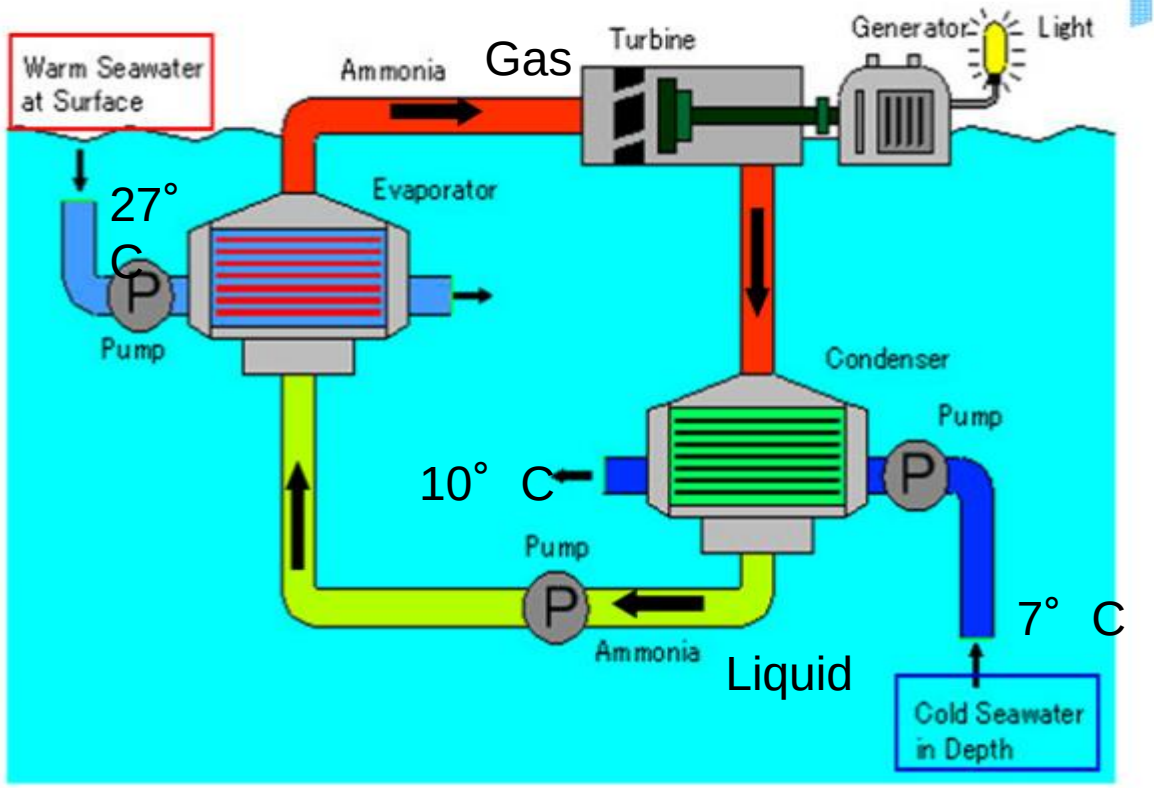
- In 1881, Jacques Arsene d'Arsonval, a French physicist, was the first to propose tapping the thermal energy of the ocean.
- Georges Claude, a student of d'Arsonval's, built an experimental open-cycle system at Matanzas Bay, Cuba in 1930.
- The system produced 22 kilowatts (kW) of electricity by using a low pressure turbine.





Principle of OTEC



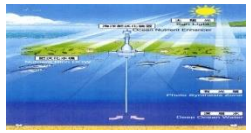


OTEC Revenue Streams, other than that of Power

Temperate Produce

"Import Substitutions"

High Value Produce



Capture-Fisheries

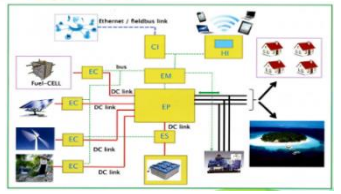
Health & Cosmetics

Ms Earth Japan, 2012

Lithium Production

Mineral H20

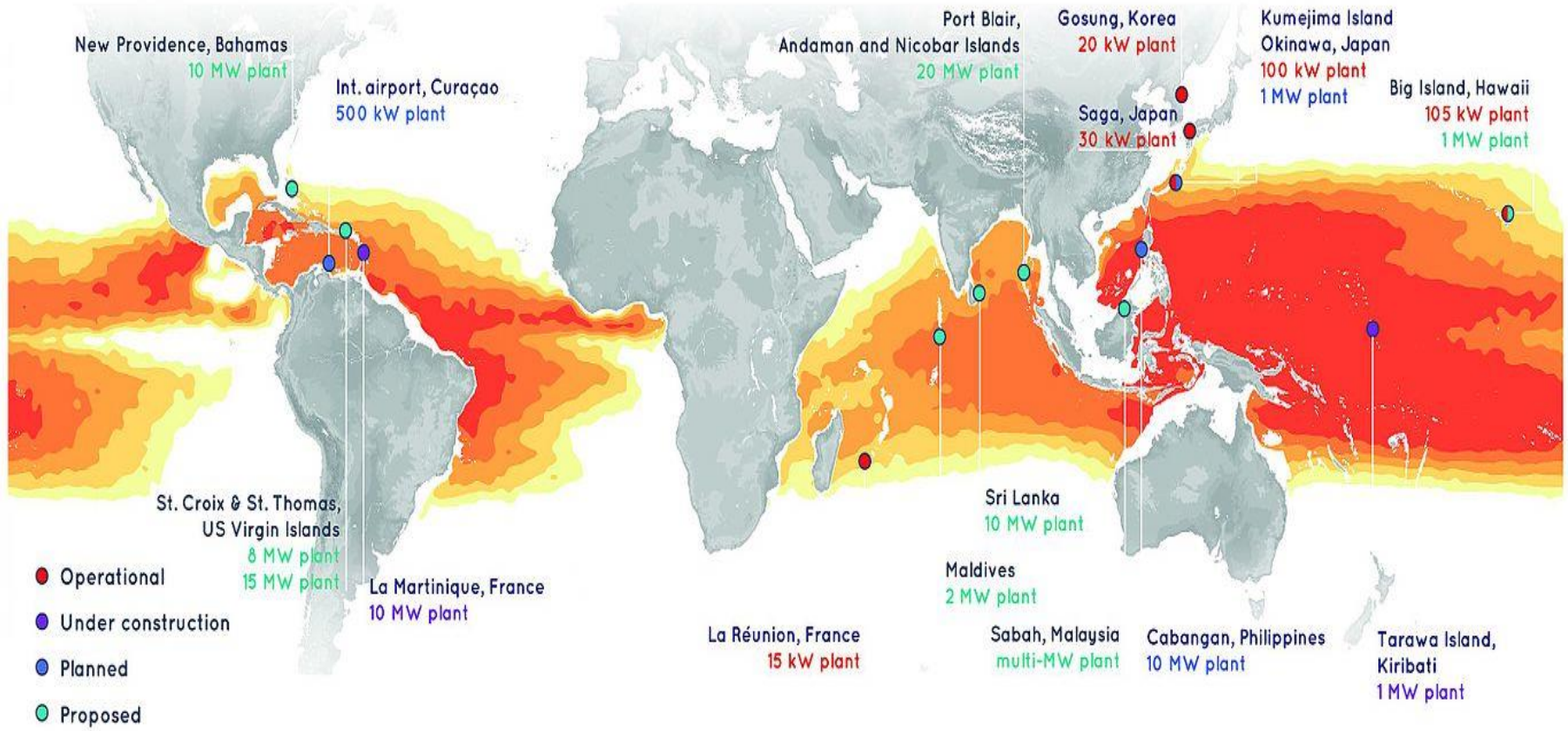
OTEC-H2



Smart-Grid With All Renewables

[Stand-alone Power Systems]

OTEC POTENTIAL

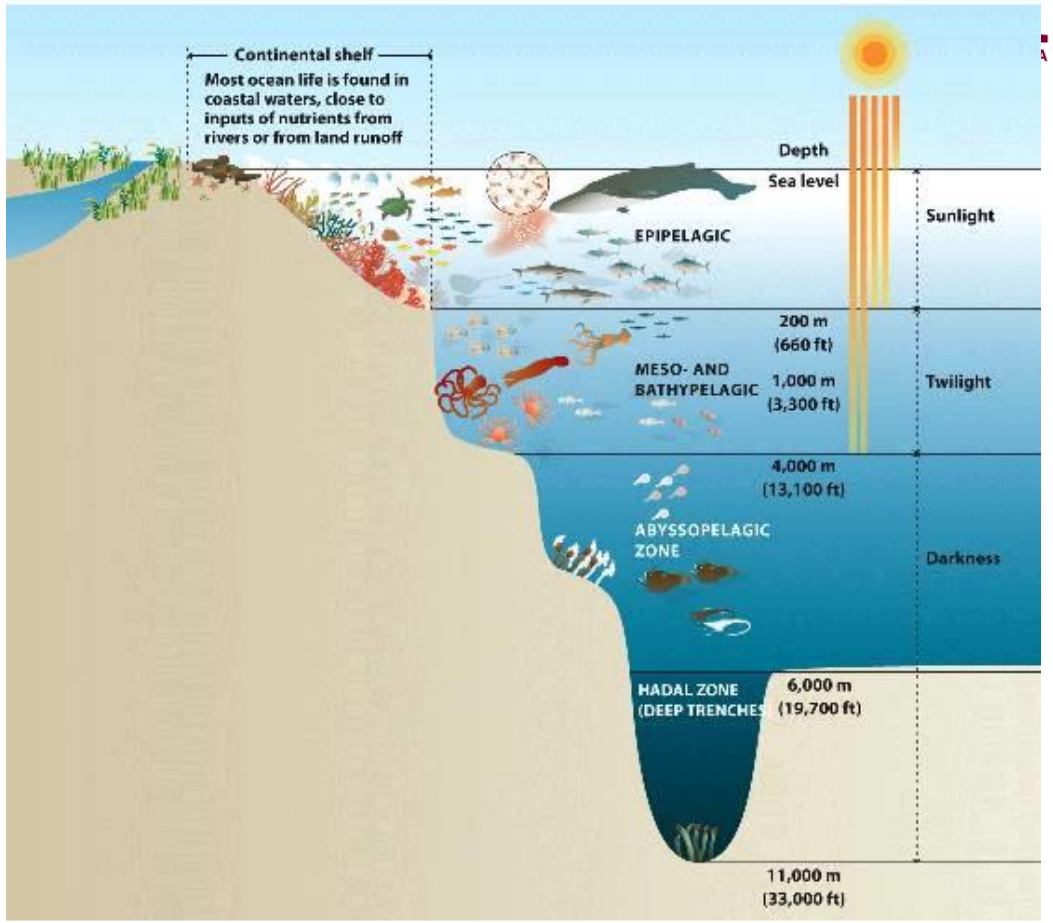


A large number of island states in the Caribbean and Pacific Ocean have **OTEC resources within 10 km of their shores**. OTEC seems especially suitable and economically viable for remote islands in tropical seas where generation can be combined with other functions e.g., **air-conditioning** and **fresh water production**.

HOW DEEP IS DEEP SEA WATER?

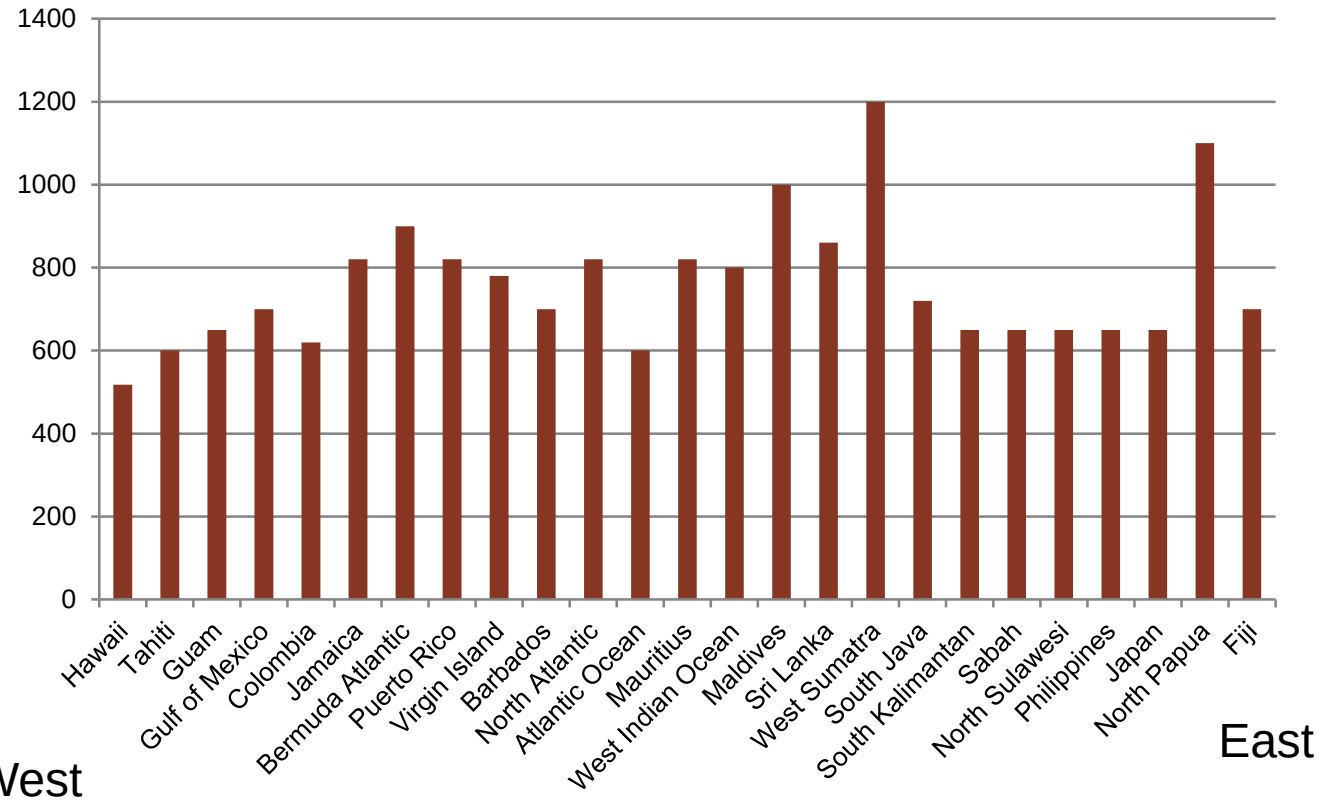
- **Deep sea water (DSW) commonly refers to a body of seawater that's is pumped up from a depth of over 200m.**
- **It is usually associated with the following characteristics:**

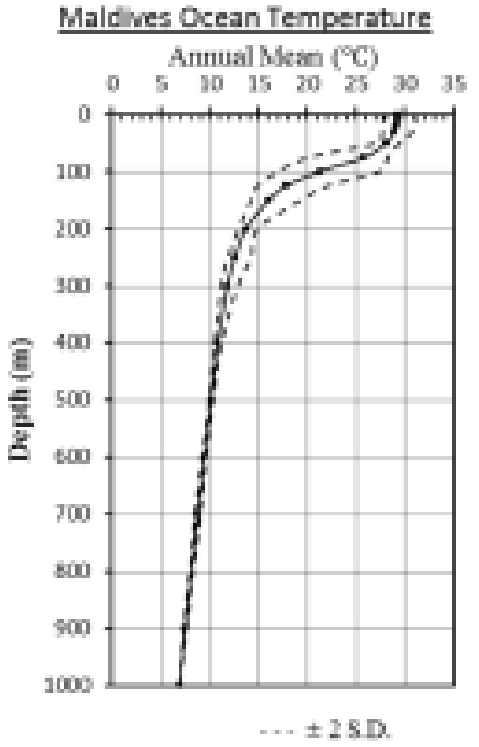
1. **low temperature**
2. **high purity**
3. **rich with nutrients, namely, beneficial elements, which include magnesium, calcium, potassium, chromium, selenium, zinc, and vanadium.**
4. **Less photosynthesis of plant planktons**



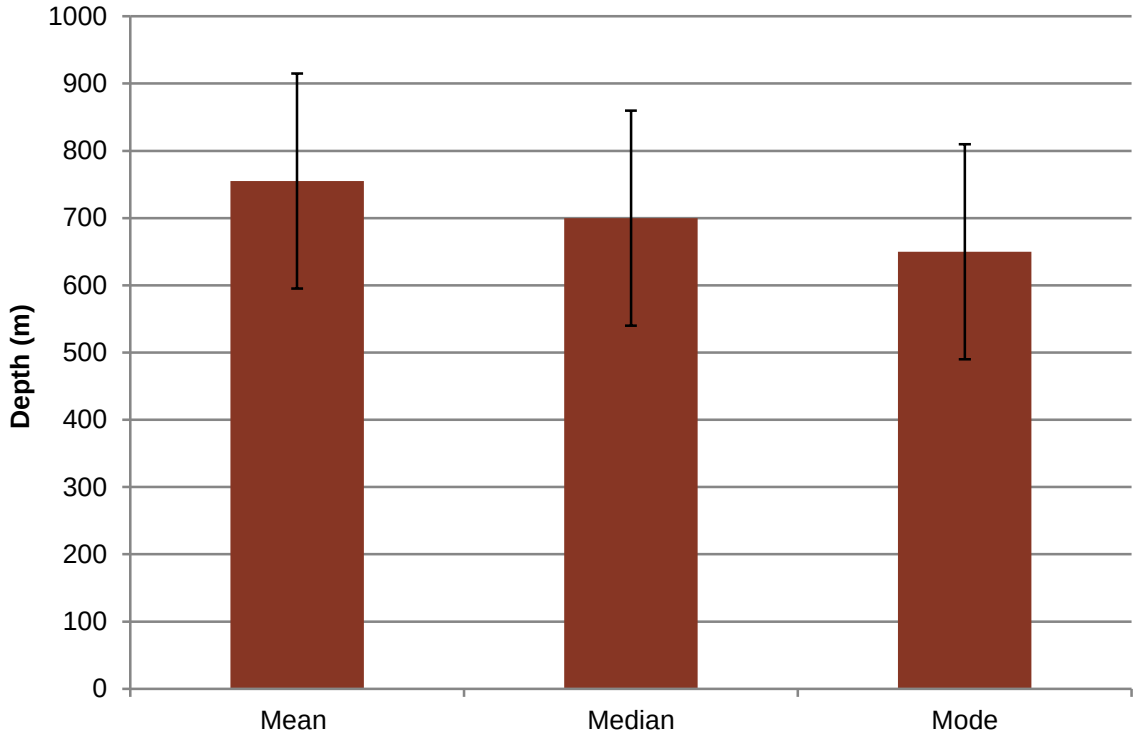
In OTEC system, DSW temperature must be having at least 20ºC temperature difference with surface water. **What is the DSW temperature if the surface water is 27ºC?**

OTEC RESOURCE ASSESSMENT & POTENTIAL IN THE TROPICS





STATISTICAL DATA ON OCEAN DEPTH @7DEGREE C



Range: 700 m- 800 m

CONSIDERATION FACTOR IN CHOOSING OTEC SITE

- **OTEC System (Open Cycle, Closed Cycle)**
- **Type of OTEC Plant (offshore, onshore or fixed platform)**
- **Distance of proposed OTEC Plant to the 700 m depths (7ºC deep sea water temperature)**

offshore, onshore and fixed platform

CHOOSING OTEC SITE

- **In this study, a simple method was introduced to determine OTEC potential sites using online database and software's.**
- **By using the software's, the best OTEC project that suited the above consideration could be proposed to the interested stakeholders.**

British Oceanographic Data Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

ArcGIS

Google Earth PRO

METHOD TO IDENTIFY OTEC POTENTIAL SITE

GEBCO

- General Bathymetric Chart of The Ocean
- Provide free bathymetry data sets to public

BODC

- British Oceanographic Data Centre (BODC)
- Online database to obtain GEBCO's bathymetry data sets

ARC-GIS

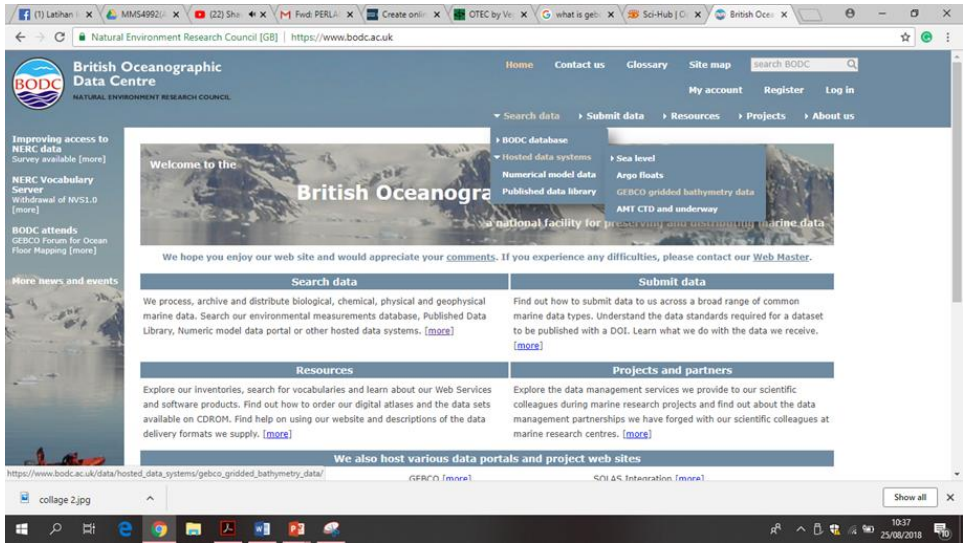
- Provide tools for mapping and spatial reasoning
- To view the raw GEBCO's bathymetry data

GOOGLE EARTH

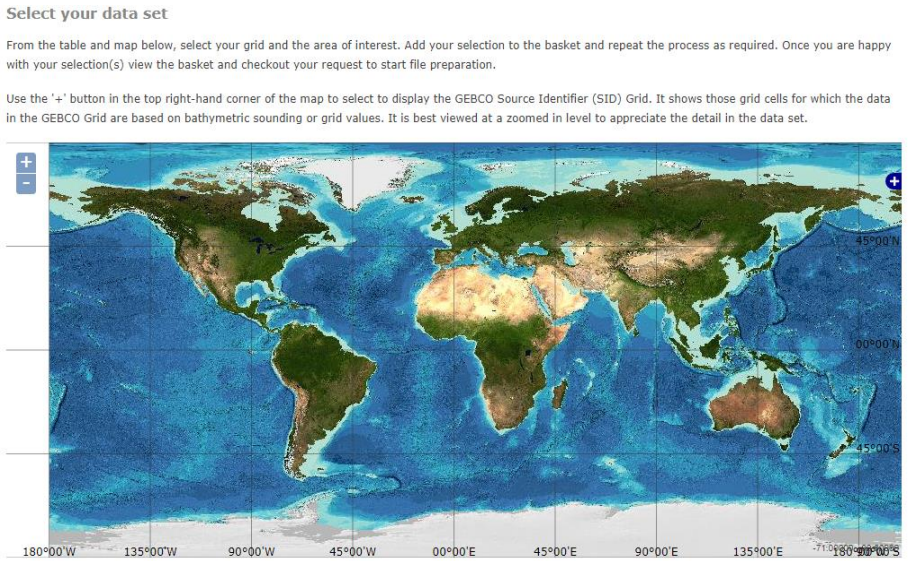
- To view the data in map form
- To identify the OTEC potential site nearest to 700m water depth

A. GEBCO DATABASE

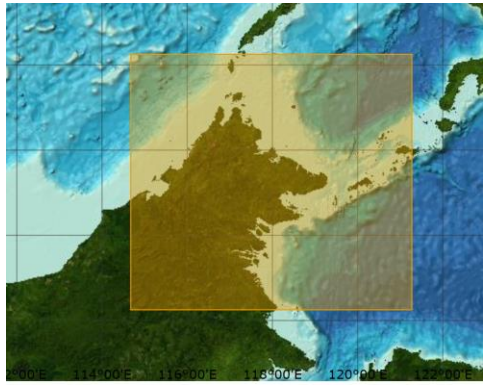
1. Access the bodc.uk to obtain GEBCO data. Sign up if you are new or login to your account.
2. Click the Hosted Data Systems and click the GEBCO gridded bathymetry data



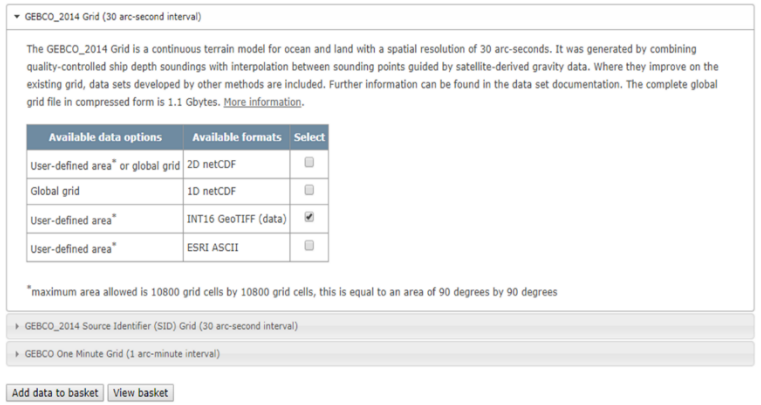
3. Select your data. Choose any country that we want to identify the OTEC potential site



4 Example of data being select; Sabah



5 After select the data, tick the INT16 GeoTIFF (data) and then click add to basket

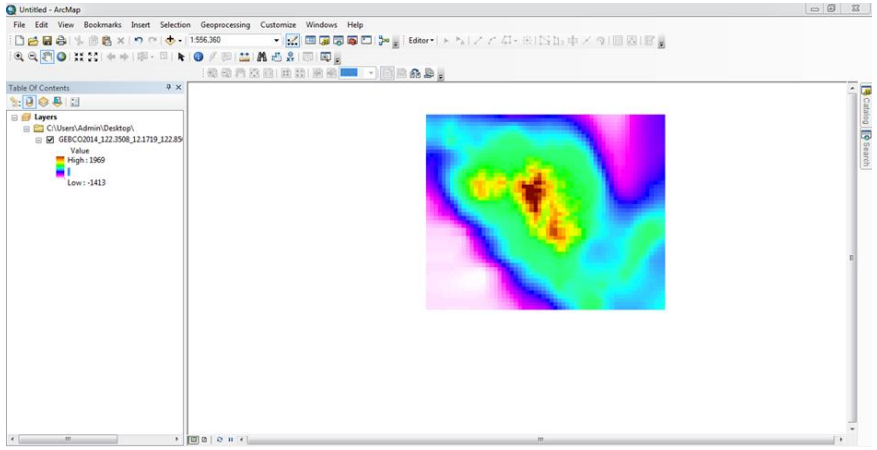


6 Click view basket and checkout your request.

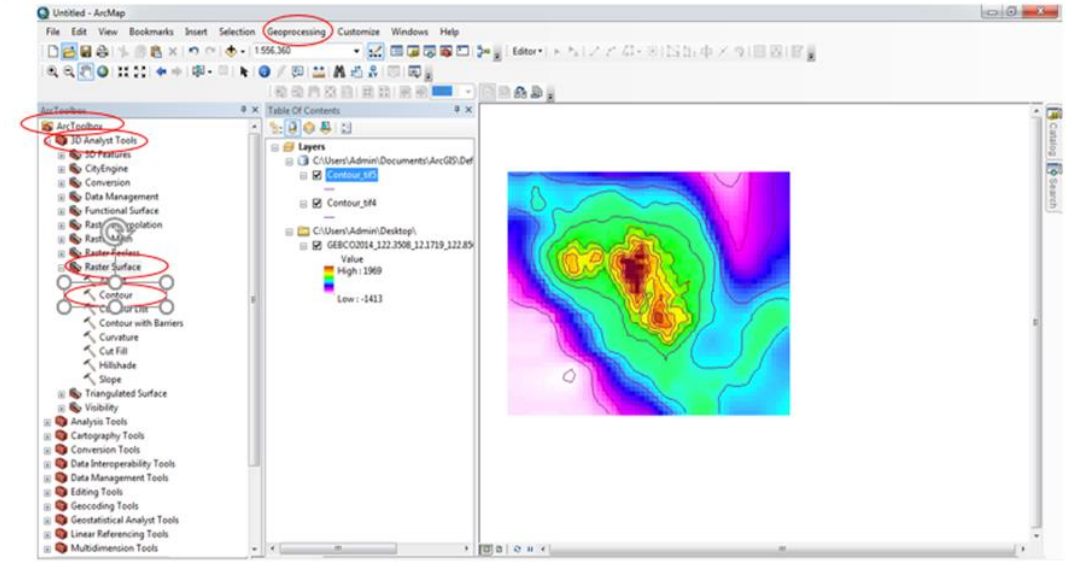
7 Data is available for download.

B. ARCGIS SOFTWARE

1. Open the download data from GEBCO in the Arc-GIS. As soon it opens, it will come out. Immediately change black-white-grey color to the ‘rainbow color’.



2. Click the Geoprocessing, then click Arc toolbox, 3D Analyst tool, Raster Surface and lastly click Contour.

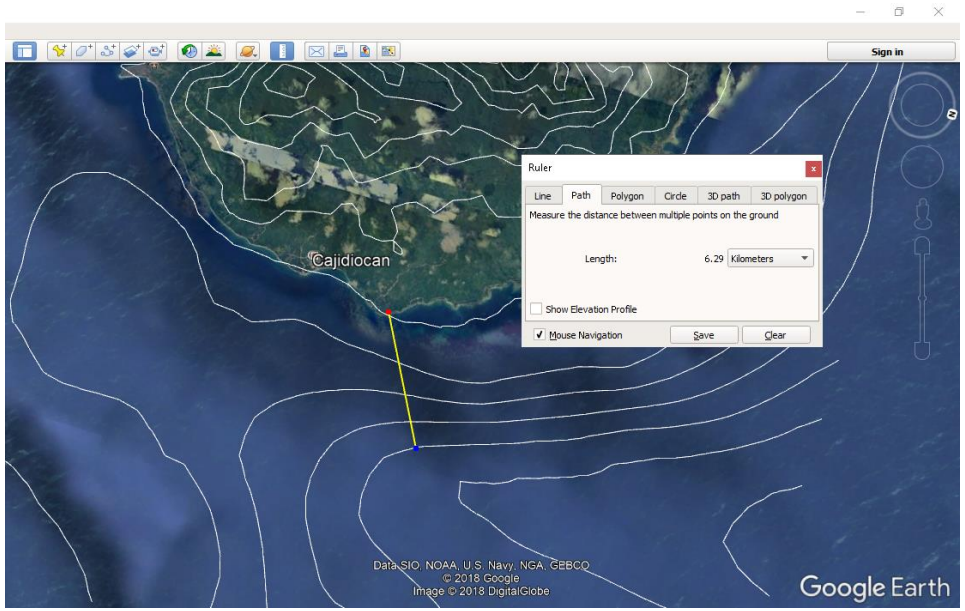


3. After done contour, click window. Search for the Layer to KML and click it. After that, data is ready to be save

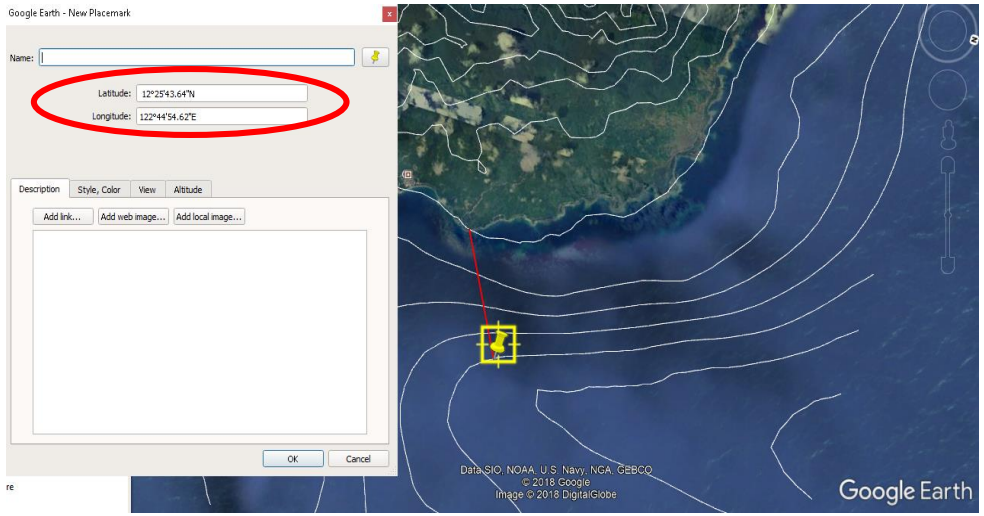
C. GOOGLE EARTH

1. Open the save file from the Arc-GIS

2. Click ‘Show Ruler’ to identify the distance of OTEC potential site to the nearest 700m water depth.



3. Click ‘Add Placemark’ in order to obtain the latitude and longitude of the OTEC potential site



CASE STUDY 1: KUME ISLAND

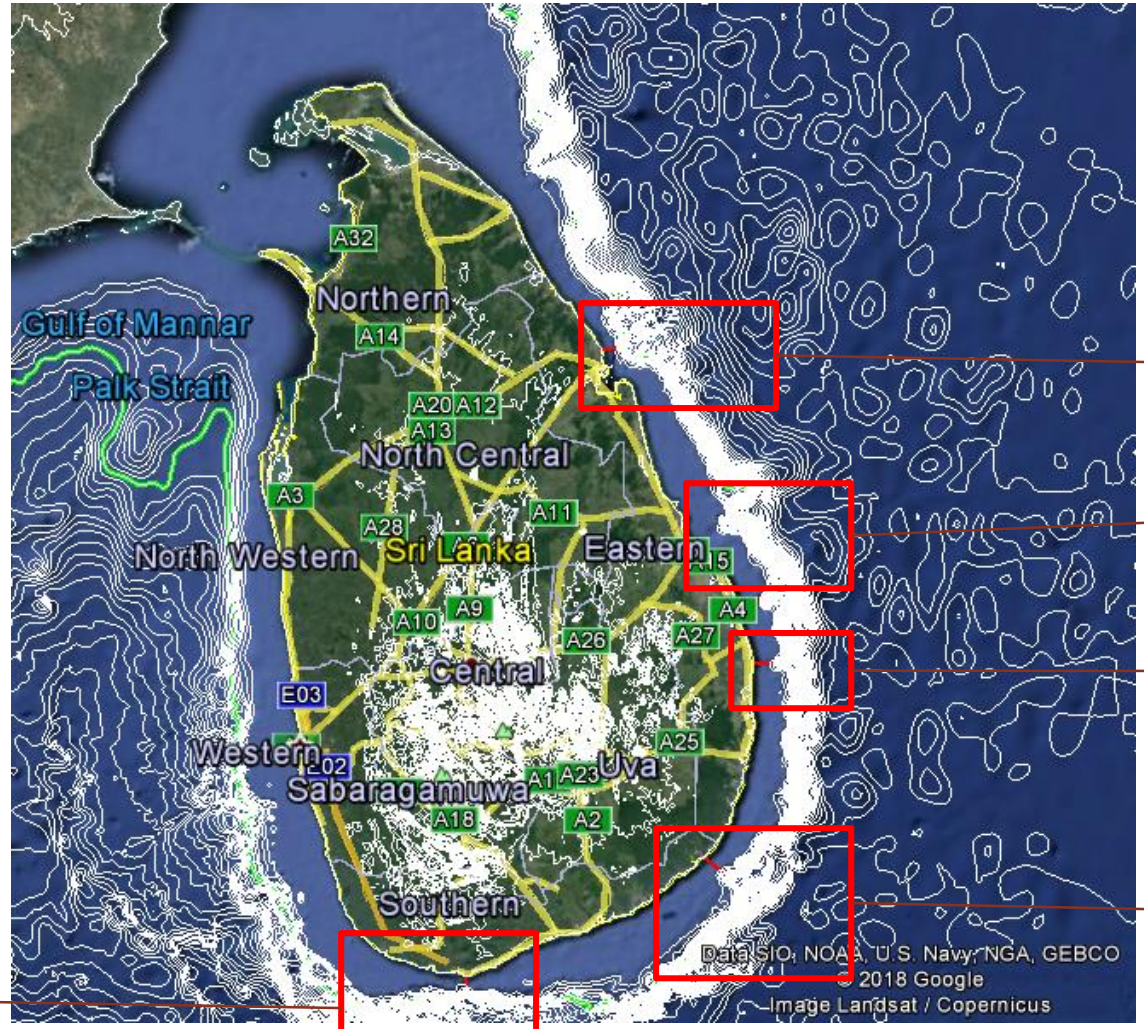
- **OTEC potential in Kume Island located alongside north east coast.**
- **Kume Island nearest OTEC Potential located less than 5km from shore.**
- **Xenesys have build one OTEC site**

Closed Cycle
Onshore Platform
Distance of proposed OTEC plant to 700m depth is 3.4km

Okinawa Prefecture Deep Sea Water Ocean Thermal Energy Conversion (OTEC) Demonstration Facility
Source: OTEC Okinawa

CASE STUDY 2: SRI LANKA

SRI LANKA OTEC POTENTIAL SITE AT NEAREST 1000M



Site 1

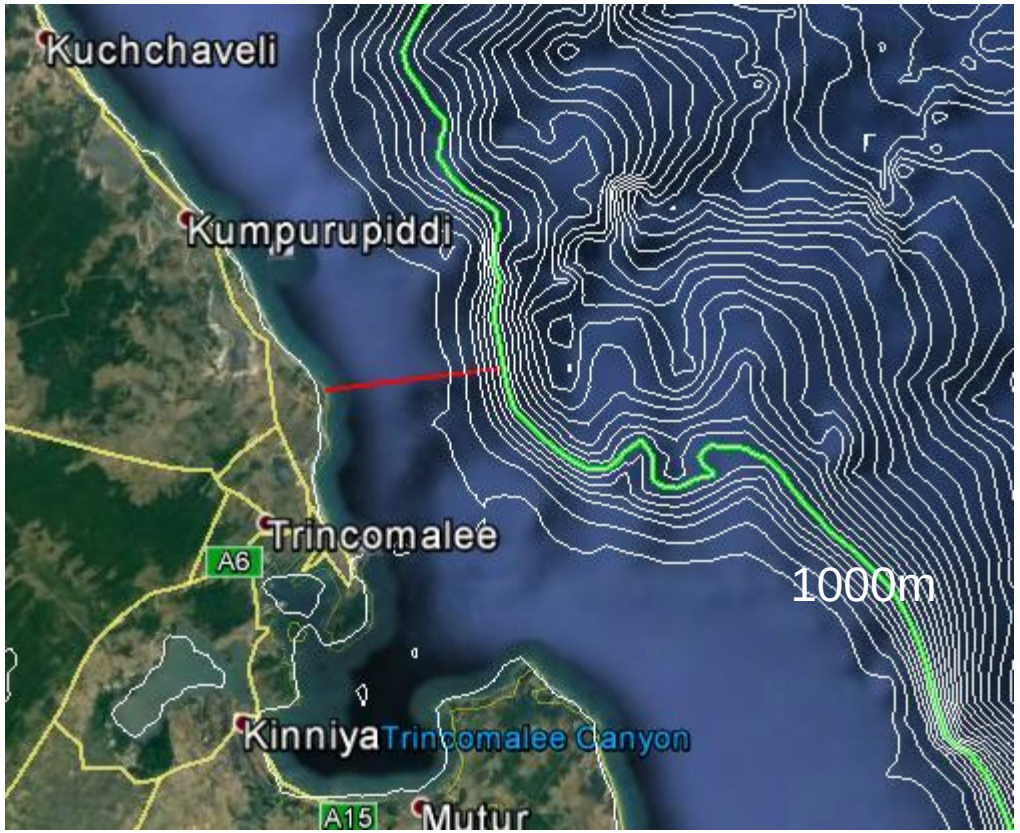
Site 2

Site 3

Site 4

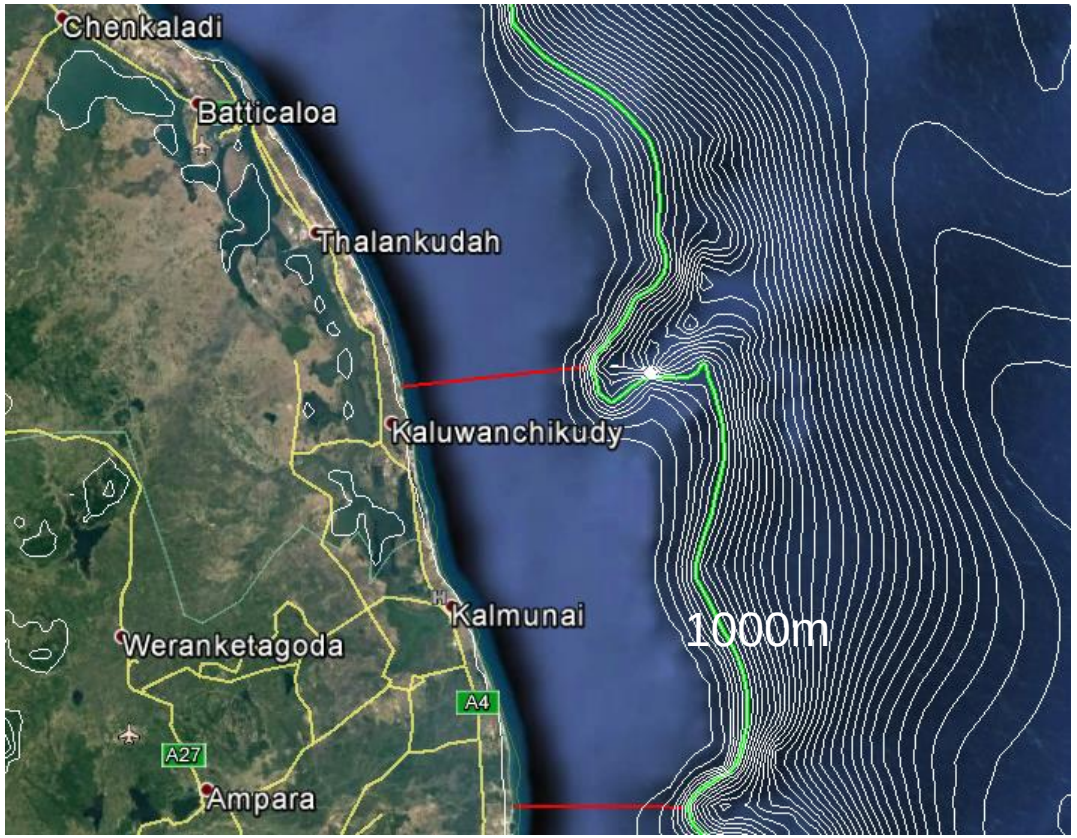
Site 5

SITE 1- OFF TRINCOMALEÈ



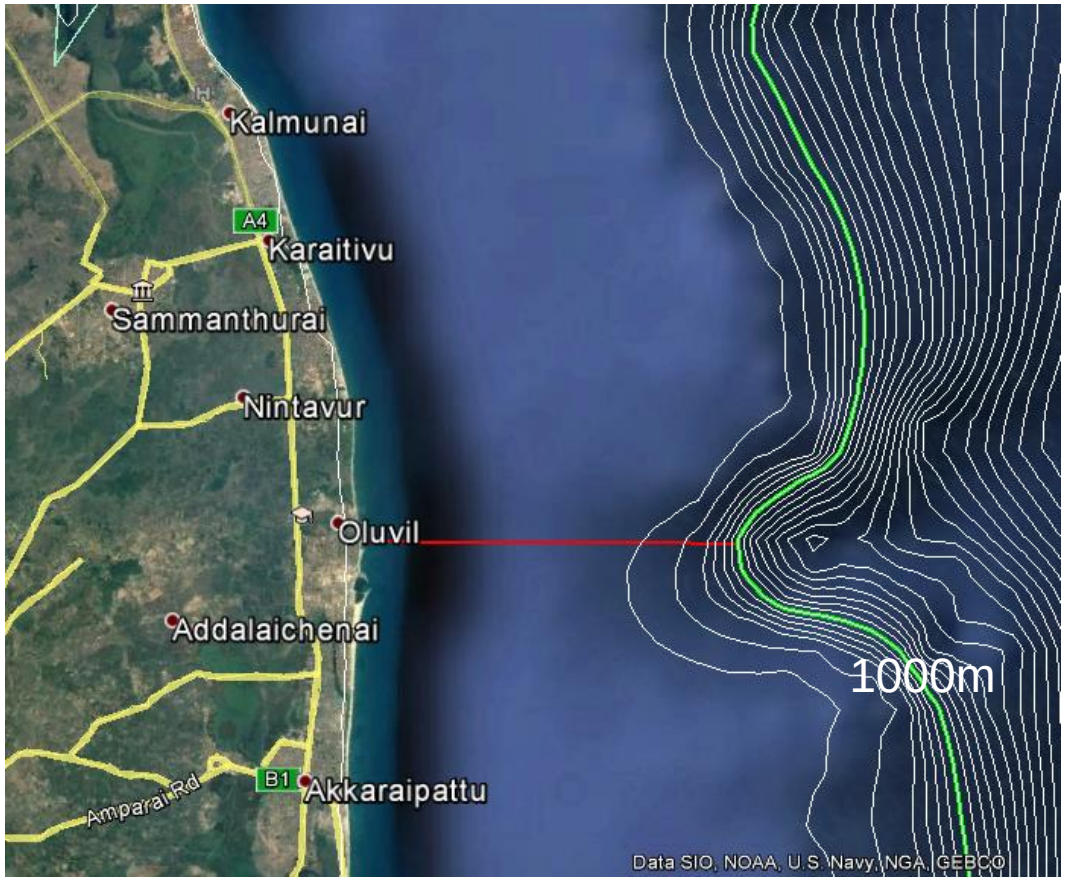
Proposed Site	Coordinate	Distance to nearest 1000m water depth (KM)
1	8°39'46.89"N 81°18'33.96"E	9.35

SITE 2- OFF KALUWANCHIKUDY



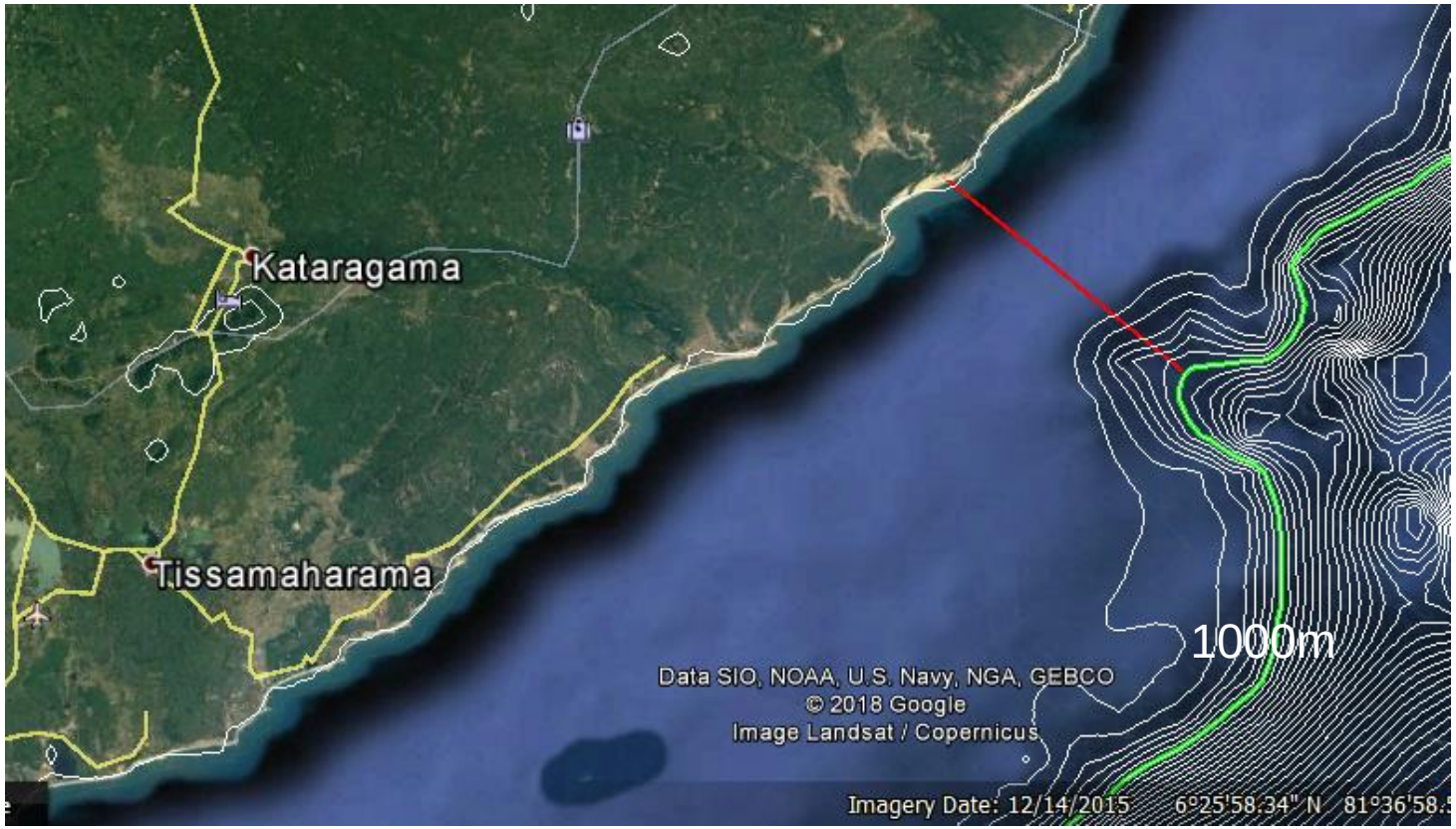
Proposed Site	Coordinate	Distance to nearest 1000m water depth (KM)
2	7°33'44.73"N 81°55'18.03"E	13.3

SITE 3- OFF OLUVIL



Proposed Site	Coordinate	Distance to nearest 1000m water depth (KM)
3	7°33'44.73"N 81°55'18.03"E	13.3

SITE 4- OFF TISSAMAHARAMA



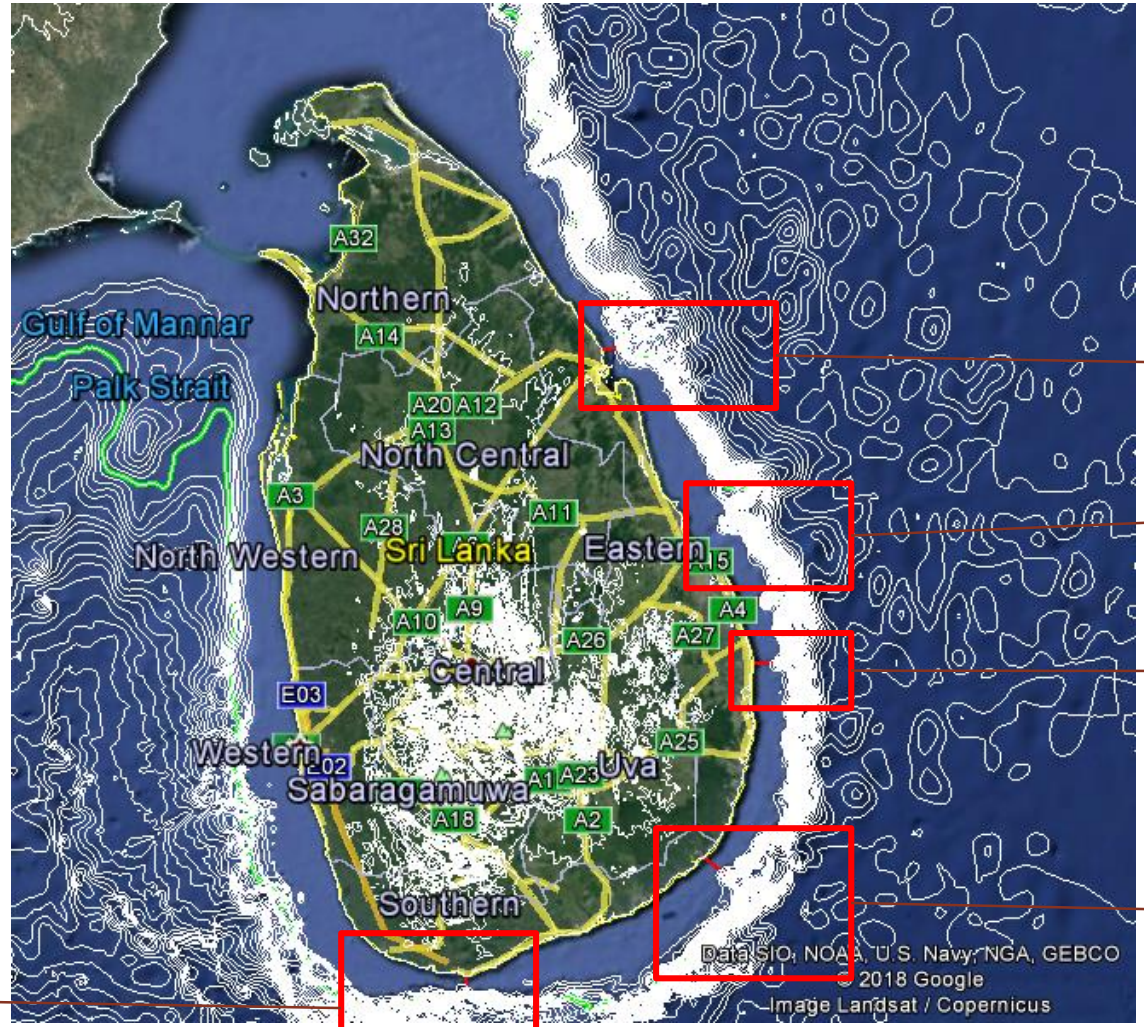
Proposed Site	Coordinate	Distance to nearest 1000m water depth (KM)
4	6°21'24.63"N 81°44'53.65"E	14.9

SITE 5- OFF MATARA

Proposed Site	Coordinate	Distance to nearest 1000m water depth (KM)
5	5°50'48.97"N 80°34'44.68"E	7.98

SRI LANKA OTEC POTENTIAL SITE AT NEAREST 1000M

Closed Cycle Onshore Platform Distance of proposed OTEC plant to 1000m depth is 7.98 km



Site 1

Site 2

Site 3

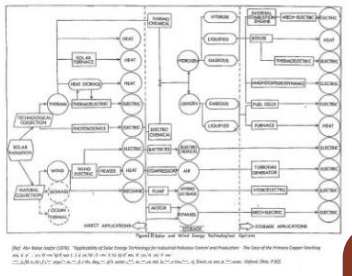
Site 4

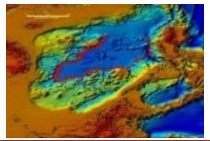
Site 5

CONCLUSION

- **OTEC potential sites could be identify by using online database and software's.**
- **The information could become good recommendation to project owner in selecting project site.**

UTM Ocean Thermal Energy Centre
Key Milestones and Achievements





1976 — Master Thesis on applicability of solar energy technology

1981 — Prior study on OTEC potential in Malaysia by Prof. Dato Ir Dr. A Bakar Jaafar

2007 — Marine survey done at the South China Sea in 2008, has confirmed that Malaysia has a great potential to exploit OTEC technology

2012 — Malaysia Prime Minister approved the application of the Ocean Thermal Energy Corporation to conduct a study to generate electricity from the deep sea in Sabah

2013 — The UTM Ocean Thermal Energy Centre established at Universiti Teknologi Malaysia.

2015 — Universiti Teknologi Malaysia (UTM) hosted the 3rd International OTEC UTM KL, 1-2 September 2015

2016 — The UTM Ocean Thermal Energy Centre joined the 4th International OTEC symposium demonstrates OTEC technology readiness and accelerated industry growth

2017 — Completion of UTM-DCNS / Naval Energies Pre-FS of OTEC Project at Pulau Layang-Layang under the MOF TDA-MoDefence Offset Programme

2018 — The UTM Ocean Thermal Energy Centre received a SATREP grant From Japanese Government to H-OTEC at Port Dickson, Malaysia, MoHE provide a matching grant Worth RM 6mil to support R&D.

Lampiran A

KEPUTUSAN PENILAIAN PEMBENTANGAN PROJEK DI BAWAH PROGRAM *SCIENCE AND TECHNOLOGY RESEARCH PARTNETSHIP FOR SUSTAINABLE DEVELOPMENRT* (SATREPS) – UNIVERSITI TEKNOLOGI MALAYSIA (UTM)

Tajuk projek	:	Development of Advanced Hybrid Ocean Thermal Energy Conversion (OTEC) Technology For Low Carbon Society & Sustainable Energy System: First Experimental OTEC Plant of Malaysia
Ketua Projek	:	Dato' Prof. Ir. Dr. Abu Bakar Jaafar
Tahun	:	2019-2024

Comments from the Department of Higher Education, Evaluation Committee and Economic Planning Unit (EPU):

i. The programme should focus on the core projects (objectives) and scale down the secondary benefit of the project.
ii. Consolidate Projects 1,2 and 3 into one project.
iii. Quotation for purchasing of equipment needs to be attached.
iv. Programme leader has to make sure the cohesiveness of the project team and take the lead.
v. To include a senior researcher/academician to head each project. Each project must be led by a different PI. The programme leader must also head a project.
vi. The programme is subject to monitoring process by the Department of Higher Education. The term and condition of MoE grant applies to this programme.

Budget must be revised and suggested breakdown are as follows:

NO.	PROJECT	REQUESTED BUDGET (RM)	REVISED BUDGET (RM)
1	**Facility**	1,080,000	(Consolidate
2	**Operational**	1,216,200	project 1,2 and 3)
3	**Heat Exchanger**	690,000	**2,500,000**
4	eDNA	669,200	500,000
5	Turbine	605,000	600,000
6	Seaweed	899,999	600,000
7	Fish	1,568,000	600,000
8	Sea Water Quality	1,651,600	600,000
9	Nanofluid	630,000	500,000
10	Business Development	339,800	150,000
	TOTAL	9,349,799	6,050,000 (Rounded to **6,000,000**)

OTEC Technology Partners

Xenesys

IRENA
International Renewable Energy Agency

Bluerise
harnessing the ocean's power

OTEC foundation

INFRAKOMAS
Infrakomas Sdn. Bhd.

MAKAI
OCEAN ENGINEERING

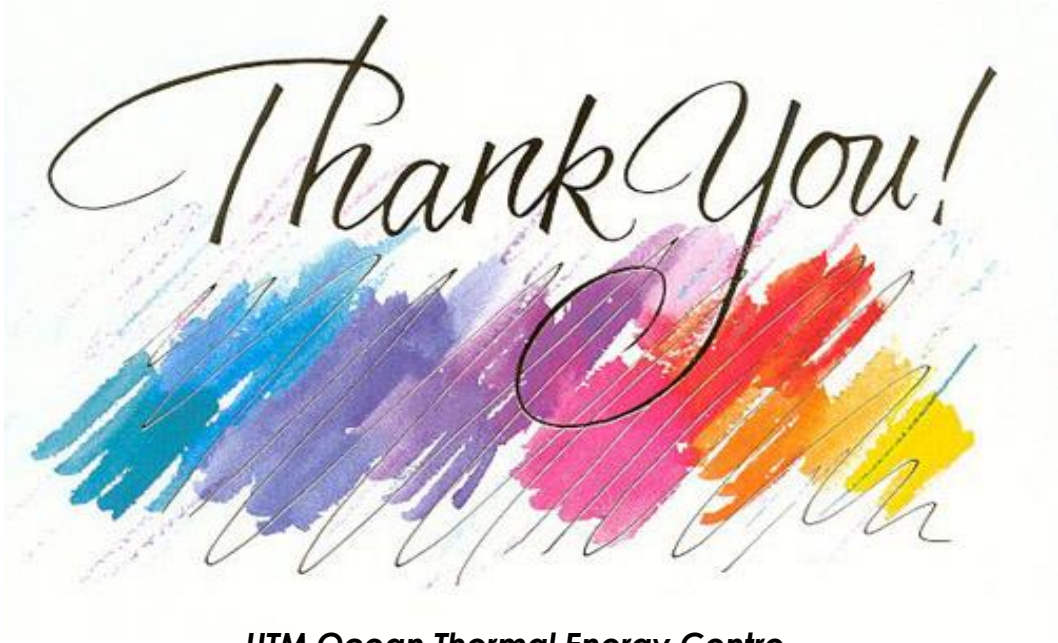
IOES
INSTITUTE OF OCEAN ENERGY
SAGA UNIVERSITY JAPAN

KRISO
KOREA RESEARCH INSTITUTE OF
SHIPS & OCEAN ENGINEERING

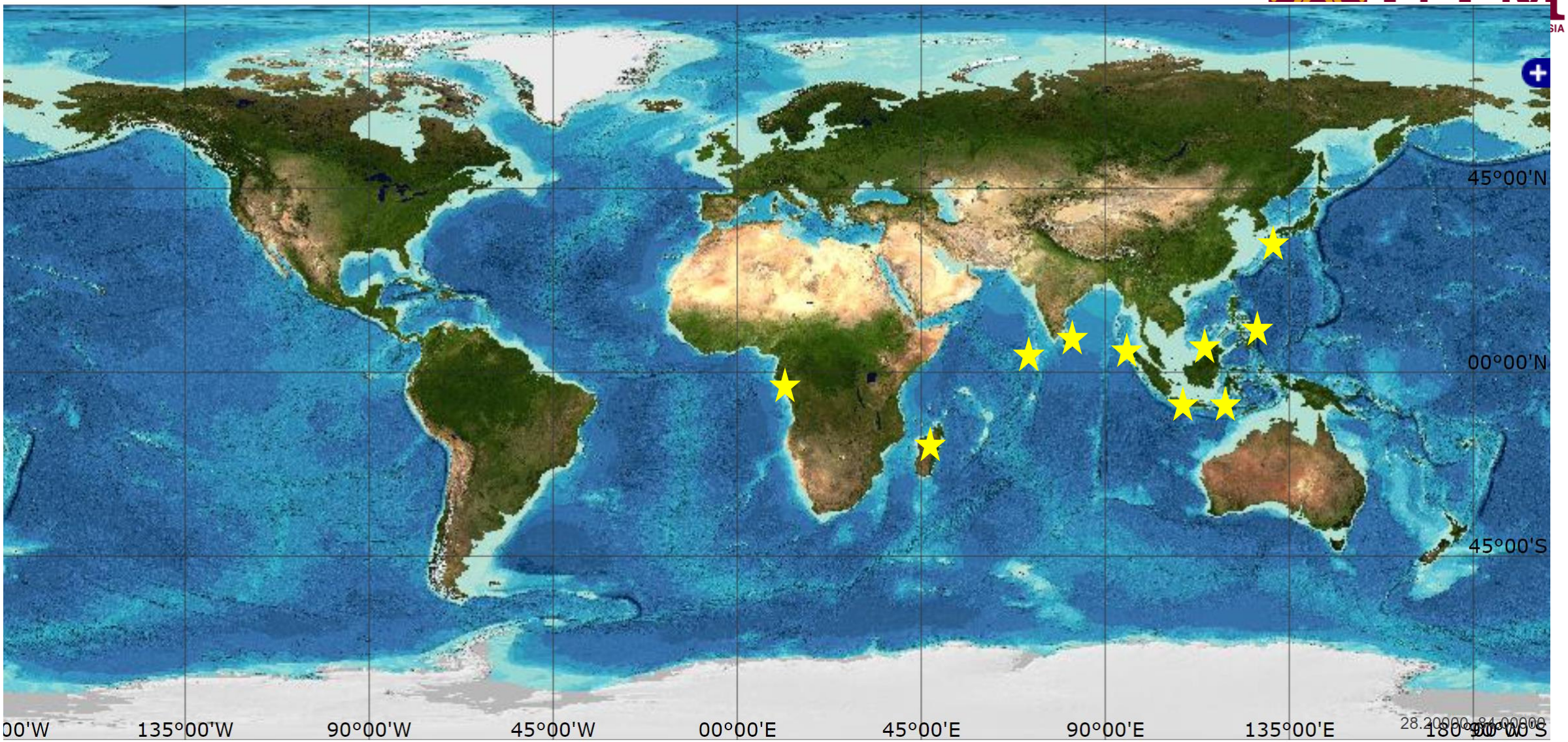
Technip

HNEI

NAVAL ENERGIES



UTM Ocean Thermal Energy Centre
Universiti Teknologi Malaysia Kuala Lumpur,
Jalan Sultan Yahya Petra,
54100 Kuala Lumpur, MALAYSIA
+603 2615 4518/4354 / 4883
utmotec@utm.my
http://otec.utm.my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