

POLICY ADVICE TO
MINISTRY OF ENERGY, WATER & GREEN TECHNOLOGY:

**OTEC FOR POWER, WATER, & FOOD FOR
THE STATE OF SABAH**

Promoted by UTM OTEC Solutions Sdn Bhd

With the Support of UTM Ocean Thermal Energy Centre (UTM OTEC)

PREPARED AND PRESENTED BY

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OUTLINE OF PRESENTATION

1. Introduction
2. “Insolvency” and “Solution” with OTEC
3. Proposed OTEC Pioneer Project
4. Recommendations

ANNEX:

- A. Proposed OTEC Project Siting
- B. OTEC Economics
- C. OTEC Project Creativity Index under RMK-11
- D. OTEC 30 MW Financial Analysis
- E. UTM Ocean Thermal Energy Centre Key Milestones
- F. OTEC Technology Partners

SABAH ELECTRICITY ON VERGE OF INSOLVENCY, SAYS ENERGY MINISTER

“The discussion is crucial, especially since SESB continues to make losses and on the verge of insolvency,”

KeTTHA Minister Datuk Seri Dr Maximus Ongkili said on Friday.



SESB’s current average tariff is 34.52 cents/kwh while cost of energy generation is 56.50 cents/kwh.


Source: The Star Online, 22 December 2017

2. “INSOLVENCY” & SOLUTION WITH OTEC

- **OTEC Proposed Tariff of RM 0.34/kWh;**
- **With Proposed Development of the 1st OTEC Pioneer Project off Tawau-Semporna coast, Sabah**
- **Financed through Public-Private Partnership with the first two-revenue streams: power & water (domestic and mineral-water)**

OTEC
120 MW=72 MW_{nett} per site

95% Capacity factor



Electricity 100%
0.6 Billion KWh/year
(15% of current consumption)

Annual Saving to SESB:
RM 120 m

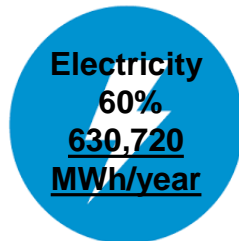
Annual Revenue @RM 0.34 kWh
= RM 214 million/year

3. PROPOSED PIONEER OTEC PROJECT

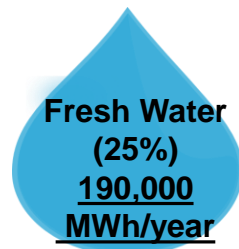
- **Total Capacity:** Multiples of $2.5\text{MW} \times 4 = 10\text{ MW}$ $\times 3 = 30\text{MW}$ $\times 4$ up to = 120 MW per site
- **Initial Capacity:** 30 MW as per Annex D
- **Capital Investment:** USD 200 mil
- **Payback Period** = 5 years
- **Annual Saving to SESB @21.98 sen**=RM 120 m
- **Tariff:** RM0.34/KWh
- **Transmission:** Existing Grid with additional growth of stand-alone power systems with renewable as well as H2FC

OTEC 72 MW_{nett}

95% Capacity factor

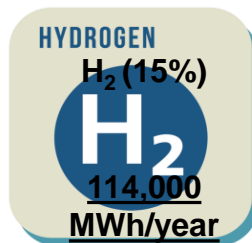


RM 129 m



Fresh Water/ Mineral Water:
RM191 m

@selling price of @RM 0.30/m³ domestic , RM 1.60/m³ commercial
24,000 m³/day



RM 66 m

@selling price of RM 40/kg,
electrolyzer efficiency 56%

**Total Annual Revenue:
RM 320 m ++
Annual Saving to
SESB:
RM 120 m**

OTEC-SYSTEM PROPOSAL

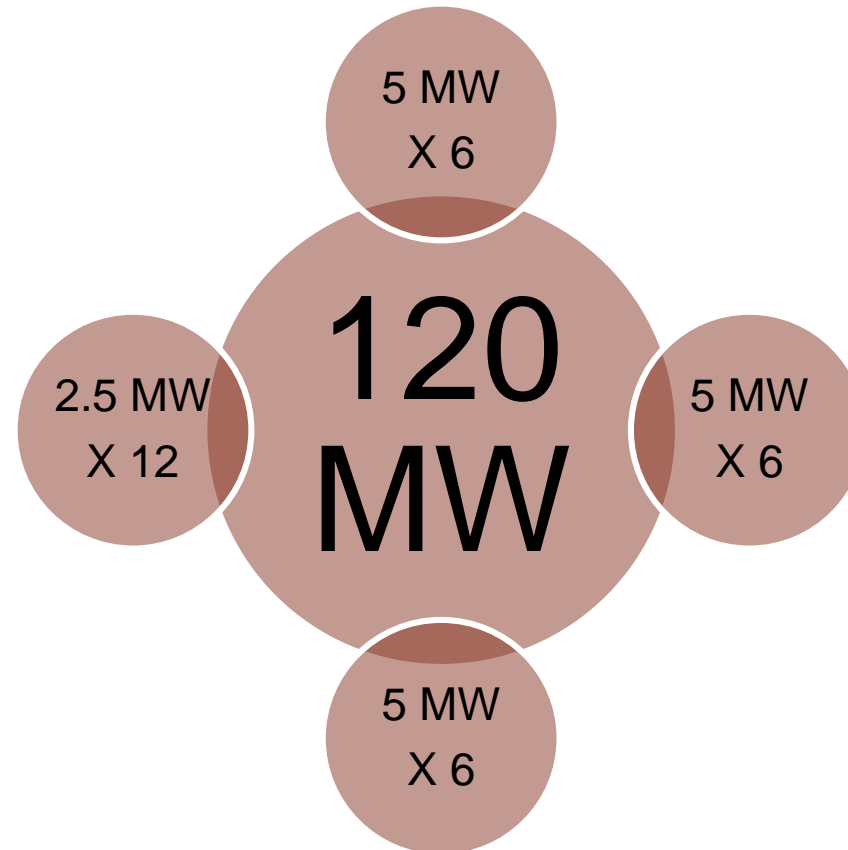


Table 1: Sabah Electricity Generation Development Proposal, MW

	Total	Total (Gas + OTEC)		Other RE	Hydro	Total (Diesel + OTEC)		MFO
2015	1335	974.55		53.4	80.1	120.15		106.8
2020	1567	1331.95		62.68	78.35	94.02	(89+5)	-
2025	1863	1434.51		37.26	353.97	37	(7+30)	-
2030	2217	1691.4063	(1631+60)	44.3394	421.2243	-		-
2035	2660	1981.6876	(1861+120)	53.20728	505.4692	-		-
2040	3219	2303.0419	(2063+240)	64.38081	611.6177	-		-

Data Source: Sabah Electricity Supply Industry Outlook 2015, Malaysia Energy Commission

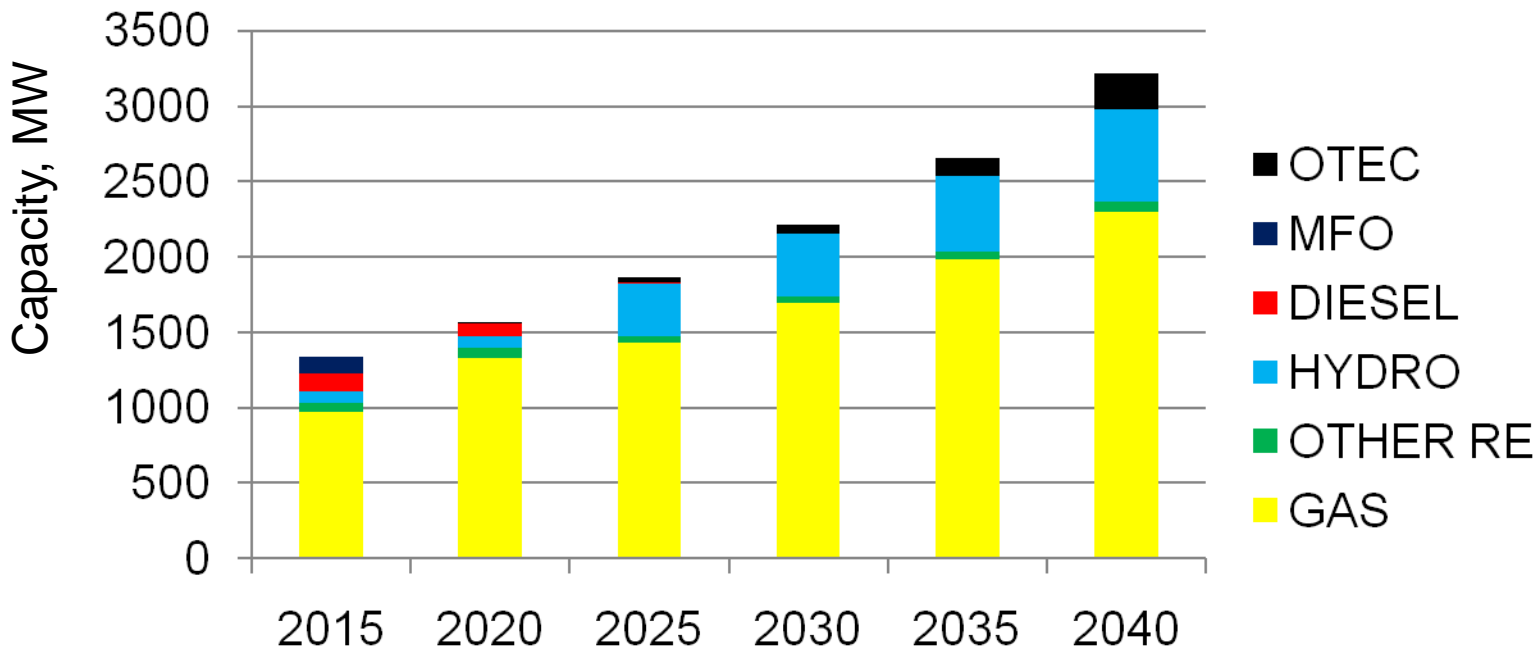
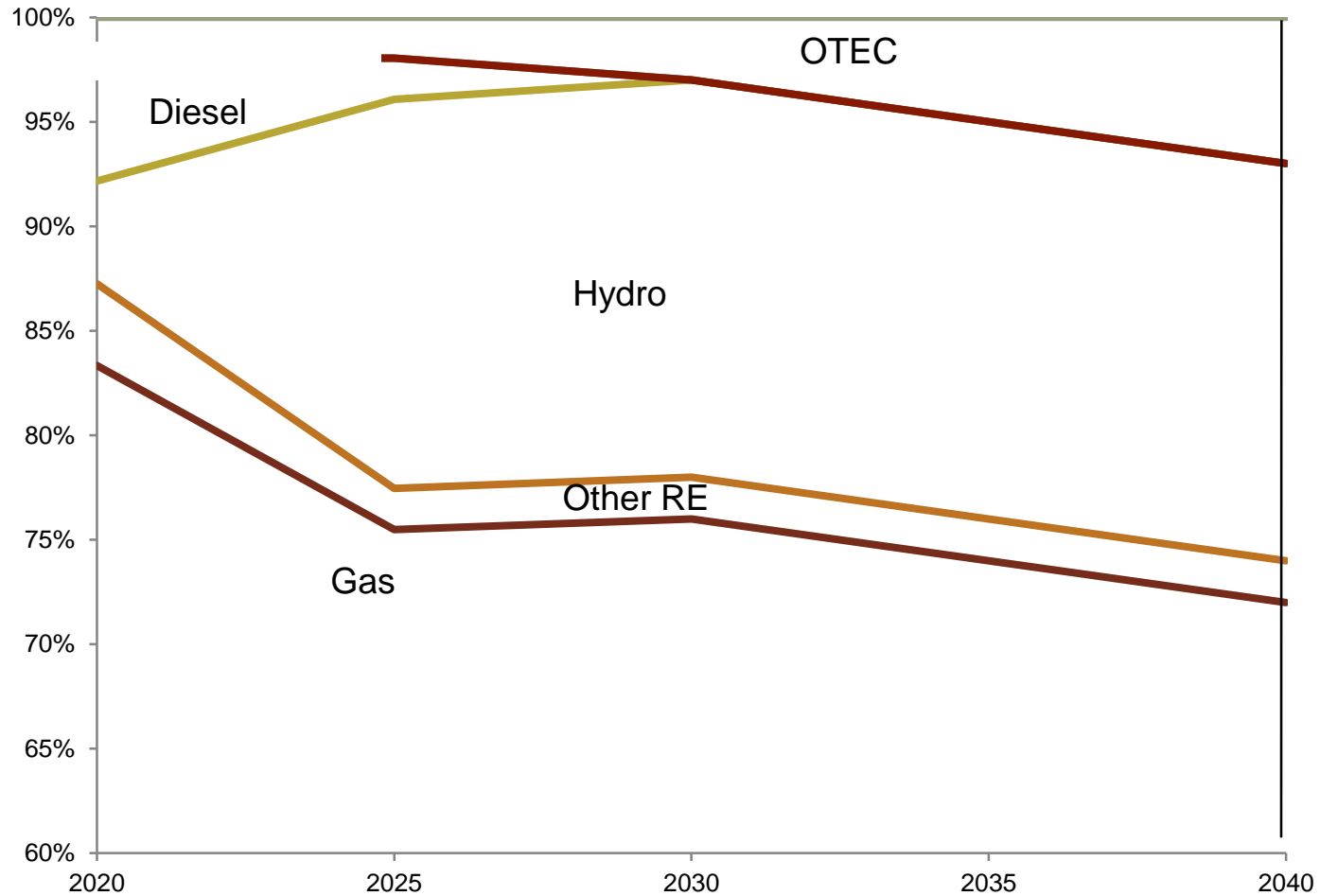


Figure 1. Sabah Electricity Generation: Energy-Mix, MW

Figure 2. Sabah Electricity Generation Development: Energy-Mix, 2020-40



RECOMMENDATIONS TO KETTHA

UTM OTEC, together with SEDA with the co-operation of SESB, be engaged:

- 1. To match the existing tariff of SESB with power from OTEC;**
- 2. To undertake the techno-economic feasibility study, preferably with KeTTHA designated agency, with estimated budget RM 5 million, in order,**
 - To recommend to the KeTTHA the size of investment required;**
 - To propose energy generation mix for Sabah with OTEC power up to 120 MW i.e. phase out diesel power plant as per Figure 1 or Table 1.**
 - To undertake up-to 30 MW OTEC Project initially with estimated capital required: USD 200 mil.**



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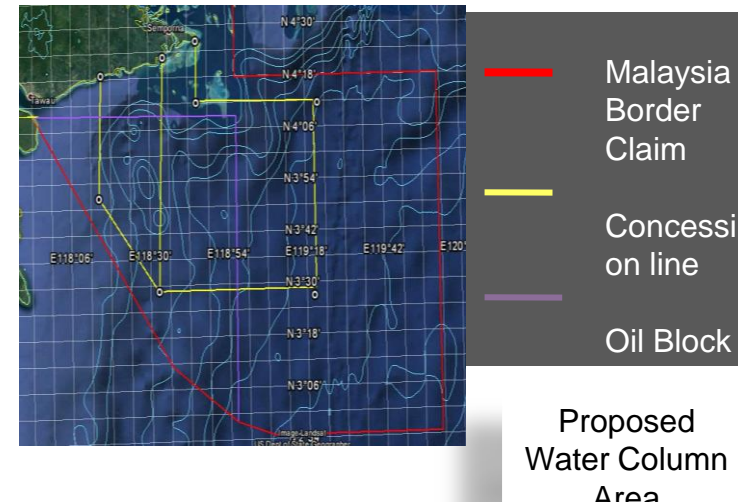
Website: <http://otec.utm.my>

ANNEX A: PROPOSED PIONEER OTEC PROJECT SITING

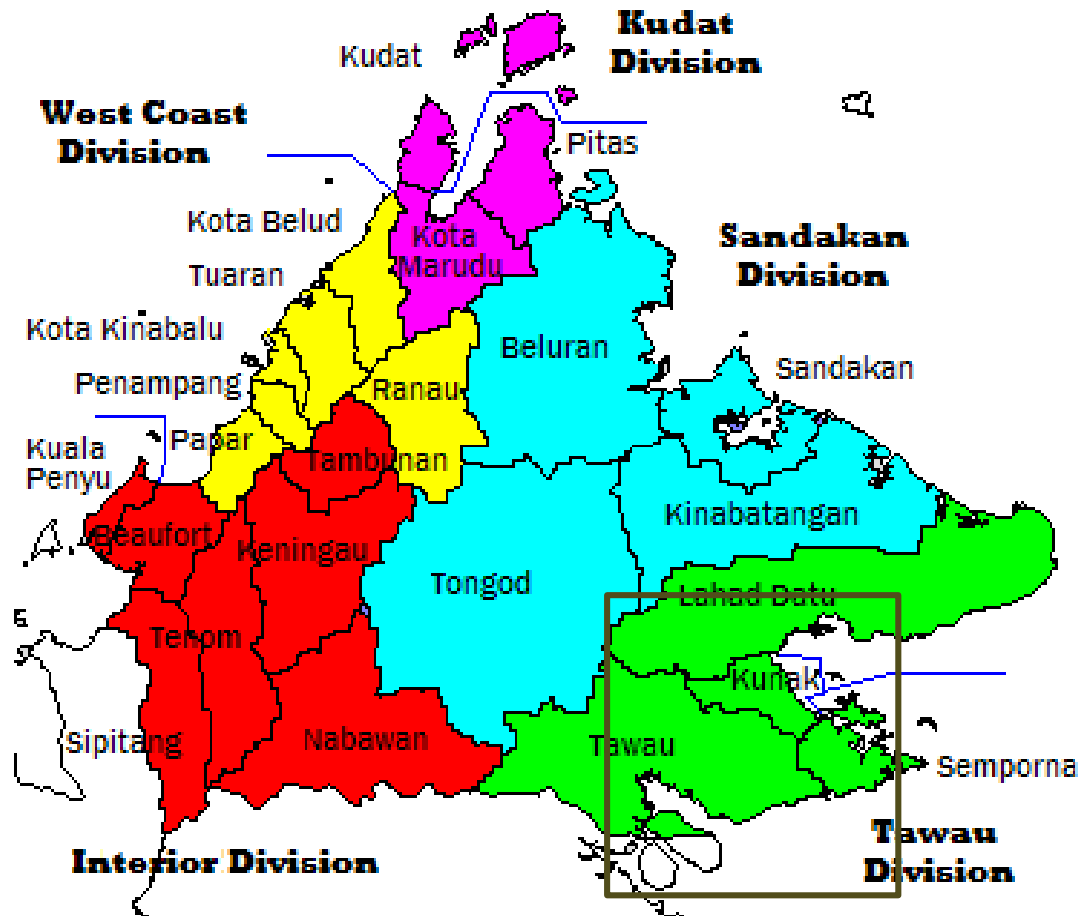
- Water Column and Coastal Land

Water Column

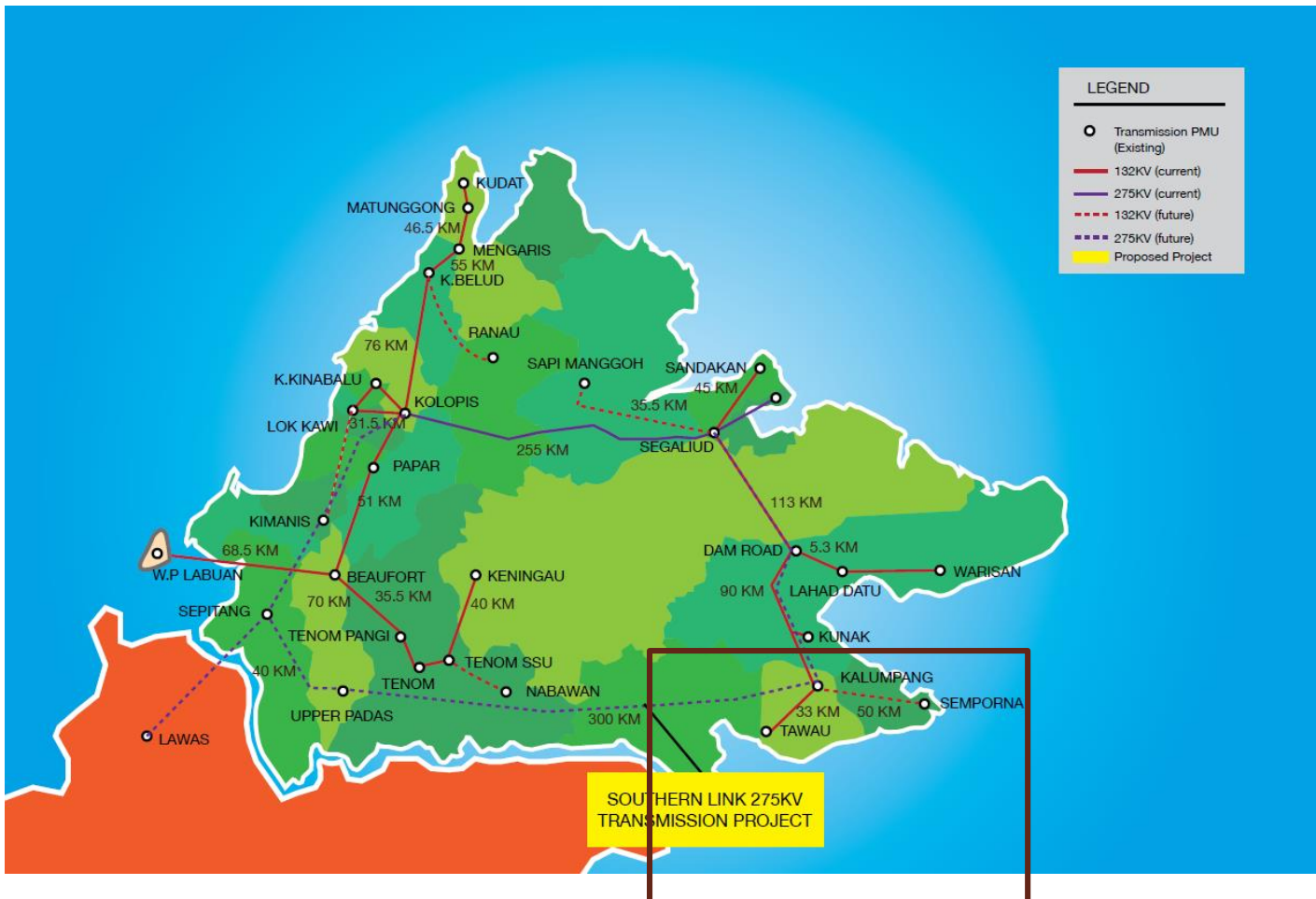
- Sabah is blessed with deep sea on the eastern region around Tawau
- In some areas the depth reaches beyond 700m and within 15km off the coast
- This maritime area is referred to as 'Water Column' which is ideal for OTEC and for harnessing the DSW



MALAYSIA, SABAH BY RESIDENCY



SESB GRID



29 January 2018

UTM OTEC Presentation to KSU KeTTHA

innovative • entrepreneurial • global

OTEC PROJECT SCHEDULE

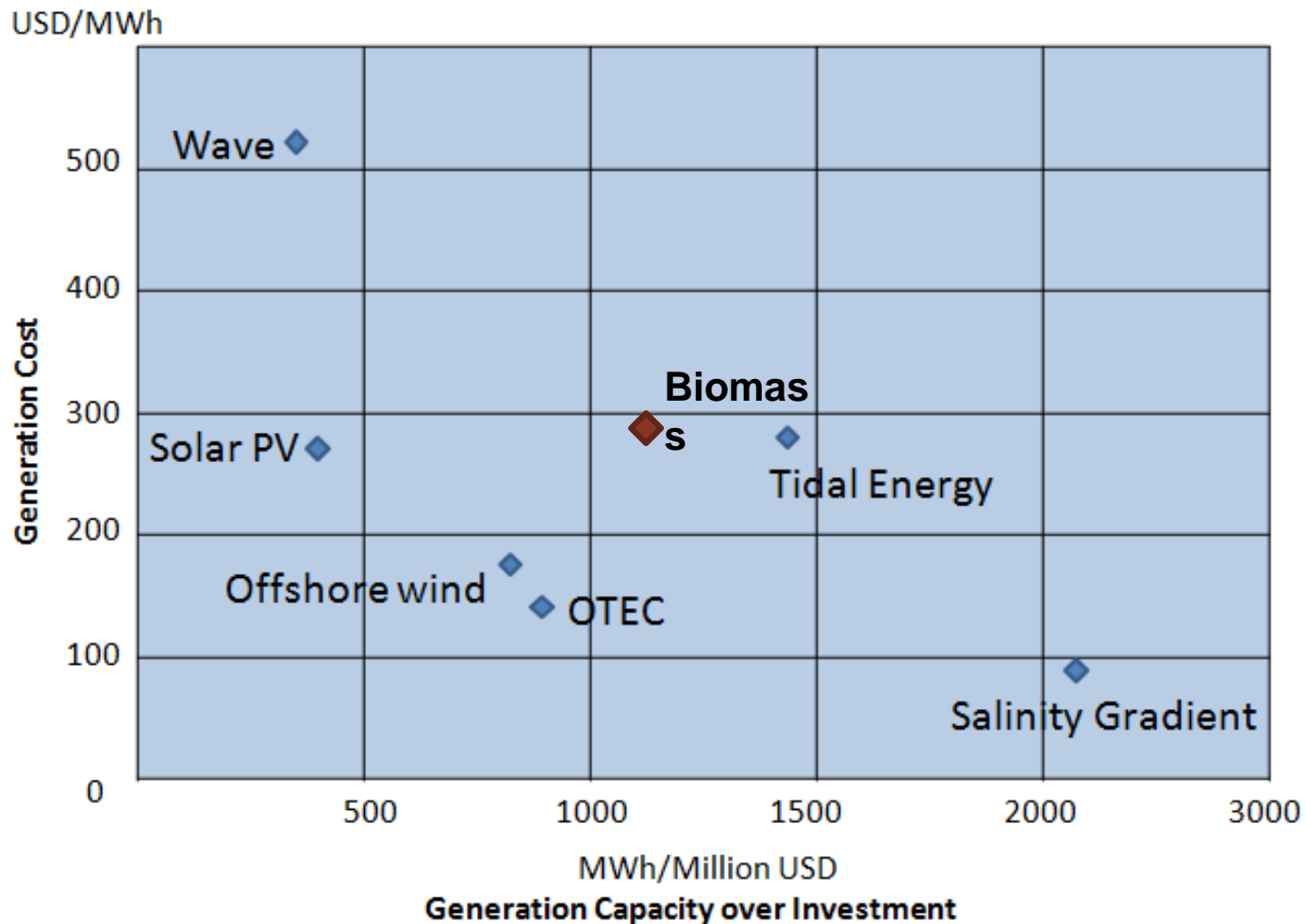
No.	ACTIVITY						
		2018	2019	2020	2021	2022	2023
	EIA & FS report						
	Engineering Design						
	- Procurement Completion						
	Start Operation						

ANNEX B: OTEC ECONOMICS

- **Comparative Analysis of Generation Cost of Power by OTEC vis-à-vis Other Forms of Renewables**
- **LCOE**
- **OTEC Proposed Development for the First 5 years**

COMPARATIVE ANALYSIS OF VARIOUS FORMS OF RE...

... AN OVERVIEW OF OCEAN ENERGY, SOLAR PV AND BIOMASS



Ocean Energy and Solar PV	Input					Capacity Factor	Output	
	Generation Capacity (MW)	(MWh) _{year}	Capacity Investment (Million USD)	MW/Million USD	MWh/Million USD		Cost of Ocean Energy (USD/KWh)	Cost of Ocean Energy USD/MWh
Wave Energy	10	24,000	63	0.16	380	30%	0.56	560
Tidal Energy	254	406,400	298	0.85	1363	20%	0.28	280
Offshore wind	10	33,600	40	0.25	840	42%	0.17	170
OTEC	53	402,800	451	0.12	893	95%	0.13	130
Salinity gradient	200	1,280,000	600	0.33	2133	80%	0.09	90
Biomass	25	170,000	148	0.17	1149	85%	0.29	290
Solar PV	10	16,000	38	0.26	421	20%	0.25	250

<https://www.adb.org/sites/default/files/publication/42517/wave-energy-conversion-ocean-thermal-energy.pdf>

http://www.irena.org/documentdownloads/publications/wave-energy_v4_web.pdf

http://www.irena.org/DocumentDownloads/Publications/Tidal_Energy_V4_WEB.pdf

http://www.irena.org/DocumentDownloads/Publications/Salinity_Energy_v4_WEB.pdf

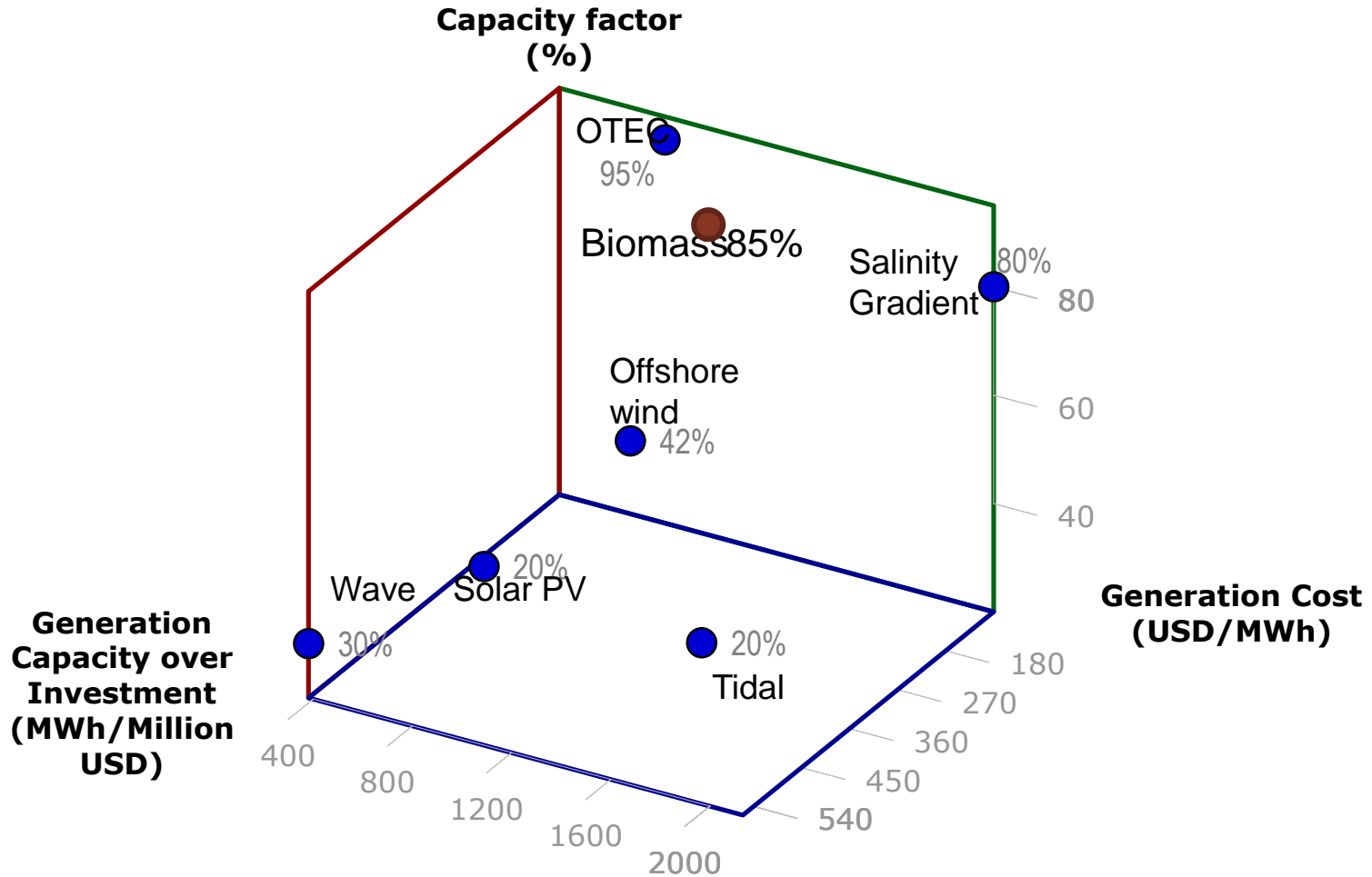
http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA-ETSAP_Tech_Brief_Wind_Power_E07.ashx

www.irena.org/documentdownloads/publications/irena_rethinking_energy_2017.pdf

https://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_Analysis-BIOMASS.pdf

<https://books.google.com.my/books?isbn=1522516727> OTEC Presentation to KSU KeTTHA

“NEW” ENERGY OVERVIEW



LCOE

Size (MW)	Source of LCOE (USD/kWh) ²				
	Vega (2007; 2012) ³	Energy and Environment Council (2011)	Straatman & van Stark (2008)	Upshaw (2012)	Muralidharan (2012)
1-1.35	0.60-0.94	0.51-0.77			
5 ⁴	0.35-0.65				
10	0.25-0.45	0.19-0.33			
28				0.13-0.65	
50	0.08-0.20	0.10-0.16	0.11-0.32		
50 (combined with offshore solar pond)	0.03-0.05		0.04-0.06		
100	0.07-0.18				0.19
200					0.16
400					0.12

^a All costs are converted into USD using currency rates at the date of publication.

^b An 8% interest rate for 15 year loan, annual inflation of 3%, and US labour costs.

^c Plants smaller than 5 MW of are scheduled to be used in combination with seawater air-conditioning systems, which share in the cost of the infrastructure and provide a significantly lower LCOE from the plant, thus it may not be relevant to show a specific price for this range.

0.08-0.32
USD/kWh

Source:
http://www.irena.org/DocumentDownloads/Publications/Ocean_Thermal_Energy_V4_web.pdf

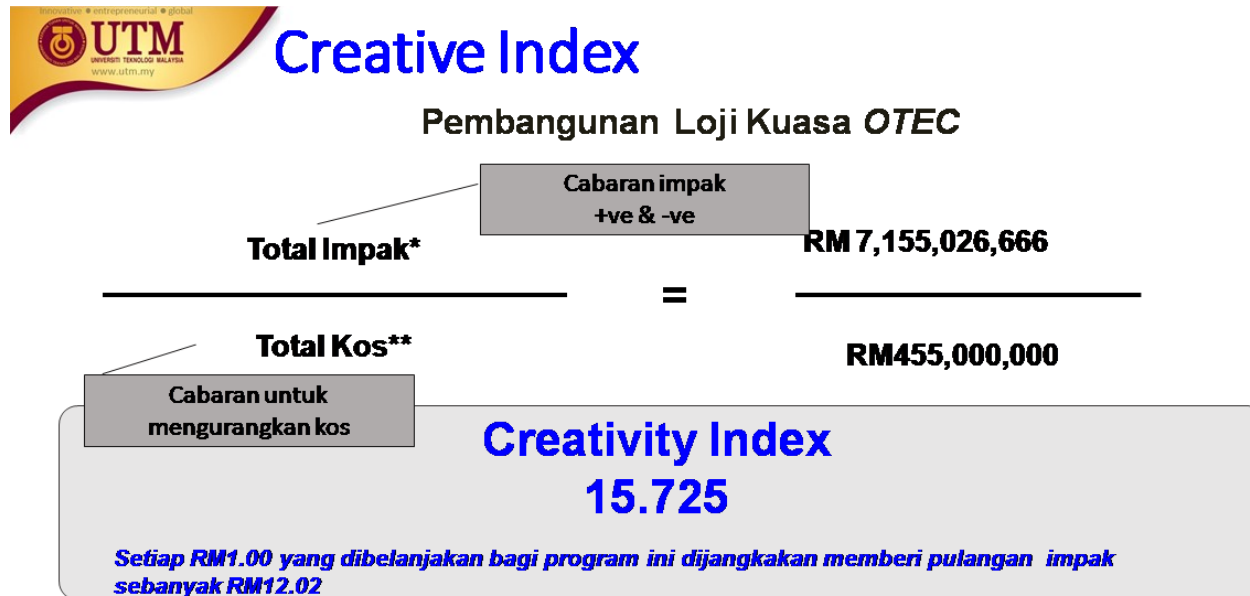
5 years planning on OTEC



	Current SESB	OTEC e- (100 MW) Selling e- alone
Generation Cost	56.50 cents/KWh	52 cents/KWh
Average Tariff	34.52 cents/KWh	34.52 cents/KWh
Subsidies	21.98 cents/KWh	17.48 cents/KWh
Annual Subsidies borne by SESB (RM)	879 Million (100%) 140.64 Million (16%)	132.85 Million (↓ 5.5%)
Annual Sabah Energy demand	4 Billion KWh	0.76 Billion KWh (16%)
5 years Subsidies (RM)	4,395 Million	N/A
OTEC Capital Investment from 5 years subsidies	N/A	703.2 Million (16 %)

ANNEX C: OTEC ECONOMICS

- Creativity Index of OTEC @RM 350 mil as per RMK-11 Submission



Nota:

- Impak untuk 20 tahun
- ** Kos DE (RM 350 juta *one-off*) dan kos OE (RM105 juta untuk 20 tahun)

ANNEX D: 30 MW OTEC FINANCIAL ANALYSIS

CAPEX: RM 800 mil

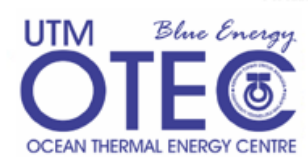
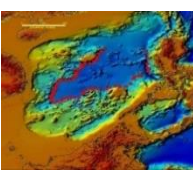
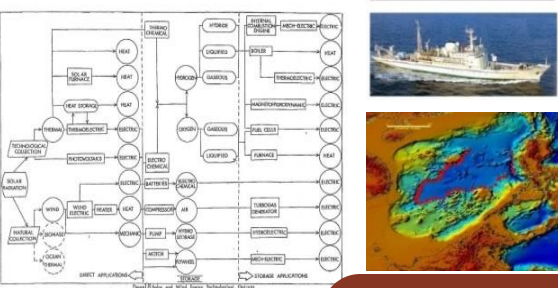
Annual Revenue: RM 254 mil

Payback Period: 5 years

IRR: 8%

NPV: RM 50 mil

ANNEX E: UTM Ocean Thermal Energy Centre Key Milestones



Master Thesis on applicability of solar energy technology

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

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

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



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

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

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

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





ANNEX F: OTEC Technology Partners



IRENA

International Renewable Energy Agency



OTEC
foundation



InfraKomas Sdn. Bhd.



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