PERDANA POLICY RESEARCH SEMINAR @PERDANA PRS2018

"RENEWABLE ENERGY & SUSTAINABILITY"

By
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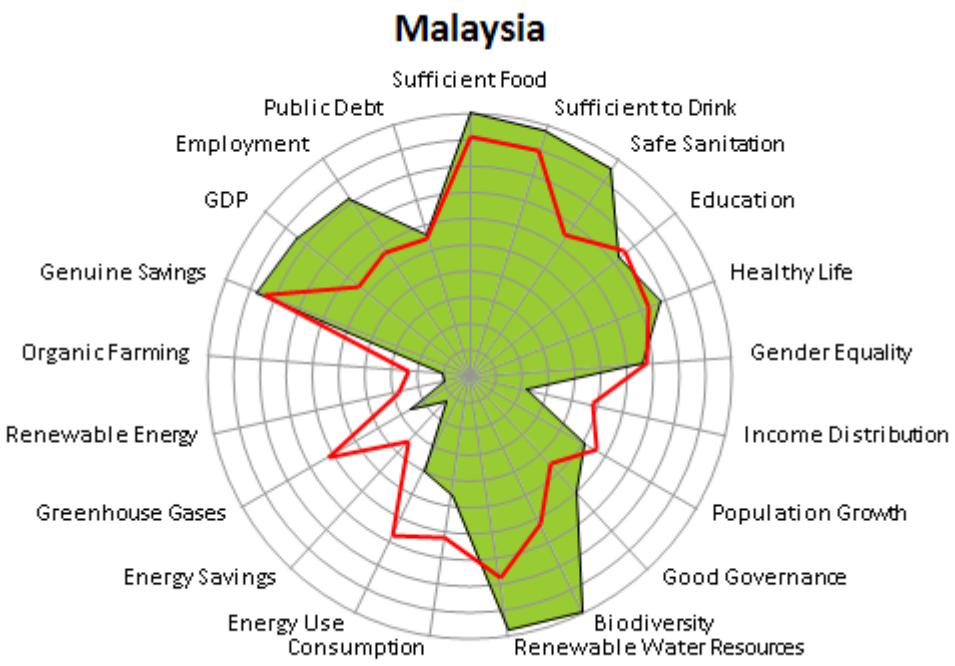
OUTLINE OF PRESENTATION

- Renewable Energy & Sustainability
- Renewable in Energy-Mix of Malaysia
- Sources of Energy: Renewable & Non-Renewable
- Ocean Thermal Energy & Sustainability
- Proposed Policy Research in Overcoming Barriers in Renewable Energy Development

SUSTAINABILITY INDEX FOR MALAYSIA:
Organic Farming, Renewable Energy, Energy Savings, Greenhouse Gases, and Income Distribution below Par
[http://www.ssfindex.com/]



Selected Sustainability Indicator Description [http://www.ssfindex.com/ssi/indicator-description/]

“Renewable Energy”=“Consumption of renewable energy as % of total energy consumption” [IEA]

”Income Distribution”=“Ratio of income of the richest 10% to the poorest 10% people in a country” [World Bank]

RENEWABLES

"Renewable energy is at the centre of the transition to a less carbon-intensive and more sustainable energy system. Renewables have grown rapidly in recent years, accompanied by sharp cost reductions for solar photovoltaics and wind power in particular. The electricity sector remains the brightest spot for renewables with the exponential growth of solar photovoltaics and wind in recent years, and building on the significant contribution of hydropower generation. But, electricity accounts for only a fifth of global energy consumption, and *the role of renewables in the transportation and heating sectors remains critical to the energy transition.*" [https://www.iea.org/topics/renewables/]

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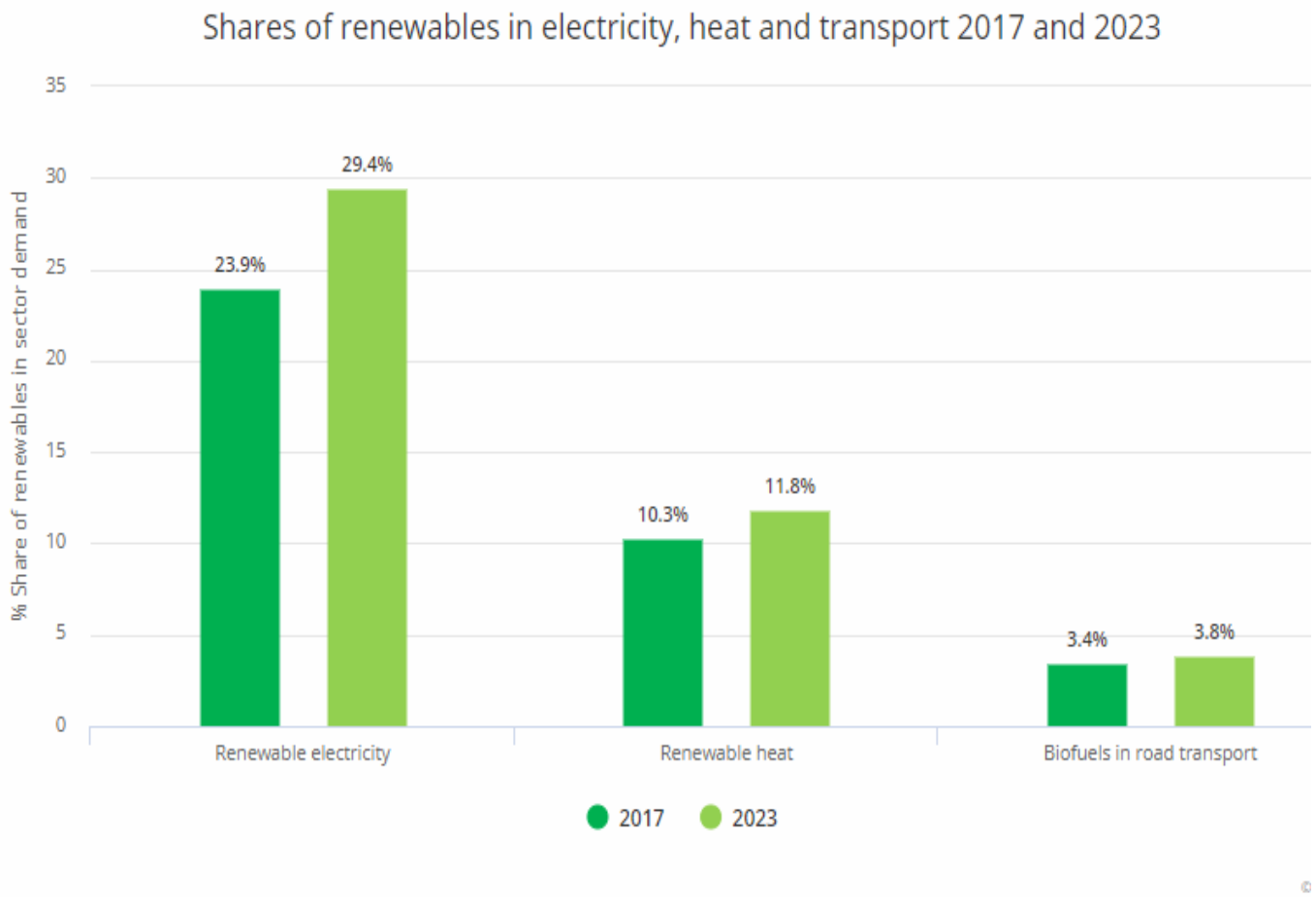


Source: Renewables 2018

In the *Renewables 2018* forecasts,

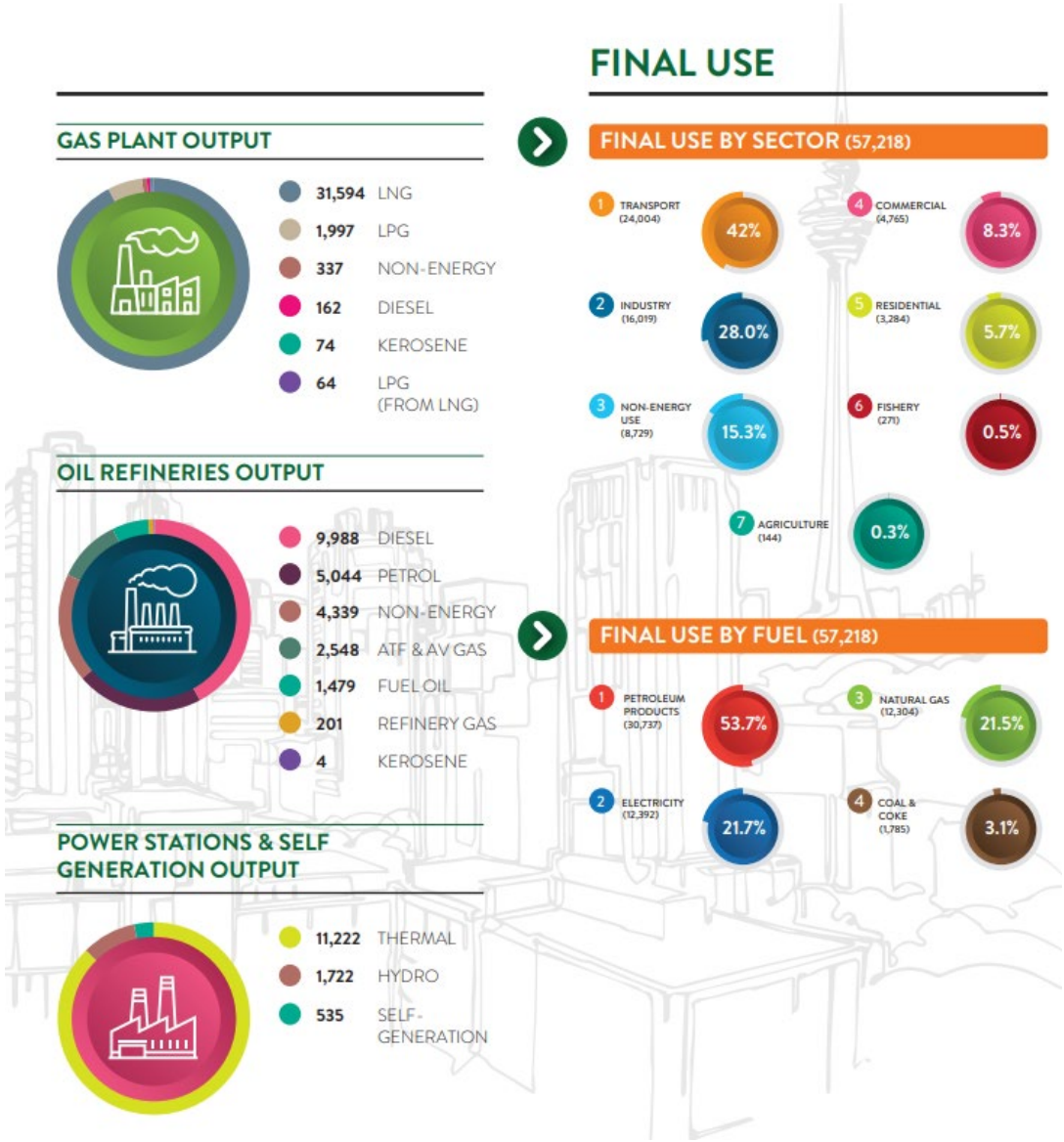
- "… the share of renewables in meeting global energy demand is expected to grow by one-fifth in the next five years to reach 12.4% in 2023."
- "Renewables will have the fastest growth in the electricity sector, providing almost 30% of power demand in 2023, up from 24% in 2017. During this period, renewables are forecast to meet more than 70% of global electricity generation growth, led by solar PV and followed by wind, hydropower, and bioenergy. A modest increase in the share of renewable heat is foreseen, as robust growth in total heat demand is expected to result from continuous economic and population growth. Renewables in transport have the lowest contribution of all three sectors, with their share growing only minimally from 3.4% in 2017 to 3.8% in 2023. Although they expand by almost one-fifth over the forecast period, renewables cover only a small portion of all energy demand in transport because of ongoing petroleum product consumption." [https://www.iea.org/topics/renewables/]

TABLE 20: PRIMARY ENERGY SUPPLY IN KTOE

	CRUDE OIL	PETROLEUM PRODUCTS & OTHERS	NATURAL GAS	COAL AND COKE	HYDROPOWER & RENEWABLES	TOTAL	ANNUAL GROWTH RATE (%)	SHARE (%)			
								CRUDE OIL AND PETROLEUM PRODUCTS & OTHERS	NATURAL GAS	COAL AND COKE	HYDROPOWER & RENEWABLES
1990	8,783	3,145	6,801	1,326	915	20,970	8.9	56.9	32.4	6.3	4.4
1991	9,443	4,163	10,112	1,564	1,053	26,335	22.7	51.7	38.4	5.9	4.0
1992	10,175	5,098	11,381	1,640	997	29,291	11.2	52.1	38.9	5.6	3.4
1993	10,135	5,816	11,360	1,352	1,262	29,925	2.2	53.3	38.0	4.5	4.2
1994	13,605	2,450	12,392	1,563	1,652	31,662	5.8	50.7	39.1	4.9	5.2
1995	16,159	608	13,960	1,612	1,540	33,879	7.0	49.5	41.2	4.8	4.5
1996	18,255	1,098	15,567	1,677	1,243	37,840	11.7	51.1	41.1	4.4	3.3
1997	17,917	3,803	19,041	1,622	790	43,173	14.1	50.3	44.1	3.8	1.8
1998	17,132	1,919	19,101	1,731	1,113	40,996	(5.0)	46.5	46.6	4.2	2.7
1999	17,643	1,807	21,476	1,940	1,668	44,534	8.6	43.7	48.2	4.4	3.7
2000	21,673	(1,431)	26,370	2,486	1,612	50,710	13.9	39.9	52.0	4.9	3.2
2001	23,590	(1,917)	25,649	2,970	1,687	51,979	2.5	41.7	49.3	5.7	3.2
2002	22,647	(523)	26,101	3,642	1,329	53,196	2.3	41.6	49.1	6.8	2.5
2003	25,344	(1,408)	27,257	5,316	1,056	57,565	8.2	41.6	47.3	9.2	1.8
2004	25,335	(82)	29,145	7,109	1,329	62,836	9.2	40.2	46.4	11.3	2.1
2005	24,339	(243)	33,913	6,889	1,313	66,211	5.4	36.4	51.2	10.4	2.0
2006	24,910	(1,670)	34,917	7,299	1,567	67,023	1.2	34.7	52.1	10.9	2.3
2007	26,571	(1,190)	36,639	8,848	1,522	72,390	8.0	35.1	50.6	12.2	2.1
2008	26,776	(1,780)	39,289	9,782	1,964	76,031	5.0	32.9	51.7	12.9	2.6
2009	26,386	96	35,851	10,623	1,627	74,583	(1.9)	35.5	48.1	14.2	2.2
2010	22,487	2,521	35,447	14,777	1,577	76,809	3.0	32.6	46.1	19.2	2.1
2011	24,679	2,224	35,740	14,772	1,874	79,289	3.2	33.9	45.1	18.6	2.4
2012	28,053	1,449	38,647	15,882	2,463	86,494	9.1	34.1	44.7	18.4	2.8
2013	27,154	5,320	39,973	15,067	3,216	90,730	4.9	35.8	44.1	16.6	3.5
2014	26,765	6,658	40,113	15,357	3,594	92,487	1.9	36.1	43.4	16.6	3.9
2015	24,971	4,194	39,364	17,406	4,253	90,188	(2.5)	32.3	43.6	19.3	4.7
2016	27,757	3,570	37,980	18,886	5,202	93,395	3.6	33.5	40.7	20.2	5.6

In 2016, Renewables, Including Hydropower =5.6% of 93,395 ktoe

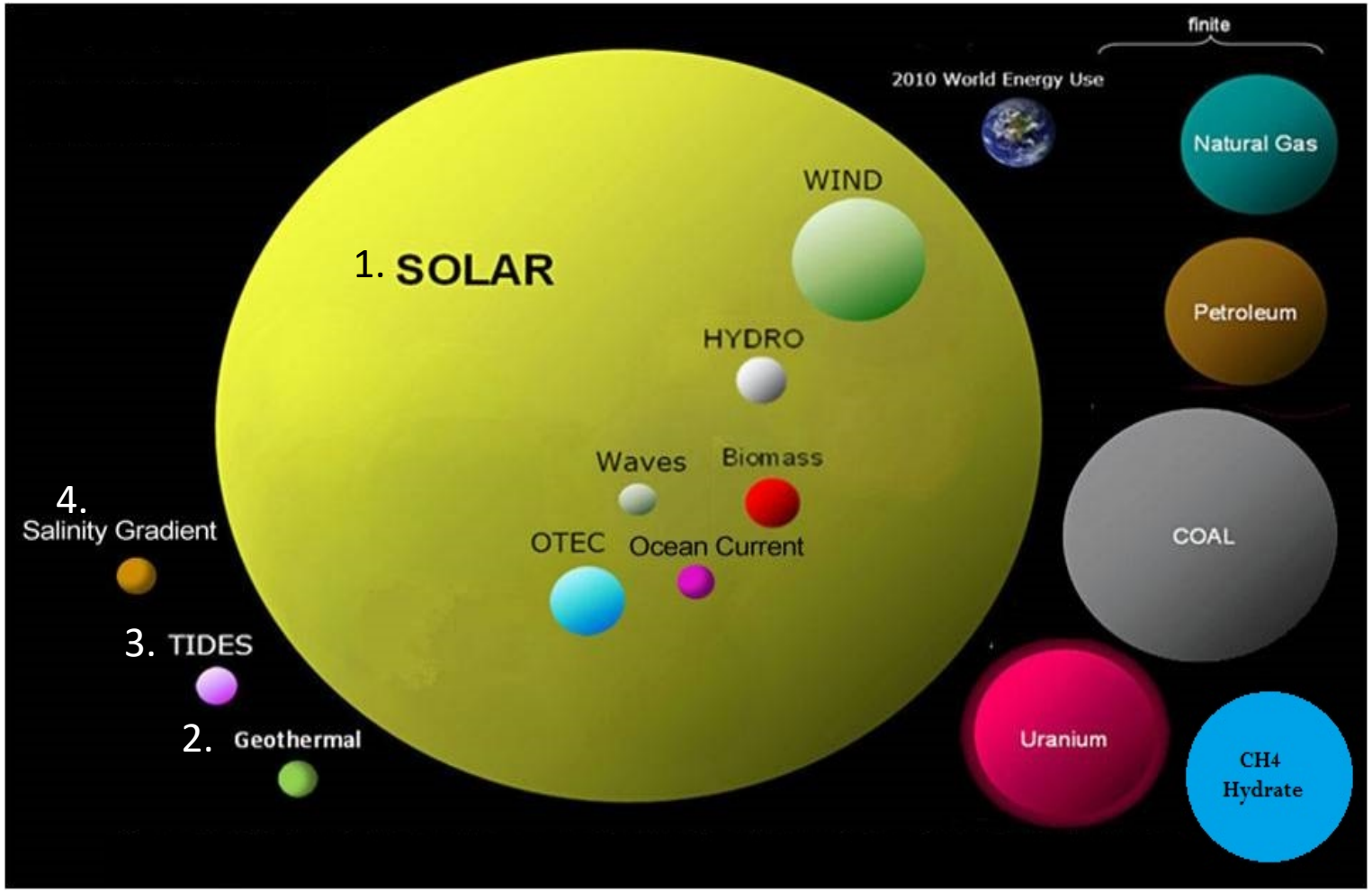
https://www.st.gov.my/en/contents/files/download/111/ST-NEB_2016_Booklet.pdf



TRANSPORT SECTOR: THE LARGEST ENERGY USER OF ALL @42%

PRIMARY & SECONDARY SOURCES OF ENERGY: RENEWABLE & NON-RENEWABLE

[Adapted from http://www.asrc.albany.edu/people/faculty/perez/index.html]



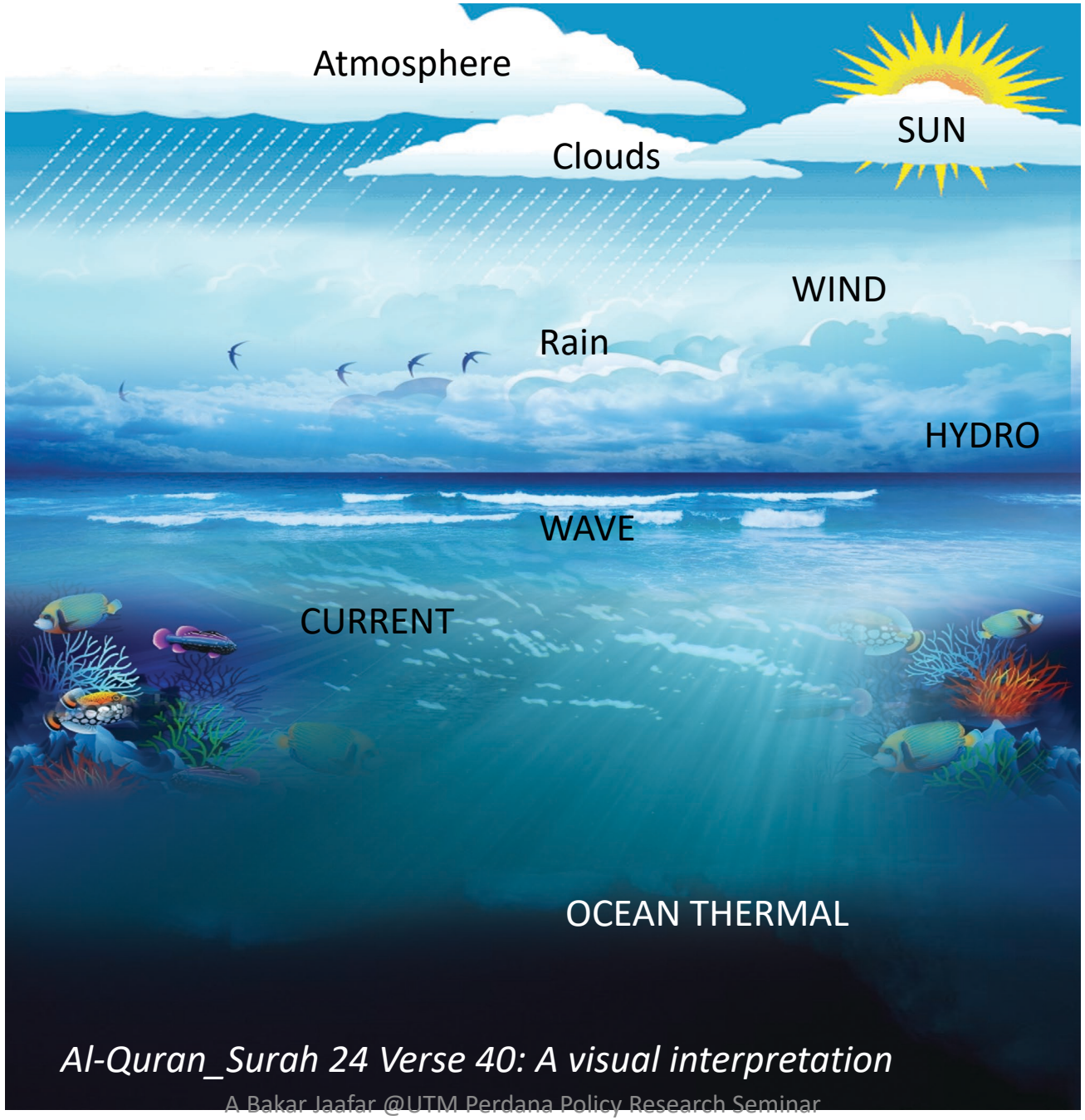
ENERGY SOURCES: RENEWABLE & NON-RENEWABLE

PRIMARY [Secondary]: RENEWABLE

1. SOLAR [*OTEC, Currents, Wave, Hydro, Biomass, & Wind*]
2. GRAVITATIONAL [*Tide & Tidal Movements*]
3. GEOTHERMAL [*Techtonics: oceanic plates going under the continents]*
4. SALINITY GRADIENT [*Salinity differential: Freshwater over Seawater*]

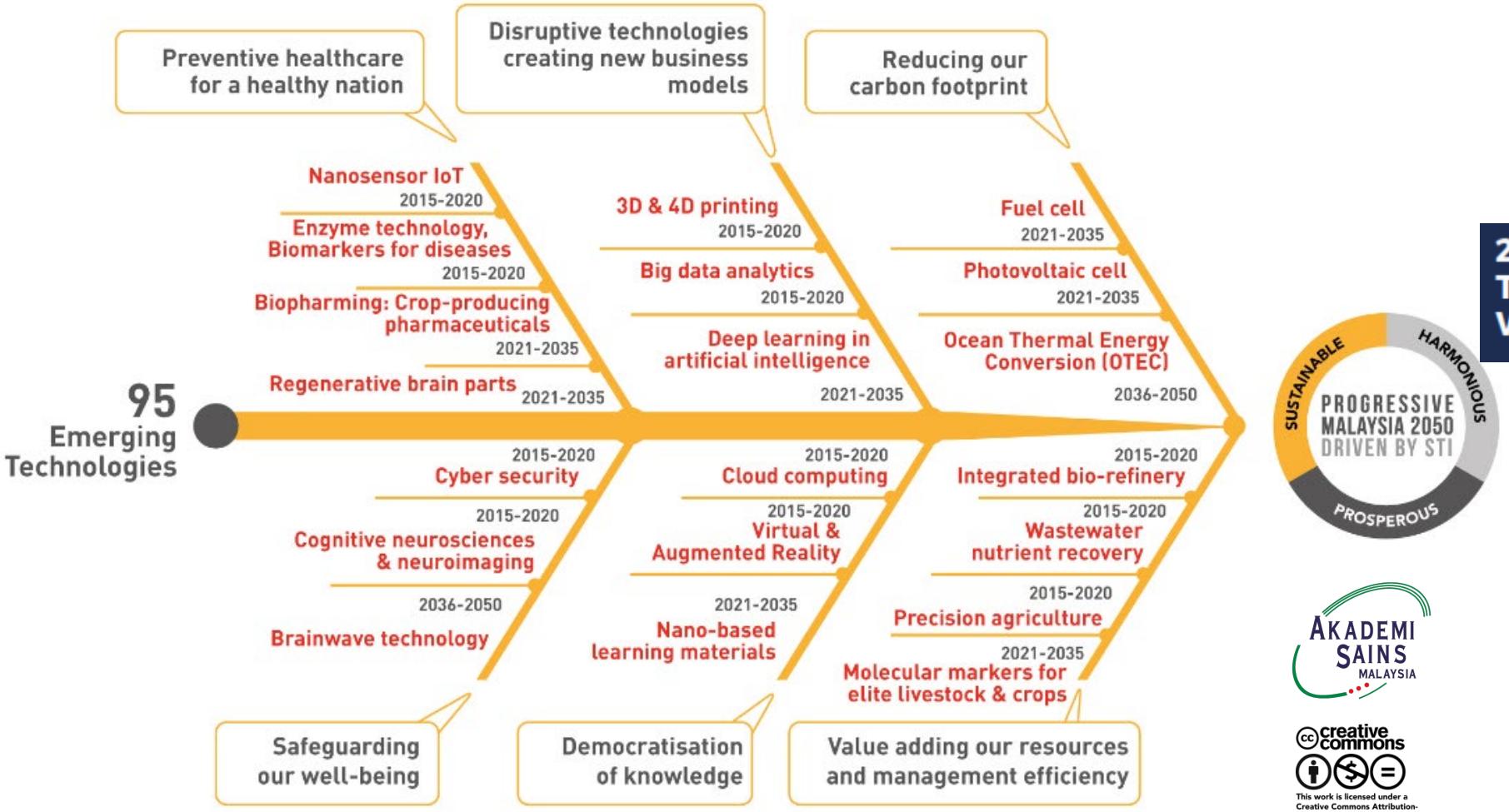
PRIMARY[Form]: NON-RENEWABLE

1. FOSSIL FUELS [*Coal, Methane Hydrate, Oil, & Gas*]
2. NUCLEAR [*Fission & Fusion*]



Al-Quran_Surah 24 Verse 40: A visual interpretation

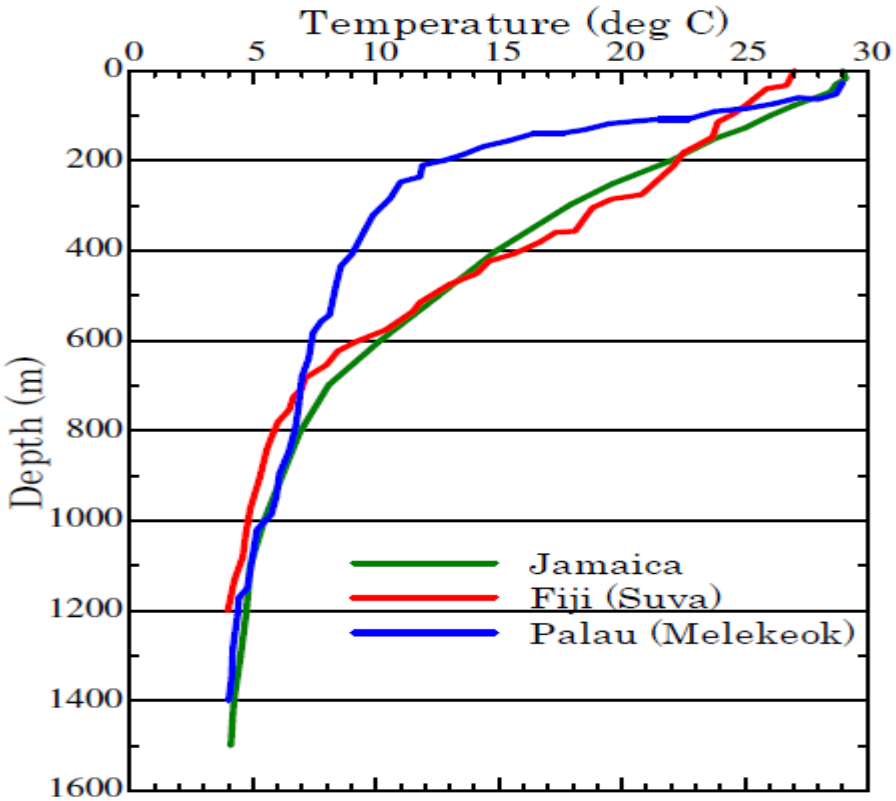
21 Impactful Emerging Technologies to Elevate Malaysia's Well-Being, Wealth Creation and Governance for Sustainability

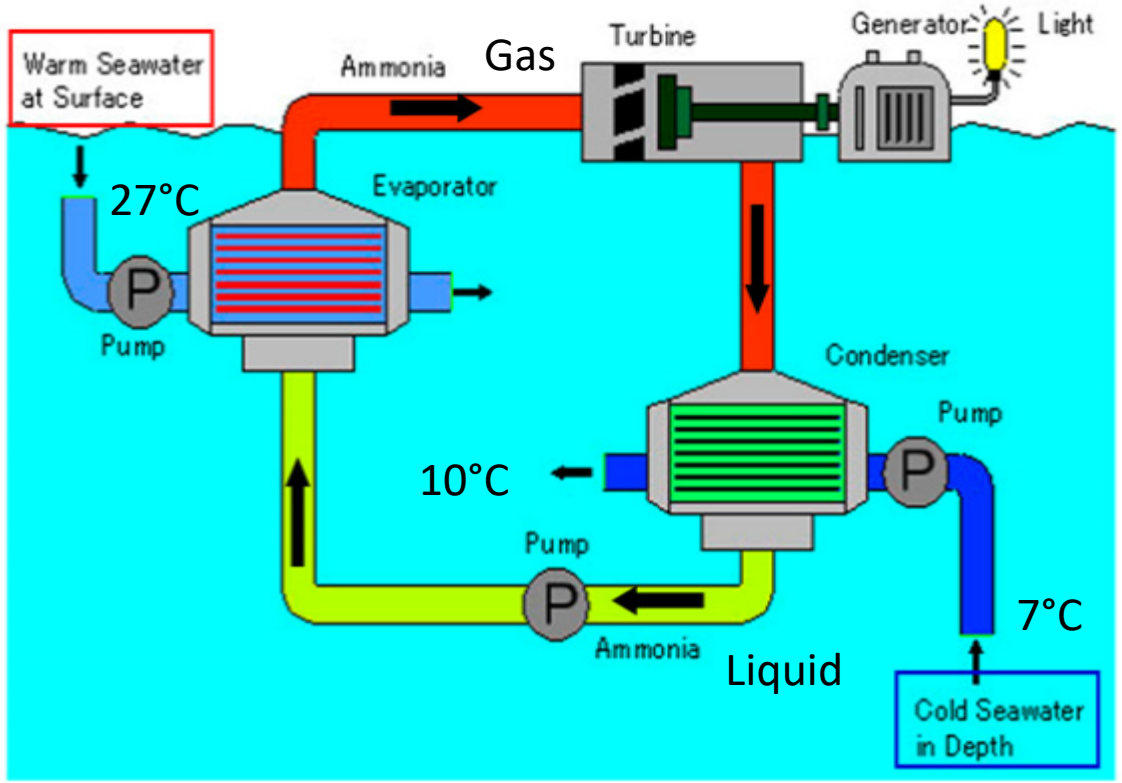


Source: ASM S&T Foresight Malaysia 2050 Report, 2017

Principle of OTEC

Al-Quran 24:40 (610-632)
Rankine (1851)
D'Arsonval (1881)
Claude (1930)



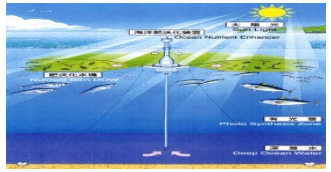


… Other Revenue Streams

Temperate Produce

"Import Substitutions"

High Value Produce



Capture-Fisheries

Health & Cosmetics

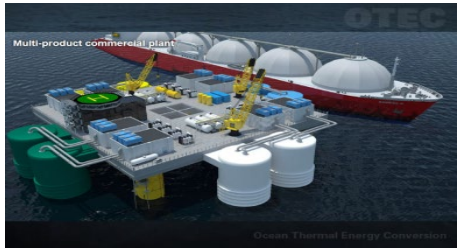
Ms Earth Japan, 2012

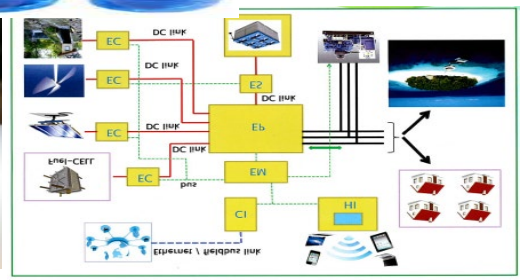
Lithium Production

Picture 5: Lithium extraction facility

Mineral H20

OTEC-H2





Smart-Grid

With All Renewables

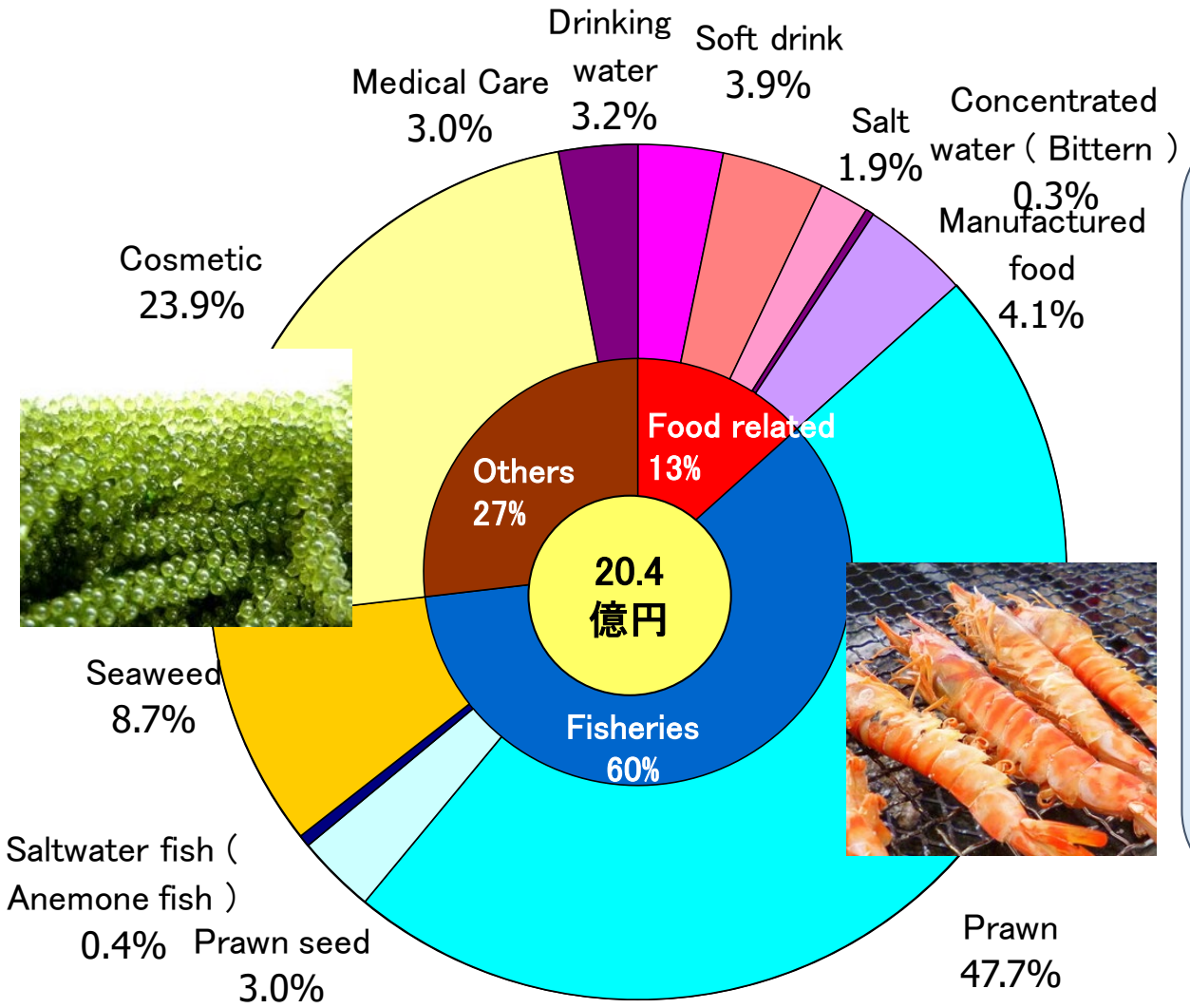
[Stand-alone Power Systems]

Kumejima, Okinawa, Japan

Transformation of Sugar and Pineapple Growers to OTEC-Driven Marine-Industrial Entrepreneurs

Deep water use as a resource for excellent industrial promotion

The current state of industrial development (deep-sea water) of Kumejima



As the main industry of Kumejima:
About 20 billion yen in sales of deep-water related companies per year.
It has become a deep-sea water use industry and island main industry (Kumejima - cho , in the prawn and sea grapes and holds a share of Japan)

Prawn seedling production : The main advantage of the cold and the cleanliness of the deep water .
Sea grape : The main advantage of the cold and the eutrophication of the deep water

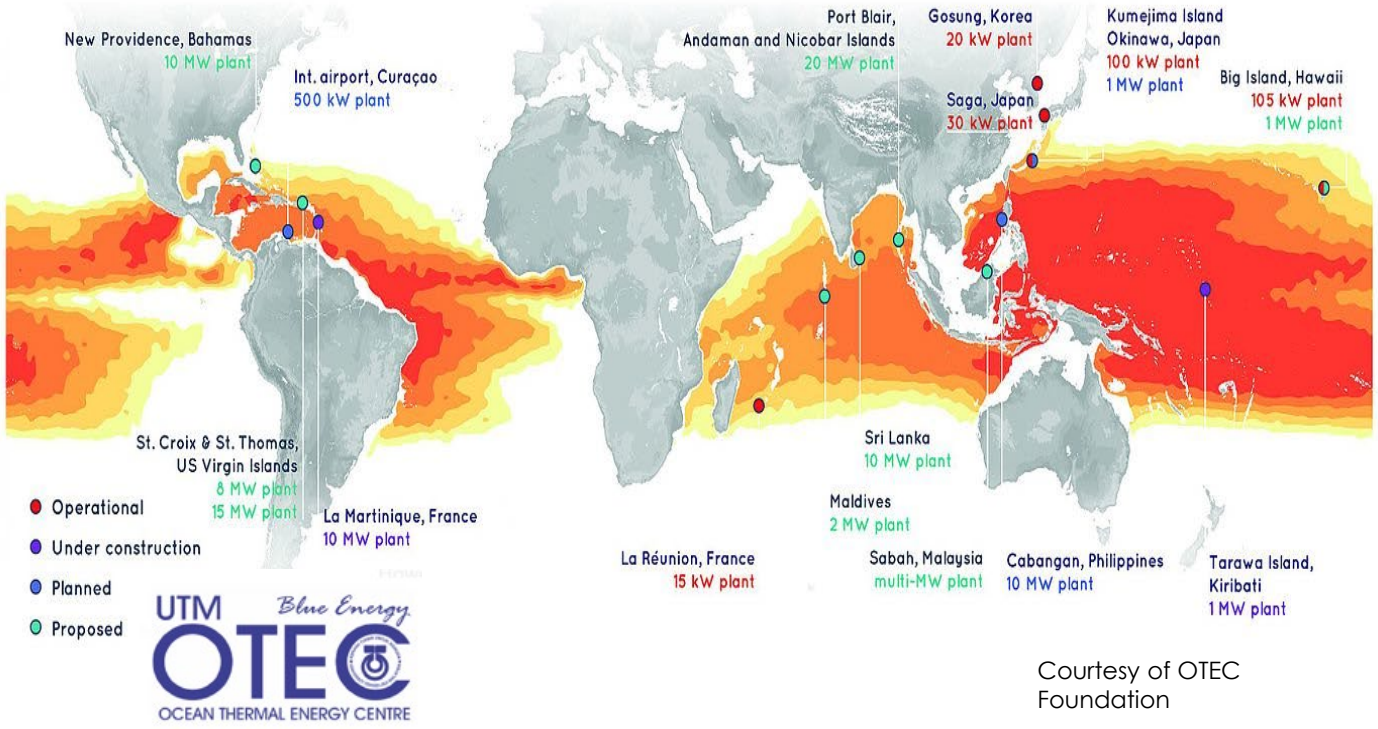
Source: " deep sea water complex use basic research " survey report , March 2011 , Kume Island

OTEC Park @Kume Island, Okinawa, Japan

Kume deep ocean water industry 2010

Industry	Industry Type	Sales (thousands of yen)
Food-related	Drinking Water	64,632
	Soft drink	77,883
	salt	37,954
	Concentrated water (bittern)	6,237
	Healthy Food	0
	manufactured food	82,135
Fisheries	Saltwater fish (anemone fish)	9,000
	Prawn seeds and seedlings	60,000
	Prawn	**970,000**
	Seaweed	175,747
Others	Agriculture	0
	Cosmetics	501,042
	Medical care	60,000
		2,044,630

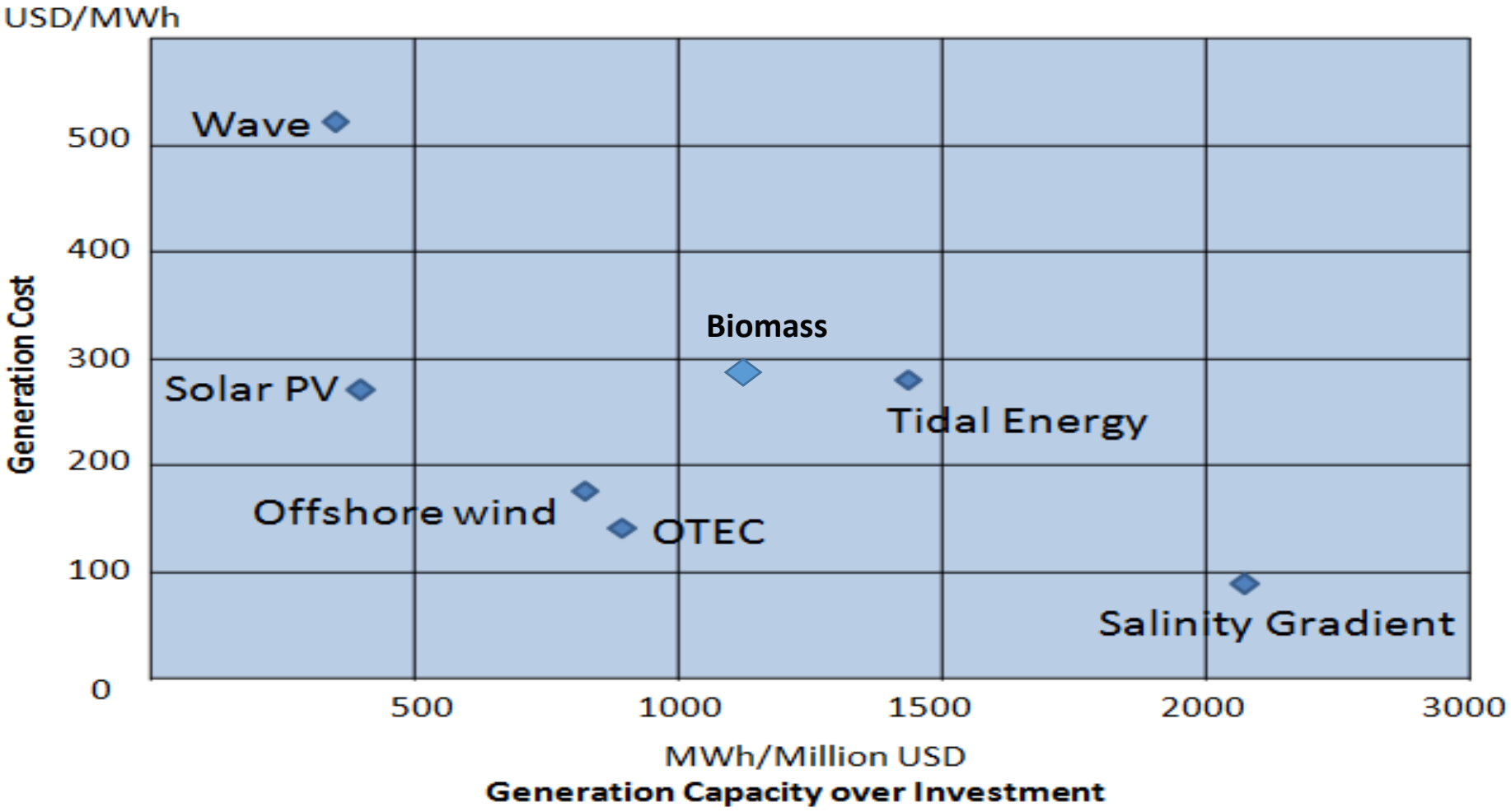
World-wide Ocean Thermal Energy-driven Development for Water, Foods, & H2Fuel



Courtesy of OTEC Foundation

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

k

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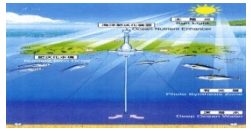
https://www.adb.org/sites/default/files/publication/42517/wave-energy-conversion-ocean-thermal-energy.pdf
http://www.irena.org/documentdownloads/publications/wave-energy_v4_web.pdf
http://www.irena.org/DocumentDownloads/Publications/Tidal_Energy_V4_WEB.pdf
http://www.irena.org/DocumentDownloads/Publications/Salinity_Energy_v4_WEB.pdf
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 Revenue Streams, other than that of Power

Temperate Produce

"Import Substitutions"

High Value Produce



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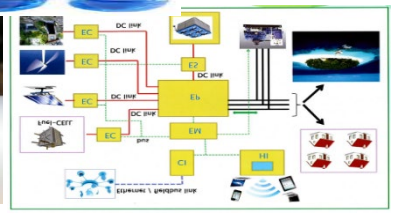


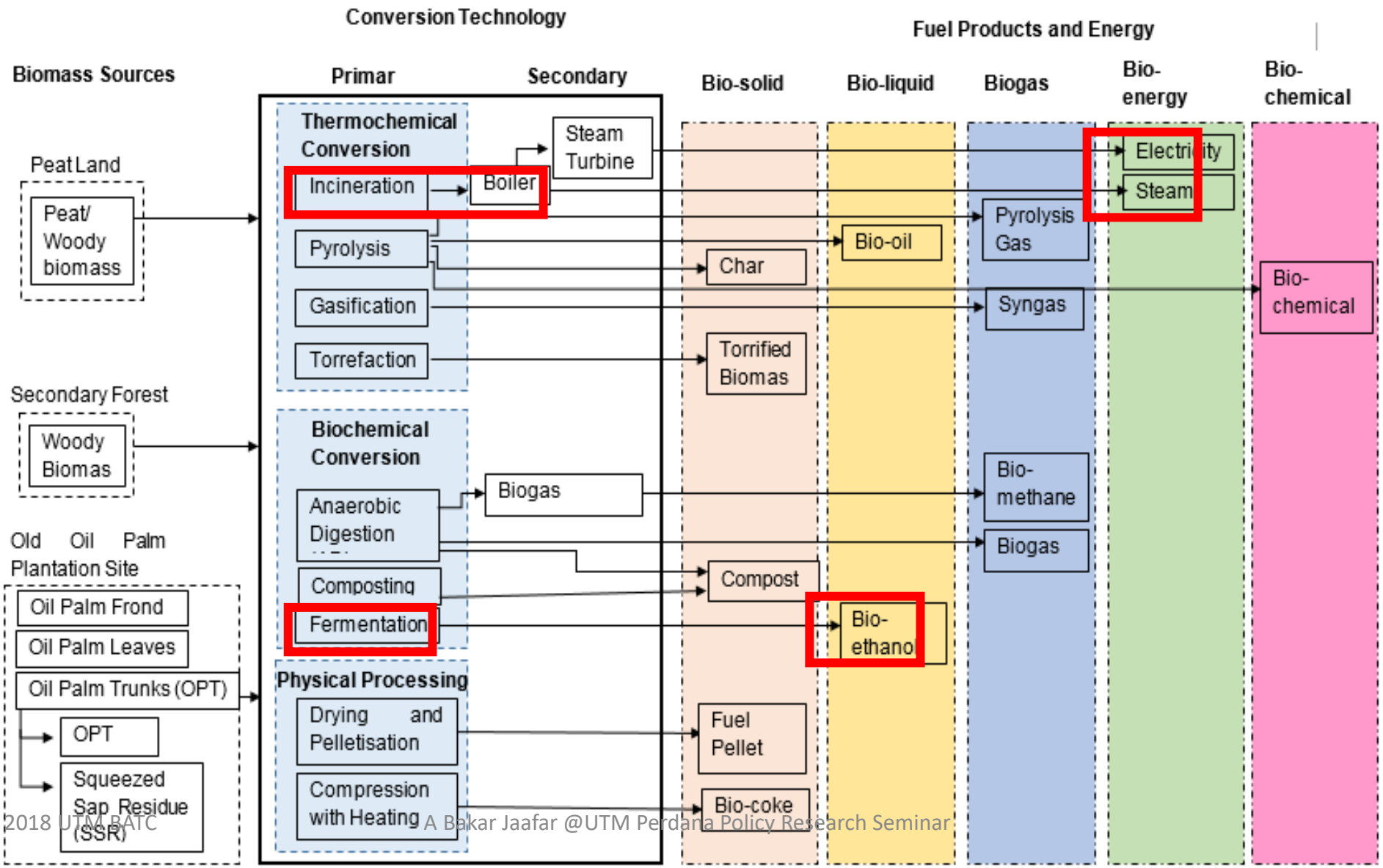
Smart-Grid

With All Renewables

[Stand-alone Power Systems]

RENEWABLE FUELS FOR TRANSPORT: HYDROGEN; BIO-DIESEL, ETHANOL-MIX

Biomass-to-Resource Potential Roadmap



HYDROGEN: THE MOST DOMINANT ENERGY CARRIER IN 21ST CENTURY

Ref: IbrahimDincer (2008)

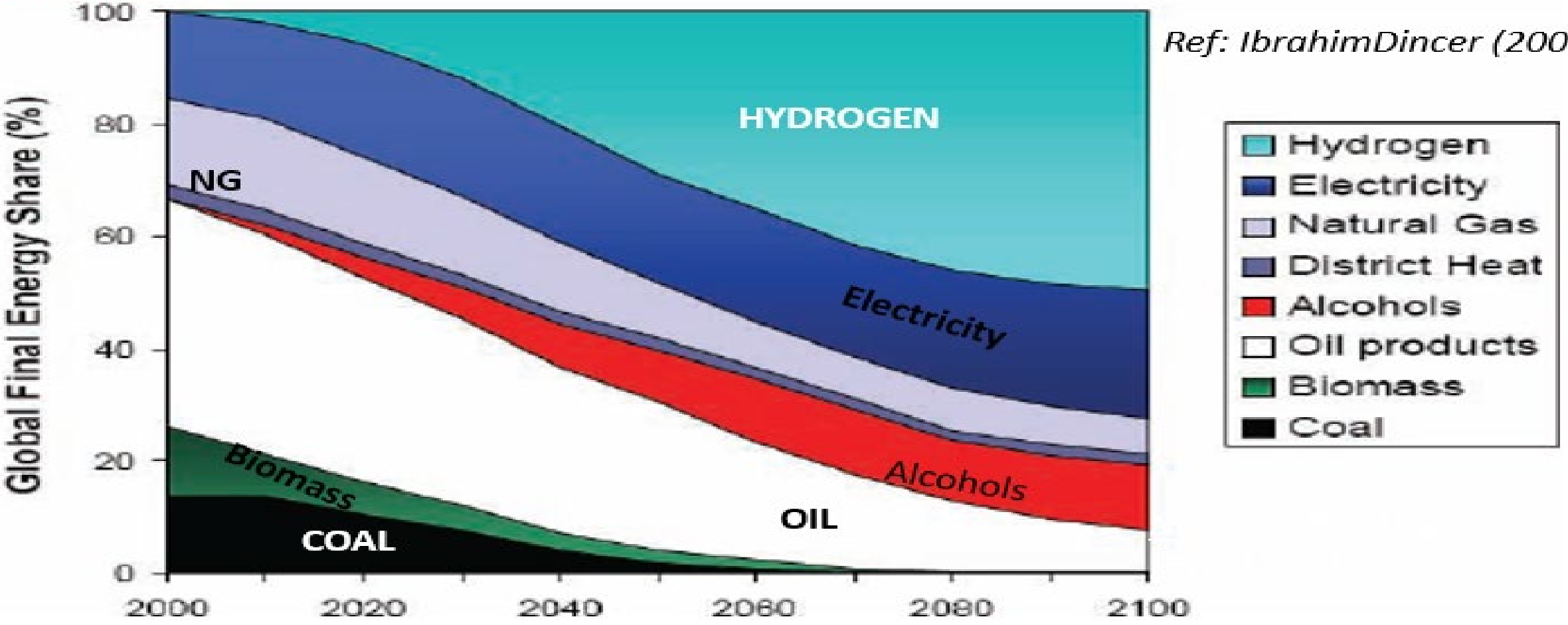
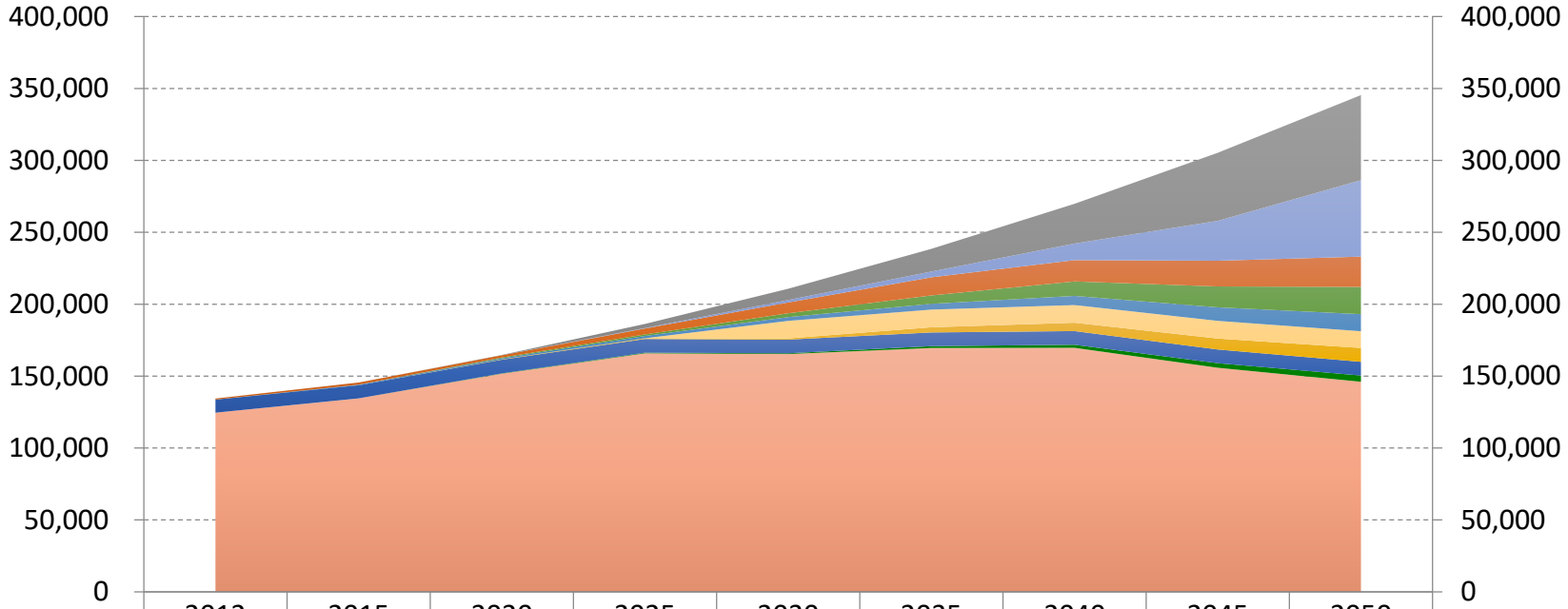


Figure 1. Evolution of global market shares of different final-energy carriers for the period 1990-2100 based on the scenario by Barreto et al. [4]. The alcohols category includes methanol and ethanol.

Scenario 2 - Electricity Generation by Fuel, GWh



	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	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
Hydro power	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

WITH ONE-MW OF OTEC, WHAT CAN BE ACHIEVED, FOR SUSTAINABILITY?

Seaweed, Seafoods etc

Reduced Obesity, bp, cholesterol.

"The Ocean of Discovery"

Income up to RM15,000/capita 1000 people

Enough Clean Water for 1000 people

"Kumejima" & Kona, HI

8,000 tonnes CO2 offset

Improved Balance

Improved Income Distribution

"Highly Sustainable"

Greater Public-Private & Community Partnership

5000 bbls of oil eq

High Quality Growth

New, Impactful

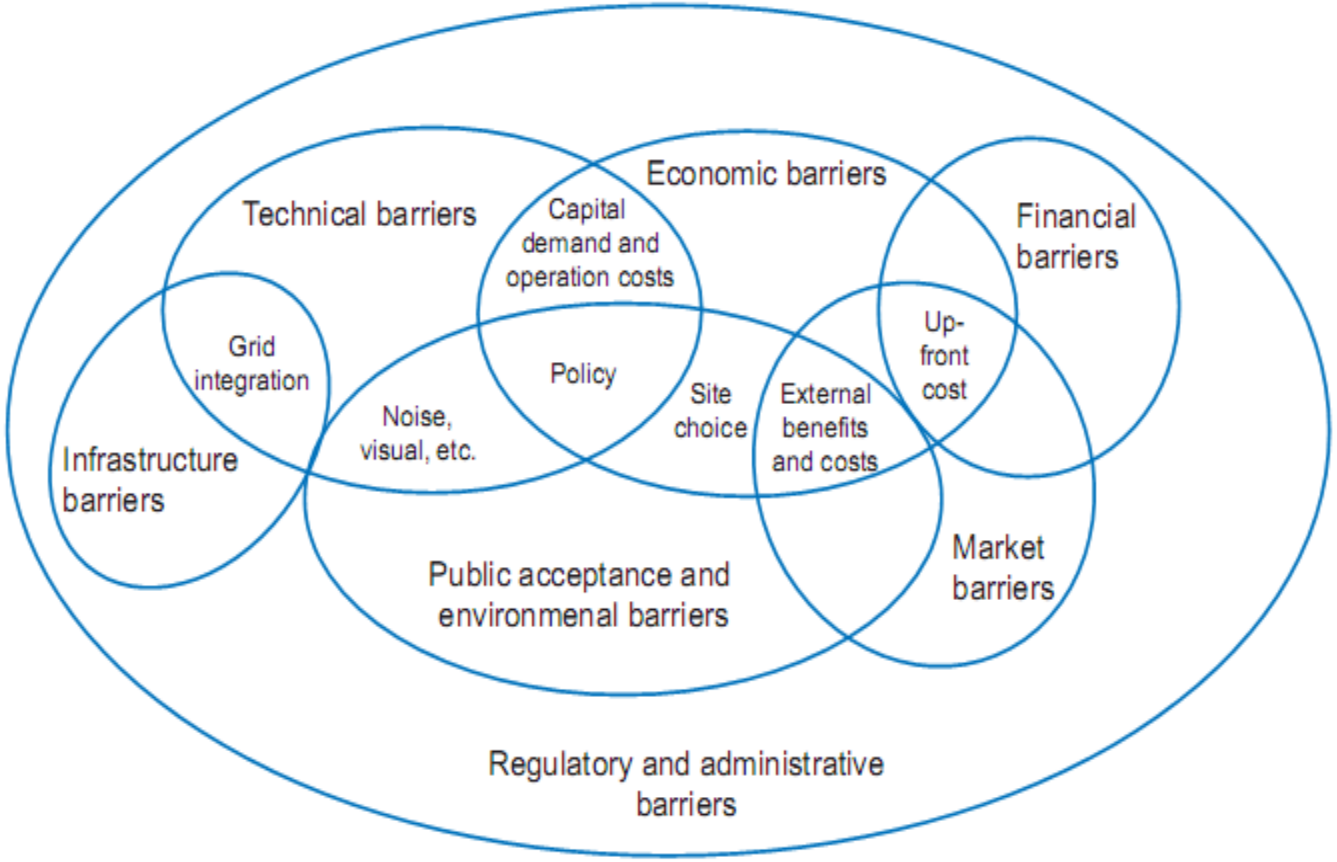
"Takuma" Capture Fishery

OTEC Parks

"... *as an important contribution to the maintenance of peace, justice and progress for all peoples of the world.*"

PROPOSED POLICY RESEARCH: OVERCOMING …

Figure 3.1 Barriers to renewable energy development



Ref: IEA, 2011:33

MAHALO, Thank You Merci Gracias спасибо 谢谢 شكر

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Director, UTM Ocean Thermal Energy Centre [www.otec.utm.my]
2012-13 Visiting Professor of UTM Perdana School
1997-2012 Nominated & Elected-Member of UN CLOS-CLCS, New York
1995-1996 Senior Processing Controller, Kumpulan Guthrie Berhad
1990-95 Director-General, Department of Environment (DOE), Malaysia
1976-1989 DOE Principal Assistant Director, Director, Deputy DG
1975-76 Staff Engineer, USEPA Office of R&D, Industrial-Environmental Research
1973-74 Factories & Machinery Inspector, Department of Factories & Machinery (now, DOSH)

Award Recipient of:
2018 Tokoh Alumni Sekolah Alam Shah
2017 Honorary Doctorate in Science (Universiti Malaysia Terengganu)
2016 *Anugerah Perkhidmatan Cemerlang*, Universiti Teknologi Malaysia
2012 *Anugerah Bukit Katil Cemerlang* sempena MELAKA 750 Tahun, Anugerah Tokoh Profesional
2011 Convocation Medal of The University of Newcastle NSW Australia

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