PERDANA POLICY RESEARCH SEMINAR
@PERDANA PRS2018

“RENEWABLE ENERGY & SUSTAINABILITY”

By
Prof Dato’ Ir Dr A. Bakar Jaafar, FASc

Director, UTM Ocean Thermal Energy Centre &
Member of Razak Faculty of Technology & Informatics

Mobile: +60123207201
E-mail: bakar.jaafar@utm.my
E-mail2: bakar.jaafar@gmail.com
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:

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

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

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
PREAMBLE

**Principle of OTEC**

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

![Graph showing temperature vs depth with labels Jamaica, Fiji (Suva), Palau (Melekeok)]

![Diagram of OTEC system with temperatures 27°C, 10°C, 7°C and phases gas, liquid]
Temperate Produce

"Import Substitutions"

High Value Produce

Health & Cosmetics

Lithium Production

Mineral H2O

Capture-Fisheries

Ms Earth Japan, 2012

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)

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

<table>
<thead>
<tr>
<th>Industry</th>
<th>Industry Type</th>
<th>Sales ( thousands of yen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food-related</td>
<td>Drinking Water</td>
<td>64,632</td>
</tr>
<tr>
<td></td>
<td>Soft drink</td>
<td>77,883</td>
</tr>
<tr>
<td></td>
<td>salt</td>
<td>37,954</td>
</tr>
<tr>
<td></td>
<td>Concentrated water ( bittern )</td>
<td>6,237</td>
</tr>
<tr>
<td></td>
<td>Healthy Food</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>manufactured food</td>
<td>82,135</td>
</tr>
<tr>
<td>Fisheries</td>
<td>Saltwater fish ( anemone fish )</td>
<td>9,000</td>
</tr>
<tr>
<td></td>
<td>Prawn seeds and seedlings</td>
<td>60,000</td>
</tr>
<tr>
<td></td>
<td>Prawn</td>
<td>970,000</td>
</tr>
<tr>
<td></td>
<td>Seaweed</td>
<td>175,747</td>
</tr>
<tr>
<td>Others</td>
<td>Agriculture</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cosmetics</td>
<td>501,042</td>
</tr>
<tr>
<td></td>
<td>Medical care</td>
<td>60,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,044,630</td>
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</table>
World-wide Ocean Thermal Energy-driven Development for Water, Foods, & H2Fuel

Source: www.lockheedmartin.com/us/products/otec.html
Courtesy of OTEC Foundation
COMPARATIVE ANALYSIS OF VARIOUS FORMS OF RE

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

USD/MWh

Generation Cost

0 100 200 300 400 500

Wave

Solar PV

Biomass

Tidal Energy

Salinity Gradient

MWh/Million USD

Generation Capacity over Investment

0 500 1000 1500 2000 2500 3000
<table>
<thead>
<tr>
<th>Ocean Energy and Solar PV</th>
<th>Generation Capacity (MW)</th>
<th>(MWh)\text{year}</th>
<th>Capacity Investment (Million USD)</th>
<th>MW/Million USD</th>
<th>MWh/Million USD</th>
<th>Capacity Factor</th>
<th>Cost of Ocean Energy (USD/KWh)</th>
<th>Cost of Ocean Energy USD/MWh</th>
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<tbody>
<tr>
<td>Wave Energy</td>
<td>10</td>
<td>24,000</td>
<td>63</td>
<td>0.16</td>
<td>380</td>
<td>30%</td>
<td>0.56</td>
<td>560</td>
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<tr>
<td>Tidal Energy</td>
<td>254</td>
<td>406,400</td>
<td>298</td>
<td>0.85</td>
<td>1363</td>
<td>20%</td>
<td>0.28</td>
<td>280</td>
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<tr>
<td>Offshore wind</td>
<td>10</td>
<td>33,600</td>
<td>40</td>
<td>0.25</td>
<td>840</td>
<td>42%</td>
<td>0.17</td>
<td>170</td>
</tr>
<tr>
<td>OTEC</td>
<td>53</td>
<td>402,800</td>
<td>451</td>
<td>0.12</td>
<td>893</td>
<td>95%</td>
<td>0.13</td>
<td>130</td>
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<tr>
<td>Salinity gradient</td>
<td>200</td>
<td>1,280,000</td>
<td>600</td>
<td>0.33</td>
<td>2133</td>
<td>80%</td>
<td>0.09</td>
<td>90</td>
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<tr>
<td>Biomass</td>
<td>25</td>
<td>170,000</td>
<td>148</td>
<td>0.17</td>
<td>1149</td>
<td>85%</td>
<td>0.29</td>
<td>290</td>
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<tr>
<td>Solar PV</td>
<td>10</td>
<td>16,000</td>
<td>38</td>
<td>0.26</td>
<td>421</td>
<td>20%</td>
<td>0.25</td>
<td>250</td>
</tr>
</tbody>
</table>
OREC Revenue Streams, other than that of Power

Temperate Produce

“Import Substitutions”

High Value Produce

Health & Cosmetics

Lithium Production

OTEC-H2

Capture-Fisheries

Ms Earth Japan, 2012

[Stand-alone Power Systems]

Smart-Grid With All Renewables
RENEWABLE FUELS FOR TRANSPORT: HYDROGEN; BIO-DIESEL, ETHANOL-MIX
Biomass-to-Resource Potential Roadmap
HYDROGEN: THE MOST DOMINANT ENERGY CARRIER IN 21ST CENTURY

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.

Ref: IbrahimDincer (2008)
<table>
<thead>
<tr>
<th>Year</th>
<th>OTEC</th>
<th>Fuel Cell</th>
<th>Bioenergy</th>
<th>Wind Energy</th>
<th>Solar</th>
<th>Nuclear</th>
<th>Wave/Tidal/Current</th>
<th>Hydro power</th>
<th>Geothermal</th>
<th>Fossil Fuel</th>
<th>Total</th>
</tr>
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<tr>
<td>2012</td>
<td>0</td>
<td>0</td>
<td>809</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>9,056</td>
<td>0</td>
<td>124,596</td>
<td>134,468</td>
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<tr>
<td>2015</td>
<td>0</td>
<td>0</td>
<td>1,455</td>
<td>0</td>
<td>437</td>
<td>0</td>
<td>0</td>
<td>9,084</td>
<td>0</td>
<td>134,571</td>
<td>145,547</td>
</tr>
<tr>
<td>2020</td>
<td>134</td>
<td>16</td>
<td>1,567</td>
<td>547</td>
<td>790</td>
<td>0</td>
<td>0</td>
<td>9,531</td>
<td>0</td>
<td>151,656</td>
<td>164,675</td>
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<tr>
<td>2025</td>
<td>2,848</td>
<td>354</td>
<td>4,088</td>
<td>1,095</td>
<td>1,579</td>
<td>0</td>
<td>0</td>
<td>9,531</td>
<td>0</td>
<td>165,891</td>
<td>186,316</td>
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<tr>
<td>2030</td>
<td>7,884</td>
<td>1,665</td>
<td>7,553</td>
<td>2,601</td>
<td>2,631</td>
<td>0</td>
<td>0</td>
<td>9,531</td>
<td>0</td>
<td>165,388</td>
<td>210,800</td>
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<tr>
<td>2035</td>
<td>15,768</td>
<td>4,054</td>
<td>12,535</td>
<td>5,913</td>
<td>3,999</td>
<td>0</td>
<td>0</td>
<td>9,531</td>
<td>0</td>
<td>149,624</td>
<td>238,500</td>
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<tr>
<td>2040</td>
<td>27,594</td>
<td>11,603</td>
<td>14,832</td>
<td>10,052</td>
<td>6,314</td>
<td>0</td>
<td>0</td>
<td>9,531</td>
<td>0</td>
<td>130,860</td>
<td>269,841</td>
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<tr>
<td>2045</td>
<td>47,304</td>
<td>27,782</td>
<td>17,823</td>
<td>14,520</td>
<td>9,502</td>
<td>0</td>
<td>0</td>
<td>9,531</td>
<td>0</td>
<td>112,096</td>
<td>305,300</td>
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<tr>
<td>2050</td>
<td>59,129</td>
<td>53,194</td>
<td>21,049</td>
<td>18,922</td>
<td>11,913</td>
<td>0</td>
<td>0</td>
<td>9,531</td>
<td>0</td>
<td>94,332</td>
<td>345,417</td>
</tr>
</tbody>
</table>

**Scenario 2 - Electricity Generation by Fuel, GWh**
WITH ONE-MW OF OTEC, WHAT CAN BE ACHIEVED, FOR SUSTAINABILITY?

**Income up to RM15,000/capita for 1000 people**

**Enough Clean Water for 1000 people**

**“Kumejima” & Kona, HI**

**8,000 tonnes CO₂ offset**

**Seaweed, Seafoods etc.**

**Reduced Obesity**

**“The Ocean of Discovery”**

**5000 bbls of oil eq**

**High Quality**

**New, Impactful**

**Improved Income Distribution**

**“Highly Sustainable”**

**Improved Balance**

**Greater Public-Private & Community Partnership**

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

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17 October 2018 UTM BATC
A Bakar Jaafar @UTM Perdana Policy Research Seminar
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
Prof Dato’ Ir Dr A Bakar Jaafar, PEng, FIEM, FASc, KMN, JSM, DPMP
BE (Hons) (Newcastle), MEn (Miami), PhD (Hawaii), Hon. DSc (UMT)

Professor, UTM Perdana School & [1 June 2013-31 May 2019]
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

Mobile: +60 123207201
E-mail: bakar.jaafar@gmail.com