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Feasibility Study on Implementation of Marine Renewable Energy in Malaysia by Considering the Project Costs and Urban Public Acceptance

Field of Study: Water Resources Engineering

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ABSTRACT

Energy demand due to increasing global population and the need for low carbon energy have led to the rising importance of renewable energy. Apart from the three most used renewable energy sources in Malaysia – solar energy, hydroelectric and biomass – marine renewable energy may be another potential player in the renewable energy market. Marine renewable energy, which comprises of tidal energy, wave energy, ocean thermal energy conversion (OTEC) and salinity gradient, can be harnessed in Malaysia as the country is surrounded by abundant water resources. The development of marine renewable energy, however, is currently still in its infancy and may face economical and societal challenges in its implementation. Clean Development Mechanism (CDM) and Feed-in Tariff (FiT) are believed to be the crucial driving forces for the marine renewable energy market as the mechanisms bring monetary profits to the investors. Profits earned through CDM and FiT system are expected to reduce the project cost of marine renewable energy. This study is aimed at examining the feasibility and to push forward the development of marine renewable energy in Malaysia. There are three parts in this study. First, the investigation of the implementation of renewable energy projects in Malaysia which is registered in CDM. Second, the proposal of reasonable FiTs for marine renewable energy. The third part of this study is to gauge the level of public acceptance of marine renewable energy, as it is crucial information to be known prior to the commencement of project. Data collections through literatures and interviews were done to complete the first part. The second part is achieved by proposing appropriate FiT rates for marine renewable energy based on Net Present Value approach, which are then validated by comparing with the implemented FiT in other countries. In the third part, a survey on public acceptance of marine renewable energy was conducted in *SS2, Petaling Jaya* and the data collected was analysed using SPSS. As a result, it is worth noting that 69% of the CDM projects are related to renewable energy. 102 local energy-

related projects were registered under CDM from 2006 to 2012 which bring to more than 7 million tonnes carbon dioxide equivalent (tCO_2e) emission reduction. For the second study, the proposed FiT for marine renewable energy in Malaysia ranged between RM 0.254 and RM 2.610 per kWh depending on the type of marine energy technology used. The proposed tariffs are exceedingly higher than the implemented FiT rates of solar power due to higher project cost. As for the final survey, 82.2% of the respondents express their support for marine renewable energy implementation in Malaysia. However, 56.8% of the respondents are reluctant to pay for green electricity. Implementation of marine renewable energy can become feasible in Malaysia once the project cost is lowered and receive supports from the government.

(462 words)

ABSTRAK

Permintaan tenaga berikutan peningkatan populasi dan keperluan untuk tenaga karbon rendah telah membawa kepada kepentingan tenaga boleh diperbaharui yang semakin meningkat. Selain daripada tiga sumber tenaga boleh diperbaharui yang terbanyak digunakan di Malaysia - tenaga solar, hidro dan biomas - tenaga boleh diperbaharui lautan boleh menjadi satu lagi pemain yang berpotensi dalam pasaran tenaga boleh diperbaharui. Tenaga boleh diperbaharui lautan, yang terdiri daripada tenaga pasang surut, tenaga ombak, penukaran tenaga terma laut dan kecerunan kemasinan, mampu memanfaatkan Malaysia yang dikelilingi oleh sumber air yang banyak. Walau bagaimanapun, pembangunan tenaga boleh diperbaharui lautan masih di peringkat awal dan mungkin menghadapi cabaran ekonomi dan masyarakat dalam pelaksanaannya. *Clean Development Mechanism (CDM)* dan *Feed-in Tariff (FiT)* memainkan peranan yang penting dalam pasaran tenaga boleh diperbaharui lautan kerana mereka membawa keuntungan kewangan kepada pelabur. Keuntungan yang diperolehi melalui *CDM* dan sistem *FiT* dijangka mengurangkan kos projek tenaga boleh diperbaharui lautan. Kajian ini adalah untuk megetahui kemungkinan dan untuk menggerakkan pembangunan tenaga diperbaharui lautan di Malaysia. Terdapat tiga bahagian dalam kajian ini. Pertama, siasatan pelaksanaan projek-projek tenaga boleh diperbaharui di Malaysia yang didaftarkan di *CDM*. Kedua, cadangan *FiT* munasabah untuk tenaga boleh diperbaharui lautan. Bahagian ketiga kajian ini adalah untuk mengukur tahap penerimaan orang ramai terhadap tenaga boleh diperbaharui lautan, kerana ia adalah maklumat penting yang perlu diketahui sebelum permulaan projek. Keseluruhan data melalui kesusasteraan dan temuramah telah dilaksanakan untuk menyiapkan bahagian pertama. Bahagian kedua dicapai dengan mencadangkan kadar FiT tenaga boleh diperbaharui lautan yang munasabah berdasarkan pendekatan Nilai Bersih Semasa, yang

kemudiannya disahkan dengan membandingkan dengan FiT yang telah dilaksanakan di negara-negara lain. Dalam bahagian ketiga, satu kaji selidik telah dijalankan di SS2, Petaling Jaya dan data yang dikumpul telah dianalisis dengan menggunakan *SPSS*. Hasilnya, 69% daripada projek-projek *CDM* berkaitan dengan tenaga. 102 projek tempatan yang berkaitan dengan tenaga telah didaftarkan di bawah *CDM* dari 2006 ke 2012 dan mengurangkan pelepasan karbon melebihi 7 juta tan karbon dioksida bersamaan (tCO_2e). Bagi kajian kedua, *FiT* yang dicadangkan untuk tenaga boleh diperbaharui lautan di Malaysia adalah antara RM0.254 dan RM2.610 setiap *kWh* bergantung kepada jenis teknologi tenaga lautan yang digunakan. Tarif yang dicadangkan adalah sangat tinggi berbanding dengan kadar *FiT* yang dilaksanakan oleh kuasa solar disebabkan oleh kos projek yang lebih tinggi. Bagi kajian yang terakhir, 82.2% daripada responden menyatakan sokongan untuk pelaksanaan tenaga boleh diperbaharui lautan di Malaysia. Walau bagaimanapun, 56.8% daripada responden enggan membayar untuk tenaga elektrik hijau. Pelaksanaan tenaga boleh diperbaharui lautan boleh dilaksanakan di Malaysia dengan menurunkan kos projek dan mendapatkan sokongan daripada kerajaan.

(412 patah perkataan)

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LIST OF SYMBOLS AND ABBREVIATIONS

ABBREVIATION OR SYMBOL	DESCRIPTION
ADB	Asian Development Bank
AIS	Additional Information Sheet
CAPEX	Capital Expenditures
CDM	Clean Development Mechanism
CDMEB	Clean Development Mechanism Executive Board
CERs	Certified Emission Reductions
CO_2	Carbon Dioxide
DCF	Discounted Cash Flow
DLs	Distribution Licensees
DNA	Designated National Authority
DOE	Designated Operational Entity
ERPA	Emission Reduction Purchase Agreement
FIAHS	Feed-in Approval Holders
FiT	Feed-in Tariff
FRIM	Forest Research Institute Malaysia
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GW	Gigawatts
h	hour
IEA	International Energy Agency

IET	International Emissions Trading
JI	Joint Implementation
KeTTHA	*Kementerian Tenaga, Teknologi Hijau dan Air*
KRW	Korean won
ktoe	kilo tonnes of oil equivalent
kW	kilowatt
kWh	kilowatt hour
LCOE	Levelised Cost of Energy
MARDI	Malaysian Agricultural Research and Development Institute
MBPJ	*Majlis Bandaraya Petaling Jaya*
MCQ	Multiple-Choice Questions
MCT	Marine Current Turbine
MOSTI	Ministry of Science, Technology and Innovation
Mtoe	Million tonnes of oil equivalent
MW	Megawatt
NCCDM	National Committee on Clean Development Mechanism
NIMBY	Not in My Backyard
NOD	National Oceanography Directorate
NPV	Net Present Value
NRE	Ministry of Natural Resources and Environment
NSCCC	National Steering Committee on Climate Change
O&M	Operational and Maintenance
OECD	Organisation for Economic Cooperation and Development
OPEX	Operating Expenditures
OTEC	Ocean Thermal Energy Conversion
OWC	Oscillating Water Column

PDD	Project Design Document
PIN	Project Idea Note
PJS	*Petaling Jaya Selatan*
PJU	*Petaling Jaya Utara*
PTM	*Pusat Tenaga Malaysia*
R&D	Research and Development
RM/kWh	*Ringgit Malaysia* per kilowatt hour
ROI	Return of Investment
SCORE	Special Committee on Renewable Energy
SEB	*Sarawak Energy Berhad*
SEDA	Sustainable Energy Development Authority
SESB	*Sabah Electricity Sdn Bhd*
SPSS	Statistical Package for the Social Sciences
SREP	Small Renewable Energy Program
SS	*Sungei Way-Subang*
TCCDM	Technical Committee on Clean Development Mechanism
TJ	Tera-joules
TNB	*Tenaga Nasional Berhad*
TWh	Terawatt-hours
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
W	Watt