TRENDS IN SOUTHEAST ASIA

RENEWABLE ENERGY

Malaysia's Climate Change Solution or Placebo?

Serina Rahman

ISSUE 11
2020

ISEAS YUSOF ISHAK INSTITUTE

TRENDS IN SOUTHEAST ASIA

The **ISEAS – Yusof Ishak Institute** (formerly Institute of Southeast Asian Studies) is an autonomous organization established in 1968. It is a regional centre dedicated to the study of socio-political, security, and economic trends and developments in Southeast Asia and its wider geostrategic and economic environment. The Institute's research programmes are grouped under Regional Economic Studies (RES), Regional Strategic and Political Studies (RSPS), and Regional Social and Cultural Studies (RSCS). The Institute is also home to the ASEAN Studies Centre (ASC), the Temasek History Research Centre (THRC) and the Singapore APEC Study Centre.

ISEAS Publishing, an established academic press, has issued more than 2,000 books and journals. It is the largest scholarly publisher of research about Southeast Asia from within the region. ISEAS Publishing works with many other academic and trade publishers and distributors to disseminate important research and analyses from and about Southeast Asia to the rest of the world.

RENEWABLE ENERGY

Malaysia's Climate Change Solution or Placebo?

Serina Rahman

ISSUE 11
2020

ISEAS YUSOF ISHAK INSTITUTE

Published by: ISEAS Publishing
30 Heng Mui Keng Terrace
Singapore 119614
publish@iseas.edu.sg
http://bookshop.iseas.edu.sg

© 2020 ISEAS – Yusof Ishak Institute, Singapore

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form, or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior permission.

The author is wholly responsible for the views expressed in this book which do not necessarily reflect those of the publisher.

ISEAS Library Cataloguing-in-Publication Data

Name(s): Serina Rahman.
Title: Renewable energy : Malaysia's climate change solution or placebo? / Serina Rahman.
Description: Singapore : ISEAS – Yusof Ishak Institute, July 2020. | Series: Trends in Southeast Asia, ISSN 0219-3213 ; TRS11/20 | Includes bibliographical references.
Identifiers: ISBN 9789814459952 (paperback) | ISBN 9789814881944 (PDF)
Subjects: LCSH: Energy policy—Malaysia. | Renewable energy sources—Malaysia. | Climatic changes—Government policy—Malaysia.
Classification: LCC DS501 I59T no. 11(2020)

Typeset by Superskill Graphics Pte Ltd
Printed in Singapore by Markono Print Media Pte Ltd

FOREWORD

The economic, political, strategic and cultural dynamism in Southeast Asia has gained added relevance in recent years with the spectacular rise of giant economies in East and South Asia. This has drawn greater attention to the region and to the enhanced role it now plays in international relations and global economics.

The sustained effort made by Southeast Asian nations since 1967 towards a peaceful and gradual integration of their economies has had indubitable success, and perhaps as a consequence of this, most of these countries are undergoing deep political and social changes domestically and are constructing innovative solutions to meet new international challenges. Big Power tensions continue to be played out in the neighbourhood despite the tradition of neutrality exercised by the Association of Southeast Asian Nations (ASEAN).

The **Trends in Southeast Asia** series acts as a platform for serious analyses by selected authors who are experts in their fields. It is aimed at encouraging policymakers and scholars to contemplate the diversity and dynamism of this exciting region.

THE EDITORS

Series Chairman:
Choi Shing Kwok

Series Editor:
Ooi Kee Beng

Editorial Committee:
Daljit Singh
Francis E. Hutchinson
Benjamin Loh

Renewable Energy: Malaysia's Climate Change Solution or Placebo?

By Serina Rahman

EXECUTIVE SUMMARY

- Malaysia pledged to reduce greenhouse gas (GHG) emissions by 45 per cent by 2030 in relation to its 2005 GDP figure. The sectors listed as the main focus of this effort included: energy, industrial processes, waste, agriculture, land use, land-use change and forestry (LULUCF). Several initiatives under myriad governments have been launched to reduce Malaysia's climate change impacts; among those has been the emphasis on renewable energy (RE).
- Malaysia's current energy mix relies heavily on coal and natural gas. Long-entrenched subsidies on these energy sources, coupled with greatly depreciating prices make it difficult for new RE producers to enter the market and increase their market share. This is in spite of positive developments in RE infrastructure and reduced RE material costs.
- Solar, biogas, biomass and mini-hydro have been put forward as the RE sources with the most potential, but all have issues of consistency and reliability. Because small energy generators cannot guarantee infallible energy production, they may not be the most viable options for the long term. Their size also denies them the economies of scale that would reduce their costs. Instead, these higher costs may be transferred to the consumer.
- Other issues include the competition for land in the development of large-scale solar farms, including the possible loss of community farmlands and hence livelihoods, if not displacement. A push for biomass and biogas as a source of energy might also lead to increased oil palm production to meet the need for consistent

supplies of oil palm waste. Biogas from municipal landfills is made even more challenging given that Malaysian municipal waste is not sorted at source.

- One possible solution is the use of hybrid RE in rural areas, comprising a mix of micro-hydro, solar and diesel-based energy generation as a back-up. However an immediate win is to ensure energy efficiency and public education to encourage emissions reduction and climate change impacts on the individual consumer.

Renewable Energy: Malaysia's Climate Change Solution or Placebo?

By Serina Rahman[1]

Under the Paris Agreement, Malaysia committed to reducing greenhouse gas (GHG) emissions by 45 per cent by 2030 in relation to its 2005 GDP figure. The target includes a caveat for an unconditional reduction by 35 per cent, and an additional 10 per cent reduction upon receipt of climate financing, technology transfer and capacity building from more developed nations (MITI, 2017).

Malaysia's commitment to climate change began with then Prime Minister Mahathir Mohamad's insistence at the 1992 Rio Earth Summit that poorer nations had already been exploited by developed countries (who were guilty of higher carbon emissions), and should be allowed to continue to develop, albeit sustainably (Varkkey 2019). This was when Malaysia first pledged to keep at least 50 per cent of the country under forest cover. Since then, several initiatives under myriad governments have been launched to reduce Malaysia's climate change impacts.

On the ground in Malaysia, many feel and see the effects of climate change; increasingly frequent and extreme weather ranging from violent storms to extended droughts, changes in the winds and monsoon seasons affecting farmers and fishermen, as well as rising sea levels encroaching on coastal communities. Studies have shown that climate change will have an extensive impact beyond those that are immediately physically visible; reduced crop yields and food insecurity, biodiversity loss and disease, increased flood intensities, coral bleaching, decrease in freshwater availability from seawater encroachment and novel human illnesses (Abdul Rahman 2018; MESTECC 2018).

[1] Serina Rahman is Visiting Fellow with the Malaysia Studies Programme at the ISEAS – Yusof Ishak Institute, Singapore.

However, not everyone necessarily connects the changes in these natural phenomena with climate change. Only 32 to 40 per cent of the general public are aware of climate change and its impacts (Varkkey 2019). This thus hampers the government's efforts to encourage Malaysian citizens and residents to take ownership of climate change issues. While there are several non-governmental organizations (NGOs) and research centres that focus on climate change awareness and action, broad-scale efforts for institutional change to accommodate and mitigate climate change impacts have necessarily been top-down (but not necessarily effective) in nature.

This paper examines some of Malaysia's efforts at climate change mitigation, thereafter focusing on the country's emphasis on renewable energy (RE) as a key tool to reduce GHG emissions and meet its reduction targets.

The first section will provide a brief overview of Malaysian government climate change-related policies through various regimes, then outline a number of its highly publicized initiatives, with an additional focus on renewable energy. Other activities that counter the efforts to mitigate climate change are also quickly examined. Following on from that is a discussion of Malaysia's current energy mix, and RE's contribution to that mix. This section also clarifies the issue of large hydropower dams and their ineligibility as a renewable energy source.

Subsequent sections will discuss the operational obstacles, climatic restrictions and economic constraints that will need to be overcome in order to achieve existing goals. The final section will draw out the realities that hamper the implementation of publicly declared aspirations to appease a "green" public hankering for signs that the country is making an effort to combat climate change, and highlight necessary areas for improvement before those ideals can be achieved.

MALAYSIAN GOVERNMENT POLICIES TO MITIGATE CLIMATE CHANGE

Soon after Mahathir Mohamad's pledge at the 1992 United Nations Conference on the Environment and Development (also known as the Rio Earth Summit), Malaysia put in place various policies to mitigate

Table 1: Significant Malaysian Government Policy Events for Climate Change Mitigation and Renewable Energy

Year	**Policy, Law or Initiative Launch**
July 1994	Ratified United Nations Framework Convention on Climate Change (UNFCCC)
2001	Small Renewable Energy Programme
September 2002	Malaysia ratified the Kyoto Protocol
2004	Feed-in-tariff (FiT) programme introduced
	Malaysia Building Integrated Photovoltaic project (with UNDP Global Environment Facility)
2006	National Biofuel Policy
2007	National Biofuel Industry Act 2007
2009	National Renewable Energy Policy and Action Plan (RE financing)
2010	National Policy on Climate Change
	Central Forest Spine (CFS) and Heart of Borneo (sustainable forest management and use of natural resources)
June 2010	FiT included in Tenth Malaysia Plan
April 2011	Renewable Energy Bill (FiT policy)
	Sustainable Energy Development Authority (SEDA) Bill
November 2015	Intended Nationally Determined Contribution (INDC) submitted to UNFCCC
November 2016	Malaysia ratified the Paris Agreement
September 2018	Announcement of 20% RE target by 2025
March 2019	Renewable Energy Transition Roadmap 2035 (RETR)
April 2019	Supply Agreement for Renewable Energy (SARE)

Source: Author's own collation.

its climate change impacts (Table 1). The table demonstrates that the interest and intention to reduce climate change impacts have long been brewing in Malaysia's halls of power.

In its Intended Nationally Determined Contribution (INDC) commitment to the United Nations Framework Convention on Climate Change (UNFCCC 2015), Malaysia listed the sectors that would have the most focus: energy, industrial processes, waste, agriculture, and land use, land-use change and forestry (LULUCF). According to World Bank figures (2014), Malaysia comes in third after Brunei Darussalam and Singapore in the region for CO_2 emissions per capita. A focus on reducing GHG emissions as an institutionalized, government-led effort across the listed sectors is thus imperative. It was in line with this that there was an increased shift towards developing renewable energy over the years, and much publicity surrounding that emphasis under the leadership of former Minister Yeo Bee Yin when the Pakatan Harapan (PH) government was momentarily in power.

Defined as an energy source that is derived from natural processes and that is replenished faster than it is consumed, the development of renewable energy in Malaysia was in response to a recognition of the damaging impacts of fossil fuels, the need to improve local energy security and future scenarios of depleting local resources. However, initiatives for renewable energy began long before PH came into power.

GOVERNMENT POLICIES AND PLANS FOR RENEWABLE ENERGY

In 2009, under Barisan Nasional (BN) and the leadership of then Prime Minister Abdullah Badawi, the Ministry of Energy, Green Technology and Water (KeTTHA 2008) launched the National Renewable Energy Policy and Action Plan (NREPAP), which led to the establishment of the Sustainable Energy Development Authority (SEDA) in 2011. A number of other programmes also laid the groundwork for initial efforts at bringing renewal energy into Malaysia; including the Small Renewable Energy Programme (2001), the Malaysia Building Integrated Photovoltaic project (2004), and the Feed-in-Tariff (FiT) (2011). It was under the Najib Razak administration that Malaysia committed to the

2015 Paris Agreement and pledged to reduce greenhouse gas (GHG) emissions intensity to GDP by 45 per cent by 2030 (relative to 2005 figures).

However, more than a decade since the NREPAP, RE generation in Malaysia is barely at 2 per cent, with most of it coming from solar Photovotaic (PV) generation (Wan Abdullah et al. 2019). In her truncated stint as the Minister of Energy, Science, Technology, Environment and Climate Change (MESTECC) under the recent PH government, Minister Yeo had lofty goals for the nation's RE generation, aiming for 20 per cent RE production by 2025.[2] In line with this target, a Renewable Energy Transition Roadmap 2035 (RETR) was announced by SEDA; with a view to balancing environmental targets, affordability, economic benefits and system stability. Shortly after, the Supply Agreement for Renewable Energy (SARE) programme was announced, an initiative enabling consumers to lease and install solar panels at no upfront cost, making RE accessible and achievable for the general public (Suruhanjaya Tenaga 2019a).

Under the Pakatan Harapan government, renewable energy and efforts to tackle climate change were a central pillar in MESTECC's initiatives. Even as she spoke of her 20 per cent RE generation goal, Minister Yeo acknowledged that Malaysia would need RM33 billion worth of investments to realize the target. In order to generate that investment, Minister Yeo was looking towards public-private partnerships and private financing, incentivized by a green financing roadmap, a green tariff and the Malaysian Green Attribute Tracking System (MGATS) (Sim 2019).

SEDA, in collaboration with industry stakeholders, then produced a Renewable Energy Transition Roadmap (RETR) 2035 to balance environmental targets, affordability, economic benefits and system stability (Suruhanjaya Tenaga 2019b). Petronas, together with other members of the Oil, Gas, Energy and Environment (OGEE) sector and the Economic Planning Unit (EPU) published a White Paper on Malaysia's

[2] Current RE generation stands at 2 per cent. The goal hinges on expansion in solar power, see Eusoff (2018).

future energy landscape. Among other points, the White Paper outlined the need to establish a neutral entity to drive and coordinate energy policies, especially to create an overall Energy Policy for long-term planning. It also recommended the amendment of the Malaysian Power Market, so as to increase transparency, liberalizing energy generation and retailing, as well as to set up the Malaysia Energy Research Consortium (MERC) so as to drive energy solution innovation, collaboration and upskill local talents. The outcome of all these initiatives were to be incorporated into the 12th Malaysia Plan 2021–25, but with the recent and sudden change of government, and other widespread and unexpected challenges as a result of the COVID-19 pandemic, it remains to be seen how far these initiatives will be able to progress.

OTHER INITIATIVES FOR AND AGAINST CLIMATE CHANGE MITIGATION

Running concurrently with these top-down efforts, were more ground-up initiatives to evolve urban centres into low-carbon cities in collaboration with the United Nations Development Project (UNDP 2019). This programme acknowledged the contribution of densely populated urban areas to GHG emissions (said to make up about 80 per cent of total emissions). As part of a global network of low-carbon cities, five participating Malaysian cities began work on integrated planning for climate action, seeking support for city-level climate financing instruments and focusing on integrated urban energy, building, transport and waste systems. These efforts at the municipal level demonstrate a common interest in combatting climate change where it has the most impact, and takes into account the principles of Local Agenda 21 that was also launched at the 1992 Rio Earth Summit.

Given the lack of public awareness and understanding of climate change and its impacts on everyone's everyday lives, more effort was also put into climate change education. One successful example of a broad statewide approach to low carbon environmental education is in Johor, where the United Nations Regional Centre of Excellence (UN RCE) Iskandar project enhances the state's primary and secondary school syllabus to incorporate issues of low-carbon and ecology. Both

these matters have been incorporated into all components of the syllabus, ensuring that environmental concern and understanding underlies all parts of a child's education. The UN RCE Iskandar, supported by the Iskandar Regional Development Authority (IRDA), has numerous programmes to ensure all Johor schools and students' active participation and action in low carbon initiatives. The programme has also since been expanded to encourage efforts by local councils across Iskandar Malaysia (*Star Online*, 31 October 2018).

While these positive initiatives were in place, there were also other developments that ran counter to the concept of climate change prevention. Malaysia is a leading producer of palm oil, and the oil palm industry accounts for 2.8 per cent of total GDP (about RM38 billion in 2018),[3] supporting rural economies and livelihoods, as well as large local and international oil palm plantations, millers and organizations. Malaysia's emphasis on oil palm, and the conversion of peat and forest land to oil palm plantations result in the release of GHGs into the atmosphere. This falls under the LULUCF sector that Malaysia committed to focusing on under its INDC to the UNFCCC.

While announcements were made on a moratorium on oil palm-related deforestation to 6 million hectares, existing rates of forest loss and minimal enforcement makes it questionable as to whether this ruling will have any impact (Mongabay, 28 November 2019). While some studies indicate that oil palm plantations contribute to carbon sequestration, resulting in a net carbon sink (because of CO_2 removal from the atmosphere),[4] many others note the damaging effects of peat swamp draining and destruction from agriculture, especially of oil palm, requiring substantial restoration and regeneration. Several government-led local and international initiatives to promote the use of the much-maligned resource so as to maintain and grow its contribution to the economy is also deemed to offset efforts at climate change mitigation.

[3] This accounts for about 38 per cent of agricultural GDP (2018). Refer to Hirschmann (2020).

[4] Refer to Yew (n.d.); Lamade and Bouillet (2005); and Nik Daud et al. (2019).

Coastal development that destroys natural habitats such as seagrass meadows and mangrove forests also run counter to climate change mitigation efforts as these habitats are also known to naturally sequester carbon, and to far greater quantities than terrestrial forests (Huxham et al. 2018; Khan 2018). Much-publicized coastal replanting efforts are often only mildly successful, with the more successful projects carried out based on extensive research and at extremely high cost (Lewis III 2001; Paling et al 2019).

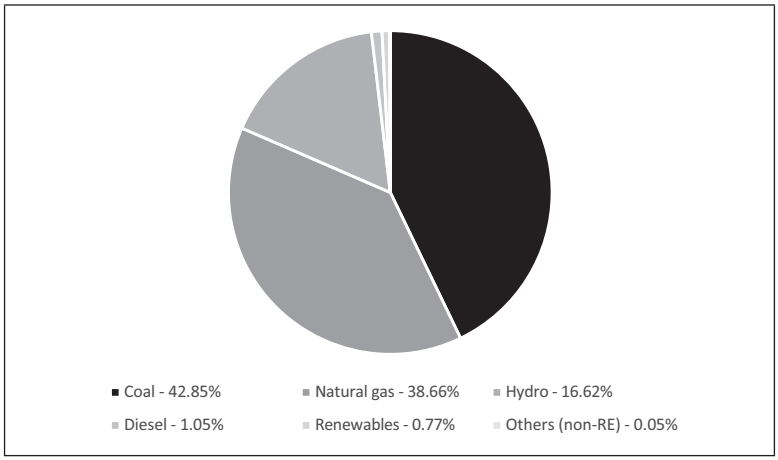
The above examples illustrate that there is often a mismatch between initiatives that work to counter climate change, and those that focus solely on infrastructural development and economic progress. Part of the dilemma lies in the long-held view of natural resources at ministerial, municipal and community levels—that they are assets to be extracted and exploited for economic gain versus being common goods that needs to be sustainably used to ensure their availability for future generations. Renewable energy lends itself to the latter approach.

MALAYSIA'S CURRENT ENERGY MIX

Natural gas and coal sources make up more than 80 per cent of local energy production, with large hydropower dams generating just over 16 per cent (Figure 1). Renewable energy sources (not including large hydro) add up to only 0.77 per cent. Not only are coal and natural gas non-renewable and finite resources, but their use contributes to increased greenhouse gas emissions (GHGs).

Figure 1 clearly demonstrates Malaysia's dependence on coal and natural gas sources for electricity generation, possibly hampering efforts to reduce GHG emissions as per the Paris Agreement commitment. While Malaysia has vast coal reserves (largely in Sarawak and Sabah), 90 per cent of the coal used to meet demand is imported because of the high costs of coal extraction—especially in rural East Malaysia where there is limited infrastructure (Foo 2015). In spite of the need to import coal, it remains the cheapest fossil fuel source available (Wan Abdullah et al. 2019). On the other hand, Malaysia has the largest natural gas reserve in Southeast Asia, the twelfth largest in the world, and extensive natural

Figure 1: Electricity Generation by Energy Source



Source: Adapted from information provided by Malaysia's Energy Commission. "Renewables" comprise biomass, solar, biogas and mini-hydro.

gas pipelines across the country. Malaysia has vast hydropower resource potential because of its many rivers, but large hydropower dams require large capital investments and have myriad social, environmental and other impacts on its surroundings. The damage that these dams inflict outweigh their benefits, hence they cannot be included in an examination of renewable energy (Weiser 2016; Gibson et al. 2017; Ansar et al. 2014).

MALAYSIA'S PLANS FOR RENEWABLE ENERGY

The Sustainable Energy Development Authority (SEDA) was established under the Energy Development Authority Act 2011 (Act 726), mainly to manage the implementation of the feed-in tariff (FiT) mechanism for renewable energy (Joshi 2018). Its function was thus not necessarily to lead the development of renewable energy, but it was meant to gather data, conduct advocacy and evaluate RE generation application and

equipment. It was not designated as an RE research entity. This thus hampered its ability to drive the establishment and spread of renewable energy in Malaysia.

On top of that, with Malaysia's existing focus on coal and natural gas electricity generation, the nation was already running on vast subsidies provided for conventional electricity generation. Current electricity prices are reflected by the price of coal and natural gas, but the cost of producing RE is higher than fossil fuels because of the materials and infrastructure required (Suruhanjaya Tenaga 2019c). These costs are then transferred to the consumer, and competes directly with highly subsidized conventional energy options. Energy expert Rachel Hoo notes that, "Although today the Levelized Cost of Energy (LCOE) of solar energy has fallen below that of fossil energy like coal, heavily subsidized fossil energy in the country disables the competitiveness of solar energy in the absence of incentives like FiT."[5]

Conventional energy production also benefits from vast economies of scale as many RE generators are small-scale businesses testing the market as a result of government incentives—but with little hope of long-term sustainability (Sovacool and Drupady 2011). Long negotiation periods before agreements and difficulties in securing finance add to the problems faced by these small companies (Petinrin and Shaaban 2015).

RE Feed-in-Tariffs were created to catalyse renewable energy developments; RE project owners were to earn monetary incentives through the sale of electricity generated to the main power utility providers.[6] FiT rates differ depending on the power utility authorities. RE project type and size serves as an agreement of electricity purchase between producer and utility authority; some rates change on an annual basis. SEDA's task was to oversee the calculation of these rates. Policymakers determined rates based on the installed capacity of

[5] Rachel Hoo, Research Fellow, Energy Studies Institute, National University of Singapore: personal communication, 6 April 2020.

[6] These refer to: Tenaga Nasional Berhad (TNB) in Peninsular Malaysia, Sabah Electricity Sdn Bhd (SESB) in Sabah and Northern Utility Resources Sdn Bhd (NUR) in Sarawak.

the RE generator, reflecting avoided costs of conventionally produced electricity. Projects that require high-tech costs usually have higher FiT rates to attract innovation and project commencement; smaller generators usually receive more assistance while larger power plants earn lower FiTs due to economies-of-scale benefits gained in production (Lim, Lam, and Hashim 2015).

EXISTING RENEWABLE ENERGY INITIATIVES

The main focus of current RE initiatives in Malaysia to date is solar PV energy. Peninsular Malaysia's energy authority, Tenaga Nasional Berhad (TNB), a government-linked company, has set up a subsidiary, TNB Renewables Sdn Bhd (Tre) which drives large-scale solar (LSS) projects (projects larger than 30 MW), and smaller-scale RE projects (less than 30 MW) comprising biomass and biogas, retail rooftop solar self-generation, Battery Energy Storage Systems (BESSs), and Microgrids and Virtual Power Plants (VPPs). Tre is at any one time an investment company, asset owner and RE project catalyst so as to achieve the 20 per cent 2025 target.

Table 2 lists the existing RE generation approaches in use and their respective benefits.[7] Large hydropower dams, although initially included in Malaysia's RE generation output calculations due to its natural sources and quick replenishment rates (Joshi 2018) are now no longer considered part of RE because of its high environmental impacts (from surrounding area habitat damage, biodiversity loss, erosion and flooding) as well as its multiple social impacts (arising from forced displacement of local communities, loss of sacred lands etc). The hydropower dam developer would also face financial difficulties in the form of high initial capital outlay, periodic (at times frequent) insufficient water capacity for target energy generation, sedimentation affecting machine performance, construction cost overrun due to unexpected earthworks and resettlement issues and compensation claims by local and indigenous communities.

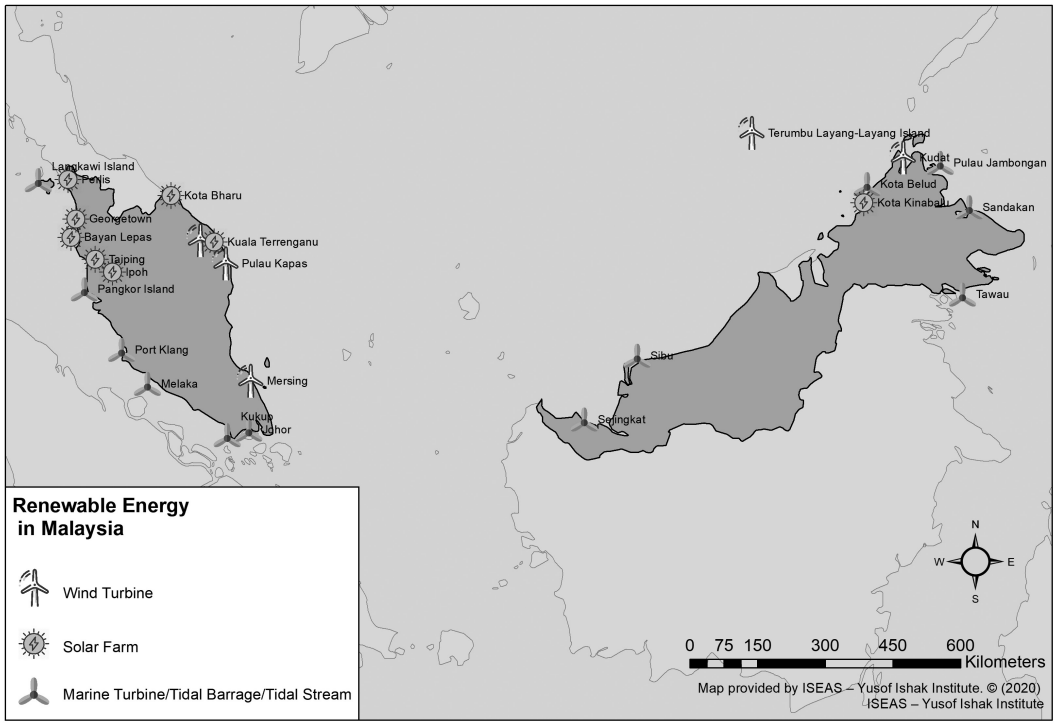
[7] Adapted from Wan Abdullah et al. (2019).

Table 2: Current and Potential RE Generation in Malaysia

RE generation source	Details	Benefits
Solar	Highest potential for uptake because of Malaysia's location at the equator, with expectations of hot and sunny weather all year round: monthly solar irradiation estimated at 400–600MJ.	Rooftop solar programme makes RE accessible to the general public.
Wind	Offshore wind power is yet untapped especially in the South China Sea during the November-to-February monsoon season.	Rural areas such as Mersing (Johor), Kuala Terengganu and Kudat (Sabah) stand to benefit from this RE source
Biogas	Processes organic waste into biogas to generate energy through anaerobic digestion processes. Can generate heat for steam production and power (co-generation) and biomethane.	Reduces organic municipal waste (including human waste or sludge), food waste, sewage and palm oil mill effluent while reducing fossil fuel use. Reduces GHG emissions as captured methane and carbon dioxide would otherwise be released into the atmosphere.
Biomass	Uses palm oil waste, rice husks, coconut and sugar cane wastes, municipal wastes and forestry wastes for co-firing in conventional power plants.	Materials are widely available, reduces reliance on fossil fuels and reduces generated waste. Also improves energy security because of local sources (as coal is imported)
Mini-hydro	Smaller than 30MW energy generation that works because of Malaysia's high temperature, humidity and rainfall volume. Many mini-hydro plants would have less impacts on rural environments than a large hydropower dam.	Cleanest energy form; GHG emissions are lower than large-scale hydro and is supported by FiT. Especially useful for rural interior areas.

Source: Author's own compilation.

Figure 2: Map of Selected Renewable Energy Locations in Malaysia



Even as existing RE energy sources are barely reaching desired targets, some administrators and researchers are encouraging exploration into other sources of energy such as marine RE through tidal barrages or marine turbines, as well as geothermal energy (Lim, Lam, and Hashim 2015; Joshi 2018). However, these sources are still in early stages of research and are not yet commercially viable. The map in Figure 2 however, illustrates possible locations of large-scale solar farms (based on reported irradiation levels of more than 1,700 KWh p/m^2), marine RE (both tidal barrages and marine turbines) as well as wind turbines.[8]

ISSUES TO OVERCOME

While RE is undoubtedly the way forward in terms of reducing reliance on fossil fuels and GHG emissions from the use of coal, there are significant obstacles in the way of the existing 20 per cent target.

Institutional and Structural Limitations

While there have been many policies in place in support of renewal energy generation, efforts have at best been ad hoc. While MESTECC's push for renewable energy was an impressive initiative, much of it remained at the public announcement stages and it is unclear how much of the policy declarations were translated into real action on the ground before Pakatan Harapan's premature removal from government. While Minister Yeo declared that there is now increased transparency on the issue of energy licences and projects, there are still substantial barriers in the form of FiT quotas, insufficient investment and funding and onerous feasibility and other requirements stipulated by energy authorities.

Overwhelming support for conventional energy sources in the form of incentives, subsidies and tax reductions also do not encourage a transition to renewable energy which conversely suffers from unattractive tariffs, utilities and poor economic efficiency (Foo 2015). There is also a severe lack of capabilities in renewable energy, and no place for capacity-

[8] The locations highlighted were collated from the following sources: Foo (2015); Wan Abdullah et al. (2019); Borhanazad et al. (2013); and Koh and Lim (2010).

building, useful and impactful research, training and quality assurance. Many of these infrastructural needs seem to be offloaded to the RE project proponent and are not borne by the government or its agencies (Sovacool and Drupady 2011).

Political stability and political will are key factors that will determine the success of Malaysia's climate change mitigation efforts. Both are now lacking with the new Perikatan Nasional government still battling for legitimacy. Since it took over the reins of power, environmental concerns were (rightfully) set aside for the more pressing need to respond to the COVID-19 pandemic. Apart from an initial commitment by the new Minister of the Environment, Tuan Ibrahim Tuan Man to continue many of the good initiatives that began under MESTECC, specifically mentioning climate change (but not RE) (*Malay Mail*, 11 March 2020), and an announcement on Earth Day on several initiatives to combat climate change (webinars, climate change discussions, poster competitions, nature talks and film screenings) (*New Straits Times*, 22 April 2020), there has been little concrete or effective action towards climate change mitigation, let alone renewable energy.

With changes to environment-related ministries, agencies and departments have to once again be realigned and reassigned. There is now an Energy and Environment Ministry (KATS), but under "energy" on its web page,[9] it only mentions water, land, biodiversity, mining, geoscience, geospatial and the KATS eco-park.

Limitations to Solar Energy

While solar energy is currently the favoured RE source, because it is deemed an infinite source, unseen costs abound. Large-scale solar projects in rural areas may result in the conversion of farmland, the uprooting of rural communities and destruction of traditional livelihoods (*Star Online*, 11 September 2019). The resultant increase in land prices and land grabbing will have an impact on farmers and indigenous

[9] Ministry of Energy and Natural Resources, Malaysia, http://www.kats.gov.my/en-my/energy/Pages/default.aspx (accessed 15 March 2020).

communities, and stands to lead to the destruction of primary forests in the name of "sustainable" energy.[10]

Beyond the competition for land between solar energy and agriculture, there is a difference between Malaysia's climate and that of the deserts of the US where most solar research is conducted.[11] Minister Yeo conceded that solar energy has its limitations in that it is intermittent and may be insufficient to ensure energy consistency at night (Petinrin and Shaaban 2015). In rural areas, the cost of solar is very high; 5 to 11 times more expensive than coal, hydro or nuclear energy. There is also the added cost and difficulty of bringing the panels into the deep interior.

Added to that is the problem of shortened lifespans in tropical climates where rain and cloudy days render solar energy unfavourable for at least 2 months in a year when battery banks run out of charge much faster (Borhanazad et al. 2013). Although new innovations have reduced its costs, the production of solar panels remains a pricey process that requires semiconductor materials and a "clean" environment on a life-cycle basis; thereby making it difficult for the industry to take up production. There is also the issue of disposal of expired solar panels. Researchers are now grappling with the problem of highly toxic solar panel waste; lead and carcinogenic cadmium can be washed out of solar modules by rainwater, making it highly complicated to dispose of them (Shellenberger 2018).

For solar energy (or any other form of RE) to be stored, batteries are required. The rare mineral materials needed to produce these batteries are extracted from terrestrial mines (largely in poor developing countries) through processes that require large amounts of freshwater usage that result in polluted rivers in already arid regions. Some of these mining facilities depend on child labour for their production. Future sources of the minerals needed for these batteries are expected to come from the deep sea. Deep sea mining also has myriad hazards tied to it. "Clean" renewable energy actually has very dirty sources (Dickinson 2019; Major 2017).

---

[10] Personal communication with energy expert from a Malaysian energy authority (name withheld) on 21 September 2019.

[11] Ibid.

Limitations to Biogas Use

Biogas seems to be a good way to both reduce waste and create energy, but the main issue faced in this energy source is unstable supplies, leading to energy instability. While the government has set a goal to divert 40 per cent of food waste from the landfill to energy generation, municipal and food wastes are not sorted at source, making this operation very difficult; there are no policies or efforts at the implementation of proper waste management. The location of biogas plants are often far away from city centres where the most waste is generated, thus reducing project viability unless the gas produced is for onsite consumption (Wan Abdullah et al. 2019). A biogas production plant connected to a palm oil mill or landfill is only financially feasible when located within 10 km from the electricity grid (Koh and Lim 2010). While biogas can be used for engine or turbine fuel, including vehicle fuel, a higher purity is required, especially if the gas is to be injected into the national gas grid. This means that a higher cost will be incurred to improve refining processes. Vehicle gas tanks and gas-filling stations will also need to be modified for its use (Hoo et al. 2017; Hoo 2019).

Human waste or sludge has also been put forward as a possible biogas source. Pyrolysis, which uses fire to generate methane from the feedstock is an energy-generation process that needs to be done properly to ensure that no health issues arise from the use of human waste. Because the energy content in human waste is based on individual diets, the energy generated from it being processed is also irregular, depending on caloric content. Furthermore, there are possible feedstock inconsistencies due, for example, to many people being away for the holiday season.[12]

Limitations to Biomass Use

Biomass, the use of agricultural waste for energy generation, is deemed a renewable source because resources used can be replanted. While biomass can be used in conventional power plants for co-firing, it can damage machinery by causing corrosion on boilers, reducing their

[12] Personal communication with energy expert from a Malaysian energy authority (name withheld) on 21 September 2019.

efficiency and generating fly ash (Wan Abdullah et al. 2019). Its biggest drawback, however, is the uncertainty in the quantity and quality of fuel source from mills. There is also a lot of competition for the use of the waste (such as for fibreboard, pulp and paper, mulching and fertilizer). The high cost of energy generation relative to conventional energy may dissuade millers from redirecting their waste to energy production (Petrinin and Shaaban, 2015).

The question that needs to be answered is how many plantation hectares are needed to ensure consistent electricity generation? Will this then lead to further deforestation? Studies in Sabah indicate that biomass energy production plants breakeven in 12 years; longer than the 9 year period required for a coal plant. Higher capital costs and the decreasing cost of coal (even though RE plants have lower running costs), make it seem less viable for small RE investors (Koh and Lim 2010). The removal of biomass from palm oil plantations as value-added resources has been used as a solution for forest fires in Indonesia, but there is a need to ensure overall sustainability instead of mere economic benefit by factoring in emissions that result from biomass transportation and processing (Tan et al. 2017).

Limitations to Wind Energy

While wind power has some potential in a few locations around Malaysia, it is seasonal, meaning total dependence on this energy source would result in energy instability. Global warming has also effected wind speeds and regularity (Tan 2016). It also requires a large capital investment. On top of that, wind energy is not yet part of the FiT scheme, meaning that there is no guarantee of purchase of energy generated by the energy authorities. Given that good wind sites tend to be in rural areas, additional investment will be required to connect the source to the energy grid. Not unlike solar panels, fibreglass wind turbine blades are very large and extremely hard to dispose of in an environmentally friendly way when they reach their 25 year limits (Belton 2020).

This is not yet a problem that Malaysia needs to face, but even maintenance and repairs of existing wind turbines (such as the one in Perhentian and Langkawi Islands) have proven to be a problem due to a

lack of spare parts and technical skills; the turbines stand as monuments to their failure today (Sovacool and Drupady 2011). Studies in Tawau, Sabah have shown that a total land area of 5182 km^2 is required to install enough wind turbines to generate 2,740 MW of electricity. This is 6.8 per cent of Sabah's total land area, and will be hard to carve out solely for RE given other far more profitable uses for the land (Koh and Lim 2010). Wind turbines also pose a noise and aesthetic pollution problem, and are a hazard to birds (Muhiudeen 2017).

THE WAY FORWARD

How then can Malaysia move towards attaining its lofty renewable energy goals and fulfil the INDC commitments submitted to the UNFCCC? The ideal of course is to attain RE levels similar to that of Germany, which in April 2020 reported its first quarter with more than 50 per cent RE production (Waldholz 2020). But Germany has had a long journey of moving from fossil fuels to renewable energy, including the shutting down of all nuclear power plants in 2019 and plans to close all coal power plants by 2038 (*Al Jazeera*, 16 January 2020). Even then, it has only set a goal of 18 per cent RE production of total energy consumption by the end of 2020. Given that Malaysia is still at its infancy in implementing RE plans, Yeo Bee Yin's 2025 RE goal and the UNFCCC pledge to reduce emissions by 2030 seem rather ambitious.

Political stability and political will are clearly necessary to push through policies and institutionalize laws to ensure effective progress towards clean energy goals regardless of the regime in power. Varkkey (2019) pointed out that Malaysia's renewed INDC commitments in 2018 did not actually meet the recommended 1.5°C limit, instead opting to set its goals at a 2°C limit. This in itself indicates a lack of political will to take the difficult steps to limit economic targets to preserve the environment. With the ministries under the current PN government devoid of specific mention of climate change and announcements avoiding declarations on renewable energy, Malaysia's political will to do what is necessary to mitigate climate change may now be far weaker.

Aside from the politics behind policy and decision-making, there is a new obstacle in the form of the COVID-19 pandemic. Not only did the

new PN government have to focus its attention on containing it, there is now a need to quickly boost the economy so that the country can recover from more than two-and-a-half months of near-total lockdown. While there were myriad anecdotal reports of signs of environmental recovery due to movement control restrictions, the push to open businesses and restart factories could easily obliterate environmental progresses made. Analysts have also pointed out that the ease and lower cost of coal-sourced energy would make it an easy fall-back in the haste to reboot production, the national economy and foreign investment (Brock 2020).

Concrete steps to produce an overarching Energy Plan that cohesively synthesizes all targets and needs, including making the necessary adjustments to the current energy market for a more even playing field need to be taken. Perhaps the existing energy authorities could each develop their own renewable energy wings as TNB has, with a focus on supporting, elevating and capacity-building local RE small-scale RE providers and innovations.

The easing of coal subsidies and adding more RE options to the FiT portfolio may also incentivize RE providers and pave the way for more equitable access to the energy market. Ideally, corruption needs to be urgently eradicated to ensure that energy projects are awarded to the best possible service provider, and not to those with the best connections. Policies should be consolidated to ensure more effective waste and agricultural management that can then feed into renewable energy generation policies.

In the medium term, the focus can be on hybrid RE feeding into micro-grids as the best solution to rural electrification problems. These enable small-scale efforts that are able to reach rural interiors with minimal damage to natural habitats and a view to only enabling access to communities, not displacement and land-grabbing. This approach is especially useful in areas with poor infrastructure or are too far from the national grid.[13]

[13] This method is currently being implemented in India: Suruhanjaya Tenaga "Powering up with Microgrids", *Energy Malaysia* 18 (2019): 5.

Hybrid RE projects would combine the installation of micro-hydro facilities together with small-scale solar installations, with appropriate training of local communities for repairs and maintenance. These RE efforts can still be supported with a back-up of coal or diesel reliant energy generation as a last option should both sun and rain fail to generate sufficient energy. Innovations in combining RE tools[14] approaches may be possible should SEDA or other research institutes be given financial and manpower support to focus on research and development.

Micro-hydro energy generation is best suited to rural areas where it is impractical to connect to the main grid, or to contribute to it. However, it is ideal for supporting just the surrounding area. The downside to this is that should development invade a rural location, the first natural resource that is affected are rivers; they are made into drains. This then would lead to the loss of local micro-hydro potential.

One immediate low-hanging fruit that can be quickly attained is to ensure energy efficiency. This can be achieved through the promotion of energy-efficient appliances (now indicated by large energy consumption labels at point-of-sale), and public education to reduce energy use and increase understanding of GHG emissions, climate change and their impacts on the individual consumer.

Improving energy efficiency not only reduces costs to the consumer and demand for energy production, but it also prevents energy leakage from not-so-efficient transmission and distribution. Assigning electrical energy managers in large organizations and energy production units can help to tackle this problem (Oh et al. 2018). A single percentage of reduction in energy loss can result in savings of RM300 million, which can then be reflected in lower costs to consumers (Suruhanjaya Tenaga 2019c).

While the future of Malaysian governance and economic recovery post COVID-19 remains uncertain, the future of energy generation, sources and use must move forward towards genuine sustainability. If it does not, any government in power will suffer the consequences of higher

[14] One example of this combination of RE methods can be found in Snowden (2020).

costs of electricity in terms of both environmental and health impacts, if not its financial implications and weak energy security. It also needs to be reiterated that this is merely one part of the puzzle when it comes to climate change mitigation; all efforts in all sectors listed in the INDC commitments needs to be implemented in tandem in order for Malaysia to truly meet its GHG emissions reduction goals.

Perhaps a more realistic timeline to transition to RE is needed, or the voice of the people from the ground may have to exert its influence on a government just barely holding on to power. But even that is based on the assumption that the general public, decision-makers and politicians have a clear understanding of climate change and its direct impacts on Malaysia and Malaysians. There is much to be done at all levels, especially concrete efforts that have more effective outcomes than mere media posturing.

REFERENCES

Abdul Rahman, H. 2018. "Climate Change Scenarios in Malaysia: Engaging the Public". *International Journal of Malay-Nusantara Studies* 1, no. 2: 55–77.

Al Jazeera. 2020. "Cleaning Up: Germany Reaches Deal to Shut Down All Coal Plants". 16 January 2020. https://www.aljazeera.com/ajimpact/cleaning-germany-reaches-deal-shut-coal-plants-200116080124654.html (accessed 30 May 2020).

Ansar, A., B. Flyvbjerg, A. Budzier, and D. Lunn. 2014. "Should We Build More Large Dams? The Actual Costs of Hydropower Megaproject Development". *Energy Policy* 69: 43–56.

Belton, P. 2020. "What Happens to All the Old Wind Turbines?". *BBC News*. https://www.bbc.com/news/business-51325101 (accessed 15 February 2020).

Borhanazad, H., S. Mekhilef, R. Saidur, and G. Boroumandjazi. 2013. "Potential Application of Renewable Energy for Rural Electrification in Malaysia". *Renewable Energy* 59: 210–19.

Brock, J. 2020. "Asia's Pandemic Stimulus May Slow the Demise of Coal". *Reuters*, 12 May 2020. https://www.reuters.com/article/us-health-coronavirus-asia-coal-analysis/asias-pandemic-stimulus-may-slow-the-demise-of-coal-idUSKBN22O0KY (accessed 30 May 2020).

Dickinson, L. 2019. "Clean Energy Requires Rare Metals. Should we Mine the Ocean Floor to get them?". *Grist,* 25 June 2019. https://grist.org/article/clean-energy-requires-rare-metals-should-we-mine-the-ocean-floor-to-get-them/ (accessed 1 May 2020).

Eusoff, N.S. 2018. "Malaysia Sets New Goal of 20% Clean Energy Generation by 2030". *The Edge Markets,* 18 September 2018. https://www.theedgemarkets.com/article/malaysia-sets-new-goal-18-clean-energy-generation-2030 (accessed 1 December 2019).

Foo, K.Y. 2015. "A Vision on the Opportunities, Policies and Coping Strategies for the Energy Security and Green Energy Development in Malaysia". *Renewable and Sustainable Energy Reviews* 51: 1477–98.

Gibson, L., E.N. Wilman, and W.F. Laurance. 2017. "How Green is 'Green' Energy?". *Trends in Ecology and Evolution* 32, no. 12: 922–35.

Hirschmann, R. 2020. "GDP from the Palm Oil Industry in Malaysia 2011–2018". *Statista,* 27 May 2020. www.statista.com/statistics/952715/malaysia-gdp-from-palm-oil-industry/ (accessed 30 May 2020).

Hoo, R. 2019. "Biogas as a Sustainable Energy Solution for Southeast Asia". *Business Times*, 29 October 2019. https://www.businesstimes.com.sg/asean-business/biogas-as-a-sustainable-energy-solution-for-southeast-asia (accessed 28 November 2019).

Hoo, P.Y., H. Hashim, W.S. Ho, and S.T. Tan. 2017. "Successful Biogas Implementation: A Mini-Review On Biogas Utilization, Energy Policies And Economic Incentives". *Chemical Engineering Transactions* 61: 1495–100.

Huxham, M., D. Whitlock, M. Githaiga, and A. Dencer-Brown. 2018. "Carbon in the Coastal Seascape: How Interactions between Mangrove Forests, Seagrass Meadows and Tidal Marshes Influence Carbon Storage". *Current Forestry Reports* 4: 101–10.

Joshi, D. 2018. “Evaluating the Performance of the Sustainable Energy Development Authority (SEDA) and Renewable Energy Policy in Malaysia”. Penang Institute. https://penanginstitute.org/wp-content/uploads/2018/06/Evaluating-the-Performance-of-SEDA-and-RE-Policy-in-Malaysia_PI_Darshan_5-June-2018.pdf (accessed 10 December 2019).

Kementerian Tenaga, Teknologi Hijau dan Air (KeTTHA). 2008. *National Renewable Energy Policy & Action Plan*. Putrajaya: Government of Malaysia.

Khan, J. 2018. “Threatened Blue Carbon Ecosystems Store Carbon 40 Times Faster Than Forests”. *ABC Science*, 26 March 2018. https://www.abc.net.au/news/science/2018-03-26/blue-carbon-mangroves-seagrass-fight-climate-change/9564096 (accessed 1 May 2020).

Koh, S.L. and Y.S. Lim. 2010. “Meeting Energy Demand in a Developing Economy Without Damaging the Environment: A Case Study in Sabah, Malaysia, from Technical, Environmental and Economic Perspectives”. *Energy Policy* 38: 4719–28.

Lamade, E., and J.P. Bouillet. 2005. “Carbon Storage and Global Change the Role of Oil Palm”. *OCL* 12, no. 2: 154–60.

Lewis III, R.R. 2001. “Mangrove Restoration: Costs and Benefits of Successful Ecological Restoration”. *Proceedings of the Mangrove Valuation Workshop*, Universiti Sains Malaysia Penang, 8 April 2001. Beijer International Institute of Ecological Economics, Stockholm, Sweden. http://www.fao.org/forestry/10560-0fe87b898806287615fceb95a76f613cf.pdf (accessed 1 May 2020).

Lim, X.L., W.H. Lam, and R. Hashim. 2015. “Feasibility of Marine Renewable Energy to the Feed-in-Tariff System in Malaysia”. *Renewable and Sustainable Energy Reviews* 49: 708–19.

Major, J. 2017. “Deep Sea Mining Could Help Develop Mass Solar Energy: Is It Worth the Risk?”. *The Conversation,* 24 April 2017. https://theconversation.com/deep-sea-mining-could-help-develop-mass-solar-energy-is-it-worth-the-risk-76500 (accessed 1 May 2020).

Malay Mail. 2020. “Good Environmental Policies Will Be Continued, Says Tuan Ibrahim”. 11 March 2020. https://www.malaymail.com/

news/malaysia/2020/03/11/good-environmental-policies-will-be-continued-says-tuan-ibrahim/1845532 (accessed 15 March 2020).

Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC). 2018. *Malaysia: Third National Communication and Second Biennial Update Report to the UNFCCC.* https://unfccc.int/sites/default/files/resource/Malaysia%20NC3%20BUR2_final%20high%20res.pdf (accessed 1 May 2020).

Ministry of International Trade and Industry (MITI). 2017. "Malaysia and the United Nations Framework Convention on Climate Change (UNFCCC): The Paris Agreement". https://www.miti.gov.my/miti/resources/Article_on_Malaysia_UNFCCC-_Paris_Agreement.pdf?mid=572 (accessed 1 May 2020).

Mongabay. 2019. "Indigenous Communities, National Parks Suffer as Malaysia Razes Its Reserves". 28 November 2019. https://news.mongabay.com/2019/08/indigenous-communities-natl-parks-suffer-as-malaysia-razes-its-reserves/ (accessed 28 November 2019).

Muhiudeen, S. 2017. "The Complexities of Alternative Energy". *The Star Online*. https://www.thestar.com.my/business/business-news/2017/11/25/the-complexities-of-alternative-energy (accessed 10 December 2019).

New Straits Times. 2020. "On Earth Day, Malaysia Moves to Control Climate Change Impact". 22 April 2020. https://www.nst.com.my/news/nation/2020/04/586506/earth-day-malaysia-moves-control-climate-change-impact (accessed 30 May 2020).

Nik Daud, N.N., S.C. Najijiofor, H.R. Thomas, K. Lum, and L.J. Hosking. 2019. "Carbon Sequestration in Malaysian Oil Palm Plantations: An Overview: Towards a Sustainable Geoenvironment". *Proceedings of the 8th International Congress on Environmental Geotechnics* 3: 49–56. https://doi.org/10.1007/978-13-2227-3_6

Oh, T.H., M. Hasanuzzaman, J. Selvaraj, S.C. Teo, and S.C. Chua. 2018. "Energy Policy and Alternative Energy in Malaysia: Issues and Challenges for Sustainable Growth: An Update". *Renewable and Sustainable Energy Reviews* 81: 3021–31.

Paling, E.I., M. Fonseca, M.M. van Katwijk, and M. van Keulen. 2019. "Seagrass Restoration". In *Coastal Wetlands: An Ecosystem*

Integrated Approach, edited by G.M.E. Perillo, E. Wolanski, D.R. Cahoon, and M.M. Brinson, pp. 687–713. Amsterdam: Elsevier.

Petinrin, J.O., and M. Shaaban. 2015. "Renewable Energy for Continuous Energy Sustainability in Malaysia". *Renewable and Sustainable Energy Reviews* 50: 967–81.

Shellenberger, M. 2018. "If Solar Panels Are So Clean, Why Do They Produce So Much Toxic Waste?". *Forbes.* https://www.forbes.com/sites/michaelshellenberger/2018/05/23/if-solar-panels-are-so-clean-why-do-they-produce-so-much-toxic-waste/#5b339a121ccd (accessed 9 November 2019).

Sim, L.L. 2019. "Ministry to Take on 80 Initiatives". *Star Online*, 4 May 2019. https://www.thestar.com.my/news/nation/2019/05/04/ministry-to-take-on-80-initiatives (accessed 1 December 2019).

Snowden, S. 2020. "First Floating Ocean Hybrid Platform can Generate Power from Waves, Wind and Solar". *Forbes*, 22 May 2020. https://www.forbes.com/sites/scottsnowden/2020/05/22/first-floating-ocean-hybrid-platform-can-generate-power-from-waves-wind-and-solar/?fbclid=IwAR2nGwiJ_ZeSzorw9KM2E66BYI21BGmvqTxZKoM_FeaghqZhLgdr2snVgwI#6c1e8e017f8c (accessed 30 May 2020).

Sovacool, B.K. and I.M. Drupady. 2011. "Examining the Small Renewable Energy Power (SREP) Program in Malaysia". *Energy Policy* 39: 7244–56.

Star Online. 2018. "Low Carbon Initiative to Expand". 31 October 2018. https://www.thestar.com.my/metro/metro-news/2018/10/31/low-carbon-initiative-to-expand/ (accessed 1 December 2019).

———. 2019. "Renewable Energy or Food?". 11 September 2019. https://www.thestar.com.my/news/regional/2019/09/11/renewable-energy-or-food?/ (accessed 28 November 2019).

Suruhanjaya Tenaga. 2019a. *Energy Malaysia* 18. https://www.st.gov.my/contents/files/download/112/Energy_Malaysia_18_(Online).pdf (accessed 28 November 2019).

———. 2019b. "A Projection of Malaysia's Energy Landscape". *Energy Malaysia* 18: 13–15.

———. 2019c. "Reliable, Sustainable and Affordable: Finding the Balance in Electricity Prices". *Energy Malaysia* 18: 31–33.

Tan, S.M. 2016. “Challenges of Venturing into Renewable Energy”. *The Edge Weekly*. https://www.theedgemarkets.com/article/challenges-venturing-renewable-energy (accessed 12 November 2019).

Tan, S.T., H. Hashim, P.Y. Hoo, A.H. Abdul Rashid, J.S. Lim, and W.S. Ho. 2017. “Mitigation the Transboundary Haze in ASEAN Country: Biomass to Energy GHG Emission Assessment”. Proceedings of the 8th International Conference on Applied Energy: ICAE2016. *Energy Proce*dia 105: 1178–83.

United Nations Development Project (UNDP). 2019. *Low Carbon Cities: Malaysia’s Response to Climate Change*. https://www.my.undp.org/content/malaysia/en/home/news-centre/articles/2019/lowcarboncity.html (accessed 1 May 2020).

United Nations Framework Convention on Climate Change (UNFCCC). 2015. “Intended Nationally Determined Contribution of the Government Of Malaysia: UNFCCC INDCs as Committed by Parties: Malaysia”. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Malaysia/1/INDC%20Malaysia%20Final%2027%20November%202015%20Revised%20Final%20UNFCCC.pdf. (accessed 1 May 2020).

Varkkey, H. 2019. “Winds of Change in Malaysia: The Government and Climate Change”. *Heinrich Böll Stiftung Southeast Asia*. https://th.boell.org/en/2019/02/27/winds-change-malaysia-government-and-climate. (accessed 10 February 2020).

Wan Abdullah, W.S., M. Osman, M.Z.A. Ab Kadir, and R. Verayiah. 2019. “The Potential and Status of Renewable Energy Development in Malaysia”. *Energies* 12: 2437. https://doi.org/10.3390/en12122437

Waldholz, R. 2020. “Germany Marks First Ever Quarter with More Than 50 pct Renewable Electricity”. *Clean Energy Wire*. https://www.cleanenergywire.org/news/germany-marks-first-ever-quarter-more-50-pct-renewable-electricity (accessed 30 May 2020).

Weiser, M. 2016. “The Hydropower Paradox: Is This Energy as Clean as It Seems?”. *The Guardian*, 6 November 2016. https://www.theguardian.com/sustainable-business/2016/nov/06/hydropower-hydroelectricity-methane-clean-climate-change-study (accessed 8 June 2020).

World Bank. 2014. "CO_2 emissions (metric tons per capita)". https://data.worldbank.org/indicator/EN.ATM.CO2E.PC (accessed 10 February 2020).

Yew, F.K. N.d. "CO_2 Removal Through Oil Palm Plantations". Malaysian Palm Oil Council. http://mpoc.org.my/co2-removal-through-oil-palm-plantations-contributes-significantly-to-malaysias-carbon-sink-status/ (accessed 30 May 2020).

ISSN 0219-3213

TRS11/20s

ISBN 978-981-4459-95-2

9 789814 459952

ISEAS PUBLISHING

30 Heng Mui Keng Terrace
Singapore 119614
http://bookshop.iseas.edu.sg