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Malaysia's Energy Landscape: Sustainabiliy and Prescriptions

Huilai Gu
Lehigh University

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Historically an energy exporter, Malaysia now faces serious challenges to satisfy rising energy demands, fuel economic growth, and mitigate emissions at the same time. This article evaluates the sustainability of the current energy structure in Malaysia, identifies three key issues threatening the country's energy security, and proposes both short-term and long-term policies to better position renewable energy resources in Malaysia's transition to a sustainable future.

Introduction

For two decades, Malaysia has enjoyed robust growth in population and consistently high GDP growth rates. To power such growth, Malaysia's energy demand has also risen considerably, with per capita energy consumption more than doubling since 1998 (IEA, "Statistics…"). The challenge of generating sufficient secondary energy sources, especially electricity and gasoline, to cope with rising demand may exert considerable pressure on the existing energy infrastructure. Although many researchers believe Malaysia has sufficient fossil fuel to satisfy growing demand, a closer examination of the country's energy mix, trade, and subsidies reveals serious issues, which threaten energy security and sustainability and could have detrimental consequences for the country's environment.

Recognizing Malaysia's excessive reliance on fossil fuel resources, the government has initiated numerous policies and regulations since 2000 in favor of renewable energy (RE) development. Malaysia possesses an ideal geography to develop solar, hydro, and biomass energy, which could help meet energy demand while reducing its carbon footprint. Nonetheless, RE remains an insignificant 2% to 3% of the national power mix almost two decades after the initiation of RE-promoting policies, hardly making a dent in replacing conventional energy sources (Oh et al.). Such evidence raises two key questions: Is there really a need for RE? If yes, would RE deployment help overcome Malaysia's energy challenges?

This essay is a two-pronged exploration of Malaysia's energy landscape. First, I evaluate the sustainability of Malaysia's current energy model. Second, I examine the efficiency of existing RE policies and propose short-term and long-term solutions that would facilitate the country's transition to a clean future.

Background

Since 1975, Malaysia has been a net exporter of crude oil, piped natural gas, and liquefied natural gas. Although the country has thrived on abundant fossil resources, various projections suggest that Malaysia's crude oil and natural gas reserves will be exhausted by 2051 and 2061, respectively (Harun). Strategically, such projections are disconcerting for a country heavily dependent on fossil fuels, particularly in a time when domestic energy demand is growing rapidly. Since 2000, while primary energy supply per capita only grew 34.7%, GDP per capita more than doubled and electricity consumption per capita increased by greater than 63.8% (IEA, "Statistics…"). In contrast to Malaysia's annual population growth rate, which has averaged 1.4% to 1.5% during the past decade ("Current Population…"), the increase in total energy consumption has risen by 70% since 2000 (IEA, "Statistics…"). With both population and GDP projected to grow over the next decade, Malaysia's energy demand will continue to increase for the foreseeable future.

The issue of rising demand in the face of diminishing reserves is most prominent in Peninsular Malaysia, which accounts for 82% to 83% of total energy consumption in the country. Since 2010, Peninsular Malaysia has experienced a 0.6-billion-barrel decline in crude oil reserves and a decline of more than 6 trillion standard cubic feet in natural gas reserves, equivalent to 20% of its total proved reserves (Suruhanjaya Tenaga). In contrast, energy surplus states, Sabah and Sarawak, in East Malaysia, have also experienced a decline in fossil fuel reserves, although their energy demands are significantly lower due to lower population. Sarawak, for instance, with almost twice the amount of natural gas reserves as Peninsular Malaysia, has less than one-tenth its population. Sabah, with a similarly small population, enjoys more crude oil reserves than the entire Peninsula. Addressing energy sustainability in Peninsular Malaysia is critically important.

The Indicators of an Unsustainable Energy Structure

Like most Southeast Asian countries, Malaysia is still heavily dependent on fossil fuels, namely, petroleum, natural gas, and coal, for both primary and secondary energy consumption. While it is reasonable to expect a decades-long transition from fossil fuels to renewable resources in any country, Malaysia seems to be heading in the opposite direction of a clean future altogether (Lima de Oliveira). The government's efforts to promote green energy research and deployment pale in comparison to its substantial economic support of fossil fuels. The following sections detail three alarming indicators of an unsustainable energy system in Peninsular Malaysia: over-dependence on coal, continuous fossil fuel subsidies, and rising oil imports.

Over-dependence on Coal

At RM0.24 (6 cents) per kilowatt electricity generated (Hannan et al.), coal is by far the cheapest yet most polluting primary energy source in Malaysia. While more than 25 countries and regions have pledged to phase out coal by 2030 (Buck), Malaysia, along with other emerging economies in Southeast Asia, has witnessed a surge in coal usage over the past decade. In 1995, only 8.5% of fuel input for power stations in Malaysia consisted of coal versus, by 2015, an alarming 47.2% (Suruhanjaya Tenaga).

For Malaysia, the consequences of over-dependence on coal are twofold. First, Malaysia is not a coal-producing state. It is almost entirely dependent on imports from Indonesia (63%), Australia (24%), and Russia (11%) (Institute of…). The fact that nearly half of Malaysia's power stations are dependent on imported resources has raised red flags in the government. While current international coal prices are low, there are already indications that Malaysia's main coal provider, Indonesia, may increase royalties. Such an act would either force Tenaga National Berhad (TNB)—the country's largest electric utility—and ultimately end users, to pay more for electricity, search for alternative coal suppliers, or develop an alternative energy source altogether. The situation may worsen, according to forecasts by CIMB Research, which projects that Malaysia's coal usage would further increase by 70% in the next decade, that is, an additional 37 million tons (Kaur). If such forecasts materialize, any

fluctuation in coal prices or interruption in coal supply could drastically affect electricity production, especially in the Peninsula.

A second consequence, equally troubling, is that coal is by far the most carbon intensive fossil fuel, emitting twice the amount of greenhouse gas (GHG) compared to its natural gas equivalent (Lima de Oliveira). As of 2018, more than 47% of carbon emissions come from the power generation sector in Malaysia (Oh et al.). The rapid growth in coal consumption has already resulted in record high GHG emissions in Malaysia, with emissions from any additional growth projected to further increase due to the lack of carbon emission regulations and environmental policy enforcement. Hence, not only would Malaysia deviate from goals, such as the "aim to reach global peaking of GHG emissions as soon as possible" outlined by the 2015 Paris Climate Agreement,[1] but also its people could suffer from increasing air pollution and related respiratory diseases. Thus, the overall outcome of increasing coal's share in the power mix may be far more harmful than beneficial for Malaysia.

Fossil Fuel Subsidies

To improve living standards and maintain electricity and gasoline at affordable prices to the public, the Malaysian government has spent billions of dollars in energy subsidies in recent years. To make up for the gap between market gas/oil prices and retail gas/oil prices to Malaysian power producers and consumers, the government spent a staggering $5.7 billion on subsidies from 2010 to 2016 (Oh et al.). Other Association of Southeast Asian Nations countries such as Indonesia also have substantial expenditures in energy subsidies ($15.9 billion, 2010–2016), but the population of Indonesia is more than eight times larger than that of Malaysia (Chatri et al.). Notably, this massive expenditure occurred during a time when the Najib Razak administration attempted to gradually remove fuel subsidies. In comparison, the reinstatement of fuel subsidies under Mahathir Mohamad's government will lead to larger expenses, potentially difficult to sustain, leading to additional strain on the nation's coffers.

Again, the consequences of massive fuel subsidies are twofold. First, from an economic standpoint, fossil fuel subsidies are inefficient and unsustainable, leading to lost energy revenues and imposing heavy burdens on the government's budget. Petronas, Malaysia's state-owned oil and gas corporation, imports 36% of Malaysia's natural gas and then supplies it to TNB at roughly 25% of the imported price (Chatri et al.). As a substantial source of income for the government, Petronas has lost an estimated $61.1 billion (since 1997) in foregone revenue by subsidizing gas used mainly by the electricity-producing sector. If the government continues to subsidize gas by as much as 70% to 75% (Chatri et al.), the accumulated loss in revenue would aggravate Malaysia's already severe national debt problem (see article by Ni in this volume). Second, from an energy-savings standpoint, continuous subsidies may cause energy waste. Fuel subsidies for the electricity generators keep production costs low, resulting in low retail electricity prices. Affordable electricity and gasoline prices do benefit low-income households; however, they also lead to significant electricity over-consumption, energy waste, and energy inefficiencies. Considering the scope and magnitude of existing subsidies, the current blanket policy to subsidize all energy consumers is arguably not the wisest allocation of government funds.

It could be argued that a blanket policy is suspiciously more political than economical in nature. A key reason that significant fuel subsidies have been the norm in Malaysia is strong political motivation, because low-income voters support subsidies to maintain their standard of living. As the Malaysian populace grows addicted to artificially low fuel and electricity prices, it becomes difficult to sustain rising subsidies yet also difficult to remove them. Any abrupt removal of subsidies or increase in energy costs might induce protests or even public unrest, as seen in the recent fuel price–triggered protests in France (Rubin and Sengupta). Given the public's expectation of low energy costs in Malaysia, any administration would be wise to devise long-

[1]Malaysia ratified the Paris Agreement on December 16, 2016.

term policies that gradually phase out energy subsidies as opposed to drastic removal.

Rising Oil Imports

With demand on the rise, Malaysia is importing more fuel now than at any previous point in history. While both oil and natural gas imports increased in the past two decades, the underlying rise in gasoline demand is particularly alarming. Based on studies by Petinrin and Shaaban, it is possible for Malaysia to become a net oil importing country within three decades, especially if no electric vehicle (EV) promotion policies are enacted.

According to the Malaysia Energy Statistics Handbook (Suruhanjaya Tenaga), the percentage of imported versus exported oil[2] in 1995 was 6.2% imports versus 93.8% exports, whereas in 2015 this metric was 34.2% imports versus 65.8% exports. Similarly, the import of liquefied natural gas increased threefold in the past two decades, although smaller in quantity compared to oil imports. A closer examination by sector indicates the increase in oil imports is far from slowing down. In 1995, energy consumed by the transportation sector consisting primarily of gasoline made up 35.8% of total energy consumption (21,883 kiloton oil equivalents). By 2015, transport sector consumption increased to 45.2% of total energy usage, while at the same time total energy usage increased by roughly 250% to a staggering 51,806 kiloton oil equivalents. By contrast, during the past two decades, residential, commercial, and agricultural energy consumption levels have remained roughly the same, while industrial usage dropped from 36.8% to 27% due to Malaysia's gradual shift from industrial production to services and technology.

Combining these trends with the predicted growth of private vehicles in the next decade, a significant climb in oil demand in the Peninsula can be projected. With existing reserves depleting, Malaysia's oil imports most likely will continue to increase. Although new off-shore drilling projects are being developed, it might take years for new projects to be in full-scale production. Rising oil imports would offset the revenue from Malaysia's petroleum and petrochemical exports, resulting in less income for the government, as well as make Malaysia more vulnerable to price swings in the volatile international oil market.

This discussion clearly illustrates some of the most pressing energy challenges faced by Peninsular Malaysia. Essentially, Malaysia's current energy model is not sustainable. The country faces a similar struggle experienced by many countries, a struggle between growing energy demand and long-term sustainability, one that is clouded by political issues and conflicting interests. Fortunately, technological breakthroughs have pushed clean resources to the center stage of global energy transformation. Viable deployment of RE projects would simultaneously fulfill energy demand and mitigate climate change. According to the IEA, renewables are positioned to provide close to 30% of global electricity demand by 2023 (IEA, "Renewables…"). Could Malaysia efficiently utilize its natural resources in the transition from fossil fuels to a clean energy future? The following section explores the avenues to a more sustainable energy model from both short-term and long-term perspectives.

The Paths to a Clean Energy Future

Blessed with abundant natural resources, Malaysia could incorporate several renewable sources into its generation mix, alleviating the stress caused by growing energy demand while reducing the country's carbon footprint. In fact, the Pakatan Harapan government included ambitious targets for RE expansion and carbon emission reduction in its fourteenth general election manifesto. Specifically, in September 2018, head of the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) Yeo Bee Yin announced the administration's goal of boosting RE from 2% to 20% in the power mix by 2030 (Eusoff). Given prior lackluster results, in order to realistically improve RE's adoption rate and performance and to effectively allocate government funding, it is vital to first identify problems in the

[2]The oil imported and oil exported are normally of different grades, meaning they have different physical and chemical properties and are used in different types of motors or engines; therefore, they are not substitutes.

existing system. I discuss some issues in prior and current RE policies and offer suggestions on how to better position RE in both the short run and long run.

Target Advantageous Renewable Resources

There are myriad renewable sources from which Malaysia can choose. Based on geography, resource availability, and current infrastructure, the three most advantageous green resources for the nation are solar photovoltaic (PV), biomass, and hydroelectric energy. The rationale behind targeting specific types of green energy is that each type of RE has a different infrastructure, installation process, expected life span, and other device-specific characteristics. Therefore, generic RE subsidies or funding programs may not be sufficient or efficient in helping individual power generators initiate and maintain their projects.

Since announcing the Fifth Fuel Policy in 2000, the government has committed considerable effort to promoting RE. For instance, the Small Renewable Energy Power program was launched in 2001 to encourage the private sector and individual households to participate in RE generation. The National Biofuel Policy in 2006 promoted the usage of bio-fluids, such as palm oil, to power vehicles either solely or in combination with gasoline. Later, the Renewable Energy Act in 2011 introduced the feed-in tariff scheme (FiT), whereby individual power producers receive a price premium on the electricity they sell back to the national grid. Except for the Biofuel Policy, most RE policies to date have tended to promote and subsidize the generic concept or usage of RE. Lacking focus and clarity, blanket policies could be a reason for the low RE penetration in Malaysia today. Considering the relative shortage of RE infrastructure in Malaysia, resource type–specific aids may be more effective because different RE producers face different problems throughout their project lifetime (Oh et al).

A breakdown of Malaysia's current green energy mix points to one primary resource of focus. As of June 2018, the installed RE capacity was 575 MW, including 42 MW in small hydro, 158 MW in biomass and biogas, and a notable 375 MW in solar PV (Shunmuganathan). Solar PV, especially rooftop solar panels, may be the most convenient and least space-consuming RE type in Malaysia. With a reduction in both capital and operating costs, as well as the increasing popularity of FiT and net energy metering (NEM)[3] policies, solar PV is considered to have the most potential in terms of both producing capacity and infrastructure (Institute of…). However, many solar producers are forced to lower their capacity factor[4] due to low premiums and solar production caps. To elaborate, the government prioritizes low electricity tariffs over RE generation (Eusoff) and limits the amount of RE-generated electricity that can be supplied to the grid due to its higher cost. To allow a higher percentage of RE-generated electricity in the grid would mean more government subsidy to balance out high RE production cost. Consequently, while the government pushes for more solar projects, the producing capacity of these solar devices is underutilized. In November of 2018, Minister Yeo announced that an open tender for a 500-MW solar project will be conducted in 2019, contributing to MESTECC's estimate of an additional 3991 MW of RE to reach their 20% penetration target. However, the FiT renewables quota has risen by only 114 MW, meaning the allowed capacity for RE-generated electricity has risen by a fraction of the renewables' maximum producing capacity (Annuar).

It is hoped that advancements in technology and further cost reduction will lower solar energy costs to levels similar to gas or coal (Zakariah). Although this would occur in due course, under current pricing and cap restrictions, it will inevitably lead to low solar capacity factors and low efficiency for years to come. To fully realize the potential of solar energy, the government not only needs to increase the number of projects but also, more importantly, should increase the solar energy

[3]NEM allows electricity customers who wish to supply their own electricity from on-site generation to pay only for the net energy they obtain from the utility.

[4]The net capacity factor of a power plant is the ratio of its actual output over a period to its potential output, if it were possible for it to operate at full capacity continuously during the same period.

production cap to a matching level. If such a goal is not economically feasible, instead of boosting the quantity of solar projects, the government might consider increasing the subsidy or FiT electricity premium to existing solar producers as well as increasing the RE quota.

Divert Fossil Fuel Subsidies to Green Initiatives

As previously discussed, the subsidy the Malaysian government provides to maintain low electricity and gasoline prices has accumulated to a staggering figure. According to estimates by Rafizi Ramli, Vice President of the People's Justice Party, the government spent RM1.4 billion in fuel subsidies in just the 2 months after the Pakatan Harapan coalition came to power ("Rafizi…"). In contrast, based on the outline of Malaysia's Green Technology Financing Scheme, the government has pledged to spend up to RM5 billion from 2018 to 2022 toward RE financing. To put these numbers into perspective, the subsidy for green projects over the 5-year span equals the subsidy for fossil fuels in just 7 months.

Nevertheless, there are signs of reduction in fuel subsidies from the new administration. Starting in 2019, the government plans to subsidize only consumers, mostly lower-income individuals, who own vehicles with small engine sizes. Such actions would reduce the total annual fuel subsidy and could be highly beneficial if the government diverts a small portion of the savings to support RE projects instead.

In addition to directly financing RE projects through bank loans, the government should consider increasing the electricity price premium paid to power producers through the FiT scheme, thus encouraging individual solar or small hydro investments. When FiT was first launched, individual RE producers received only a 1% premium, an amount far from sufficient for investors to reach the break-even point in the short run (Oh et al.). Since then, the government has gradually increased the price premium; however, the amount is still too low to incentivize widespread deployment.

With the cost of RE technology decreasing rapidly, future projects may be easier to finance. Nevertheless, at this stage of RE development in Malaysia, government funding is still essential to achieving a higher RE penetration in the energy mix. The public's awareness of the necessity of environmental protection and climate mitigation is only at a very basic level (Kardooni et al.). Consequently, economic incentives remain the primary driver in pursuing sustainable energy.

When considering the gradual reduction of fuel subsidies, the government should also be cautious regarding the amount of reduction and the targeted end users. According to Hakim and colleagues, the direct welfare impact of fuel subsidies on consumers differs notably by income group: the benefit for the top 20% of households (by income) was more than four times higher than that of the bottom 40% in terms of subsidies received. Removing the fuel subsidy from the top 20% of households might not cause significant hardship because this income group does not necessarily need such subsidies to maintain their standard of living. However, the government would be wise to consider the needs of the bottom 40%, who would suffer most financially, and the middle 40%, whose fuel expenditure accounts for the highest percentage among the three groups (Hakim et al.). Given that an increasing number of high-income and middle-income households participate in clean electricity generation through the FiT or NEM scheme, the negative impact of fuel subsidy removal may be partially countered by a boost in the RE subsidy.

Create Long-term Policy Frameworks

Introduction of a carbon tax

Carbon taxes are recognized as effective in limiting GHG emissions, thereby mitigating climate change, in an economical manner. Since their initiation in the EU, carbon tax systems have received varying degrees of critique and public acceptance. In September 2018, the Pakatan Harapan government opened the discussion of implementing a carbon tax to help meet the aggressive goal of 40% carbon emission reduction by 2020 (Zakariah). Although the effective enforcement of carbon

tax legislation could reduce emissions and potentially limit the usage of carbon-intensive resources, in particular coal, it likely would take years to develop comprehensive carbon legislation in Malaysia, a nation lacking prior experience with such a system (Wong et al., "As an Emerging…").

With a proper framework, the introduction of a carbon tax and possibly an emission trading scheme (ETS) would benefit Malaysia on two levels. The primary benefit is the reduction in GHG emissions. Roughly 55% of CO_2 and other polluting gases are emitted from electricity generation and the transportation sector (Joshi). Admittedly, vehicle road emissions are hard to track, but vehicle fuel consumption and engine types may be classified and taxed according to their estimated carbon footprints. In comparison, power plant emissions are much easier to calculate. The government could target coal-intensive power plants with a higher carbon tax, thereby urging such utilities to replace coal with green resources. The second benefit of a carbon tax system is revenue. Several studies (Wong et al., "As an Emerging…"; "Wong et al., "Carbon…") have shown that a carbon tax of RM30 ($7.29) per ton of CO_2 could raise RM3 billion in 1 year, if imposed on coal-based and gas-based power generators. If the tax is also imposed on vehicles and other emission sources, the tax revenue might increase up to RM7 billion. Such substantial revenue not only would reduce the government's fiscal deficit but also could be reinvested into other RE initiatives, such as FiT or NEM, thus forming a sustainable loop of green financing.

Nevertheless, it is naïve to think a carbon tax would be an overnight success. It takes time for the impact to materialize, and an effective carbon tax necessitates rational pricing and strict policy enforcement. If the charges are insignificant, large power producers may choose the tax penalty instead of using cleaner resources, simply because the cost of remediation may outweigh the tax burden. To realistically combat GHG emissions, it is essential for Malaysia to develop and execute carbon tax legislation with progressive carbon pricing (Joshi). Initially, the public likely would react unfavorably to a heavy carbon tax, whether it is imposed on vehicles or power plants, but in time, gradual increases in carbon taxes might be more acceptable to a younger and more environmentally conscious public. Once a fundamental carbon tax system is established, Malaysia could consider the development of ETS, a system in which carbon emission allowances can be traded between utilities and companies like a commodity. To date, the EU is the only entity that has successfully established a large-scale ETS; however, the system is being introduced in more countries every year, with the promise of becoming a global trend.

Promotion of electric vehicles

EVs have long been promoted as clean alternatives to gas-powered cars; however, advocates often underestimate an EV's actual life-cycle emission.[5] Widespread EV adoption might increase overall GHG emission instead of reducing it, if the electricity used is generated by polluting resources. For Malaysia's current energy mix of 2% RE and over 50% coal (Oh et al.), any large-scale promotion of EVs would inevitably exacerbate air pollution.

The long-term outlook for EVs holds promise. As discussed previously, gasoline consumption by the transportation sector has increased both in percentage and in magnitude, yet Malaysia's oil reserves might be exhausted within decades. The electrification of public and private transportation could relieve Malaysia's dependency on oil and oil imports while increasing revenue from petroleum exports. The environmental benefits would also be significant, as the gasoline-powered transport sector contributes to 29% of CO_2 emissions (Sang and Bekhet). Once the share of clean energy becomes substantial in the power mix, widespread adoption of EVs would protect Malaysia from international oil market volatility, while improving the country's energy sustainability.

Conclusion

To simultaneously satisfy rising demand

[5]The life-cycle emission of an EV measures its overall carbon footprint, from the source of energy that provides its electricity to the carbon emission it could reduce compared to a normal vehicle.

and achieve energy sustainability is a grave challenge for any growing economy. Historically considered a fossil fuel exporter, Malaysia may soon face the severe consequences of depleting oil and gas reserves, not to mention the environmental damages from excess usage of coal. Significant fuel and electricity subsidies, growing dependence on coal, and rising oil imports have seemingly succeeded in providing continuous energy at an affordable price to the Malaysian people. However, such an energy structure is vulnerable, inefficient, contaminating, and highly unsustainable for the long run.

In theory, the technological advancement and cost reduction in various RE sources could enable widespread RE usage, thus satisfying growing energy demands while mitigating climate change. In reality, however, the conflicting interests between oil and gas companies (Petronas) and electric utilities (TNB) as well as deep-rooted political motivations undermine existing RE policies. For RE to achieve a critical quantum in the energy mix, the Malaysian government should implement and enforce policies that target advantageous RE sources and gradually divert fuel subsidies to green initiatives, aiming to boost economic incentives for clean energy adoption. Furthermore, to devise a long-term policy framework for a carbon tax may accelerate the retirement of fossil fuels, thus reducing GHG emissions. The transition from fossil fuel dominance to the age of RE might stretch decades, and time is not on Malaysia's side.

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