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The Future of Malaysia's Energy Mix

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Executive Summary

- **As Malaysia plans the next phase of its energy policy it will need to increase the share of sustainable energy whilst trying to balance other demands of access, affordability, and job creation.**

- Following several periods of energy development **Malaysia has developed a diversified energy mix.** However, in recent years this has included **substantial growth in coal consumption,** driven by demand in the power generation sector. Indeed, Malaysia is in an almost unique position of being a major importer of coal, whilst being a major producer and exporter of natural gas.

- **Malaysia has made progress towards delivering its carbon emission commitments** under the international Paris Agreement and has made progress in increasing the share of renewables, in particular through successful solar auctions.

- **Despite this progress, current policies are not on track to achieve the ambitious targets.** Moreover, while the Covid-19 pandemic is likely to result in a reduction of GHG emissions in the short term, the trajectory will likely revert to the previous situation unless significant further action is taken.

- **The energy transition in Malaysia still faces a number of broader challenges.** The cost of solar power has fallen dramatically but solar generation remains variable and intermittent until low cost storage options become viable. Malaysia's options for dispatchable renewables are hampered by lack of infrastructure, which will take some time to address.

- Therefore, while renewable capacity is growing steadily and is expected to reach 12-13 GW grid installed capacity by 2030, **conventional energy will still play a significant role in Malaysia's energy supply for the coming decades.** However, as Malaysia moves towards a renewable energy future the role of conventional energy will change from supplying baseload to ensuring supply stability, by smoothing the inherently variable nature of most renewables with a dispatchable source.

- **The choice of conventional, dispatchable fuel is essentially a choice between coal and natural gas.** Whilst coal is generally more affordable than natural gas, it is nearly twice as polluting. Moreover, natural gas is better suited to play the supporting role to intermittent renewables since it is generally cheaper to cycle combined-cycle gas power plants than coal-fired plants of similar scale, and gas can also be used to power smaller combustion engines, specifically designed for flexibility and peak demand.

- **In light of this, replacing coal with gas is a low hanging fruit for Malaysia.** Since natural gas is also a domestically available natural resource, the extraction and production is associated with significant economic benefits, when compared to coal, which is mostly imported. The natural gas industry contributes to jobs and economic growth, in addition to proving a supplementary source of fiscal revenue. The domestic availability of natural gas can also ensure security of supply, which can be complemented by the growing global offer of LNG cargoes.

- **However, substitution of coal for natural gas alone will not be sufficient to ensure Malaysia mitigates the risks and capitalises on the opportunities of the global energy transition**. The government will also need to put in place policies to ensure that Malaysia can adapt, including reducing dependencies on fiscal revenues, and seize new opportunities of new technologies.

- As the government plans for the next phase of energy policy in Malaysia, it should consider the widest range of factors, including environmental and economic externalities. **Replacing coal with gas is the low hanging fruit and beyond that the government should develop polices to adapt to and seize the opportunities of the energy transition.**

Introduction

Balancing an increasing share of sustainable energy without compromising on access, affordability and job creation has been a central concern to policymakers across the world and Malaysia is no exception. Furthermore, the economic importance of the oil and gas industry to Malaysia add complexity to these already challenging policy issues. How can Malaysia foster the growth of greener, less-carbon intensive, sources of energy while preserving reliability of supply and affordability of cost? Can the country achieve its Paris Agreement pledge with the current energy mix and policies?

The supply of renewables, and solar in particular, has been growing in Malaysia with the support of policies that have led to rounds of fresh investments in rooftop solar (commercial and residential) and utility-scale solar farms. These new investments are very visible to the casual observer and, by this metric, the country's energy sources are getting visibly greener. Besides being a tropical and sunny country, Malaysia is also gas-rich, and natural gas is the only fossil fuel predicted to grow in the decades to come because of its multiple uses (such as electricity generation and petrochemicals) and lower environmental impact than coal and crude oil. Despite these favourable background conditions, an analysis of government statistics reveals that, over the years, Malaysia has become increasingly more reliant on imported coal, the dirtiest of the fossil fuels. In terms of primary energy share, coal has increased from 5% in 1996 to 20% in 2016 (Energy Commission, 2018).

This paper looks at the energy industry of Malaysia which has, paradoxically, recorded both the increase of coal and renewable energy in its matrix. It is in this context that the government will now need to consider the future of energy policy as it develops the 12th Malaysia Plan. Investments in the energy sector, such as power plants, are designed to have a useful life of decades, therefore decisions taken today will impact future generations for years to come. This paper considers the policy choices in relation to deciding on the energy mix for Malaysia:

1. **Part 1** outlines the development of Malaysia's energy policy, which has resulted in the current energy mix;

2. **Part 2** assesses Malaysia's renewable energy commitments and current policies to meet these targets; and

3. **Part 3** assesses the choice of natural gas and coal as bridging fuels to support the transition to renewables. It also discusses the role of a new national energy policy to support the country in adapting to the ongoing energy transition, seizing new business opportunities in green technologies, and leading in sustainability.

Part 1: Development of Malaysia's Energy Policy

Malaysia's energy policy has evolved over the years reflecting the governments' priority of providing electricity to sustain the country's rapid growth and developing domestic natural resources. While policymaking power ultimately rests with government officials in the administration, operating under the authority of bills approved by the Parliament, key players in the history of the development of energy infrastructure have also been state-owned enterprises (SOEs) like Tenaga Nasional and Petroliam Nasional Berhad (PETRONAS).

Tenaga Nasional is Malaysia's largest utility company and has a history that dates back almost seven decades. It has a near-monopoly on electricity generation, transmission and distribution in Peninsular Malaysia, while Sabah Electricity Supply Sdn Bhd (SESB) and Sarawak Energy Berhad (SEB) play similar roles in their respective markets. All three companies operate as vertically integrated businesses, meaning that they have activities in generation, transmission, and distribution. In generation, competition has been gradually introduced since the 2010s, with new players investing in power-generating plants as Independent Power Producers (IPPs).

PETRONAS, now Malaysia's most important company, has a peculiar history. It was born in the context of the oil nationalism of the 1970s and the strengthening of OPEC (Lima-de-Oliveira, 2020). As such, it was first created as a vehicle to renegotiate contracts with major foreign O&G companies. In the late 1960s, Shell and Esso started offshore oil exploration in Malaysian waters but production was miniscule, amounting to less than 10,000 bpd in the 1960s. Yet, it had potential and the Malaysian government decided to revamp the legal framework by centralizing regulatory and ownership rights from states and negotiating new contracts with oil companies that would increase the taxes from oil production. This was achieved via the Petroleum Development Act 1974 which paved the way for the establishment of PETRONAS and provided the newly incorporated firm with ownership and exclusive rights for exploration and exploitation of petroleum resources in the country. More than just a rent-collector, PETRONAS sought to develop national capabilities in human resources and in the supply chain through regulations built into the Production Sharing Contracts (PSCs) that foreign oil companies signed (Lima-de-Oliveira, 2017).

The National Petroleum Policy was established in 1975 to regulate the oil and gas industry and was intended to provide for adequate supply of petroleum at reasonable prices (Abdul-Manan et al., 2015). However, the policy focused exclusively on petroleum as an energy source and was not designed to diversify Malaysia's energy mix (Abdul-Manan et al., 2015). It was not until 1979 that Malaysia developed the more comprehensive National Energy Policy, which encompassed supply (including diversification), utilization and environmental impact (Abdul-Manan et al., 2015). This policy was expanded in the early 1980s, with the National Depletion Policy of 1980, which aimed to avoid the premature depletion of oil reserves by controlling the rate of production and the Four Fuel Diversification Policy of 1981 to promote reliability and security of the energy supply by increasing use of coal, natural gas and hydroelectric (Abdul-Manan et al., 2015). To implement the goals of the diversification policy, the Sixth Malaysia Plan (1990-1995) and the Seventh Malaysia Plan (1996-2000) emphasised the increase in the use of natural gas, driven by the electricity generation sector (Abdul-Manan et al., 2015). As a result, the energy share of natural gas in the total primary energy demand increased from 16% in 1990 to close to 40% in 2000 (Malaysia Energy Information Hub).

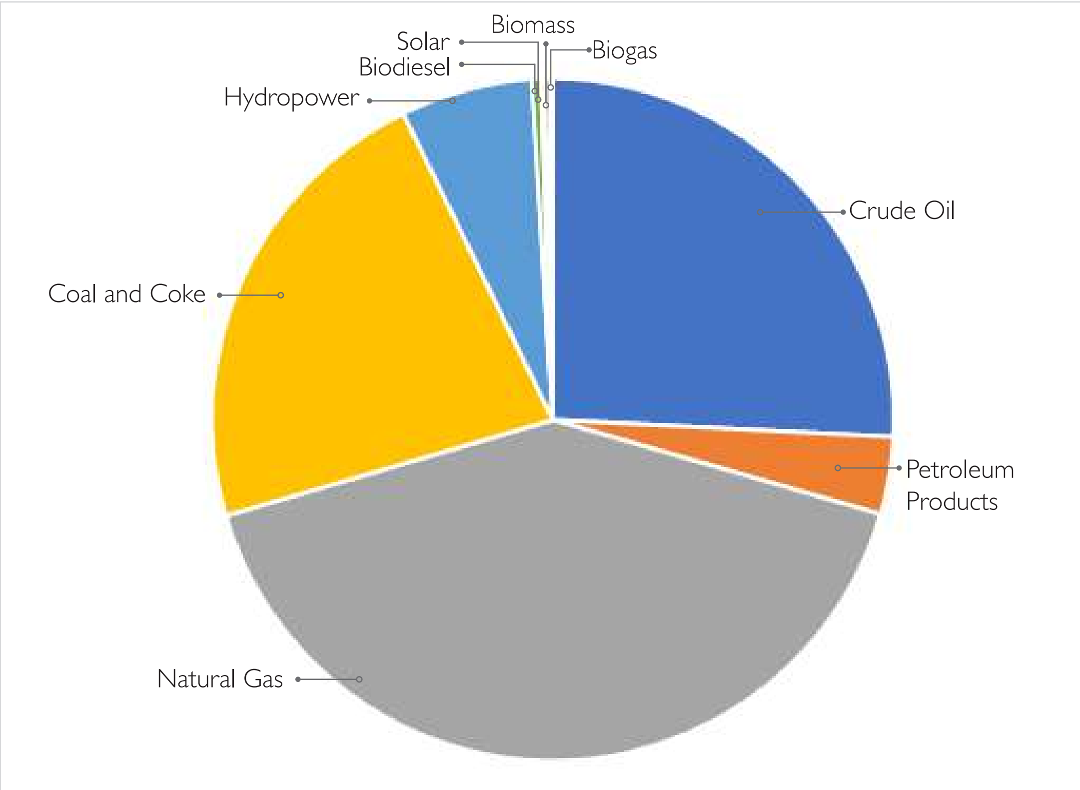
The Eighth Malaysia Plan (2001-2005) and Ninth Malaysia Plan (2006-2010) continued to promote the uptake of natural gas, but also increased the focus on renewables, leading to the National Biofuel Policy in 2006 and the Malaysian Biofuel Industry Act 2007 (Abdul-Manan et al., 2015). In 2009 the government launched the National Renewable Energy Policy and Action Plan, supported by the Renewable Energy Act in 2011 and the establishment of the Sustainable Energy Development Authority (SEDA). The principal objectives of the National Renewable Energy Policy and Action Plan are:

- To increase RE contribution in the national power generation mix;
- To facilitate the growth of the RE industry;
- To ensure reasonable RE generation costs;
- To conserve the environment for future generations; and
- To enhance awareness on the role and importance of RE (SEDA, n.d.).

Malaysia's current energy mix

These successive energy policies have contributed to the development of the current energy mix in Malaysia (Figure 1.).

Figure 1. Primary Energy Supply (ktoe) by Fuel Type,2018

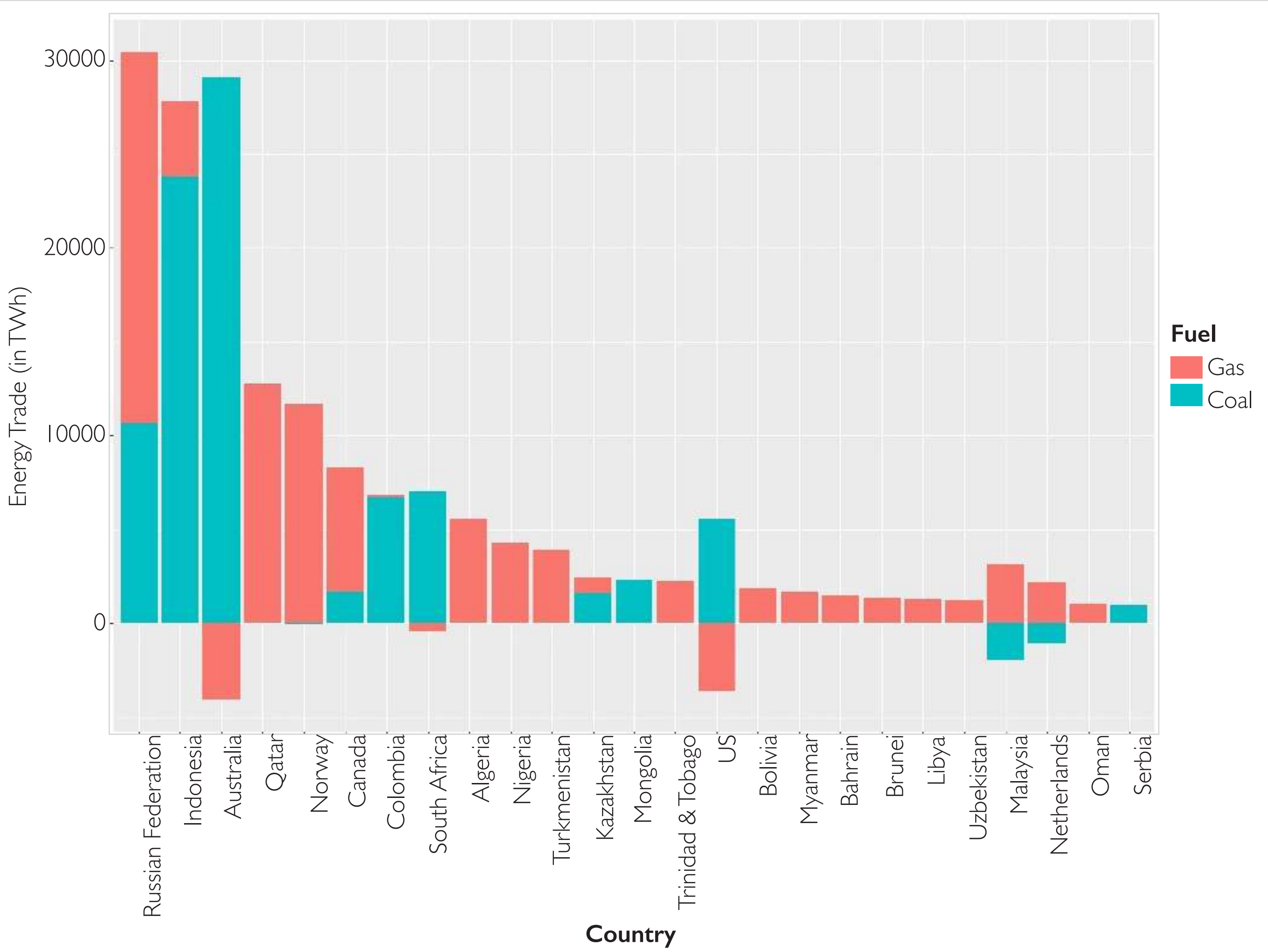


Source: Malaysia Energy Information Hub

Despite efforts to increase the role of renewables in the energy mix, Malaysia has also made a strong bet on coal in recent years by raising consumption more than 17-fold – from 767 ktoe in 1998 to 17,101 ktoe in 2016 (Energy Commission, 2017). As a share of electrical energy generation, coal supplied 46% of the total 150,442 GWh in 2016. This high use of coal despite domestically available natural gas and commitments to increase renewables presents a paradox at the heart of Malaysia's current energy mix.

Figure 2 illustrates this with an international comparison. It shows the trade balance for coal and natural gas for the leading 25 countries. Volumes for coal and natural gas trade were converted to terawatt-hour (TWh) (to provide a direct comparison) and averaged over the 2008 to 2018 period. Typically, gas-rich countries consume their gas domestically first, and export the surplus. Some nations are rich in both gas and coal and export them both – like Russia, Indonesia and Australia. It is quite unusual to be both an importer of coal and an exporter of gas, like Malaysia. Only the Netherlands appears in the same situation for this group of countries that have significant coal and gas trade volume. On the other hand, countries like Australia and the United States, which were exporters of coal and importers of natural gas, have more recently become net gas exporters.

Figure 2. Trade balance of coal and gas (in TWh), 2008 - 2018



Source: Authors' calculation based on BP Statistical Review of World Energy

This growth in the use of coal presents a challenge when considering Malaysia's efforts to de-carbonise its energy matrix, specifically in the context of ambitious domestic and international commitments.

Part 2: Malaysia's commitments to carbon reduction

In the run-up to the 21st Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC), held in Paris in 2015, Malaysia committed itself to reducing its greenhouse gas emission intensity by 45% per ringgit of real GDP by 2030, relative to its 2005 baseline. This commitment is split, where 35% reduction is unconditional and an additional 10% reduction is conditioned *"(…)upon receipt of climate finance, technology transfer and capacity building from developed countries."* This commitment is referred to as Malaysia's Nationally Determined Contribution (NDC) under the Paris Agreement (UNFCCC, 2015). This commitment follows Malaysia's pledge from 2009, to reduce greenhouse gas emission intensity by 45% per ringgit of real GDP by 2020, relative to 2005, conditioned on *"(…) receiving the transfer of technology and finance of adequate and effective levels from our Annex I partners(…)"* (MyCarbon, 2012).

Malaysia has made significant progress towards these targets, though far from reaching the pledge from 2009. The most recent projections from the then Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) of emissions intensity of GDP, relative to the 2005 baseline, as presented in the 3rd National Communication and 2nd Biennial Update Report to the UNFCCC (NC3/BUR2) are shown in Table 1, below. The table shows the expected relative emissions intensities in 2020, 2025 and 2030, under a Business as Usual (BAU) scenario, which only includes current interventions, a PLAN scenario, which includes current and planned interventions and an Ambitious (AMB) scenario, which projects further intervention in addition to what has already been planned and implemented.

As shown in Table 1, Malaysia still has a significant shortfall under the PLAN scenario, with additional reduction requirements in annual emissions of 75,000 and 22,500 GgCO2e, to reach the 45% intensity reduction target under approach 1 and approach 2, respectively.

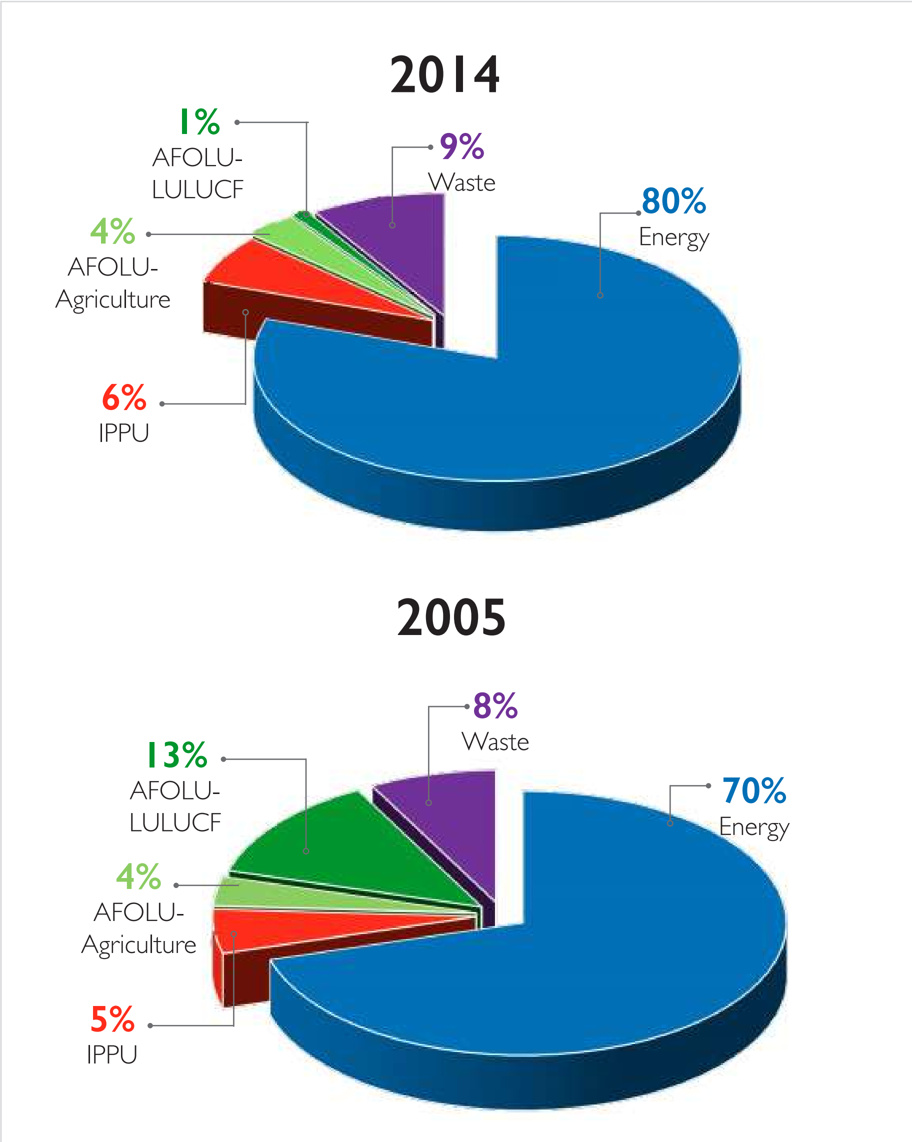
Table 1. Emission scenario breakdown for BAU, PLAN and AMB scenarios (emissions in '000 GgCO2e)

Sector	2005	2020			2025			2030		
	Baseline	BAU	PLAN	AMB	BAU	PLAN	AMB	BAU	PLAN	AMB
Energy	198.51	325.11	318.40	310.04	378.68	365.83	353.73	449.71	427.05	391.87
Industrial Process and Product Use	15.10	22.09	21.89	21.77	23.95	23.57	23.26	26.11	25.54	25.05
Agriculture	10.03	11.93	11.60	11.16	12.24	11.84	11.38	12.52	12.08	11.61
Waste	21.93	32.42	30.56	28.30	35.87	31.79	28.51	39.29	33.31	28.34
Indirect N_2O emissions from atmospheric depositions	1.11	1.84	1.83	1.77	2.22	2.19	2.06	2.67	2.63	2.40
LULUCF emissions only	35.99	19.24	16.83	14.42	19.24	16.83	14.42	19.24	9.59	2.35
LULUCF Removals	-233.92	-254.96	-258.42	-260.26	-250.84	-255.92	-259.16	-246.65	257.62	261.02
LULUCF emissions and removals (net emissions)	-197.93	-235.72	-241.59	-245.84	-231.60	-239.09	-244.74	-227.41	-248.03	-258.67
Total without LULUCF (Approach 1)	246.68	393.39	384.28	373.04	452.94	435.23	418.94	530.29	500.61	459.27
Total with LULUCF emissions only (Approach 2)	282.67	412.63	401.11	387.45	472.18	452.06	433.36	549.53	510.20	461.62
Total with LULUCF emissions and removals (Approach 3)	48.75	157.67	142.69	127.20	221.34	196.14	174.20	302.89	252.58	200.60
GDP at constant 2010 price (RM billion)	659.64	1,338.87	1,338.87	1,338.87	1,691.77	1,691.77	1,691.77	2,068.44	2,068.44	2,068.44
Emission Intensity (kg CO_2 eq/RM) without LULUCF (Approiach 1)	0.3740	0.2939	0.2871	0.2787	0.2677	0.2537	0.2476	0.2564	0,2420	0.2220
Emission Intensity (kg CO_2 eq/RM) with LULUCF (Approiach 2)	0.4285	0.3083	0.2997	0.2895	0.2791	0.2672	0.2562	0.2567	0.2467	0.2232
Emissions Intensity (kg C02 eq/RM) with LULUCF emissions and removals (Approach 3	0.0739	0.1178	0.1066	0.0950	0.1308	0.1159	0.1030	0.1464	0.1221	0.0970
Changes in Emission Intensity from 2005 level without LULUCF (%) (approach 1)		-21.4%	-23.2%	-25.5%	-28.4%	-31.2%	-33.8%	-31.4%	-35.3%	-40.6%
Changes in EmissionIntensity from 2005 level with LULUCF emssions only (%) (Approach2)		-28.0%	-30.1%	-32.4%	-34.9%	-37.6%	-40.2%	-38.0%	-42.4%	-40.6%
Changes en Emission Intensity from2005 level with LULUCF emissions and removals (%) (Approach 3)		59.4%	44.3%	28..6%	77.0%	56.9%	39.3%	98.1%	65.2%	31.2%

Source: MESTECC, 2018, pp. 7

Malaysia's greenhouse gas emissions are dominated by emissions related to energy use, and this share of total emissions has been growing, from 70% of total emissions in 2005 to 80% in 2015, as shown in Figure 3, below. This is primarily a function of a steady growth in emissions related to energy consumption and a drastic reduction in land conversion from agriculture or forest to settlement (MESTECC, 2018, pp. 41-48)

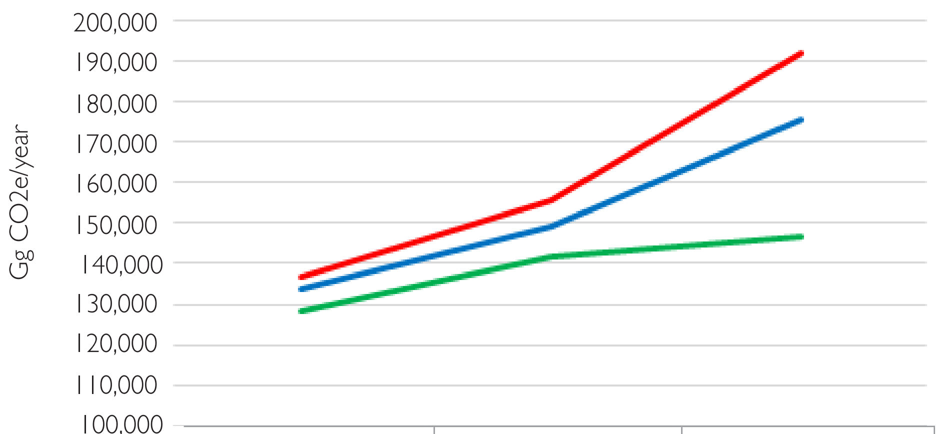
Figure 3. Percentages of Greenhouse Gas emissions by Sector in 2005 and 2014



Source: MESTECC, 2018, pp. 41

The difference between the PLAN and AMB scenarios represents a difference in emissions of ~49,000 GgCO2e in 2030, 29,000 GgCO2e of which are attributable to electricity and heat generation. NC3/BUR2 states that *"[t]he large reduction between the PLAN and AMB scenarios between 2025 and 2030 is a result of the assumption that all new power plants installed after 2025 would be powered by natural gas instead of coal"* (MESTECC, 2018, pp. 68). As such, the curbing of coal consumption for electricity production plays a crucial role for Malaysia to honour its international commitments towards GHG emissions reductions. The divergence in emissions from electricity production between the PLAN and AMB scenarios is clearly shown in Figure 4 below:

Figure 4. Emissions from electricity generation by scenario



	2020	2025	2030
BAU	136,533	155,760	191,990
PLAN	133,520	149,378	175,614
AMB	128,212	141,895	146,715

Year

Source: Author's calculations based on MESTECC, 2018, pp. 70

The AMB scenario further relies on a few key improvements within the energy sector, relative to current and planned interventions: (MESTECC, 2018, pp. 66)

1. Increase large hydro power installations to 8,129MW by 2030 (same as PLAN, 4,773MW installed in 2014);

2. Increase other renewable installations to 5,066MW by 2030 (up from 3,902MW in PLAN and 278MW installed in 2014);

3. Increase in thermal efficiency for new thermal power plants to 46% for coal and 60% for Combined Cycle Gas Turbines by 2030 (up from 37% and 55% in PLAN and 33% and 42% averages in 2014);

4. Save 10% of total electricity between 2025 and 2030 (in addition to the 8 % savings expected from the National Energy Efficiency Action Plan (2016) between 2016 and 2025 in PLAN);

5. Continuous improvement in gas transformation efficiency and zero continuous flaring and venting in all oil and gas operations.

Malaysian renewable energy policies

Policies to reduce the greenhouse gas emissions from electricity generation date back to the 8th Malaysia plan and the Fifth Fuel Policy of 2000, which targeted 500 MW of renewable energy (not including large hydro), to be installed on the grid by 2005. However, by 2010 only 41 MW of renewable energy had been installed (Maulud & Saidi, 2012). Only with the introduction of the Feed-in Tariff (FiT) with the Renewable Energy Act in 2011 did renewable installation in Malaysia pick up steam. The roll-out of renewables under the FiT can be seen in Table 2 below. The FiT scheme offers a significant premium for renewable energy installations, though with quotas for each energy type.

Table 2. Installed Capacity (MW) of Commissioned RE Installations under the FiT

Year	Biogas	Biogas (landfill / Agri Waste)	Biomass	Biomass (Solid Waste)	Small Hydro	Solar PV	Total
2012	2.00	3.16	12.00	8.90	11.70	31.53	69.29
2013	3.38	3.20	0.00	0.00	0.00	106.99	113.57
2014	1.10	0.00	12.50	0.00	0.00	61.82	75.42
2015	0.00	5.40	13.80	7.00	6.60	60.34	93.14
2016	0.00	14.33	19.50	0.00	12.00	77.84	123.67
2017	0.00	23.73	0.00	0.00	0.00	38.66	62.39
2018	0.00	11.71	0.00	5.85	20.00	3.56	41.12
2019	0.00	19.69	0.00	0.00	20.00	0.02	39.71
Cumulative	6.48	81.22	57.80	21.75	70.30	380.76	618.31

Source: SEDA, 2019b

More recently the Large Scale Solar scheme (LSS) has significantly ramped up the roll-out of photovoltaic power installations. Awards here happen via auctions, which allow for competitive bidding to drive down the price faced by the Malaysian government. The FiT no longer applies for new solar PV installations, as these have been moved to the Large scale solar scheme (SEDA, 2019a). Auctions to date have all been over-subscribed (PV Magazine, 2019), and the first projects are starting to come online (TNEC, 2019).

In 2018, Malaysia's government established a target of 20% of installed electricity generation capacity to be from renewable sources by 2025[1]. To reach this target, it is estimated that a total of approximately 6,900 MW of renewable capacity (not including large hydro) would have to be installed by 2025.[2] This represents an increase of approximately 3,300 MW and 3,000 MW relative to the PLAN scenario for 2025 and 2030, respectively (MESTECC, 2018, pp. 188). Assuming the bulk of this additional capacity will come from solar PV, this represents additional renewable generation of approximately 4.8 TWh.[3] Using the latest available grid emission factor for Malaysia of 0.694 tCO2e/MWh (SEDA, 2019b), this represents a net reduction of emissions on the order of magnitude of 3,300 GgCO2e per year, relative to the PLAN scenario. While this is indeed significant, it is well below the 22,500 GgCO2e reduction required to reach the 45% intensity reduction target. As a result, achieving the Paris commitments will require reduction of emissions from non-renewable sources, i.e. reducing the use of coal relative to less emitting fuels.

Malaysia's energy transition and the future of renewables

Beyond the specific Paris carbon emission reduction target, there is a broad imperative to plan for the energy transition in Malaysia to provide for a more sustainable source of energy. As of 2017, Malaysia consumed approximately 160,000 MWh of electricity (Energy Commission, 2019), and this figure is expected to grow on par with the general energy demand, and thus nearly double by 2030 (MESTECC, 2018, pp. 66). While renewable capacity is growing steadily and is expected to reach 12-13 GW grid installed capacity by 2030, conventional energy will still play a significant role in Malaysia's energy supply for the coming decades. However, as Malaysia moves towards a renewable energy future the role of conventional energy will change from supplying baseload to ensuring supply stability, by smoothing the inherently variable nature of most renewables.

Variability in renewable generation

Hydro and solar power are the main types of renewable energy currently being rolled out in Malaysia. Solar power in particular suffers from highly variable energy output, as both the height of the sun in the sky and weather greatly impacts the production of electricity at any given time. Wind power has similar issues but has yet to be implemented in Malaysia at the grid level, due to low average wind speeds (The Borneo Post, 2015). While part of the system-level variability gets smoothed out as the number of individual installations increases as illustrated by Figure 5 below, the inherent variability stemming from an electricity system heavily reliant on intermittent renewables, constitutes a significant challenge to the remainder of the energy system, as the proportion of solar energy in the system increases. In particular, it requires dispatchable energy sources that can match demand in real time (Bird et al., 2013). To do this with renewable sources would require either wide deployment of dispatchable renewables such as hydro, biomass or biogas, or non-dispatchable alongside storage solutions such as pumped hydro storage or grid scale batteries. Each of those options are examined below. Such deployment would require time, necessitating conventional energy such as coal and natural gas to provide this service in the interim.

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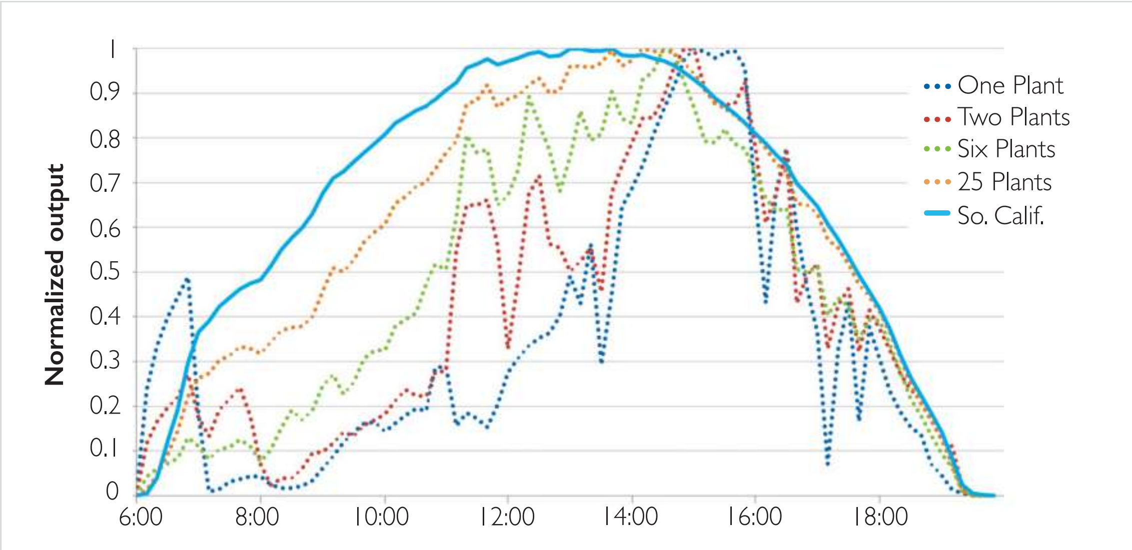
1. As of the writing of this report however, this target has yet to be included into official projections of future GHG emissions. Furthermore, in February 2020, Malaysia's government changed from the Pakatan Harapan coalition to the Perikatan Nasional and is unclear which policies and targets would be kept.

2. Meeting with MESTECC on Dec 9th 2019.

3. Assuming 1450 hours of peak-equivalent production per year.

Figure 5. Normalized power output for increasing aggregation of PV in Southern California



Source: Bird et al., 2013

Dispatchable renewables and storage

- **Hydro power** is the largest source of dispatchable renewable energy in Malaysia. Currently there is 4,773 MW of installed capacity, and this is expected to increase to over 8,100 MW by 2030 (MESTECC, 2018). Today this represents approximately 11% of total electricity generation. However, 80% of the total potential capacity resides in East Malaysia, as well as most of the current production, while most of the electricity demand is in West Malaysia, with economically viable resources estimated at around 10,000 GWh/year (Othman, 2005). This could in principle be solved by linking the two grids, and RM10 billion plans for underwater cables for that purpose have been discussed in the past. However, these plans have been scrapped in multiple rounds of negotiations, so this solution seems unlikely in the near term (The Malaysian Reserve, 2017).

- The second option for dispatchable renewable energy is **biomass and biogas.** Malaysia through its expansive palm oil industry is rich in these by-products. There have already been mandates implemented through the Economic Transformation Programme to ensure the capture of methane from the treatment of Palm Oil Mill Effluent (POME), the high organic waste water associated with the extraction of crude palm oil from the palm fruits. These efforts are estimated to generate approximately 500 MW of grid-installed capacity (AIM, 2013). Biomass from palm residues is estimated to represent a total potential of 2,400 MW, however there are significant competing uses including biochemicals, which represent a significant shadow-cost of utilizing this resource exclusively for energy purposes (AIM, 2013).

- Lastly, **energy storage** represents the ultimate solution for the intermittency issues of renewables. **Pumped hydro storage** storage (PHS) has been used for decades as a way of saving energy from baseload plants to match peak demand. PHS has the benefit of being relatively cost-effective, and for allowing long-term storage to account for inter-seasonal variation as well as inter-day variation (International Hydropower Association, 2018). However, capacity is limited by available reservoir capacity, and has the same issues as for hydropower described above.

- In recent years, **grid-scale batteries** have made headlines, mostly as a peak-shaving tool. Costs are still very high, representing an increase in CAPEX for solar PV of ~67%, to transform it into pseudo-dispatchable production (at least for intra-day variability of supply) (Fu et al., 2018). While prices are expected to drop significantly over the next couple of decades, (Cole et al., 2019) it is unlikely to be a feasible, large-scale solution for the near term.

In summary, while there are a multitude of renewable energy potentials in Malaysia, which given a long enough timeline could be patched together to provide Malaysia with an all renewable energy supply, this requires drastic, large-scale change of the energy system, requiring large-scale investments over multiple decades. As such, conventional energy will need to provide the flexible supply in the interim.

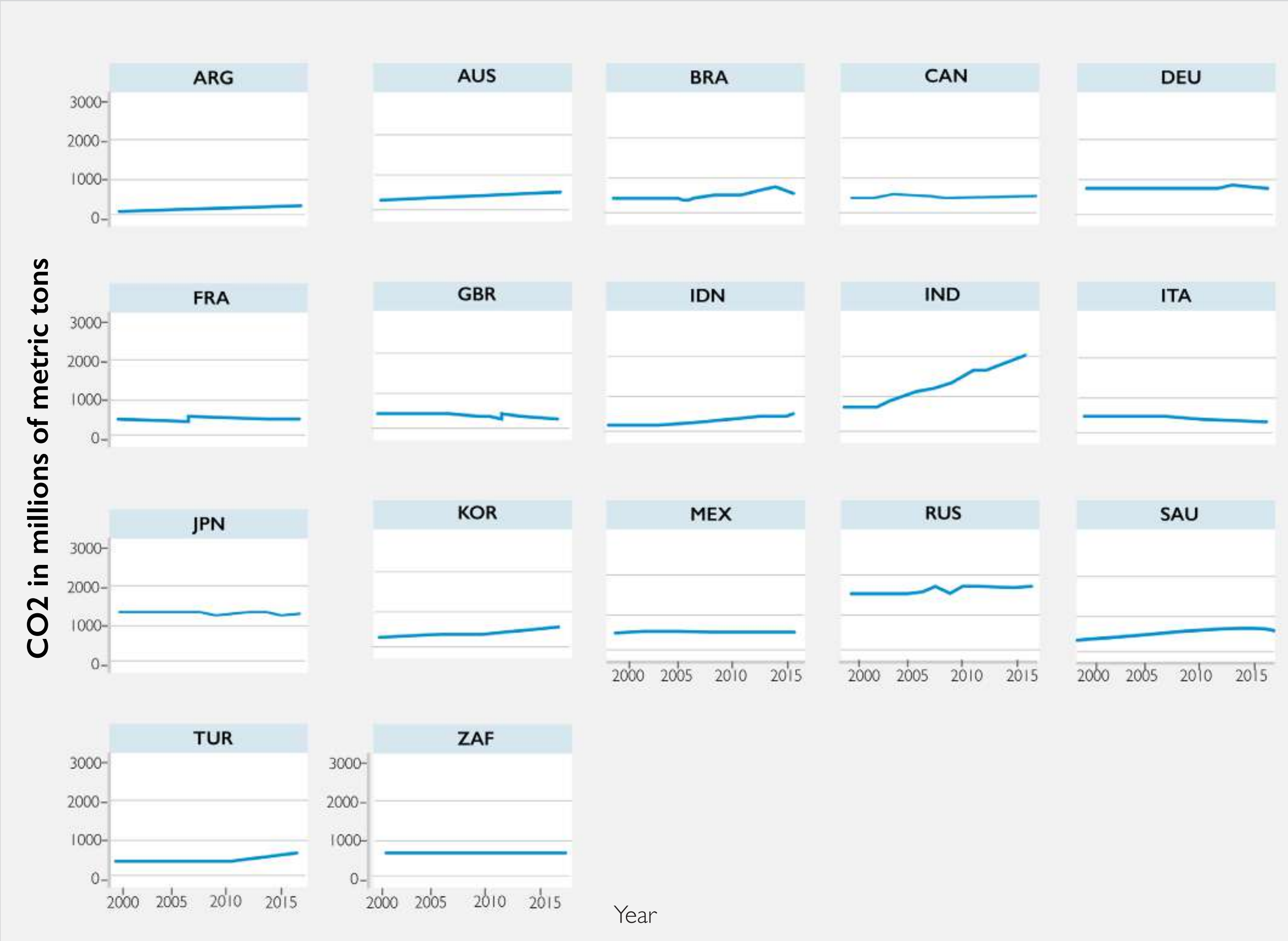
Malaysia's GHG trajectory post-COVID 19

At the time of writing, the economic and environmental impacts of the COVID-19 pandemic are still unraveling, representing a significant source of uncertainty to future projections of energy demand which cannot currently be reasonably accounted for in the analysis above. It is however possible to look at the impact of previous economic slowdowns, both short- and medium-term, to assess whether the pre-slowdown projections should be completely disregarded.

The closest analogue for the current economic environment in recent history is the 2008-9 financial crisis, as it too produced an unexpected slowdown of the economy on a global scale. While it is still too early to determine the relative magnitudes of the two events, the drop in economic output would likely produce similar patterns in GHG emissions.

On aggregate, global GHG emissions did see a slight dip in 2009 following the financial crisis, but bounced back quickly to record highs in 2010 (DOE/Oak Ridge National Laboratory, 2011). While many countries have shown a gradual decoupling of their economies from the GHG emissions in the years since the crisis, there is little indication that the crisis itself caused a persistent downshift in emissions (Sadorsky, 2020). While detailed data for Malaysia has not been available, this trend can be seen in Figure 6 below, shown in the national emission trajectories for a variety of economies. While some countries show a significant dip around the time of the financial crisis, most seem to quickly revert to their previous trajectories.

Figure 6. CO_2 emissions for 17 countries (2000-2017)



Source: Sadorsky, 2020

For this reason, the most reasonable assumption, until more data is available, seems to be that Malaysia will likely see a decrease in GHG emissions in the short term, followed by a reversion to the previous trajectory, unless significant action is taken in the meantime.

Part 3: Energy Transition and the importance of a new, comprehensive, national energy policy

The desired mix in the country's energy consumption necessary to achieve greenhouse gas emission reductions is a key, but not the only, piece of a national energy policy that can address the many challenges brought up by the ongoing global energy transition and climate change. The energy transition, in specific the gradual replacement of fossil fuels by renewable sources of fuel, is not solely driven by policy choices. In fact, more and more, it is an economic reality as renewables sources, such as solar and wind, become more cost-competitive and spur new businesses ranging from component manufacturing, installation, to end-user solutions.

Notwithstanding the likely inevitability of the transition due to technological advancements and cost-reductions, policy choices will be critical in defining which countries will lead or will be laggards. Policy is fundamental to speed up the transition and seize new business opportunities by capturing value in green technologies.

We start by exploring the easiest of the policy choices for a gas-rich country like Malaysia in need of reducing its carbon footprint.

The low-hanging fruit: replacing coal for natural gas

Given the ongoing need for some conventional fuels as Malaysia transitions, the question then arises of the choice of fuel - principally between natural gas and coal. Despite being a gas rich country and policy commitments to reduce carbon emissions, Malaysia has been increasing its use of coal. As previously highlighted, in terms of primary energy share, coal has increased from 5% in 1996 to 20% in 2016. In the fuel mix for electricity generation, coal has increased from 11% in 2000 to 44% in 2017. Over the same period, the relative share of natural gas in the electricity generation mix has declined from 74% to 38% (Energy Commission, 2018). This trend seems set to continue as current policy calls for a maintenance of coal-fired generation capacity, i.e. replacement of retiring coal capacity with new coal capacity, as is reflected in the PLAN scenario.

The growing preference for coal has been motivated by the lower cost of using coal in electricity generation vis-à-vis natural gas. However, this price of fuel does not account for the social cost of higher emissions associated with emissions - the negative environmental externalities of coal. The Environmental Defence Fund (EDF) defines the social cost of carbon as the measure of the economic harm from those impacts, expressed as the dollar value of the total damages from emitting one ton of carbon dioxide into the atmosphere. The EDF currently estimates the social cost of carbon at over $50/MT (EDF).

In recognition of the significant costs of emissions, and the policy ambitions to reduce overall levels of carbon emissions, many countries have implemented mechanisms to introduce a direct cost for carbon (Rabe, 2018). More than 40 governments worldwide have now adopted some sort of price on carbon, either through direct taxes on fossil fuels or through cap-and-trade programs, including Emissions Trading Schemes (ETS). Even a relatively modest carbon tax in Malaysia would significantly reduce the price advantage of coal over gas: the Oxford Institute for Energy Studies estimate that if $15/tCO2 were added on top of other costs, the advantage of coal over natural gas would be reduced significantly (Oxford Institute for Energy Studies, 2016) and the Penang Institute estimate that with a carbon tax of RM150/tCO2e, the cost of producing electricity at gas power plants would be only 14.2% higher than coal-fired alternatives – assuming no changes to fuel input costs (Darshan, 2019). Furthermore, the fuel price itself can vary significantly, and at lower prices the relative cost advantage of coal diminishes, given that the fixed costs of gas installations are generally lower (IEA, 2015).

In addition to being roughly half as polluting as coal in terms of CO2 emissions, natural gas also has other advantages as a bridge fuel towards a cleaner energy matrix – specifically the speed of dispatch and cycling costs (i.e. the costs associated with ramping production of a power plant up and down). In both of these categories, gas is superior to coal. While large combined-cycle gas power plants have substantial cycling costs, they are generally cheaper to cycle than coal-fired plants of similar scale, and gas can also be used to power smaller combustion engines, specifically designed for flexibility (Bird et al., 2013). The flexibility to quickly ramp up or down a dispatchable source of energy is critical to accommodate a growing share of renewables, given their intermittency. Both gas and coal can provide energy 24-hour, but gas can do so quicker and with less carbon emissions, critical characteristics to reduce total carbon emissions and complement intermittent renewables. Beyond its superior role as a complement to renewables in general, the use of natural gas also represents significantly more socio-economic benefit in comparison to coal, in Malaysia.

As one of Malaysia's main commodities, the natural gas industry has a significant impact on the economy through various channels. The industry makes a significant direct economic contribution, in terms of output and employment. As an advanced industrial sector, the natural gas industry is characterised by relatively high paying and high productivity jobs. IDEAS estimates that when including jobs created in the supply chain and wider economy, the natural gas industry supports over 82,000 jobs and generates over RM136 billion in output (IDEAS, 2020). Aside from the economic footprint, the natural gas industry also provides a major fiscal contribution to the government in Malaysia from taxation and royalty. Based on data from Rystad Energy, we estimate that natural gas can contribute US$ 86.4 billion, or about RM371 billion to public finances over the next decade (see Appendix 1).

Finally, natural gas is currently the most dynamic part of the fossil fuel industries. It may be surprising to some that, up until the second half of the 20th century, gas had been an undesirable by-product of the extraction of crude oil. This was so because substantial investments are needed to capture, process and transport natural gas – challenges that are less important for the easy to transport and store fuels like coal and crude oil. Therefore, the common practice had been to flare the gas (burn) and avoid drilling in areas that were likely to be more gas-rich rather than oil-rich. However, as the market for gas developed over the years, with transportation over larger distances made possible by investments in pipelines and custom-built ships filled with liquefied natural gas (LNG), it became possible to link production sites with consumers. Today, traditional oil majors, like Shell, are increasingly targeting their exploration and production (E&P) activities to gas plays as part of their energy transition strategy. The sector has also been the target of intense R&D in the world, both on new methods of extraction (such as shale gas) as well as transportation and applications. This dynamism contrasts to the coal sector, which has stagnated as an industry (Bradford 2018). Therefore, Malaysia could stand to gain by linking the development of its gas resources to active local research programs, as has been done elsewhere (Lima-de-Oliveira 2019).

Most of the coal used in Malaysia is imported and therefore – unlike for natural gas – the socio-economic benefits of coal production are concentrated in those countries from which Malaysia imports. The increase in consumption of natural gas, particularly if it drives renewed efforts in local exploration and production (E&P), will result in a commensurate increase in the economic footprint of the industry, with associated socio-economic benefits for Malaysia.

Comparison Table for Coal and Gas

Policy Priority	Coal	Natural Gas
Affordability	Lowest cost option, with no carbon tax	Generally more expensive than coal, competitive at lower fuel costs
System Stability	Stable supply of power	Stable supply of power, but with lower dispatch and cycling costs
Supply Security	Majority of coal is imported	Majority of natural gas is produced domestically; growing LNG global market can complement local production if needed
Emissions	Highest carbon emissions among conventional fossil fuels	Significantly higher emissions than renewables, but half as polluting as coal
Fiscal Impact	Lower cost fuel, but no fiscal benefit associated with coal	Higher cost relative to coal, but significant fiscal benefit from production
Socio-economic Impact	Coal is imported with limited local economic impact	Natural gas is major industry in Malaysia with significant economic footprint

Speeding up the transition and seizing new opportunities

Gas can play an important role in the energy transition by displacing coal and supporting the growth of renewables given its potential to serve as a dispatchable source of energy. It is, however, still a fossil fuel and just the replacement of coal by natural gas will not be enough to face the decarbonisation challenges imposed by climate change. Besides, the role of natural gas as a supplier of peak demand will be challenged in the years to come by technological gains in energy storage (e.g., batteries) and grid management. A study by Carbon Tracker (2009) predicts that by the second half of the 2020s, the cost of new dispatchable renewables will be cheaper than new fossil fuel plants and, by 2030s, cheaper than their operating cost. Therefore, there is an interval of time where gas can contribute to decarbonisation efforts but might later be economically superseded by cleaner alternatives, at least for electricity generation.

As a country with significant wealth built around the fossil fuel industry – including fiscal resources extracted from O&G and the economic activities generated by PETRONAS and their partners and suppliers – it would be of great risk to not anticipate and react to global changes in the patterns of energy consumption. Besides, the transition also brings new growth opportunities along the renewable supply chain (component manufacturing, installation, operation, etc.) and mobility – opportunities that can represent new pillars of economic growth and knowledge creation. Therefore, a national energy policy that takes into account emerging global trends and aims to position Malaysia as a leader will need to focus on two key objectives: adapt for a world of declining fossil-fuel consumption and heightened environmental concerns and seize opportunities in new business models and green technologies to provide new sources of job creation and fiscal revenues. Below we provide some examples of policies that could be considered:

Adapt the business and fiscal environment:

- Support the upgrading of capabilities in the O&G supply chain to unlock new resources and promote international expansion, thus becoming less dependent on local resources to sustain their businesses. Incentivize diversification to renewables by promoting areas that current O&G players have transferable skills (e.g, project management, offshore installation for wind energy).

- Reduce government (federal and state) dependency on fiscal revenues from O&G production, smoothing short-term price fluctuations by limiting yearly transfers from the O&G sector to the treasury. Further, accumulate resources to fund business adaptation and transition to green fuels (funded from O&G proceeds and, potentially, a carbon tax).

Seize new business opportunities:

- Aggressively promote new mobility solutions, energy efficiency standards, and electrical vehicles infrastructure and manufacturing, future-proofing Malaysia's automobile industry beyond internal combustion engine (ICE) technology.

- Further develop Malaysia's solar photovoltaic capabilities by deepening domestic linkages and integrating with R&D and other component manufacturing.

- Promote energy efficiency and higher penetration of intermittent renewables by adopting smart grids with real-time pricing.

This is a non-exhaustive list of policy considerations aimed at anticipating and adjusting to changes in the energy system and capturing value from emerging business opportunities. It would need to be complemented with an enabling framework that promotes competition and innovative-behaviour, including regulatory changes and facilitating the flow of capital to promote green, sustainable development (UNCTAD 2019).

Conclusion

Over the decades since Malaysia's first national energy policy, successive administrations have effectively provided sufficient energy resources to support the country's economic growth and diversified its energy mix. In response to the global challenge of climate change, Malaysia has now committed to an ambitious programme of decarbonisation, including international commitments to reduce emissions intensity. These commitments have been accompanied by efforts to stimulate the production and consumption of renewable energy, particularly large scale solar. However, in parallel Malaysia has increased its consumption of coal - driven by demand for electricity generation - relative to gas which is domestically produced and somewhat at odds with commitments to decarbonise.

Now, as the government considers the future direction of energy policy, it should reflect on the widest range of factors when determining the energy mix moving forward, in particular

Successfully navigating the energy transition and delivering on Malaysia's ambitious commitment to decarbonisation will require an ambitious approach to national energy policy.

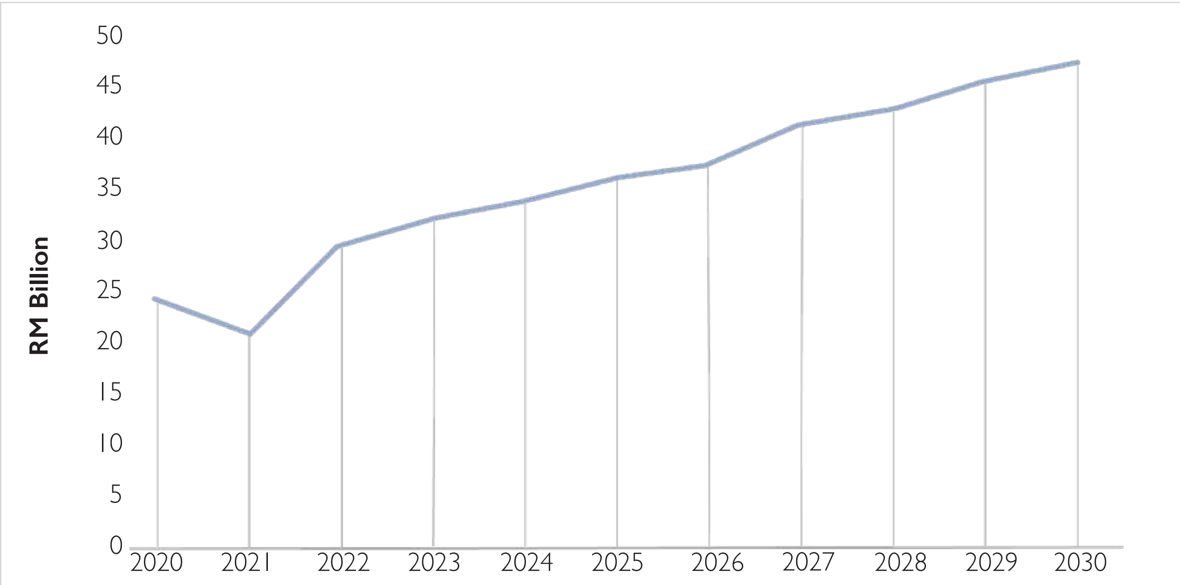
Whilst maximising the use of renewables should be the priority, due to technical limitations, conventional fuel will continue to play a role in the medium term. Here, replacing coal with natural gas is a low hanging fruit to support the transition. Whereas coal has provided a cheap source of fuel, the high carbon emissions risk undermining Malaysia's efforts to decarbonise.

However, while natural gas can play a significant role as a bridge fuel, it is still a fossil fuel and with limited capacity to address the broader global climate change challenge. Furthermore, gas will have its competitiveness challenged in the decades to come by cost-reductions in renewable sources coupled with developments in energy storage, potentially solving the intermittency problem. Thus, Malaysian policymakers should seek to anticipate and adjust to the energy transition by helping companies to adapt and capture value from emerging business opportunities.

Appendix 1: the gas industry in Malaysia

Natural gas can play a key role in energy transition by accelerating the retirement or reducing the use of coal-fired power plants. Malaysia, as a gas-rich country, can reduce its carbon footprint by replacing coal and can also benefit from the economic activity involved in this industry. Figure 7 shows the forecast of government take – the taxation and royalties - derived from gas extraction in Malaysia. The data represents the base case scenario as end of July 2020, therefore, already taken into account the post Covid-19 energy demand shock. However, as in the past, external factors can play a significant factor, given the price of natural gas is determined internationally. At higher prices, more fields are economically profitable to exploit (which can increase the total volume of production). Furthermore, higher prices also can result in more than a proportional raise in government take due to the terms of the production-sharing contracts (PSCs). Figure 8 and 9 illustrate the potential future production and government take respectively according to three different scenarios for the Brent reference price.

Figure 7. Forecast of Government Take from natural gas in RM Billion, 2020-2030

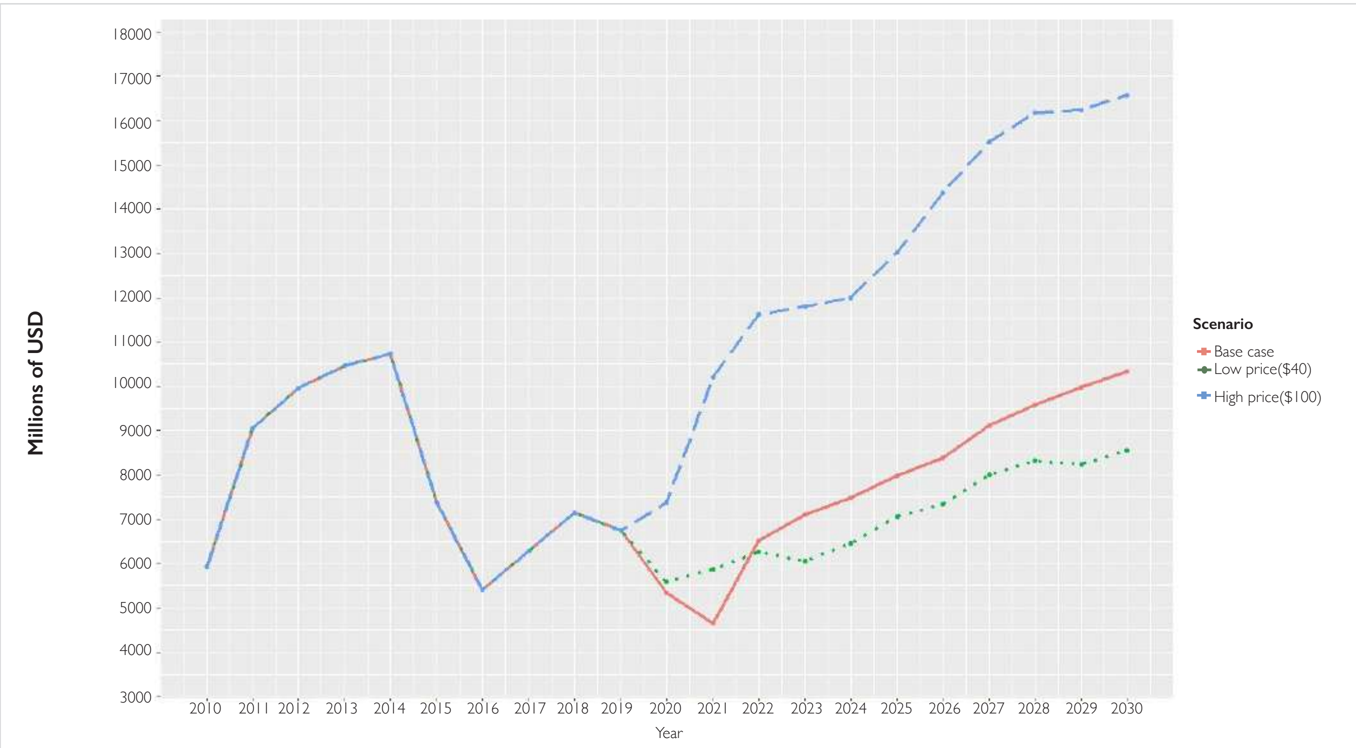


Source: Authors' calculations based on Rystad Energy

Figure 8. Forecasted natural gas production under different price scenarios

Source: Authors' calculations based on Rystad Energy

Figure 9. Forecasted government take from natural gas under different price scenarios



Source: Authors' calculations based on Rystad Energy

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