Accelerating Climate Action and Transition to Low Carbon Economy

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Abstract:

The competitive business environment around the world shows that today's environment and factors affecting it are very different and more complex than what was in the past (Ghodzi, 2015). Climate change is one of the key risks faced by businesses which also impacts the national economies of every country around the world. In Oct 2018, the UN's Intergovernmental Panel on Climate Change (IPCC) reported that at the current development rate, global warming of 1.5°C is likely between the year 2030 and 2052. This level of warming will cause irreversible damage and increase climate-related risks such as those of energy, water supply, human health and economic growth.

Hence, it's inevitable to accelerate the climate action and transition towards low carbon economy where hydropower can play an important role in accelerating the climate action and creating the foundation for the transition to low carbon economy. In 2018, Sarawak CO_2 grid emission intensity is at 193 gCO_2/kWh which is 57% lower than the global average of 450 gCO_2/kWh (World Economic Forum, 2019). This is mainly due to the increase of renewable energy generation from 1,248 GWh (2011) to 20,888 GWh (2018). Over the 8 years period, Sarawak's grid emission intensity has significantly reduced by 72 % from 698 gCO_2/kWh in 2011 to 193 gCO_2/kWh in 2018.

The transition towards renewable energy generation provides an opportunity to address multiple environmental, economic, and development needs of the country and the world at large [1,2]. This paper will highlight the role of hydropower in accelerating climate action and low carbon economy from the sustainable competitive advantage perspectives.

Keywords: ***Accelerating Climate Action, Low Carbon Economy, Sustainable Competitive Advantage Perspectives***

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[1] *InterAcademy Council, Lighting the Way: Toward a Sustainable Energy Future Report, Energy Supply, Chapter 3, The InterAcademy Council, The Netherlands, 2007*

[2] *V. Modi, S. McDade, D. Lallement, and J. Saghir, Energy and the Millennium Development Goals, The Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project, and World Bank, New York, NY, USA, 2006.*

1.0 Introduction - Electricity Sector in Malaysia And Sarawak

All economic activity requires energy and globally, energy generation is dominated by energy from fossil fuels which results in carbon emission. The link between the economic growth, carbon emission and climate change is one of the complex and critical issues faced by the energy sectors globally. From the supply side perspectives, renewable energy plays an important role that provides foundation to address climate action and transition to low carbon economy by providing a reliable, clean and affordable energy while meeting the environmental, economic, and development needs of the country.

For Malaysia, the overall energy consumption is predicted to grow at an annual rate of 4.8% from the year 2000 to 2030 and the final energy demand is expected to triple by the year 2020 from the current consumption level.[3] The Malaysian electricity sector or grid connected electricity system can be categorised into three regions or grid systems, namely Peninsular Malaysia, Sarawak and Sabah.

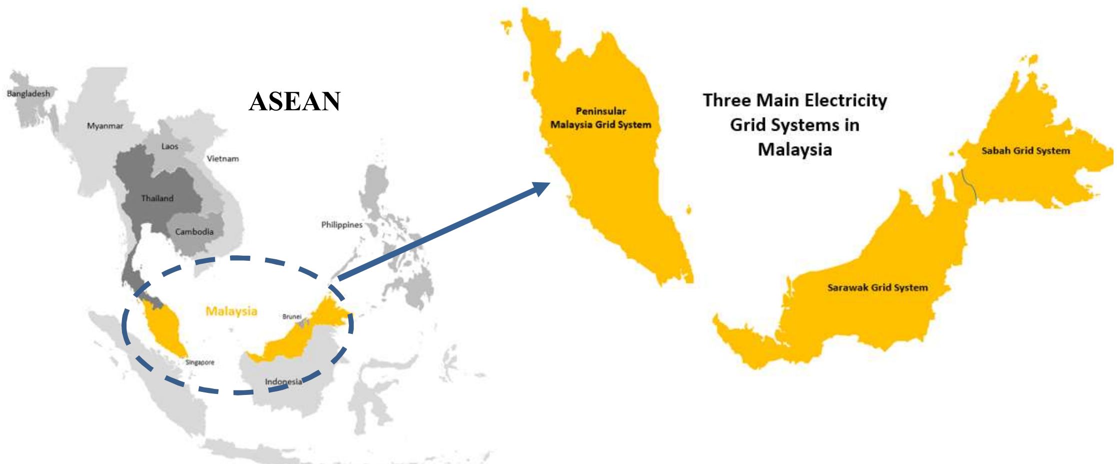

Figure 1: Three Main Electricity Grid Systems in Malaysia

These grids are not interconnected with each other, where in 2017 the Peninsular Malaysia grid has the highest installed capacity of 24,139 MW[4] followed by Sarawak grid with an installed capacity of 4,641 MW and Sabah grid with an installed capacity of 1,184 MW. The overall generation mix in Malaysia is dominated by thermal generation with a share of 82% or 132,790 GWh and hydropower generation with a 17% or 26,712 GWh.

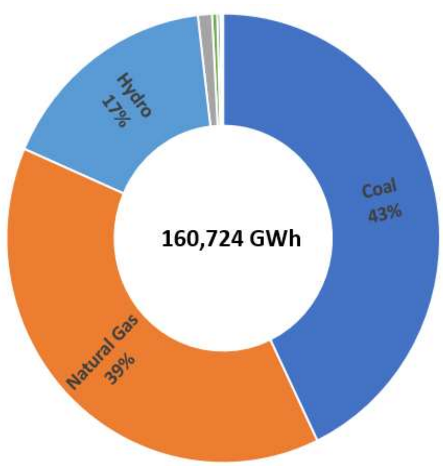

Figure 2: Malaysia Overall Generation Mix

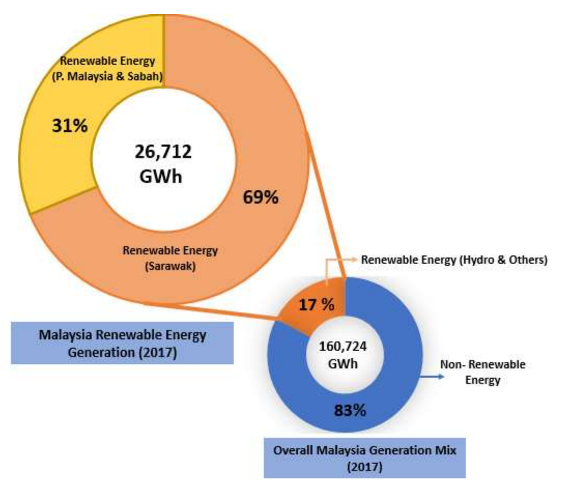

Figure 3: Malaysia Renewable Energy Generation

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[3] *Lopez, G.; Laan, T. Biofuels—At what cost? Government Support for Biodiesel in Malaysia; International Institute for Sustainable Development: Geneva, Switzerland, 2008; Available online: https://www.iisd.org/gsi/sites/default/files/Final_Malaysia_2.pdf*

[4] *Energy Commission (2017), Performance and Statistical Information on Electricity Supply Industry in Malaysia; Available online:* https://www.st.gov.my/contents/files/download/99/ST-MPSIPEM_2017_Booklet-FINAL-15-07-2019-LATEST.pdf

Sarawak Energy Berhad (Sarawak Energy), fully owned by the state of Sarawak is the largest hydropower developer and operator in Malaysia with a hydropower grid installed capacity of 3,452 MW followed by the Peninsular Malaysia grid with 2,536 MW and the Sabah grid with 73 MW. Its electricity sales alone account for 4% of the state's GDP and in terms of generation mix, Sarawak grid hydropower generation constitutes about 69% or 19,241 GWh (2017) of the overall renewable energy generation in Malaysia (Figure 3).

2.0 Accelerating Climate Action

Climate change, as defined by the Intergovernmental Panel on Climate Change (IPCC), is a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2013a).[5]

In 2015, the Paris Agreement set an unprecedented ambition to stabilise global temperature rise to between 1.5°C and 2°C, while at the same time mobilise significant financing to adapt infrastructure, and society in general, to the impact of climate change. Malaysia is the signatory to the Paris Agreement and intends to reduce its GHG emission intensity of GDP by 45% by the year 2030 relative to the emission intensity of GDP in 2005. This consist of 35% on an unconditional basis and a further 10% is condition upon receipt of climate finance, technology transfer and capacity building from developed countries.

The United Nations has rolled out a list of 17 Sustainable Development Goals of which one particular goal focusing on the climate change is SDG 13-Climate Action. SDG 13 is aimed for all countries to strengthen their resilience and adaptive capacity to climate related hazards. Climate actions goals are defined by the United Nations as taking the urgent actions to tackle climate change and its impact and considered as the active efforts to reduce greenhouse gas emissions. Committed countries take part in this action by integrating climate action measures to their national strategy, policies and planning in their regional, national and international agenda.

Pursuing these initiatives requires solutions to be co-ordinated at national and international levels of which Malaysia was one of the 186 countries that has set the commitment to reduce global warming carbon emissions by 2030 through a National SDG Roadmap aligned with the 11th Malaysia Plan. Priority areas were developed under the pillar of "Enhancing Environmental Sustainability through Green Growth", one of which was the Priority Area C – Combating Climate Change and reducing disaster risks. The need to urgently strengthen global response to effects of climate change concurrently intensifies the need for countries to strive for better proportion for clean and renewable energy sources, whereby hydropower can play a key role.

Table 1: Important Events in International Climate Change Treaties & Negotiations

Year, Location	Outcome
1992, Rio de Janeiro	UN Framework Convention on Climate Change (UNFCCC). Countries agree to reduce emissions with "common but differentiated responsibilities."
1995, Berlin	The first annual Conference of the Parties to the framework, known as a COP. U.S. agrees to exempt developing countries from binding obligations.
1997, Kyoto	At the third Conference of the Parties (COP-3) the Kyoto Protocol is approved, mandating developed countries to cut greenhouse gas emissions relative to baseline emissions by 2008-2012 period.
2001, Bonn	(COP-6) reaches agreement on terms for compliance and financing. Bush administration rejects the Kyoto Protocol; U.S.is only an observer at the talks.

[5] *Victor D.G., D. Zhou, E.H.M. Ahmed, P.K. Dadhich, J.G.J. Olivier, H-H. Rogner, K. Sheikho, and M. Yamaguchi, 2014: Introductory Chapter. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.*

2009, Copenhagen	COP-15 fails to produce a binding post-Kyoto agreement, but declares the importance of limiting warming to under 2°C. Developed countries pledge $100 billion in climate aid to developing countries.
2011, Durban	(COP-17) participating countries agreed to adopt a universal legal agreement on climate change as soon as possible, and no later than 2015, to take effect by 2020.
2015, Paris	COP-21 195 nations sign the Paris Agreement, providing for worldwide voluntary actions (NDC's) by individual countries.

Source: The Economics of Global Climate Change Global Development (2017)

3.0 Hydropower and Climate Change

According to IHA 2018 Hydropower status report, it was recorded that 4,185 Terawatt hours (TWh) in electricity was generated from hydropower in 2017, which avoided up to 4 billion tonnes of greenhouse gasses and pollutants. Commonly regarded as a cleaner source of energy, hydropower in comparison to conventional coal power plants has the potential to prevent emissions up to 3GT CO_2 per year representing about 9% of global CO_2 emissions [2].

Hydropower projects could also have an enabling role beyond the electricity sector, as a financing instrument for multipurpose reservoirs and as an adaptive measure regarding the impacts of climate change on water resources, because regulated basins with large reservoir capacities are more resilient to water resource changes, less vulnerable to climate change, and act as a storage buffer against climate change. [3]

In general, hydropower is a source of energy that produces minimum GHG emissions. The CO_2 emissions per GWh are 3–4 t for hydropower run-off river, and 10–33 t for hydropower with a reservoir; these values are about 100 times less than the emissions from traditional thermal power (WEC, 2004)[6]. According to SRREN (2011), which is a special report of the International Panel on Climate Change (IPCC) titled "Renewable Energy Sources and Climate Change Mitigation," shows that the majority of lifecycle GHG emission estimates for hydropower cluster are between 4 and 14 g CO_2eq/kWh.[7]

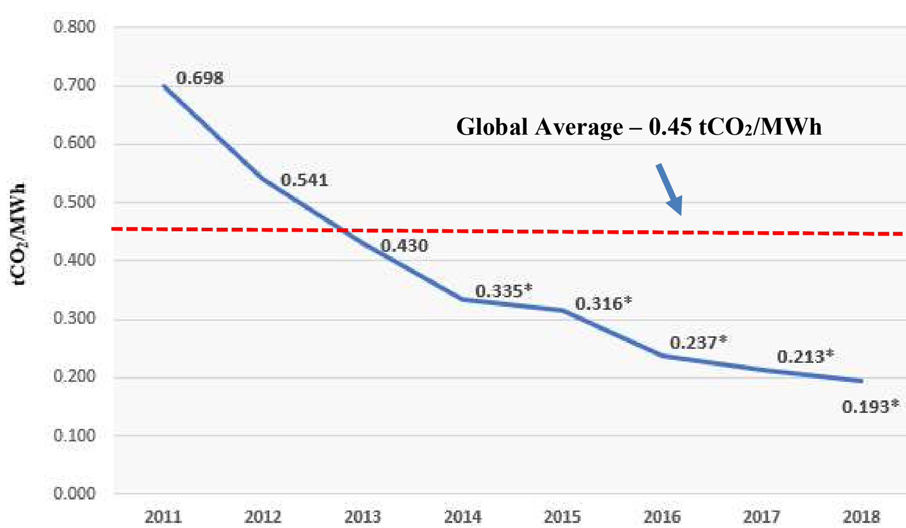

Figure 4: Sarawak Energy Main Grid Emission Intensity (tCO_2/MWh)

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[6] *World Energy Council. Comparison of energy systems using life cycle assessment: a special report of the World Energy Council. London: World Energy Council; 2004.*

[7] *Edenhofer O, Pichs-Madruga R, Sokona Y, Seyboth K, Matschoss P, Kadner S, et al., editors. Renewable energy sources and climate change mitigation: summary for policymakers and technical summary—special report of the intergovernmental panel on climate change. New York: Cambridge University Press; 2011.*

In Sarawak, hydropower is delivering clean, reliable and affordable source of energy to meet the State's economic and social development, energy security, affordable and reliable energy. Renewable energy share in Sarawak has grown by 1572% since 2011 which significantly contributes to the reduction of CO_2 emission intensity where Sarawak's main grid CO_2 emission intensity has shown drastic declining trend since 2011 due to the significant increase of renewable energy share in Sarawak generation mix (Figure 4). This quantum leap had seen the reduction of Sarawak CO_2 grid emission intensity by 72% from 698 gCO_2/kWh (2011) to 193 gCO_2/kWh (2018) which is 57% lower than the global average of 450 gCO_2/kWh (World Economic Forum, 2019).

4.0 Hydropower and Transition to Low Carbon Economy

The use of high-carbon energy - coal, oil, gas and electricity – has increased substantially in Indonesia, Malaysia, Philippines and Thailand in the last 25 years, with an annual growth rate of 7%. The annual energy requirement of the countries are expected to increase by 4.2% over the next 25 years where the figure is just 1.7% for the rest of the world. [8,9]

High levels of economic growth coupled with growing population and urbanization have resulted in a substantial increase in demand for energy. The relationship between use of energy and economic growth has been a subject of greater interest as energy is considered to be one of the important driving forces of economic growth in all economies (Pokharel, 2006).[10] Whereas, the low-carbon economy growth is related to sustainable economic growth with an economy that is based on low carbon generation sources that has a minimal output of greenhouse gas emissions into the biosphere, specifically referring to the greenhouse gas carbon dioxide[11 12].

In the context of ASEAN, energy generation and demand are growing steadily, with the combined energy needs of the Association of Southeast Asian Nations (ASEAN), the PRC, and India are expected to increase by 83% during the period to 2030 (IEA–ERIA 2013). The region's energy-related carbon emissions will be almost double from 33.7% in 2010 of global emissions to 46.1% in 2030[13]. With vast hydropower potentials within the region, it would be prudent to position hydropower as the catalyst in transition to low carbon economy. Hydropower is known globally as the largest single source of renewable energy, clean and relatively cheap electricity price. With this energy available to the region, it will attract potential investment especially for heavy and power intensive industries. Hence, role of hydropower demonstrates a good economic case as a foundation in energy transition towards low carbon economy.

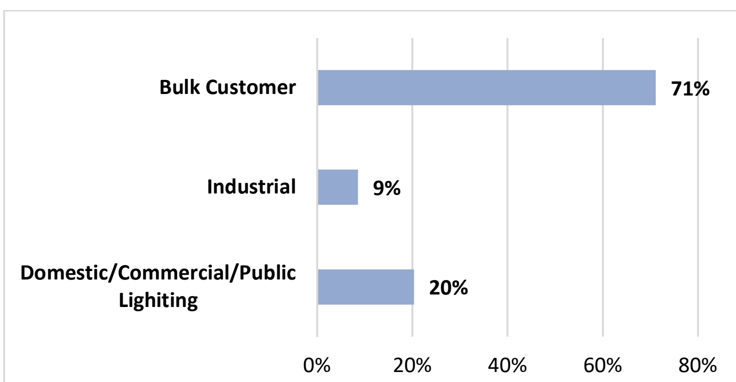

Figure 5: Sarawak Energy Customers by Types

Since 2008, Sarawak has embarked on its journey towards the transition to low carbon economy via an integrated long-term plan of economic development namely the Sarawak Corridor of Renewable Energy (SCORE). SCORE is the long-term 2008–2030 development plan focussing on growing the renewable energy sector and targets 10 high-impact priority industries, with the aim of attracting major projects that will also create downstream

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[8] *ASEAN Centre for Energy (ACE) , Renewable Energy Policies: Jakarta: ASEAN Centre for Energy, 2016*
[9] *International Energy Agency (IEA), World Energy Outlook, Paris : International Energy Agency, 2016*
[10] *Pokharel, S. H. (2006). An Econometrics Analysis of Energy Consumption in Nepal. Energy Policy, 1–12.*
[11] *Kondyli, J. Measurement and Evaluation of Sustainable Development: A Composite Indicator for the Islands of the North Aegean Region, Greece. Environ. Impact Assess. Rev. 2010, 30, 347–356.*
[12] *Reilly, M.J. Green growth and the efficient use of natural resources. Energy Econ. 2012, 34, 85–93.*
[13] *ADBI (2019). "Managing the Transition to a Low-Carbon Economy: Perspectives, Policies, and Practices from Asia"*
South, S. (1981). "Competitive advantage: the cornerstone of strategic thinking". Journal of Business Strategy, Spring, 1, 15-25.

opportunities for smaller businesses[14]. The key elements in the development strategy for SCORE is to focus on leveraging Sarawak's abundance of potential in renewable hydropower energy. Currently, bulk customers dominate the electricity demand in Sarawak by 71% followed by Domestic/Commercial Customers by 20% and Industrial Customers by 9%.

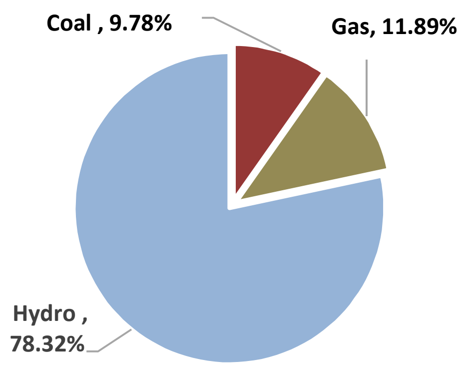


Figure 6: Sarawak Energy Generation Mix (2018)

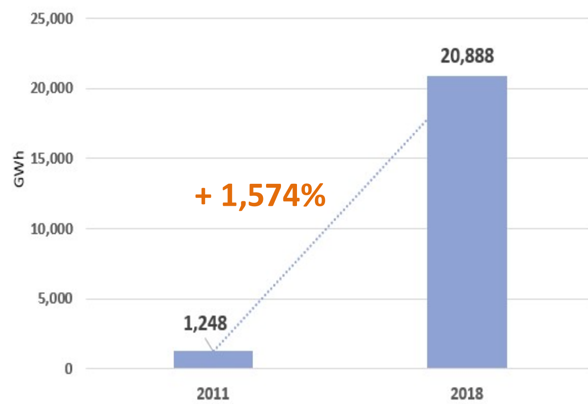


Figure 7: Comparison of Renewable Energy Generation between 2011 and 2018

Sarawak Corridor for Renewable Energy (SCORE) has made it possible for Sarawak Energy to invest on large scale hydropower and thus creates a foundation towards the transition to low carbon economy. Hydropower provides inexpensive, affordable, reliable and sustainable renewable energy to attract foreign investment in energy intensive industries. Prior to SCORE, Sarawak power generation mix were predominantly from thermal sources (coal, gas and diesel fuel). To date, hydropower generation has increased by 1,574% from 1,248 GWh in 2011 to 20,888 GWh in 2018 which accounts for about 78% of Sarawak generation mix.

5.0 Competitive Advantage of Hydropower – Climate Action and Low Carbon Economy

The governments are also increasingly recognizing the importance of Hydropower and they have become a part of the national strategies in combatting climate change, at the same time delivering affordable and clean energy, with means to manage freshwater and improving the livelihood of their people. (IHA, 2019)

Transitioning to a low carbon economy presents both a significant opportunity and an enormous challenge. An opportunity in that the commercialization of low-carbon solutions, including clean energy technologies, can further catalyse an important emerging market and support the transformation of the global energy sector.[15] Energy has always become one of the strategic factors that drives business decision making. Coupled with energy-efficient processes, climate -friendly technologies and decision to curb GHG--- this will lead to competitive edge to whom who are able to take the opportunity. (McKinsey & Company, 2009).

5.1 Hydropower – Baseload Demand

Sarawak Energy's electricity sales has increased significantly by 139% from RM 2.32 billion in 2013 to RM 5.55 billion in 2018 with an average increase of 19% per annum. The significant growth in electricity sales was supported by an increase of renewable energy generated and a similar upward trend was observed with an increase of 262% from 5,765 GWh (2013) to 20,888 GWh (2018). There is a strong correlation between electricity sales and renewable energy generated (r = 0.99) between 2013 to 2018. This relationship shows the capability of hydropower to meet the mass demand (baseload) of energy in Sarawak as compared with other renewable energy sources.

[14] http://www.recoda.com.my/what-is-score/
[15] *Goldman Sachs, Transition to a Low-Carbon Economy, 2010*

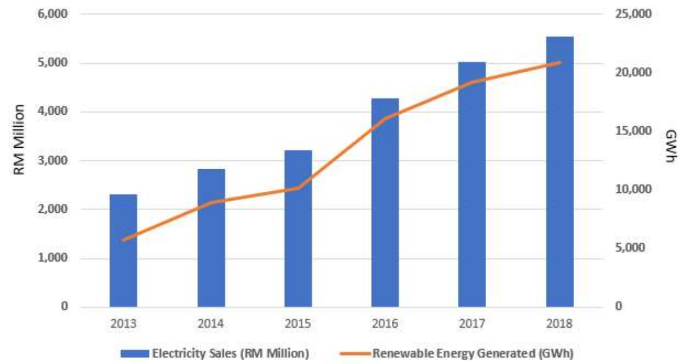


Figure 8: Relationship between Electricity Sales and Renewable Energy Generated

5.2 Hydropower Operation and Maintenance Cost

Hydropower operations require little maintenance that leads to low operation and maintenance (O&M) costs (IPCC, 2012). The O&M costs is relatively low compared to other REs, which is between 1.5% to 2.5% of investment costs per year. (Lako, 2010). Large hydropower is also well-known for its very long lifetime, thus the cost will be spread over time, producing a lower and more competitive LCOE.

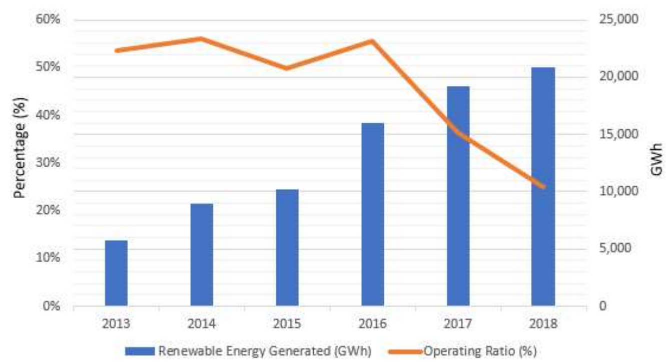


Figure 9: Relationship between Renewable Energy Generated and Operating Ratio

For Sarawak Energy, the operating ratio has reduced by an average of 46% per annum in contrast with an increase of renewable energy generated by 31% per annum. The reduction in operation ratio, indicates that the operation expenses are becoming an increasing smaller percentage of net sales. This shows that renewable energy generated contributes to lowering the overall operating cost of Sarawak Energy. In addition, hydropower can be used for peaking purposes too as it is able to respond to power demand fluctuations much faster compared to other generation systems such as thermal electric power stations (Locher, 2004)

5.3 Catalyst to economic growth and productivity

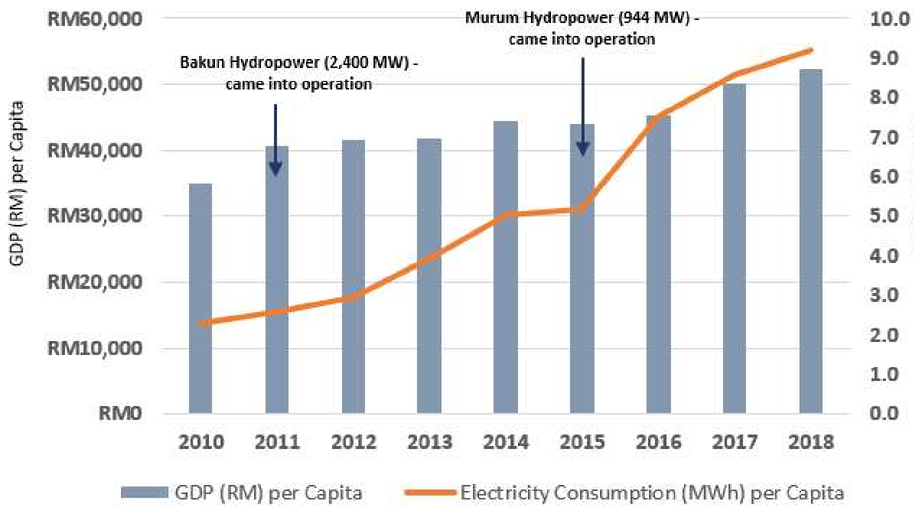
Socioeconomic analyses on electricity and development are based on correlations between the main electricity indicators (i.e., consumption per capita per year, kWh per year per capita, and the percentage of the population with access to electricity (AE%)) and the macro-socioeconomic indicators (i.e., gross national income (GNI) per capita and human development index (HDI)).

All socioeconomic analyses show that in developed countries (those with high income (HI) and a high HDI), 100% of the population has access to electricity, and the average consumption is about 8500 kWh per year per capita. In contrast, for countries with low income and low HDI, only about 25% of the population has access to electricity, and the consumption is less than 500 kWh per year per capita. Thus, there is a strong correlation between electricity indicators and socioeconomic development[16].

[16] *Berga L. Dams for sustainable development. In: Proceedings of High-level International Forum on Water Resources and Hydropower; 2008 Oct 17–18; Beijing, China; 2008.*

For Sarawak, the total revenue from the sales of electricity accounted for is 4% of the State's GDP whereby the renewable energy generation has grown by 1,574% from 1,247 GWh in 2011 to 20,888 GWh in 2018. This is as a results in the increase of electricity consumption by 264% from 2.3 MWh per capita in 2011 to 9.2 MWh per capita whereby 78% of the generation was supplied by renewable energy in 2018.

Figure 10: Electricity Intensity – Electricity Consumption per Sarawak GDP



Notes:
1. State of Sarawak GDP (2010 – 2018) at current price
2. Department of Statistic Malaysia – GDP (2010-2018) & Population (2010-2018)
3. *Sarawak Energy - Electricity Consumption (MWh)*

The State of Sarawak GDP has grown steadily on an average of 5.3% from 2010 to 2018 except for 2015, which indicates real economic growth and strong economic output. As shown in Figure 10, GDP per capita growth has a strong correlation coefficient ($r = 0.93$) to the electricity consumption per capita where renewable energy from hydropower is the key foundation for the strong growth in Sarawak. From 2010 to 2018, the average growth of renewable energy is about 56% per annum and the demand of electricity has also created an indirect economic spin-off to the State's economy.

6.0 Conclusion

Developing countries have already started to move towards low carbon economy and market sustainable development to bring competitiveness to their industries. Low carbon economy is essentially defined as having a system that aims to minimize greenhouse gasses emission while accelerating the economic development of a country or state.

Hydropower generation playing an important role in decarbonizing Sarawak electricity grid whereby in just over 8 years Sarawak grid emission intensity has significantly reduced by 72% from 698 gCO_2/kWh (2011) to 193 gCO_2/kWh (2018) due to the increase of renewable energy generation from 1,248 GWh in 2011 to 20,888 GWh (2018). Shifting the generation mix toward renewable energy has accelerated climate action as well as providing access to clean, reliable and affordable energy for State economic development.

Hydropower generation is the foundation in the transition toward low carbon economy that can further catalyse on the economic growth and social development for Sarawak where the electricity consumption has increased from 2.3 MWh per capita in 2011 to 9.2 MWh per capita in 2018 whereby 78% of the generation was coming from hydropower.

From the supply side perspectives, renewable energy plays an important role that provides foundation to address climate action and transition to low carbon economy by providing a reliable, clean and affordable energy while meeting the environmental, economic, and development needs of the country.

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The Authors CVs

Mohamad Irwan Aman is a Senior Sustainability Manager for Sarawak Energy Berhad and his main responsible is to develop and implement sustainability strategies which reflects Sarawak Energy's values and supports for its business plans. He holds a Master of Science in Environmental Engineering and Master of Business Administration in Finance. He has had 21 years of working experience in research & development, environmental impact assessment, strategic planning, feasibility studies, project financing, due diligence assessment, and audits in energy and finance sectors. In addition to his working experience, he also had been engaged as a technical advisor in various local and international projects related to sustainability projects, such as: Korea–Malaysia ASEAN CDM +3 & NAMA Program; Malaysia Grid Emission Baselines; Malaysia–Denmark CDM Implementation Action Plan; Malaysia Energy Balance & Emission Inventory for National Communication 2; and Malaysia Standard for Carbon Emission at Organisation Level (ISO 14000/TC 207).

Isma Khuzaima is a Senior Manager for Corporate Performance & Stakeholders Engagement in the Strategy & Corporate development Department of Sarawak Energy Berhad. She graduated with a Bachelor's Degree (Hons) in Chemical Engineering from University of Manchester, Institute of Science & Technology (UMIST), UK. She has 15 years' working experiences, with the last 6 years with Sarawak Energy Berhad. Her experiences in the utility industry has seen her involved in project financial modelling, business case analysis, corporate performance monitoring as well as engaging stakeholders especially the government agencies on company's strategic information.

Dayang Zanariah graduated with a Bachelor's Degree (Hons) in Civil and Structural Engineering as well as a Masters of Science Degree in Engineering from the University of Leeds, UK. As a civil engineer, Dayang Zanariah is currently working with the hydropower division under the Project Execution Department. Her working experience in hydropower ranges from the initial planning, pre-engineering design stage, and currently involvement in the supervision of one of the packages of a mega hydropower project. She was also involved in setting up the best practices structure for the Project Execution Department, in developing towards project integration excellence.

Mohd. Firdaus graduated in the Bachelor Degree of Civil Engineering and Corporate Masters in Business Administration from the University Malaysia Sarawak, Malaysia. He is currently being stationed on site as part of the project management team for the construction of a 10 MW HEP, and is in charge of the quality control and assurance of one of the project work packages. His experience includes involvement in different phases of hydropower progress, such as planning, tender design, as well as feasibility studies for other hydropower projects.

Zaimie Zainal Abidin holds a position of Sustainability Executive (Reporting & Analysis) and his main role is to assist in the development of Sarawak Energy's Sustainability Report, monitoring data governance and system as well as its disclosures. He also involved in executing other sustainability initiatives and assisting to embed sustainability good practices in the business operation. He graduated with a Bachelor's Degree (Hons) in Chemistry (Forensic Analysis) from the MARA University of Technology and MBA in Communication & Public Relations from the Limkokwing University of Creative Technology.