Wind, hydro and solar energy challenges for Technical Vocational and Training (TVET) electrical entrepreneur in Malaysia: A review

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Abstract. Renewable energy is one of the alternative energy resources in Malaysia to replace fossil fuel use, which is an important issue that needs to be established. Some of the possible renewable energy sources are wind, hydro and solar. Since 2019, various incentives announced by the Malaysian Ministry of Energy and Natural Resources (KeTSA) to enhance renewable energy development which is in line with Government Energy policy. However, today, in contrast to the participation of investors and international contractors, the presence of entrepreneurs and domestic workers in this sector is feeble. In this regard, the Technical Vocational and Training (TVET) institution is seen to have the potential to minimize this crisis by creating competent, skilled and competitive electrical entrepreneurs for the field of renewable energy. This paper explores the ability of TVET electrical entrepreneurs to participate in renewable energy businesses. Based on the literature on energy entrepreneur development, it was found that the TVET electrical entrepreneur faces four challenges, namely financial, technology costs, logistics and government support. The proposed future development of renewable energy is in Mini-hydro and solar photovoltaic (PV), while wind power does not seem viable to TVET electricity entrepreneurs.

1. Introduction

The world's current needs for affordable, renewable energy (RE) have been growing and taking the path of sustainable development, decarburization, and climate security [1]. Unlike in previous years, today's policymakers and regulators need a different market and economic context, including preparing for RE development. Wind, hydro and solar (WHS) REs has the potential to be developed. These resources are available in specific areas in Malaysia which must take into government consideration.

In 2018, Malaysia announced that it had set a target of 20% RE in its generation mix by 2025 [2]. The Southeast Asian nations, which thermal power plants mainly power, recorded a two per cent contribution from RE to its generation mix at the end of 2018. To achieve the target of 20% in 2025, it is estimated that Malaysia will need RM33 billion (US$8 billion) worth of investments in its RE sector[3]. The expected investments would come from the government and public-private partnerships and private financing [2] and [4].

There is an opportunity where young electrical entrepreneurs can take part RE development. However, knowledge and skills about RE be strengthened in their studies so that the challenges in entrepreneurship can be overcome well without directly affecting the investors and government [5]. The government should promote efforts to grow technical entrepreneurs in the field of RE through Technical

Vocational Education Training (TVET) institutions or any technical institution that will produce highly qualified technical entrepreneurs in preparation for 20% RE generation by 2025[6].

It was noticed that the graduates of TVET institutions still lack the capabilities to be an electrical entrepreneur in the region. To be exact, just 12% of the total number of TVET institutions in Malaysia is pursuing the fields of WHS [7]. This shows that the students in the electrical field are less ready to venture into electrical entrepreneurship, especially in renewable energy after graduation. Similar problems also have been observed in which the graduates have the entrepreneurial potential but lacked entrepreneurial knowledge, confidence, creativity and innovation in facing global challenges [8].

This study aims to identify the current issues on the development of RE in Malaysia and the challenges faced by TVET electrical entrepreneur to involve, participate, and get into the real business of WHS RE.

2. Overview of Sustainable Energy

2.1. Renewable Energy (RE) Development in Malaysia

As a developing country, Malaysia made a quick response to global warming with the initiation of RE development campaign in the National Energy Policy by setting a target of 5% for RE generation [2]. Commercial energy consumption in Malaysia has gradually risen and is increasing at the pace of national economic growth. Economic growth, industrialization and urbanization have been showing to be directly related to commercial energy use and to the consumption of energy products. Based on the Energy Malaysia Magazine in 2017, it showed that the total energy consumption in Malaysia had reached 21,773 MW and energy generated from various generation plants either from conventional thermal coal, gas or hydro were at 28,324 MW [2]. It is clearly found that the reserve margin of total energy is only 23.13%.

In Malaysia, several potentials RE resources have been developed, where the most considerable renewable energy came from solar, hydro and biomass. However, according to the 11th Malaysia Plan (2016-2020), the Malaysian government under the Ministry of Energy and Natural Resources (KeTSA) had launched the strategy and action plan that was aimed to achieve a target for RE of 7.8% or 2080 MW of the total electricity generation in 2020[2]. Hence, the incentives and encouragements through programmes such as Feed-in Tariff (FiT), Large Scale Solar (LSS) and Net Energy Metering (NEM) were introduced [9].

In December 2020, KeTSA again introduced NEM 3.0 programme to provide the opportunity for users to install the Solar Photovoltaic (PV) system into their premises [10]. This initiative is going to have an impact on the reduction of electricity bills, thus enhances the development of RE in this country. The quota of 500 Megawatt (MW) will be distributed to the consumer who is interested start from February 2021 until December 2023 to achieve the target of 20% RE electricity generation 2030[3],[10]

2.2. Wind, Hydro and Solar (WHS) in Malaysia

Another form of potential RE in Malaysia is wind power. Compared to other windy countries, Malaysia can be classified as a low wind speed country. In Malaysia, heavy winds are usually blowing from the Indian Ocean and the South China Sea. The mean monthly wind velocity is between 1.5 and 4.5 m/s. Areas at higher altitudes can harness wind power from 9 to 11 m/s. In Peninsular Malaysia, Mersing, Johor and Kuala Terengganu have been listed as high wind regions, while in the East Malaysia Kudat, Sabah recorded the highest. Generally, due to the monsoon season, the southern part of peninsular Malaysia has more wind capacity and more wind in January [4]. Recently, several wind powers developed in Malaysia but still in assessment to determine the wind energy capability for main electric generation. Table 1 shows the study on windmills that have been installed since 1995, where Pulau Terumbu, Sabah has the highest expected power generated with 150 kilowatts (kW) and Setiu, Terengganu has the smallest windmills with 3 kW based on the research by Universiti Malaysia Terengganu[11].

Table 1. The generation of wind energy in Malaysia [11].

Location	Power Generated (kW)	Owned by
Pulau Terumbu, Sabah	150	Tenaga Nasional
Pulau Perhentian, Terengganu	100	Tenaga Nasional
Kudat, Sabah	25	Tenaga Nasional
Setiu Terengganu	3	Universiti Malaysia Terengganu

Malaysia also has great potential from its natural hydropower resources. As Malaysia has 189 rivers with a total length of approximately 57,300 km, this is primarily due to its unique geographical advantage. In 2016, hydropower generation contributed to 13% of Malaysia's total power generation. Most of the large hydroelectric plants are owned by Tenaga Nasional Berhad (TNB), and two more plants under construction in Nenggiri (300 MW) and Tekai (156 MW) in the state of Kelantan. Small or mini-hydropower stations below 30 MW operate in a liberalized market, which means that they are open to any private developer and are mainly incentivized by the Sustainable Energy Development Authority (SEDA) in Malaysia Feed-in Tariff (FiT) scheme. Currently, these mini-hydropower stations contributed up to 200 MW of Malaysian energy generation [12].

At the initial stage of the deployment of wind and mini-hydropower in Malaysia, support and incentives from the government are needed in capital-intensive investment. Unlike solar, FiT incentive is still available for mini-hydro power and wind power plant [13]. However, the low wind speed condition is restricting the generation of wind energy, where suitable technologies for low wind conditions should be explored to harness wind power's untapped potential. Figure 1 shows the forecast mix of electricity generation until the year 2026. It was found that the coal energy generation will be decreased, and the presence of RE will take about 19% of the total electricity generated.

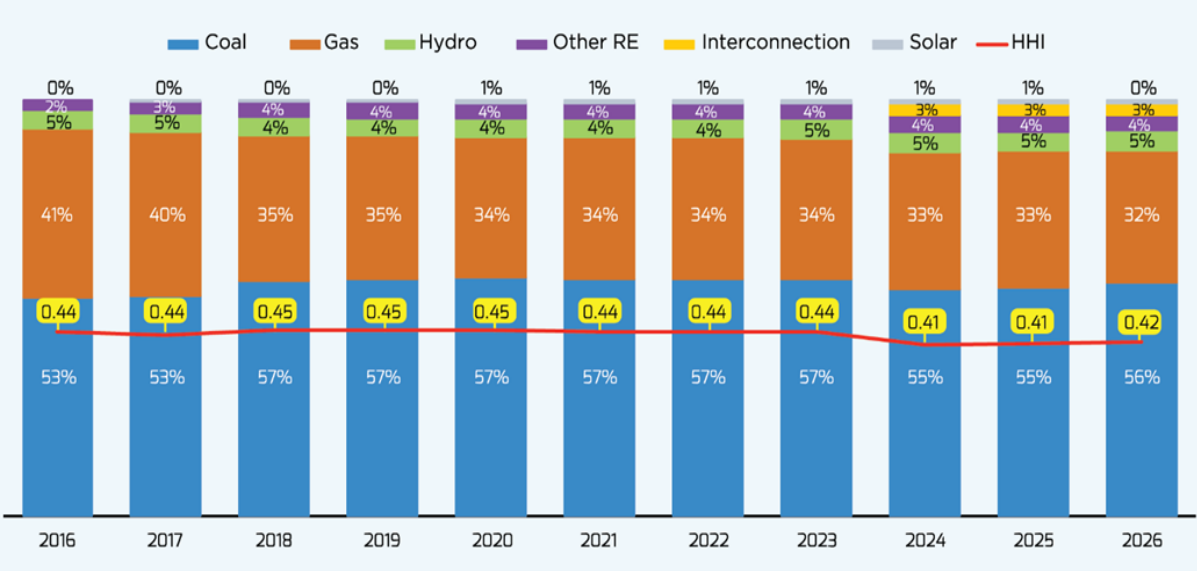

Figure 1. Generation mix in Peninsular Malaysia[14].

As a critical element in RE development, solar play a significant role in the RE programs initiated by the government, especially KeTSA. In order to encourage the generation of solar photovoltaic (PV) more widely, incentive schemes such as NEM, LSS and FiT were announced due to the high resource potential of solar in Malaysia [citation needed]. The low impact in initial costs and healthy market price competitions makes the development of solar PV energy generation ahead of other RE resources. Generally, the federal government is still struggling to achieve their target of 20% RE electricity generation in the year 2025 despite various incentives provided [3]. The involvement of local companies

in the development of RE generation is one of the issues in the solar PV implementation. This is due to the fact that solar technology was owned by foreign companies. Thus the role of TVET electrical entrepreneur is required to drive the production of RE in accordance with the country's aspirations and desires.

2.3. Challenges for TVET Electrical Entrepreneur

The concept of "entrepreneur" or "entrepreneurship" was never consistent among economists (the word "entrepreneur" comes from the French verb entreprendre, meaning "to undertake") [15]. The classical and neoclassical economists left entrepreneurs out of their formal models, although the idea of an entrepreneur existed and was recognized for centuries: they believed that perfect knowledge would be known to entirely rational actors, leaving little space for risk-taking or experimentation. Economists did not actively integrate entrepreneurship into their models until the middle of the 20th century [16].

In Malaysia, the entrepreneurial sector is seen as the best mechanism for reducing the unemployment rate among young people, especially among Technical Vocational Education and Training (TVET) graduates [17]. Entrepreneurs can generate economic growth for the nation by serving as job producers. It is common knowledge that Malaysian young people, especially the TVET graduates, are currently facing a tough challenge to find a place in their career selection [18]. This is due to the increase of employer demands and career challenges, where graduates are evaluated in terms of academic credentials and skills and other value-added abilities. In developed countries, they are facing problems to absorb the rising number of graduates, where the employment system is seen as having constant pressure on the existing labour market.

The electrical field is one of the sectors that impacting the development of engineering entrepreneurship, where every single engineering fields nowadays must have the elements of electricity. As an electrical entrepreneur, the ability to overcome a new technology is the prior requirement. TVET graduates usually have the basis of high-skilled workers and problem-solving analysts, where strong technical values and productivities are loaded within their curriculum [19]. With the dawn of the IR 4.0 era, electrical entrepreneurs face new challenges that require them to get out of their normal practices to adapt to the advancement of new technologies such as the Internet of Things (IoT), Big Data analysis and the use of Virtual Reality (VR) for additional tools in the installation and maintenance purposes [20].

The development of RE from WHS indicates a gap to be fulfilled by the TVET electrical entrepreneurs. With the announced incentives by the federal government, TVET electrical entrepreneurs must participate and get involved in their fields. The elements and needs of WHS-based RE are needed to be exposed in their studies [16]. However, one of the problems faced by these entrepreneurs is the culture of the business that restricted them to explore more [21]. It is found that four challenges are faced by TVET electrical entrepreneurs that limit them in starting up a new business area, as shown in Table 2.

Table 2. Challenges faced by Technical Vocational Education and Training (TVET) electrical entrepreneur into RE business [21][22].

Challenges	Description
Financial	1. Difficulty obtaining credit with inadequate provision and access to official finance. 2. Secure the investor’s interest.
Skills & knowledge	1. Electrical graduate’s lack of skills related to RE business 2. Insufficient entrepreneurship education in the curriculum.
Prices of the technology	1. Failure to compete with fossil energy service or suppliers. 2. Lack of research and development transfer

Physical infrastructure and logistic	1. Lack of infrastructure and potential areas. 2. High cost on logistics due to no access in remote area
Governance support	1. Lack of policy, legislative and tax incentives. 2. Lack of enforcement on property rights, contracts

Since TVET electrical entrepreneurs have fundamental skills and proper operating methods, the government and related agencies should pay particular attention to their ability to adapt to solar technologies. However, the limited experiences and exposure in the RE business needed to be evaluated. Based on the challenges presented in Table 2, external variables must be considered to empower the involvement of TVET electrical entrepreneurs for RE generation in Malaysia [23].

3. Result and Discussion

Based on the literature review, it is found that the role of electrical entrepreneurs, especially the Technical Vocational and Training (TVET) graduates in RE generation, is very tough, whereas the potential of the three significant resources of WHS is different [7]. Wind energy generation in Malaysia faced the problem of low wind condition [11]. Several unsuccessful developments or the failure of wind turbines generator demonstration projects, such as the ones at Swallow Reef and Small Perhentian Island, indicated that it is not easy to build RE from wind power capacity in Malaysia, which is located in an equatorial area with low wind speed, seasonally variable monsoons and even inter-monsoon cycles with minimal wind and high humidity. From TVET institutions, there is a shortage of information and skills to be provided to the technical student. The number of RE plants is too limited for experiential learning on installation or maintenance.

It differs from mini-hydro generation, where the electricity generation technology is still slowly moving without rapid changes [24]. Therefore, TVET institutions are not faced with channelling the latest information on the generation, maintenance, associated facilities and even training facilities process. Furthermore, the incentives advertised by the government still available with long term agreements that attracted investors to involve with the development. Thus, TVET electrical entrepreneurs must cater to the vast installation and maintenance projects [25]. Figure 2 illustrates that the mini-hydro generation will always be available throughout the year as one of the component RE to achieved 20% RE generation goal.

The most potential renewable energy (RE) development from the literature review is from solar photovoltaic (PV), where the incentive from the government is desirable. With the solar PV equipment prices decreased drastically due to many resources throughout the world, especially from China, this leads to the rapid development of RE generation from solar PV [21] and [25]. Government energy policy helped to enhance this by providing special incentives starting from February 2021 until December 2023 with Net Energy Metering (NEM) 3.0 and Large Solar Scale (LSS) 4.0 with the quota of 1500 Megawatt (MW). Table 3 indicates that the demand for LSS increases year by year with the reduction of cost RM per kilowatt hour [9].

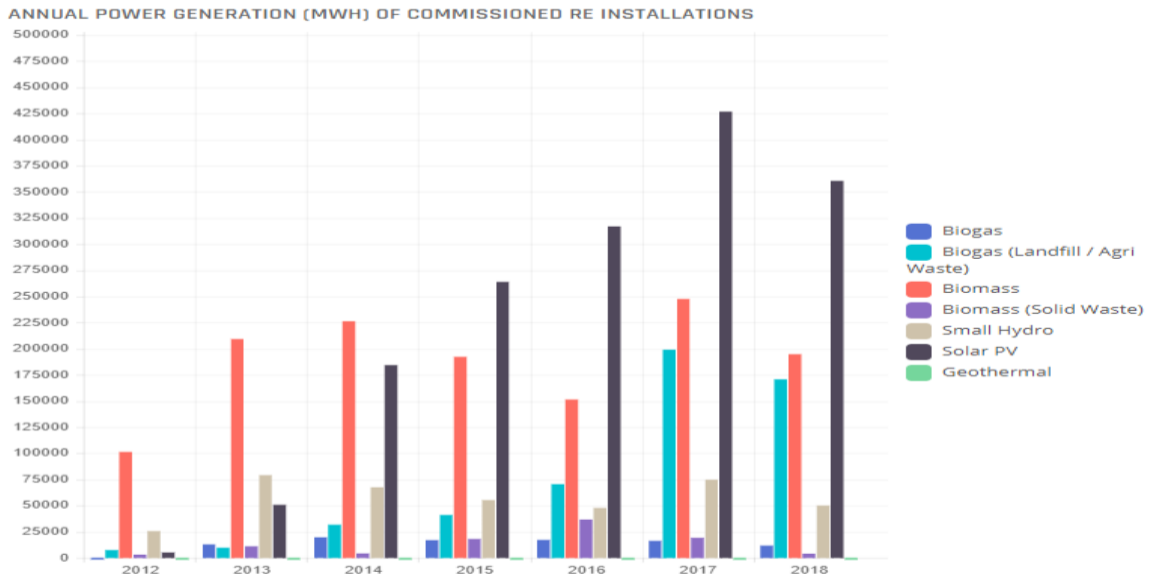

Figure 2. Renewable energy (RE) under FiT refer the Energy Commission updates [2].

Table 3. Total quota Large Solar Scale (LSS) awarded in Malaysian RE development [26].

Scheme	Year Announced	Quota (MW)	Award (MW)	*RM/k Wh*	Project Commercial
LSS 1	2016	250	450	0.43	2018
LSS 2	2018	500	563	0.42	2020
LSS 3	2020	500	490	0.33	2022
LSS 4	2021	1000	-	0.17	2023

Referring to Table 3, TVET electrical entrepreneurs are seen to have a brilliant opportunity to penetrate the business market in solar PV with the highest quota offer announced by the government to achieve the target of 20% RE in 2025. TVET institutions in Malaysia need to be aware of the rise in solar PV growth, where skilled solar workers, particularly entrepreneurs, need to be equipped with sufficient knowledge to ensure that they are present as a passenger of technology and as a driver of technology [21].

4. Conclusion

In conclusion, the main challenges faced by TVET electrical entrepreneurs are financial support, government tax and policies, and the lack of skilled workers in the field of RE. With the ambitious goal of RE generation development announced and attractive incentives schemes, it will surely enhance the development of mini-hydro and solar PV and the development of skilled workers and entrepreneurs from the TVET institutions. Furthermore, a more comprehensive regulatory framework must be defined to establish a foundation upon which governance values and mechanisms can be imposed to support the systematic growth of the energy market and its associated consumers and industries.

Nowadays, TVET electrical entrepreneur is still unable to meet the government's policy requirements for the development of RE by 2024 because the challenges discussed above require support from TVET institutions and industry players and investors. An excellent incentive announced, the dream of TVET electrical entrepreneur development in the field of RE will undoubtedly be realised in the future.

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