Journal of Positive School Psychology
2022, Vol. 6, No. 3, 258–266
http://journalppw.com

Land Administration Perspective for Solar Farm Development in Malaysia

Mohd Shahrizan Sahid[a], Robiah Suratman[b*], Hishamuddin Mohd Ali[c],

Department of Real Estate, Faculty of Built Environment and Surveying
Universiti Teknologi Malaysia 81310 Johor Bahru, Malaysia (Author a, b, c)
*Author Email: shahrizan7@gmail.com *Corresponding Author Email: robiah@utm.my*

Abstract

The increase of energy demand has made solar energy as one of the green and sustainable alternative energy in the world. World energy demand has been increased due to globalization and population growth. This factor makes the need of alternative energy since the current energy that are using depleted natural resources. Solar energy has been found as a great potential as the solar radiation can be accessed globally. Promoting this energy however has inevitably forced this new industry to face some drawbacks particularly related to land matters. Therefore, this paper reviews the solar farm development, policy evolution, and current legislation practices that govern the country's land administration. The review of the existing procedures in some states that have developed solar farms shows that there is no uniformity in the legal framework used in developing solar farms as there are different methods and approaches of land approval used by the State Authority. The discussion in this
paper is used to determine the direction a legal framework development that serves as a foundation to standardize the land approval for solar farm development in Malaysia following the sustainable land use management. This leads to a strong motivation and interest for the development and use of renewable energy technology especially in the country.

Keywords: Solar Farm, Land Development Approval, Land Use Management, Sustainable Development Goals (SDGs)

1. Introduction

2. Solar Energy Generation

2.1 Policy Evolution of Renewable Energy

Malaysia's framework on renewable energy began with the formation of National Energy Policy in 1979, followed by National Energy Reduction Policy in 1980, 4th Fuel Diversity Policy 1981, and 5th Fuel Policy in 2000. Then, the government's initiatives towards developing renewable energy and green technology were established by the Ministry of Energy, Green Technology, and Water in 2009 (currently the Ministry of Energy, Science, Technology, Environment, and Climate Change – MESTECC). In addition, an organization focusing on green technology was established i.e. Malaysian Energy Centre in 1997, in which it was rebranded in 2010 as Malaysian Green Technology Corporation (MGTC).

Prior to the implementation of National Green Technology Policy, Malaysia mainly focused on achieving energy efficiency and renewable energy generation in the energy sector. The government also established programs e.g. Malaysian Energy Efficiency Improvement Program (MIEEIP), Small Renewable Energy Power Program (SREPP), and BioGen and Malaysia Building Integrated Photovoltaic (MBIPV). After the introduction of the policy in 2009, various programs and financing schemes to encourage community involvement were implemented e.g. green technology financing scheme, green city program, green procurement and eco-labelling, green vehicles, green awareness exhibitions, and the creation of green technology-based jobs.

In the 11th Malaysia Plan (2016-2020), six strategic priorities were established to achieve the SDGs i.e. (i) enhance inclusiveness of the people, (ii) improve the well-being of all, (iii) accelerate human capital development for developed countries; (iv) continue green growth for sustainability and resilience; (v) strengthened infrastructure to support economic growth, and (vi) revitalize economic growth for greater prosperity (Malaysia Eleventh Plan, 2015). Through the plan, Malaysia has transformed from a raw material-based economy to a diversified economy and an export of high-tech products. Malaysia is also categorized as a mid-high-income country with inclusive economic growth (World Bank, 2015). However, these transformations pose challenges to the development of environmental sustainability as the world was severely impacted by the increased carbon footprint, global warming and climate change (Hanis Hashim, 2016). Presently, Renewable Energy Transition Roadmap (2035) was concluded by the end of 2019 and the outcome of the roadmap will be included in the 12th Malaysia Plan (2021-2025). This roadmap will help chart the RE towards achieving 20% in the national installed capacity mix by 2025 (IEA, 2019).

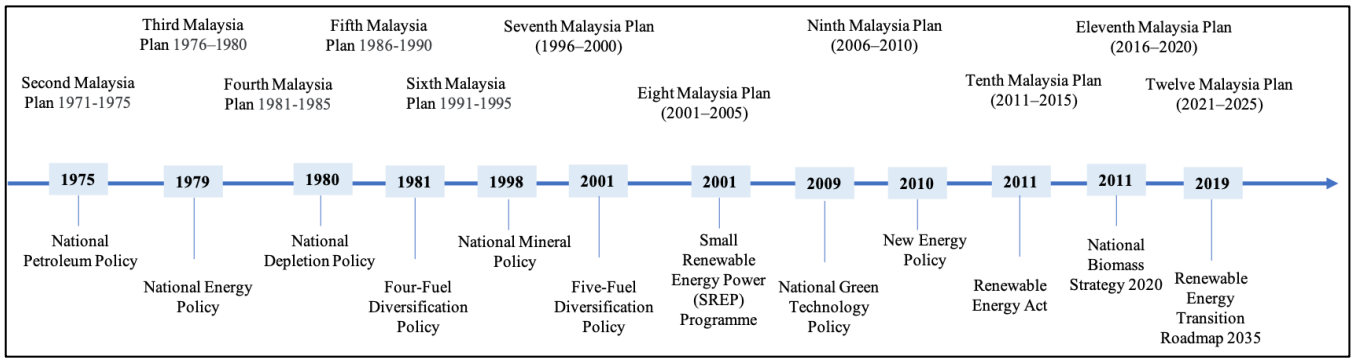

Figure 1: Evolution of Energy Policy in Malaysia.
Source: Modified from Oh et al., 2017; Khor and Lalchand, 2012.

2.2 Government Initiatives and Incentives to Promote Solar Energy

In the beginning of solar energy development in Malaysia, the solar generation was used for heating water at home (Ibrahim, 2001); the first attempt made by the government to promote the successful use of solar energy from the Malaysian Integrated Photovoltaic Building project (MBIPV) launched in 2005. MBIPV's Final Report (2011) stated that the project has led to the reduction of long-term cost and sustainability of photovoltaic technology through the integration of building design. The project primarily focuses on the development of integrated photovoltaic buildings (BIPV) technology while enhancing the country's capacity of the market through three ways i.e. (i) policy and awareness, (ii) technical efficiency and market improvement, and (iii) technology development and support. In order to further promote RE in Malaysia, the Sustainable Energy Development Authority (SEDA) was established under Act 726 in 2011 to administer and manage the implementation of the feed-in tariff mechanism which is mandated under the Renewable Energy Act 2011(SEDA, 2011).

Malaysia's power utility company, Tenaga Nasional Berhad (TNB) is responsible to centralize the power generation, transmission and distribution. The development of the first utility-scale PV power plant with a 50MW capacity in Malaysia took place in the state of Kedah. The land requirement for this capacity is about 300-500 acres which is directly connected to a 132-kV transmission line. This project is a joint venture between 1Malaysia Development Berhad (IMDB), TNB and DuSable Capital Management LLC (Sabo et al., 2016). Cypark, which is TNB's supplier, currently has five solar farms in Perlis, three in Negeri Sembilan, and one in Johor. The solar farms can benefit around 8,000 households in nearby villages, but also run modern

greenhouse agriculture using an automated fertilizer system (Bernama, 2012).

On the other hand, there are several programmes held by SEDA Malaysia in order to promote solar energy generation in the country such as Feed in Tariff (FiT), Net Energy Metering (NEM), Large Scale Solar (LSS), Self-Consumption, and MySuria. As part of the effort to ensure continuous support toward green technology projects, the Ministry of Finance via the Malaysia Government (proposed by Ministry of Energy, Science, Technology, Environment and Climate Change, MESTECC) has introduced Green Technology Financing Scheme (GTFS 2.0) as financial aid to develop solar farm in the country. Other than that, there are two incentives provided by the government i.e. Green Investment Tax Allowance (GITA) and Green Income Tax Exemption (GITE).

2.2.1 Feed in Tariff (FiT)

From the year 2001 onwards, new energy policies related to renewable energy were introduced. Among the most effective programs which have cost-effective technique are quota and direct incentives or voluntary goals which are proven to be better than RE (Hashim H, 2011). Feed in Tariff (FiT) which was launched in December 2011 is described as evolutionary mechanism in the country's energy industry as it enables the public to become energy producers. Under FiT, companies or individuals who hold a feed-in approval certificate issued by SEDA Malaysia are allowed to generate RE from four sources i.e. photovoltaic solar, biogas, biomass, and mini-hydro. The holder is eligible to sell renewable energy at the FiT rate (Energy Commission, 2011). However, the public is limited to generate solar energy through photovoltaic technology (SEDA, 2011). Furthermore, energy producers have to sign Power Purchase Agreement (PPA) with TNB as a Distribution Licences (DLs) for 21 years for solar energy and 16 years for biomass and biogas. However, Energy Commission (2018) stated that FiT implementation method has been discontinued in Malaysia due to the declining of PV technology costs, hence resulting in the scheme being discontinued and terminated in 2017.

2.2.2 Net Energy Metering (NEM)

Government's meeting in July 12, 2019 highlighted the key issue of the PV industry that need to convert the NEM concept from existing net billing to true Net Energy Metering. This is to improve the return of investment of solar PV under the NEM. Effective from the 1st January 2019, Net Energy Metering (NEM) is improved by adopting the true net energy metering concept to allow excess solar PV-generated energy to be exported back to the grid on a one-on-one offset basis. This means that every 1kWh exported to the grid will be offset against 1kWh consumed from the grid, instead of at the previous displaced cost.

Based on the experience of FiT, solar photovoltaic (PV) is a technology that requires minimal construction with a high intake rate compared to other RE technologies. The declining RE cost including PV system is one of the factors to maintain the RE price in market. As such, solar PV technology is better suited to the NEM scheme to complete FiT and Large-Scale Solar (LSS) scheme that enables the people to play an active role in reducing climate change. Furthermore, the government also introduced registered solar PV investor (RPVI) for NEM program which allows any company to become an investor under the solar PV projects. Under RPVI, the investor provides leasing or power purchase agreement (PPA) services.

2.2.3 Large Scale Solar (LSS)

Malaysia has implemented Large Scale Solar scheme (LSS) through bidding deals managed by the Energy Commission and the Power Purchase Agreement (PPA) signed by successful licensees and bidders. It was one of the government's efforts after the FiT scheme was halted through the Eleventh Malaysia Plan focusing on the development of solar projects with the capacity of 1MW up to 50MW to achieve solar generation target of 1,000MW by 2020. Electricity payments were paid accordingly using fixed rate. At present, there are three rounds of competitive and open bidding of LSS in Malaysia. The first round of the bidding process is funded by domestic investors while the second and third rounds are open to external investors (Energy Commission, 2017).

Other than that, the government also has implemented Self Consumption (SELCO) scheme that requires a private generating licence if the system size is over 72kW as mandated by the Energy Supply Act. In 2017, the government has launched a specialized social programme called MySuria to enable those in the B40 (below 40%) income group to benefit from the government support by having a 3kWp system installed at their homes but this initiative has been discontinued in 2018

3. Current Practice of Land Approval for Solar Farm Development

Currently, there are a few methods used by the State Authority in terms of land approval to develop solar farm in agricultural land. Thus far, some of the State Authorities use Special Permit to allow landowners to apply development activities other than agricultural purposes (INSTUN, 2014). For example, some state uses Special Permit to develop solar farm in their area. In order to enable the non-agricultural development to be carried out without any elements of violation that will lead to forfeiture by the State Authority, the issuance of Special Permit is one of the methods to assist Land Administrator in decision-making as there is no specific guideline and procedure available. Furthermore, it is more appropriate and cost-effective rather than having to apply and change the land condition accordance to Section 124 or 124A National Land Code 1965.

3.1 Land Approval of Solar Farm in The State of Johor

In Johor, the Land Administrator has issued a special circular to permit the issuance of Special Permit which is read together with the Circular No. 1/2003 of Department of General Director of Lands and Mines (JKPTG), Special Permit Issuance of Temporary Agricultural Land for the Mean Other Than Agriculture and Its Practice in Johor. This circular is the basis for the State to formulate Special Permit issuance policy to be implemented at each respective state level. For the issuance of Special Permit on the agricultural land in Johor, Circular No. 3/2006 lists down only two types of use, first of which the management of matter relating to the telecommunications tower or structure and second of which the management of matters relating to the use of agricultural land for non-agricultural purpose. The first purpose involves government land, agricultural land, and building structure, while the second purpose involves private agriculture land. **Table 1** simplifies this matter.

Table 1: Form of Approval Issued Based on Land Type

Purpose	Matter	Land/Building	Form of Approval
1	Tower/matter management telecommunication transmitter	Government Land	Temporary Occupancy License (LPS)
		Land (Agriculture/ Unconditional)	Temporary Special Permit
		on building	Permit under Uniform Building By-Laws (UBBL) 1984
2	Management of matters relating to the use of agricultural land for non-agricultural purposes	Land (Agricultural)	Temporary Special Permit

Source: Johor Land and Mines Office Circular No. 3/2006

Table 1 shows that not all application processes made in accordance with Johor PTG Circular Number 3/2006 will be issued a temporary Special Permit by the state of Johor's land administration. Some of the application processes specified in the circular will be issued with another approval in the form of Temporary Occupancy License (LPS) or permit under specific law. Regarding the alienated land in Circular No. 3/2006, it refers to any land that is subject to the provisions of Section 53 and 55 of the NLC 1965 where the use of such land is subject to the terms of implied condition for agriculture land. The implementation of this circular is to assist the standardization of the guidelines and rates of Special Permit payment

for the purpose of building telecommunication towers or structures and the use of agricultural land for non-agricultural purposes throughout the State of Johor.

For each Special Permit application approved by the Director of Lands and Mines of Johor, a document will be issued in the form of permit made in Form 19C (Regulation 2) of the Johor Land Rules 1966 (Amendment 2004). The application for Special Permit for the purpose of establishing a telecommunication tower that has been approved is subject to a ten-year approval period. The fee for permit issuance is RM80.00 per 100 square meters or part thereof per annum. Although the Special Permit issued on the agricultural land is valid for a period of 10 years, its renewal still needs to be applied annually. This means that the cost of renewal of Special Permits must be paid annually because Land Administrator will not accept full payment for ten years. For the application of the renewal of permit, the consideration and approval shall only be made by the Land Administrator on the district level.

Any approval and issuance of the Special Permit requires the land administration, in particular Registration Unit, to incorporate a memorial into the ownership document relating to the issuance of the Special Permit. Memorials are made using the manual method rather than the electronic system method, computerized land registration system (SPTB). The question may arise as to whether this manual entry method complies with the requirements and application of section 5A of the KTN which enforces Schedule 14 in relation to the SPTB.

3.2 Land Approval of Solar Farm in State of Kedah

The development of solar farms in the state is defined as a temporary land use activity that has a maximum term of 25 years. The development of solar farms is not subject to any zoning or zoning modification procedures. Other land activities e.g. agriculture, residential, commercial, industrial or institutional are used to maximize potential land use without being bound by existing zoning. The land must be restored to its original status upon the completion of the operation and use of the land. The State Authority of Kedah has drafted Kedah Solar Farm Guidelines to improve the General Kedah Solar Farm Guidelines. This final draft was completed in 2019 consisting of three main objectives: (i) Set up a guiding principle for local planners and planning authorities in the process of approving development applications; (ii) Set up a standard planning guidelines by all local authorities in the State of Kedah, and (iii) As a facilitators to local planning authorities in development planning.

The solar farm development project in the State of Kedah is subject to the approval of the Planning Permission (PP) by the Local based on the categories of principals or accessories and the scale of the project is evaluated based on the power generation capacity. The principal category is a large-scale ground-based solar power generation for the purpose of supplying electricity to commercial-oriented national grid networks with capacities such as small (<5 MW), medium scale (5-30 MW), and large scale (> 30 MW). The accessory category is solar-integrated building (PV-BIPV) integration. Domestic consumption and surplus energy after being rejected for personal use are channelled to the national grid based on a resale system to Tenaga Nasional Berhad (TNB). **Table 3** shows the categories and scale of solar farms in the State of Kedah.

Table 3: Categories and Scale of Solar Farm in the State of Kedah

Category	Scale	Capacity	Estimated Site Area (Acres)
1. Principle Ground mounted solar farm (Utility Scale Solar PV) USSPV	Small	< 5 MW	<25
	Medium	5 MW-30 MW	26-150
	Large	>30 MW	>150
2. Accessories	Building Integration	NA	NA

	• Building Roof • Building walls • Building Structure

Source: Kedah Solar Farm Guidelines Draft (2019)

The proposed solar farm development projects in the State of Kedah involve several stages i.e. Planning Permission application, building plan, engineering plan, land work plan, and erosion and erosion control plan. Application for solar farm development must be processed by Full Planning Permission. Local Authorities use the Design Permission Application Checklist template specifically for solar farm projects. The Planning Permission Application is submitted with the approval of the Building Plan.

The application of PP for solar farm development is subject to the usual procedures adopted by all of the State Authorities of Kedah. Applications for solar farm development projects do not have to wait for support letters or preliminary reviews from the four departments involved at the pre-negotiation stage. The developer may also submit a Planning Permission Application to the OSC; the local authority without a letter of support from the department. The application fee for existing planning permission does not specify a specific fee for the planning permission process specifically for solar farm development activities. Accordingly, the new fee level of the Planning Permits process for solar farm development projects is set at RM1,000 per acre (refer to **Table 4**).

In addition, the Special Fees for Land Use are also referred to as in-lieu payment for the development of solar farms that are not subject to changing the land use requirements during the solar farm operation. It is a Special Land Tax formulated for solar farm activities modified from the rates used in the Kedah Land Rules. Once the Planning Permission is obtained, the project proponent needs to consult the District Land Office to certify the express conditions (solar farm) in the ownership document and a new Land Tax rate will be imposed.

Table 4: Fee Rate Charged in Solar Farm Development Project

Area (Acres)	Rate /MP (RM)	Rate / Acre (RM)
< 50	0.20	809.40
51 – 100	0.15	607.05
101 – 200	0.10	404.70
> 200	0.075	303.53

Source: Kedah Solar Farm Guidelines Draft (2019)

A solar farm development project over 150 acres with 30MW electricity generation capacity is subject to the preparation of the Environmental Impact Report (EIA) and the Social Impact Report (SIA). For a medium-scale project of less than 150 acres, the Social Assessment Report through a Focus Discussion Group (FGD) with the Stakeholders and local communities is sufficient. The need for Environmental Impact Assessment (EIA) and Social (SIA) is based on the scope of the project site that will impact the environment on the impact of land work and construction, not on the operational level. It is to evaluate the impact of solar farm project before, during and after implementation of the project on the environment and the local community. Large scale solar farm project activities (over 150 acres) should be included as activities under Schedule 1 Environmental Impact Assessment (see Department of Environment). Based on the characteristics, properties and design of different solar farm components with common property development, the preparation of reports e.g. TIA, RSA and Terrain Mapping is not required.

Meanwhile, for the solar farm development projects before the Kedah State Solar Development Guidelines were adopted, the land and local authorities used the Limited Planning Permission (LPP) granted to developers and must be renewed each year making it difficult for developers to finance financing with banks. Therefore, the Local Authority should review the LPP given to the developers of the solar farm project prior to the State Kedah Solar Farm Planning Guidelines. The mechanism for submitting the Planning Permission for redistribution of projects granted by the LPP is necessary to enable the Local Authority to issue Full Planning Permission under Section 21 of the Town and Country Planning Act 1976 (Act 172).

The site of a solar farm project that has been left in operation for more than a year without the consent and consent of the local authority is categorized as an abandoned project. The Local Authority must apply a clause in the KM approval requirements that authorize the Local Authority to enter any solar farm project site should the project engineers fail to produce the components and hardware within three months of the expiry date. Local authorities have the right to enter the site for the purpose of carrying out components, hardware, physical structure or hazardous waste. The developer must agree to allow the local authority to carry out the removal and clean-up work in accordance with the KM approval agreement. The cost will be borne by the developer or project developer.

3.3 Issues and Challenges Based on The Existing Legal Practise of Land Approval

Section 115 (1) NLC 1965 stated that only one out of five of the agricultural land is allowed to be built with the building. In the early stages of the introduction of the use of this Special Permit, only a small portion of agricultural land was built for non-agricultural purposes. Therefore, a question has been raised whether the development of solar farm which covers large areas of land and eliminates its nature as an agricultural land is still appropriate (using the Special Permit)? Because the development of solar is temporary, the decision to use Special Permit is seen as appropriate to help promote solar development. But it remains controversial among legal practitioners as some states direct developers to change the terms of the agricultural land. However, if the land used is rented or leased for a period of time, then the original landowners do not have the intention to revoke application because the original agreement with the developers only allow them to use the land for solar development. In this case, the Special Permit addresses the concerns of the developers in order to get land approval to develop solar farm.

Land availability is a critical component for optimal solar farm plant. If the plant is placed too close with residential areas, it may be hazardous to the environment and have a significant impact on urbanization and population growth. The availability of different land use categories may fluctuate, thus making certain categories of land use types unsuitable for PV installation including water bodies, environmentally sensitive land, and developed urban areas. Accessibility to the road and the grid are essential during the entire lifespan of a PV power plant. Issues with the technical losses and the cost of developing the future transmission lines are the priorities of siting large-scale, integrated smart-grid PV power plants. On the one hand, the accessibility to the existing grid saves considerable transmission losses and the additional cost of infrastructural development.

Next, land suitability is an essential element of a large-scale PV installation. However, the suitability does not constitute land availability because of scarce resource in acquiring it for large-scale project (Chi et.al, 2009). It is also a difficult process in any society because the unwillingness of landowners to give out their valuable land resources and even given the high cost of compensation constitutes a threat to smooth project implementation. Other than that, the lack of willingness of landowners to transfer their ownership is one of the challenges that constitutes a hindrance to project execution (Sabo et al., 2017). Outside private ownership for residential use, land use for agricultural purposes, culture or spiritual use, and reserve lands are more difficult to acquire. The emergence of most of the problems emerged from the involvement of public perception, political system and policy formulation.

Large-scale renewable energy projects are distributed network systems that require large expanse of land beyond the base power plant.

Fthenakis and Kim (2009) asserted in a study that land requirement for large scale PV projects goes beyond the identification of optimal sites. Additional land areas are required for several other components of the projects such as network connection between the existing system and a new project, and access road for both of which are not limited to the grid line, but some substantial areas recognized as ROW (right of way) along the route. Ideally, new grid and road networks will traverse land areas owned by different holders including state, public, private or tribal lands some of which may even have access restrictions (Belfiore et al., 2013). Besides that, land use is among the most influential criteria with regard to PV site selection for energy investment i.e. forest and reserves, granary areas, paddy land, water bodies, wetlands and built-up area; these areas may not be used because of economic and environmental interest (Carrión et al., 2008; Charabi et al., 2011; Uyan, 2013; Van Haaren et al., 2011; Sánchez-Lozano et al., 2013; Ong et al., 2013). The standard land requirement (acreage) for large-scale PV implementation is 3.31 acres per 1MW.

There is no constant revision of land use policies that accommodate changes in the accelerated global development to reduce unnecessary hindrances to land acquisition. Hernandez et al. (2014) revealed that one way to minimize the cost of large renewable energy project and to avoid privately own land is by making use of degraded lands through co-location with agriculture and feasibility of deployment alongside canals and aqueducts. Power plant site is the only landed property needed for PV installation. Considerations for the primary and secondary land requirement entail among the aforementioned strategies, therefore making provision for the local solar policies and solar resource map to guide decision-making, encourage hybrid power system, engage community participation in the planning and execution processes, identify location to avoid installation, and utilize suitable prime agricultural land (Tsoutsos et al., 2005; Fthenakis et al., 2009; Tian et al., 2009; Hernandez et al., 2014).

4. Conclusions

Solar farm is a new industry in Malaysia, but it has a great potential to be developed in the country as an alternative energy resource. In order to fulfil and meet the increasing demand, land administration must be equipped with comprehensive and relevant procedure and policies to support its development in the future. Land policy needs to control the implementation process of the development to avoid conflicts with land use occupancy. As such, exploiting renewable energy sources clearly provides a new form of competition for the land which brings pressure to all territories, resulting from the need for urbanization and at the same time the preservation of forest areas, as well as natural resources and lands with recognized agricultural features.

References

Belfiore F, Taylor T, Moisan B, Zappia M, Cinarelli E. Risks and opportunities in the operation of large solar plants. Solar Power Gen; 2013.

Carrión J.A, Estrella A.E, Dols F.A, Toro M.Z, Rodríguez M, Ridao A.R. Environmental decision-support systems for evaluating the carrying capacity of land areas: optimal site selection for grid-connected photovoltaic power plants. Renew Sustain Energy Rev 2008; 12:2358–80.

Charabi Y, Gastli A. PV site suitability analysis using GIS-based spatial fuzzy multi-criteria evaluation. Renewable Energy 2011; 36:2554–61.

Chi Man Hui E, Omar I, Ismail M. Kotaka's model in land acquisition for infrastructure provision in Malaysia. J Financial Manage Property Construct 2009; 14:194–207.

Cozzi, L., Chen, O., Daly, H., & Koh, A. (2018). Population without access to electricity falls below 1 billion. *IEA Blog, October, 30*.

Energy Commission. Peninsula Malaysia Electricity Supply. Furuku eizo (Hatsubai); 2017.

Department of Director General of Lands and Mines Circular No. 1/2003.

Energy Commission. (2017). Energy in Malaysia. *Suruhanjaya Tenaga*.

Sabo, M. L., Mariun, N., Hizam, H., Mohd Radzi, M. A., & Zakaria, A. (2016). Spatial energy predictions from large-scale photovoltaic power plants located in optimal sites and connected to a smart grid in Peninsular Malaysia. *Renewable and Sustainable Energy Reviews*, *66*, 79–94. https://doi.org/10.1016/j.rser.2016.07.045

Funabashi T. A GIS approach for estimating

optimal sites for grid-connected photovoltaic (PV) cells in Nebraska. University of Nabraska; 2011.

Hashim, N. (2013). *Strategi Penambahbaikan Proses Pelupusan Melalui Pemberimilikan Tanah Kerajan Di Pejabat Daerah Dan Tanah Ipoh* (Doctoral dissertation, Universiti Teknologi Malaysia).

Hashim, H., & Ho, W. S. (2011). Renewable energy policies and initiatives for a sustainable energy future in Malaysia. *Renewable and Sustainable Energy Reviews*, *15*(9), 4780-4787.

Hernandez R, Easter S, Murphy-Mariscal M, Maestre F, Tavassoli M, Allen E, et al. Environmental impacts of utility-scale solar energy. Renew Sustain Energy Rev 2014; 29:766–79.

International Energy Agency. Renewables in Global Energy Supply IEA, Paris (2007)

Ibrahim, K. *Buku sumber guru: tenaga diperhabarui dan kecekapan tenaga*. Pusat Pendidikan dan Latihan Bagi Tenaga Diperbaharui dan Kecekapan Tenaga (CETREE), Universiti Sains Malaysia.

Fthenakis V, Kim HC. Land use and electricity generation: a life-cycle analysis. Renew Sustain Energy Rev 2009; 13:1465–74.

Johor Land and Mines Office Circular No. 3/2006

Johor Land Rules 1966.

Kardooni, R., Yusoff, S. B., & Kari, F. B. (2016). Renewable energy technology acceptance in Peninsular Malaysia. *Energy policy*, *88*, 1-10.

Kedah Solar Farm Guidelines Draft (2019)

Lindahl, J., Stoltz, C., Oller-Westerberg, A., & Berard, J. (2018) National Survey Report of PV Power Applications in Malaysia.

Mcnabb, D. E. (2019). The population growth barrier. In *Global Pathways to Water Sustainability* (pp. 67-81). Palgrave Macmillan, Cham.

National Land Code (NLC) 1965.

Nilsson, M., Griggs, D., & Visbeck, M. (2016). Policy: map the interactions between Sustainable Development Goals. *Nature*, *534*(7607), 320-322.

Omar, I., (2002). Rules Affecting the Land Development Process in Malaysia A Review on Regulation of Environmental Impact Assessment (EIA). Paper presentation at the 8th Pacific Rim Real Estate Society Conference. Lincoln University, Christchurch, New Zealand.

Petinrin, J. O., & Shaaban, M. (2015). Renewable energy for continuous energy sustainability in Malaysia. Renewable and Sustainable Energy Reviews, 50, 967-981.

Sabo, M. L., Mariun, N., Hizam, H., Mohd Radzi, M. A., & Zakaria, A. (2016). Spatial energy predictions from large-scale photovoltaic power plants located in optimal sites and connected to a smart grid in Peninsular Malaysia. *Renewable and Sustainable Energy Reviews*, *66*, 79–94. https://doi.org/10.1016/j.rser.2016.07.04

Seksyen Perundangan Tanah (2014). *Laporan Kajian Prosedur Siri 2: Pengeluaran Permit Khas Penggunaan Sementara Tanah Pertanian Bagi Maksud Yang Tidak Berkaitan Pertanian : Praktis Negeri Johor*.

Tisza K. GIS-based suitability modeling and multi-criteria decision analysis for utility scale solar plants in four states in the Southeast US. Clemson University; 2014.

Tsoutsos T, Frantzeskaki N, Gekas V. Environmental impacts from the solar energy technologies. Energy Policy 2005; 33:289–96.

Unit, E. P. (2015). Eleventh Malaysia plan, 2016-2020: Anchoring growth on people. *Putrajaya: Prime Minister's Department*.

Uyan M. GIS-based solar farms site selection using analytic hierarchy process (AHP) in Karapinar region, Konya/Turkey. Renewable Sustain Energy Rev 2013; 28:11–7.

Zainol, Z. (2015). *The Impact of PV Location on Voltage Profile and Line Losses* (Doctoral dissertation, Universiti Teknologi Malaysia).