Journal of Sustainability Science and Management *e-ISSN: 2672-7226*
Volume 14 Number 3, June 2019: 35-42

A CASE STUDY ON THE POTENTIAL PHOTOVOLTAIC APPLICATIONS IN LANGKAWI ISLAND

NUR AZFAHANI AHMAD*, ALIA ABDULLAH SALLEH AND SITI JAMIAH TUN JAMIL

Building Surveying Department, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610 Perak, Malaysia

**Corresponding author: nuraz020@perak.uitm.edu.my*

Abstract: With 27 million tourists every year, the tourism sector in Malaysia has exponential growth, by 3% to 5% annually. Due to this growth, the sector has an escalated demand in electricity consumption. Tourism accommodations were developed in many islands in Malaysia. Therefore, the national grid needs extensive power generation capacity to cater to the demand. Since Malaysia is primarily reliant on fossil fuels for generating electricity, fossil fuel depletion issues might threaten the reliability of electricity supply. This may lead to future energy scarcity and may affect the sustainability of the tourism sector, particularly for islands that have depended on tourism as an economic resource. This paper will investigate the potential of adopting photovoltaic (PV) systems for a tourism island in order to allow this sector to be resilient in accessing self-sufficient electricity. Langkawi Island, a prominent tourism island in Malaysia, has been selected for the case study in order to understand the daily energy demand and the potential of installing PV panels to resorts and chalets in the island. The study has proven that chalets in Langkawi have the potential to generate electricity from PV with an expected monthly saving of 50% and gain an acceptable payback period of 17 years.

Keywords: Sustainability, tourism, green electricity, solar, Malaysia

Introduction

Electricity demand by the Malaysian tourism sector has increased by about 4.9 % in the past 10 years due to the improved standard of living, the effective tourism policy and cheap cost of electricity (APEC, 2013). Despite the recent increase in electricity tariff (averaging at 3% to 5%) (TNB, 2016), the national electricity consumption continues to increase every year, with generation capacity escalating from 336 MW in 1965 (TNB, 2009; Naidu, 2010)to 30 GW in 2014 (EIA, 2014). This rapid upward trend has resulted in the decision by the Government to control energy subsidies by increasing the electricity tariff to end-users (Gardner-Stephens, 2013). Consumers who use electricity above 300 kWh per month have to bare a rebate-reduction in their power bill (TNB, 2016). In addition to this situation, the issues of South-China Sea Territorial disputes (Buszynski, 2010) and the fossil fuel resources depletion (Zittel *et al.*, 2013), have created a challenge in fulfilling the growing demands of electricity for the nation.

In the tourism sector, the demands to use electricity is crucial for 24 hours per day and Malaysia needs a more resilient electricity supply to mitigate any future risk of power rationing. Chand *et al.* (2016) reported that 2000 - 8000 kWh of monthly electrical energy consumption is consumed by chalet users in the tourism sector per year in Malaysia. Despite its consumption percentage, use in the tourism sector is smaller than that in the residential sector (residential sector: 10000 – 15000 kWh/month) (Ahmad & Byrd, 2012), and meeting its demand is still a challenge to the Government since this sector is rapidly growing.

It is projected that by 2020, the tourists in Malaysia will increase to 34 million people and the power consumption in the tourism sector will also increase up to 128 GWh (Tourism Malaysia, 2016) (Figure 1). Therefore, it is significant to study on the potential of providing supplementary power supplies for the tourism sector, especially in areas like the tourism islands. At the moment, there are limited studies on the relationships between an increase of tourist population and the energy demand. There are also no recent studies focusing on the impact of power outage on the tourism sector, and the solution to overcome the issue of power interruption for tourism islands.

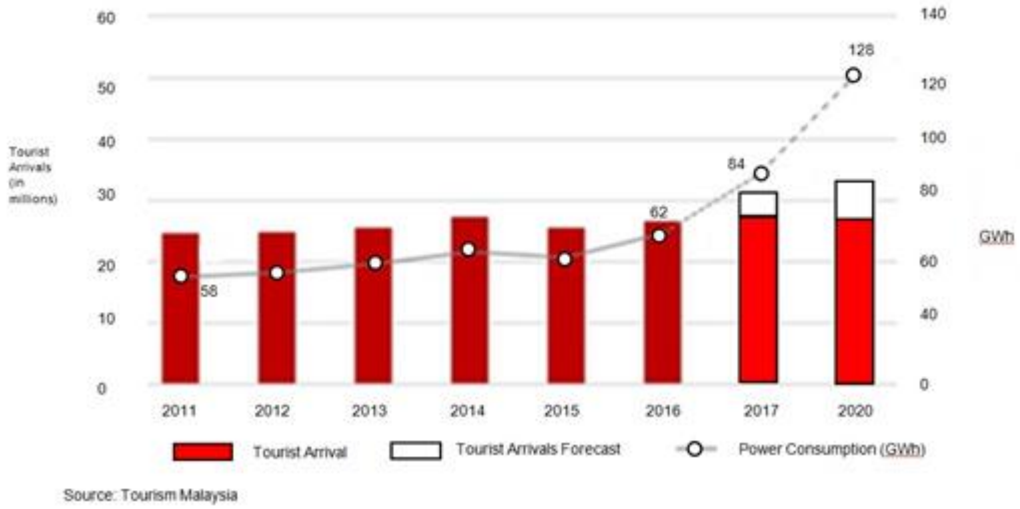

Figure 1: Tourist arrivals vs. power consumption (2011 – 2020)

The issue of power interruption in many tourism areas is critical. Many Asian tourism cities with high demand of electricity, like Bali, Phuket and Mumbai (Hamid & Rashid, 2012; Erviani, 2014) have shown that power interruption cannot be prevented if there is power-rationing situation. Many studies have also proven that it is possible that power supplies will be reduced or cut-off due to energy scarcity (BBC, 2008; Luke,2010;Matthewman & Byrd, 2014). For example, the case in Bali has proven that with serious electricity deficit, the islanders have been experiencing power outages of 1 to 3 hours per month more than any other islands in Indonesia (Erviani, 2014). In Phuket, residents and tourists experienced largest power blackout in Thailand's history in 2013, between 2 hours to 8 hours, affecting many local businesses and small chalets (Epstein, 2013). In Mumbai, there was 9% gap between India's energy requirement and the energy resource available resulting in a frequent outage in the tourism hotspots (Romero, 2012). For countries that depend on the tourism sector for its economy, power interruptions need to be avoided. One of the solutions is through empowering renewable energy.

With an insecure supply of energy, there is a risk of an inadequate supply of electricity. There is apprehension that this situation can affect the tourism islands in Malaysia which need stable power supply. Tourism island like Langkawi, despite its rapid development, still does not have supplementary system for backup power supplies in most of the chalets (Berita Harian, 2018). During the event of emergencies, like other small tourism islands, these chalets will experience blackout.

Many related issues will occur, especially the issues of safety and security, disruption of traffic and telecommunications that may affect the tourism industry. Therefore, it is important to explore the potential of utilising self-sufficient electricity for the tourism areas. In this context, the feasible option is to introduce an alternative power supply.

With a significant amount of sunshine, Malaysia has immense potential to utilise electricity from solar energy. In this paper, the electricity load profile of selected chalets in Langkawi will be investigated in order to extend the feasibility of using roof-mounted solar PV as a supplementary power supply. Through Sequential Exploratory Mixed Method approaches, various methods have been carried out in this research, through: (i) a case study, (ii) modelling process, (iii) numerical analysis (load profile and PV potential analysis) and (iv) cost-benefit analysis, within the period of 12 months of the research period.

The Case Study

Langkawi Island is a marine park located in the state of Kedah, Malaysia and lies on the west coast in the north of Peninsular Malaysia. For this paper the main Langkawi Island will be the focus since most of the residents live on it (Asia Development Bank, 2010), even though there are 99 cluster islands.

At the moment, there are almost 60,000 residents on the main island (Fee *et al.*, 2005; Department of Statistics Malaysia, 2010) where almost 20% of the locals own private chalets (Bhattacharya, 2016). Meanwhile, resorts are owned by larger corporations and will not be analysed in this paper. Despite the distance of this island from the mainland, the entire island has stable electricity supply which is powered by fossil-fuel resources from Tenaga Nasional Berhad (TNB, 2009).

However, most of the chalets in the island do not have specific supplementary system for backup power supplies in the event of emergencies. It is contradicting with the other small tourism islands, for instance Tioman, Pangkor and Sibu Islands, that have hybrid renewable energy supplies (Haris, 2010).

Power outage issue is not frequent in Langkawi. However, when it occurs, it may sometimes last for 24 hours, especially in areas near to the beach. During the peak season, Tenaga Nasional Berhad received outage complaints for more than 3 to 4 times per week due to overloaded power issues (Bhattacharya, 2016; Berita Harian, 2018). Efforts need to be made to establish an alternative so as to supplement power supplies to these chalets in any emergencies.

Until 2016, there are almost 1000 chalets which were operating on the main land (Bhattacharya, 2016) which demanded high electricity consumptions. The case study selected is a typical medium-rate chalet in Langkawi, which is preferred by the tourists due to its strategic location, accessibility and inexpensive rates(Berita Harian, 2018).

Over 100 chalets have been selected through random sampling process for the data collection stage, focusing on medium-rate chalets. A prototype chalet has been developed through modelling approach that has a 3 m x 6 m floor plan, which is built on stilts. There is a 3 m x 6 m gable roof and a mansard roof for the verandah area. Figure 2 presents the typical layout of the chalet.

(a) Elevation View of a Typical Chalet (b) Floor Plan

Figure 2 (a) and (b): Typical layout of tourism chalet in Langkawi, Malaysia

From a field survey, it was found that the electrical appliances were used from 6 am in the morning, but between 8 am to 5 pm, the load profile decreased. Less or no people were in the chalet sat this time, since most of them are tourists. Extensive electricity consumption in the chalets was expected to be between 6 to 10 hours at night. Basically, significant electrical appliances such as iron, electric kettle and television would be used in the morning. Later in the day, appliances such as television, hand phone chargers, fans or night lamps might be used. The limitation for this research was that only chalets without air-conditioning systems were selected for the study. This is to give a clear justification on the power output variable since the energy from using air-conditioning system is unpredictable and may vary depending on the usage and the ambient temperature. Table 1 shows the detail.

Table 1: Duration of electricity consumption in the chalet

Time	6 am – 8 am	8 am – 5 pm	5 pm - midnight	Midnight– 6 am
Electrical Appliances	Lighting, Iron, Electric Kettle and Television	-	Television, Lighting, Hand Phone Chargers, Fans	Television, Lighting, Hand Phone Chargers, Fans And Night Lamps

The Load Profile Analysis

The pattern of load profile in the chalet is identified based on the daily electricity consumption used by the consumer. This is necessary in order to explore the potential of generating electricity from PV panels. Table 2 and Figure 3 show the electricity consumption pattern based on the types of appliances used in the chalet for a given time period of 24 hours (Table 2 and Figure 3).

Table 2: Daily consumption of electricity for the chalet

Appliances	Standard Load (Watts)	Quantity	Daily Average usage (h)	Total Wh/ daily	kWh/ daily
Lighting	30	5	10	1500	1.5
Television	100	1	10	1000	1
Fan	120	1	10	1200	1.2
Electric Kettle	1400	1	1	1400	1.4
Iron	1000	1	1	1000	1
Hand Phone Chargers	35	2	5	350	0.35
Night Lamp	70	1	8	560	0.56
TOTAL					7.01

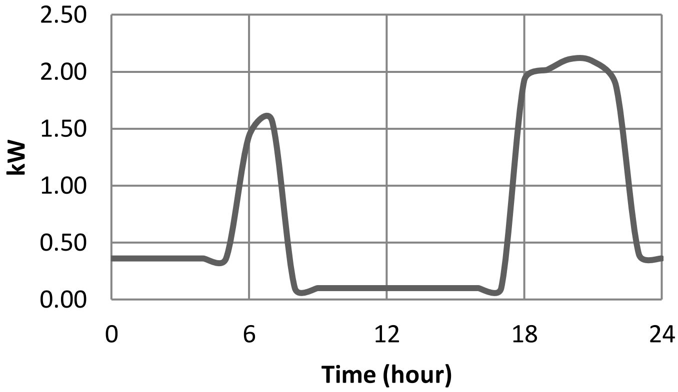

Figure 3: The daily load profile pattern of electricity for the chalet.
(*Data is based on Typical Electrical Appliances Used Daily in Chalet).

From Table 2, it is found that the average daily load profile is 7 kWh for one chalet which is equivalent to 210 kWh per month. The load profile data was collected using digital energy data logger in order to identify the electrical energy used over a given time period of 24 hours (Table 2 and Figure 3).

The PV Potential Analysis

At this stage, the potential of utilising photovoltaic panel for the chalet's roof was investigated. Malaysia receives abundant solar radiation every day ranging from 4.8 kWh/m^2 to 6.1 kWh/m^2 per day (Lau *et al.*, 2010). With the distinctive features of gable roof for each chalet and with a pitch roof of less than 30º, the efficiency of the solar panels will be 95% (Ahmad & Byrd, 2011; 2012;2013) for each chalet. This indicates a significant potential of utilising PV panels for the chalet.

For this analysis, it has been assumed that 2 kWp of panel system is used with an output of 16% efficiency and no-shading effect from trees. This system is considered economical since the roof area is small (3m x 6m) and the electricity consumption is only 7 kWh per day (Ahmad & Byrd, 2013). It is estimated that 50% of the roof area of the chalet is feasible for the location of PVs (NREL, 2003; MBIPV, 2011).

The amount of electricity a PV panel can produce depends on three factors: (a) the size of the panel, (b) the efficiency of the solar cells and (c) the amount of sunlight the panel receives (EcoDirect, 2014). Table 3 shows the calculation for PVs potential analysis from the time between 8 am to 6 pm, considering all three factors have been met.

Table 3: Solar output based on 2 KW PV power system

Characteristics of Solar Radiation				2 kW power system	
Time	Sun power (W/m^2)*	PV system efficiency used (%)**	Area of roof (m^2) (Based from NREL guideline)**	Solar Power Rating (Watt/h)	Solar Power Rating (kWh)
8	180			426.24	0.4
9	300			710.4	0.7
10	500			1184	1.2
11	780			1847.04	1.8
12	940			2225.92	2.2
13	1000	0.16	14.8	2368	2.4
14	920			2178.56	2.2
15	640			1515.52	1.5
16	400			947.2	0.9
17	240			568.32	0.6
18	180			426.24	0.4
		Total Solar Output (kW)/day			14.3 kWh

data from Malaysian Meteorological Department (2017)
*** basically, to generate 2,000 (2 kw) from a 16%-efficient system, 14.8 of roof area is needed respectively (NREL, 2003).*

It was found that by installing 2 kWp PV system,14.3 kWh of electricity per day could be produced, which is equivalent to 420 kWh of electricity per month. This is 100% more than the actual electricity consumption in the chalet. However, this is dependent on the sky condition and the weather for the month.

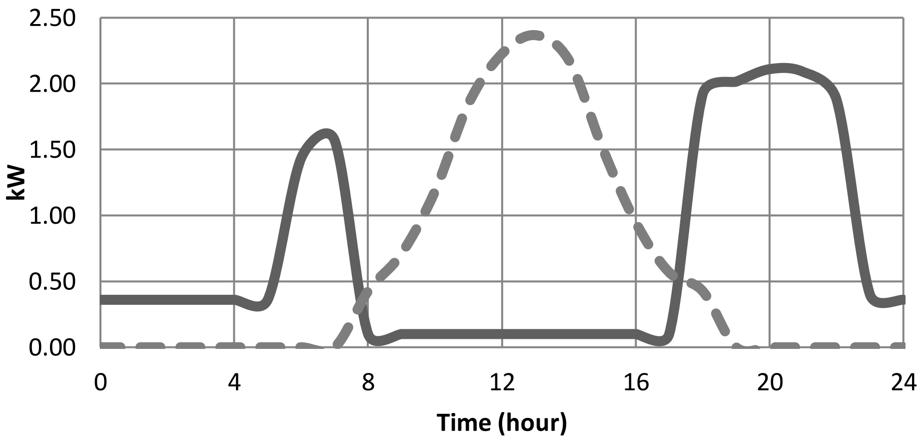

Figure 4 shows the correlation between the patterns of electricity output for a 2 kWp PV system with the chalet's energy demand. The grey curve (dotted line) represents a load from 2 kW PV system and the black curve (straight line) represents the load profile of the chalet.

From Figure 4, it can be seen that the amount of energy generated from PV panels is 2/3rd greater than the chalet's total demand during the day time. During the day (8 am to 6 pm), the chalet would only consume 1/3rd of the overall electricity produces from PV panels. The results show the considerable potential of solar energy for the chalet where the energy could be used for the chalet during the day or stored in batteries for later usage. Since the electricity consumption for the chalet is only 7 kWh per day, the excess of electricity gained from PV panels (14.4 kWh – 7 kWh = 7.3 kWh) can be stored into the battery for future consumption or feed-back to the grid using a hybrid system.

The Cost-Benefit Analysis

The cost-benefit analysis is necessary in identifying the feasibility of the system in reducing monthly electricity bills and in determining the return of investment (ROI) for installing a PV system onto the chalet. Table 4 shows the monthly electricity bill for a chalet, which has used 210 kWh electricity per month (data is taken from Table 2 = 7 kW x 30 days).

Table 4:Actual Expenses for Monthly Electricity Bill (For 1 Chalet).

Electricity unit in Malaysia (Based on TNB)	**Malaysia's Electricity tariff (From TNB)/MYR**	**Maximum Consumption (kW)**	Amount (MYR)
First 200 units (0-200):x	0.218	200	43.60
Next 10 units (201-210)	0.334	10	3.34
Total Bill/Month (MYR)			46.94

Based on Table 4, it is proven that with the installation of 2 kW PV panels, the electricity bills can be reduced to 100%. This is based on the 420 kWh of electricity per month generated from PVs (refer Table 3), which basically is more than the consumption. However, since solar radiation is not constant for every hour, the chalet would need to import electricity from TNB at times when there is insufficient solar energy. This is considering that the PVs do not supply the chalet electricity demand over a 24-hourperiod.

In order to make PVs financially attractive, the surplus electricity needs to be sold to the Government through a scheme provided for example Net Energy Metering (NEM) scheme (SEDA, 2017), to be exported to the grid. Under this new scheme, any surplus electricity generated from PVs will be exported and will be paid at the prevailing Displaced Cost, as fixed by the Malaysia Energy Commission (SEDA, 2017). For a chalet to be able to have a balance between imported and exported electricity, the ratio of electricity generated should be 1:1 to energy consumed (Ahmad & Byrd, 2011). However, in consideration of financial advantages, the required capacity of PV system should be less than 2 kWp system. More capacity than this will incur more expenses on the PVs. This would not provide profit to the chalet owner.

In terms of Return of Investment (ROI) for installing the cost, it is known that the cost of installing a PV panel is lower. MBIPV (2011) reported that in 2005 the price for 1 kWp was RM 31,000 but in 2010 it was RM 19,120.00 per kWp. In 2017, the price has reduced gradually to RM 5,000 per kWp (SolarNRJ, 2017). It is projected that in 2020, the price will continue to reduce by 10% (Muhammad-Sukki *et al.*, 2011). With an assumption that there is no interest during the process of installing PV systems (e.g PVs are bought using own money), a simple payback period is shown in Table 5.

Table 5**:** Return of Investment (ROI)

ITEM	**2 kWp (MYR)**
(a) Installation Cost (MYR)*(price on 2017)	10,000.00
(b) Saving on electricity bill *MYR 46.94 x 12 months*	563.28
(c) Revenue from Net Energy Metering (NEM) tariff (price formula from SEDA) Net Billing = [Energy consumed x Gazetted Tariff] – [Energy exported x Displaced Cost] *= (210 kWh x RM 0.21) – (210 x RM 0.20) = RM 44.10 – RM 42.00 = RM 2.10* *= MYR 2.10 x 12 months*	25.20
(d) Payback period (Year) Installation Cost (RM) / Total revenue (RM) (annually) *= RM 10,000 / RM 588.48*	17 years

** data from Malaysia Bosch solar energy (bosch energy, 2010)*

From Table 5, it is found that the payback period for installing 2 kW PV system is 17 years. However, in order to allow a more feasible payback period, the PV panel system can be shared by 2 or 3 chalets since the electricity consumption for one chalet is half the electricity produced by PVs. The result highlights the importance of the Government or Non-Governmental Organisations (NGOs) have a pivotal role to play in providing a suitable financial scheme or subsidy to attract chalet owners to install a solar PV system since MYR 10,000 is still considered huge for many chalet owners. The examples can be seen from many countries that have provided support through RE financial subsidies in order to encourage locals to install PV systems (Dei *et al.*, 2010; Kabir *et al.*, 2010)

Conclusion

This study has looked into the supply and demand of electricity for Malaysian tourism chalets in order to justify that there is a significant relationship of providing electricity from solar energy as a source to supplement the demand for electricity and sustainable tourism accommodations. Chalets in Malaysia have the potential to generate electricity from PVs where the surplus electricity can be sold to the national grid through a suitable scheme known as Net Energy Metering (NEM). In addition, chalets can reduce their monthly electricity bills to 50% and receive an acceptable payback period of 17 years. It also signifies that the tourism industry in Malaysia can be sustained if self-sufficient electricity supply can be made available. However, it will depend on the number of chalets that are keen to install the PV system and the engagement of the chalet owners. The Government of Malaysia also needs to be proactive in helping the tourism stakeholders to be involved in solar electricity generation. Many strategies need to be to be put in place so as to encourage them to install this technology, for example providing financial aids and suitable solar subsidies.

Acknowledgements

The authors would like to express their sincere gratitude to the participants involved in the study, including several chalet owners in Langkawi Island and Sustainable Energy Development Authority of Malaysia (SEDA Malaysia) in providing data and information for this paper.

References

Ahmad, N. A.,& Byrd, H. (2011). *Solar photovoltaics for vernacular housing in rural Malaysia: Towards energy security and equitability of low-income groups.* Paper presented at the International Conference of Built Environment in Developing Countries (ICBEDC) 2011, Penang.

Ahmad, N. A., & Byrd, H. (2012). *The electricity load profile for supply and demand: Towards the feasibility of solar energy in Malaysian rural housing.* Paper presented at the Sustainable Future Energy Conference 2012, Bandar Seri Begawan, Brunei.

Ahmad, N. A., & Byrd, H. (2013). Empowering distributed solar pv energy for malaysian rural housing: Towards energy security and equitability of rural communities. *International Journal of Renewable Energy Development (IJRED), 2*(1), 59-68.

APEC. (2013). *Energy Demand and Supply Outlook* (5th ed., pp. 97-108): Asia Pacific Energy Research Centre

Asia Development Bank. (2010). Asian Development Bank & Malaysia: Fact sheet.*Asian Development Outlook 2010*. Manila: Asia Development Bank.

BBC. (2008). *Melting in Zanzibar's blackout, BBC.* Retrieved from http://news.bbc.co.uk/2/hi/africa/7427957.stm

Berita Harian. (2018). 18 Inisiatif majukan langkawi, *Berita Harian*. Retrieved from https://www.bharian.com.my/berita/nasional/2018/05/421127/18-inisiatif-majukan-langkawi

Bhattacharya, R. (2016). Langkawi Island information. Retrieved from https://www.langkawi-insight.com/langkawi_000001.htm

Bosch Energy. (2010). Bosch solar energy, AG SolarPanel Price.

Buszynski, L. (2010). Rising tensions in the South China Sea: Prospects for a resolution of the issue. *Security Challenges, 6*(2), 85-104.

Chand, M. R. R., Basrawi, F., Ibrahim, H., Taib, M. Y., & Zulkepli, A. (2016). A study on energy consumption of a resort located in the East Coast of Malaysia. *International Journal of Advanced and Applied Sciences, 3*(5), 49-54.

Dei, D. T., Islam, A., & Khan, A. H. (2010). *Current Financial Schemes of Solar Home System Projects in Bangladesh and Users Opinion, 10*(6), 51-55.

Department of Statistic Malaysia. (2010). *Preliminary Count Report*. Putrajaya: Government of Malaysia.

EcoDirect. (2014). 4000 watt micro inverter solar panel kit. Retrieved from http://www.ecodirect.com/4kW-Micro-Inverter-Solar-Panel-Kit-p/eco-4000w-micro.htm

EIA. (2014). Electricity supply industry in Malaysia performance and statistical information 2014. Retrieved from http://www.st.gov.my/index.php/en/downloads/category/99-statistics-electricity

Epstein, J. (2013). Thailand suffers power outage, leading many to question what happened to its power protection plan.Retrieved from https://www.powerprotectionresource.com/articles/339623-thailand-suffers-power-outage-leading-many-question-what.htm

Erviani, N. K. (2014, July 14, 2014). Bali Island powerless for three hours, *The Jakarta Post*. Retrieved from http://www.thejakartapost.com/news/2014/07/14/bali-island-powerless-three-hours.html

Fee, C. V., Sani, A., Nidzam, A., Barlow, H. S., Michael, J., Gurupiah, & Hashim, D. M. (2005). *The Encyclopedia of Malaysia, Volume 5 : Architecture*. Kuala Lumpur: Archipelogo Press.

Gardner-Stephens, R. (2013). TNB to Review Malaysia Electricity Tariff. *Power Insider Asia*. Retrieved from https://www.pimagazine-asia.com/tnb-review-malaysia-electricity-tariff/

Hamid, K. A., & Rashid, Z. A. (2012). Chapter 9: Economic Impacts of Subsidy Rationalization Malaysia. In Y. Wu, X. Shi & F. Kimura. (Eds.), *Energy Market Integration in East Asia: Theories, Electricity Sector and Subsidies* (ERIA Research Project Report 2011-17 ed., pp. 207-252). Jakarta: ERIA.

Haris, A. H. (2010). *Industry briefing on feed-in tariff procedures* MBIPV, SEDA & KeTTHA. Kementerian Tenaga, Teknologi Hijau dan Air. Kuala Lumpur.

Kabir, M. A., Dey, H. S., & Faraby, H. M. (2010). *Microfinance: The sustainable financing system for electrification and socio-economic development of remote localities by Solar Home Systems (SHSs) in Bangladesh*. Paper presented at the Systems Conference (2010), 4th Annual IEEE.

Lau, K. Y., Yousof, M. F. M., Arshad, S. N. M., Anwari, M., & Yatim, A. H. M. (2010). Performance analysis of hybrid photovoltaic/diesel energy system under Malaysian conditions. *Energy, 35*(8), 3245-3255. doi:10.1016/j.energy.2010.04.008

Luke, T. W. (2010). Power Loss or Blackout: The electricity power collapse of August 2003 in North America. In S. Graham (Ed.), *Disrupted Cities: When Infrastructure Fails* (pp. 196). UK: Routledge.

Matthewman, S., & Byrd, H. (2014). Blackouts: a sociology of electrical power failure.*Social Space (Przestrzeń Społeczna)*.

MBIPV. (2011). PV system cost.Retrieved from http://www.mbipv.net.my/content.asp?zoneid=4&categoryid=12

Muhammad-Sukki, F., Ramirez-Iniguez, R., Abu-Bakar, S. H., McMeekin, S. G., Stewart, B. G., & Chilukuri, M. V. (2011). *Feed-in tariff for solar pv in Malaysia: Financial analysis and public perspective.* Paper presented at the Power Engineering and Optimization Conference (PEOCO), 2011 5th International.

Naidu, G. (2010). Chapter 7: Infrastructure Development in Malaysia. In N. Kumar (Ed.), *International infrastructure development in East Asia - towards balanced regional development and integration*(pp. 204-227): Economic Research Institute for ASEAN and East Asia.

NREL. (2003). *A consumer's guide: Get your power from the sun*. (DOE/GO-102003-1844). Washington: The US Government. Retrieved from http://www.nrel.gov/docs/fy04osti/35297.pdf.

Romero, J. J. (2012). Blackouts illuminate India's power problems. *IEEE Spectrum, 49*(10), 11-12. doi:10.1109/mspec.2012.6309237

SEDA. (2017). NEM concept. Retrieved from http://seda.gov.my/?omaneg=000101000000010101010001000010000000000000000000&s=5732

SolarNRJ. (2017). Residential solar. Retrieved from http://www.solarnrj.my/residential-solar.html

TNB. (2009). Powering the nation (1949-2009). Annual Report. Retrieved from https://www.tnb.com.my/assets/annual_report/AR09Eng.pdf

TNB. (2016). Pricing and tariff. Retrieved from http://www.tnb.com.my/residential/pricing-tariffs

Tourism Malaysia. (2016). Tourism Malaysia 2016 Annual Report.

Zittel, W., Zerhusen, J., Zerta, M., Ludwig-Bölkow-Systemtechnik, & Arnold, N. (2013). Fossil and nuclear fuels – the supply outlook (pp. 178). Ottobrunn/Germany: Energy Watch Group.