CURRENT STATE AND FUTURE PROSPECT OF SOLAR ENERGY IN AN ELECTRONIC DEVICE MANUFACTURING COMPANY

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FACULTY OF SCIENCE
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CURRENT STATE AND FUTURE PROSPECT OF SOLAR ENERGY IN SELECTED ELECTRONIC DEVICES MANUFACTURING COMPANY

ABSTRACT

Solar energy system is a potential energy recruitment which helps to reduce greenhouse gases to the environment. The implementation of solar energy in industrial sector assist to achieve the nation's renewable energy goals. The aim of this research is to analyse the efficiency of photovoltaic system installed at a selected industrial area and its future prospect in terms of economical, social acceptance, and environmental benefits. The research site is located at the city of Shah Alam, Malaysia. The objectives of the research are to determine the total energy generated, analyse cost saving and CO_2 reduction from the solar panel installed at the electronic devices manufacturing site. In addition, the acceptance and perspective of renewable energy among the employees were assessed in smaller scale. Furthermore, the challenges in execution and its future prospect were also identified. The methods used in the research work are study case analysis and data collection techniques such as group focus discussion, questionnaire, and utilizing archived data. The research determined the current total energy reduction of year 2019 and 2020 from the installed solar system versus conventional energy usage in 2018. The roadmap of future solar energy installation from year 2022 to 2027 at selected site determined at 19% of CO_2 reduction. As conclusion, the study reveals research limitations and suggestions to improve the growth of solar energy at manufacturing site.

Keywords: Solar energy, industrial area, sustainable building, future prospect

SITUASI SEMASA DAN PROSPEK MASA HADAPAN TENAGA SOLAR DALAM SEBUAH SYARIKAT PENGILANG PERANTI ELEKTRONIK

ABSTRAK

Tenaga solar adalah suatu tenaga yang berpontensi untuk menyumbang penjanaan elektrik dan dapat mengurangkan kesan rumah hijau kepada alam sekitar. Implementasi tenaga solar di sektor industri dapat membantu untuk mencapai matlamat tenaga diperbaharui di negara kita. Tujuan penyelidikan ini adalah untuk menganalisis kecekapan sistem fotovoltaik semasa dan prospek masa hadapanya di sebuah kilang peranti elektronik yang terletak di bandar Shah Alam, Malaysia dari segi manfaat ekonomi, sosial dan persekitaran. Objektif penyelidikan ini adalah untuk mengenal pasti penjanaan elektrik dari sistem tenaga solar dan menganalisis penjimatan kos serta pengurangan karbon dioksida dari penyelengaraan sistem tersebut. Tambahan pula, penerimaan dan perspektif terhadap tenaga diperbaharui juga dinilai dalam skala kecil dalam kalangan pekerja di kawasan penyelidikan. Cabaran dalam melaksanakan sistem ini dan prospek masa hadapannya telah dikenal pasti. Metodologi yang digunakan bagi penyelidikan ini adalah dengan cara analisis kes kajian dan teknik pengumpulan data seperti temu bual, pengedaran soal-selidik dan penggunaan data solar yang telah direkodkan. Kajian ini juga telah mengenal pasti penjimatan tenaga semasa bagi tahun 2019 dan 2020 berdasarkan dengan penggunaan elektrik konvensional pada tahun 2018. Hala tujuan prospek masa hadapan tenaga solar untuk 2022 hingga 2027 dikenalpasti 19% pengurangan pelepasan karbon dioksida. Sebagai kesimpulan, peyelidikan ini memperlihat rentangan yang timbul dalam pelaksanaan sistem tenaga solar dan memberi cadangan untuk meningkatkan pengunaan tenaga solar di kawasan industri.

Kata kunci: Tenaga solar, sektor industri, bangunan lestari, prospek masa hadapan

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LIST OF ABBREVIATIONS

EC	:	Energy Commission
FiT	:	Feed-in Tariff
IRENA	:	International Renewable Energy Agency
kWh	:	Kilowatt hour
LSS	:	Large Scale Solar
MBIPV	:	Malaysian Building Integrated Photovoltaic Project
MW	:	Megawatt
MGTC	:	Malaysia Green Technology Corporation
NEM	:	Net energy metering
NGO	:	Non-governmental organization
PTM	:	Pusat Tenaga Malaysia
PV	:	Photovoltaic
RE	:	Renewable Energy
SEDA	:	Sustainable Energy Development Authority
TNB	:	Tenaga Nasional Berhad

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 General Introduction

Malaysia is Southeast Asia's second-largest oil and natural gas producer, and the world's fifth-largest exporter of liquefied natural gas (LNG) as of 2019 (IEA, 2021). It is undeniable that, the fossil fuels usage is adding up CO_2 emission level in the environment. Unsustainable source of conventional energy recruitment such as fossil fuel and natural gas usage have led developers and policy makers to consider alternative energy creation to support the growing energy demand. The alternative energy such as solar, wind, hydro and biomass are classified as clean energy because they produce almost zero carbon dioxide to the environment. Solar power has the maximum promising backup power because it has many advantages over other renewable energy resources (Mekhilef et al., 2012). Photovoltaic solar panel now has a large market to develop the clean energy (Chowdhury et al., 2020). Climate change has been major concern in the United Nation's millennium project due to the global average temperature increased to 1 °C over the past century (Shubbak, 2019). World Health Organisation (WHO) reported that climate interruptions have contributed to nearly 160,000 people deaths annually and estimated to rise if the temperature going to increase (Mostafaeipour et al., 2021). To overcome the climate change crisis, solar energy has more benefits over other renewable energy (Mekhilef et al., 2012). In line with Paris Agreement on CO_2 reduction goals, decarbonization initiatives must be aggressive to reduce the negative impacts on climate change within 50 years according to IRENA'2017 (Rabaia, M. K. H et al., 2021). Solar energy has received much attention in overcoming global energy shortage and controlling the carbon footprint to the environment (Shahsavari & Akbari, 2018).

However, the solar energy development from the law and legal point of view is still immature. Since the electricity generation from the Fifth Fuel Policy was only 0.3%

achieved in 2005, Malaysia government established an exclusive Renewable Energy (RE) Policy and action plan to enhance the uptake of renewable energy technology among the stakeholders and investors (Jamaludin et al., 2020). To date, the Minister of Energy and Natural Resources have mentioned that the total RE capacity for Malaysia stands at 7,995 MW and plans to increase to 31 % of renewable energy mix in 2025 (MIDA, 2021). The law and policy development for solar energy is crucial for all countries to achieve its 2030 energy and climate goals (Heffron et al., 2021). According to research by Heffron et al., (2021), the development of legal infrastructure on solar energy would consume time not only on planning, raising funds and build up policy, but also need to overcome challenges economically and socially. The law development for the solar energy must be a major role for a country to implement the energy transmission as it creates a clear road map towards the usage of renewable energy nationwide.

According to Solar Power Europe in Global Market Outlook for Solar Power (2017-2021), the competitiveness for solar energy continue to grow as the market price for solar energy in 2016 plunged which was lower than the price guarantee the United Kingdom government signed for the Hinkley Point C nuclear power plant (Schmela & Doring, 2017). The report also states that Asia Pacific Region became the largest solar powered region globally with total capacity of 147.2 GW which is equivalent to 48% contribution of the global market share in solar energy implementation. This also have pushed the European solar pioneers to second place which have total capacity of 104.3 GW at contribution of 34% globally in the solar energy market.

The solar energy utilization able to eliminate the greenhouse gas emission such as carbon dioxide (CO_2), nitrogen oxide (NO_x) and sulphur dioxide (SO_2). The expand of solar energy usage helps to reduce 69 to100 million tons of CO_2, 126,000 to 184,000 tons of SO2 and 68,000 to 99,000 tons of NOx by 2030 (Shahsavari & Akbari, 2018). The energy demand is at peak in developing countries in Asia and anticipated to increase at 3.7% a year (Bashir, M. F et al., 2022). Furthermore, natural gas usage in Malaysia grew constantly from less than 5% in 1978 to 41% in 2015 due to the increase in world oil price (Chatri, F et al., 2018).

To understand the effects of solar energy on industrial sector, this study will analyze the current state of solar energy benefits in an electronic device manufacturing company and its future prospect towards reduction of CO_2 emission. The company was selected as research site due to its easy accessibility to collect information on the implementation of solar energy.

1.2 Research Background

The adverse climate change over the years led to catastrophic natural disasters such as massive floods, abnormal droughts, wildfires and many more. Compared to two centuries ago, statistics have showed there are 30% more CO_2 emission in our environment now (Mostafaeipour et al., 2021). Reports from International Energy Agency (IEA) stated the implementation of renewable energy such as solar energy is not only for controlling the climate change rate but also to have energy security in the future (Mostafaeipour et al., 2021). Feed-in tariff system is one of the initiatives started by the government to enhance renewable energy growth in Malaysia. However, the initiative does not cope the high cost of renewable energy implementation due to budget constraints (Jamaludin et al., 2020). To combat such situations, Green Investment Tax Allowance and Green Income Tax Exemption was introduced by Malaysia government, under Malaysian Green Technology and Climate Change Corporation (Jamaludin et al., 2020).

Nevertheless, the pace of renewable energy such as solar energy implementation is much aggressive in the Europe countries. New York State enacted the Climate Leadership and Community Protection Act in June 2019 to combat the greenhouse gases emission with the objectives to generate 100% clean energy sources by 2040 with interim target of 70% renewable electricity by 2030 (Katkar et al., 2021). The appealing photovoltaic solar market gained the United States attention to increase their renewable energy plan, where in New York State the capacity of solar energy scale has increased five times over the last five years from 2018 (Katkar et al., 2021).

1.3 Problem Statement

Due to ample sunshine and an average irradiation of 1,643 kWh/m^2 per year, Malaysia's tropical climate is ideal for the development of solar energy (Chua & Oh, 2011). According to energy experts, about 10% of the world's electricity will be generated by solar power plants by 2050 (Ab Kadir et al., 2010). However, there are lack of investors and manufacturers who are considering the implementation and development of solar energy system in our country.

The challenges of executing large scale solar energy systems are due to lack of awareness on the benefits of the renewable energy to the environment among the stakeholders and insufficient of competent persons in the related field. Besides, the energy poverty has been identified in many regions of the world. About 1.9 billion depend on traditional biomass energy for cooking and many rely on kerosene for lighting in Asia (Shahsavari & Akbari, 2018). International Energy Agency (IEA) reported that many steps need to be taken to reduce the dependence on crude oil as main source of energy (Wong, S.L, 2015).The study of this research will determine the current efficiency of installed solar panel towards energy saving initiatives in line identifying the possible challenges involved in realizing the solar energy at industrial site.

1.4 Research Aim

The aim of the study is to analyse the efficiency of photovoltaic system that has been installed at the selected industrial site in the perspective of economic benefits, social acceptance, and environmental benefits. The purpose of this study is to focus on the reduction CO_2 achieved after installation of solar energy, to assess the perception and acceptance of renewable energy among employees and identify the roadmap of future solar energy implementation at the selected site.

1.5 Research Objectives

Objectives of this study are as follows:

1. To determine total energy generated from solar photovoltaic panels installation at an electronic devices manufacturing company.
2. To analyze cost and greenhouse gases (GHG) emission reduction from the solar energy project.
3. To assess the acceptance and perspective of renewable energy among the industrial employees.
4. To understand the challenges that present in the organization in implementing solar energy at industrial site.
5. To identify the future prospect of solar energy in the selected manufacturing site.

1.6 Scope of Work

This research will discuss on the current state of solar energy status implemented at an industrial area and its future prospect in the district of Shah Alam, Malaysia. An electronic device manufacturing company has been selected as the location to conduct the research based on the accessibility on the solar energy generation data, distance of the research site from living place and its strategic location within the industrial area. The factors evaluated to assess the current state of the solar energy utilization are total kWh generated from the solar panels installed, the total CO_2 and cost reduction achieved during the research conduct and the challenges involved in expanding the solar energy project at the selected site.

1.7 Dissertation Structure

The dissertation content with five chapters namely introduction, literature review, materials and method, result and discussion and conclusion and recommendation.

The first chapter provides general introduction about the dissertation including background of the research, review of previous studies, aim and objectives of the study and scope of work.

The second chapter is literature review which focuses more on the background of solar energy development in terms of initiatives taken by the government to expand its application, the successful stories of solar energy development in Malaysia and the status of solar energy globally. The chapter also evaluated the current growth of solar energy of other countries and reviewed the challenges in implementing solar energy.

The third chapter provides information on the site description and explain about methods used in retrieving the data from solar energy system at the selected site, performing calculations and conversion on the collected data, interviews conducted with the energy management team members and questionnaire distribution on acceptance and perception of solar energy among the workers of the selected industrial site. Furthermore, the fourth chapter represents all the obtained results, and the fifth chapter presents discussion over the results.

Finally, the sixth chapter is the conclusion which summarizes the findings of the study and a few recommendations for future work.

CHAPTER 2: LITERATURE REVIEW

2.1 The progress of renewable energy in Malaysia

Malaysia relies on fossil fuels such as natural gas, oil and coal for long period to generate energy (Oh, T.H et al., 2018). Energy consumptions are applicable in many sectors such as industrial areas, transportation, residential, commercial business areas and many more. The highest energy consumption reported by Energy Commission, was from industrial sector where about 49% of energy consumption in Malaysia was solely from industry, 30% from commercial sector, residential was at 20% while agriculture and transport were less than 1% in 2019 (Energy Commission, 2019). Electricity demand in Malaysia increases as many development activities being implemented for the past 33 years (Shekarcian et al., 2011). Malaysia regarded as fortunate due to its strategic location which have abundance of natural resources such as solar, wind, hydro power and biomass which known to be crucial requirements for renewable energy technology (Gomesh et al., 2013). Globally, the top four countries which installed solar power are China, Germany, Italy, and USA at the capacity of 32 509 MW, 16 987 MW, 8043 MW and 7665 MW respectively (Ohunakin, O.S et al., 2014). As of 2020, China remains the top solar energy installer followed by United States, Japan and Germany globally (Rabaia, M. K. H et al., 2021). To preserve the availability of fossil fuel for longer term, Malaysia government have developed fuel diversification goals by considering renewable energy such as solar in various sectors (Haiges, R et al., 2017). The law and policy development for the solar energy must be a major role for a country to implement the energy transmission as it creates a clear road map towards the usage of renewable energy nationwide.

Energy Commission is a statutory body established under the Energy Commission Act 2001, is responsible for regulating the energy sector, specifically the electricity and piped gas supply industries, in Peninsular and East Malaysia which is regulated under Ministry of Energy and Natural Resources. According to Energy Commission, (2019), renewable energy in 2019 earned four times as 2018 which is from 179 MW to 725 MW. This is in line with national renewable energy policy which is to achieve 20% renewable energy (RE) capacity mix by 2025. The goal of the policy is to increase RE energy growth by convincing the public and stakeholders to adopt RE as a second option for energy recruiting. The RE vision is driven by few initiatives such as implementing Enhanced Net Energy Metering (NEM) And Solar Leasing, implementing Large Scale Solar system (LSS), execute non-solar RE projects, establish RE facilitation programmes under Sustainable Energy Development Authority (SEDA) Malaysia and enabling greater access to renewable energy sources (Energy Commission, 2019).

Sustainable Energy Development Authority (SEDA) Malaysia is another statutory body developed under the Sustainable Energy Development Authority Act 2011 [Act 726]. The critical role of SEDA is to manage and regulate the implementation the feed-in-tariff system which is mandated under the Renewable Energy Act [Act 725]. The firm is regulated under the Ministry of Energy and Natural Resources as well. The functions of SEDA incorporated under Renewable Energy Act 2011 are to guide the Minister and relevant government entities on sustainable energy affairs including the policy law development and initiatives to be executed to encourage sustainable energy practice. Apart from that, they also promote and form renewable energy policy, being an administrator of developing sustainable energy and feed in-tariff system, review and revise the sustainable energy laws to Federal Government and conduct research on the development of renewable energy.

During Eighth Malaysia Plan 2001-2005, government of Malaysia introduced Fifth Fuel Policy 2000 (5FP2000) which emphasized on sustainable energy development such as biomass energy, biogas, municipal waste, solar and mini hydro for electricity generation (Chua & Oh, 2011). Solar energy has been identified in Third Industrial Master Plan (IMP3) in 2006-2020 plan, which reported photovoltaic cells recorded USD 10 million in 2005 (Chua & Oh, 2011).

Under Renewable Energy Act 2011, to promote energy generation from renewable energy resources up to 30MWNet, Feed-in Tariff (FiT) scheme was introduced (Mansur et., 2018). Feed-in-tariff was the initiatives introduced in the expanding renewable energy in the country by providing a good return of profit for the electricity generated from the renewable energy system installed (Chatri et al., 2018). Five renewable energy was confirmed under this system such as biomass, biogas, hydro power, solar photovoltaic and geothermal (Malik & Ayob, 2020). The application of FiT scheme was limited to Peninsular Malaysia and not expanded to East Malaysia due to difference in the governance of electricity (Ravichandran & Selvaraj, 2021).

However, the FiT scheme was replaced by Net Energy Metering (NEM) scheme in November 2016 to encourage consumers to use renewable energy or self-energy consumption system (Celvakumaran et al., 2019). Under this programme, RE consumers are allowed to use the energy generated from the RE system, and extra energy generated can be sold to TNB via feed back to the grid at a cost set by the Energy Commission (Amran et al., 2019) . NEM 1.0 scheme in 2016-2018 subscription was low with only 27.8 MW achievement in the end of 2018 (SEDA Malaysia, 2021b). However, after revising the energy generated offset mechanism in NEM 2.0, the total quota of 500MW were fully subscribed by consumers and investors at the end of 2020 (SEDA Malaysia, 2021b). Again NEM 3.0 was introduced by the Energy and Natural Resources Minister on 29 December 2020 to give opportunities to consumers to install more solar panels and moving to its direction of achieving renewable energy vision (SEDA Malaysia, 2021b).

One of the projects introduced to encourage photovoltaic installation was the Malaysian Building Intergrated Photovoltaic Project (MBIPV) in 2004 (Mekhilef et al., 2014). According to the research of Mekhilef et al., (2014), after revising the guidelines MS1525 in 2006, the goal to achieve energy efficiency was on non-residential buildings. Apart from that, SURIA1000, a subsidy provided by government, also was introduced under MBIPV project aiming at residential and commercial sectors to promote solar energy system in buildings. From this initiative, the energy consumers able to get electricity customers with price rebates on PV systems under the MBIPV project (Seng et al., 2008). Under this programme, from 39 applications, 14 proposals were approved in the first round of bidding process and the selected candidates received a 53 percent discount on their PV systems on average (Seng et al., 2008).

The successful point from initiating solar energy utilization is the development of green building in Malaysia which proved to be the evidence of energy efficient programmes. Pustaka Raja Tun Uda comprised with 6 floors; a modern architecture library has installed solar photovoltaic panels on its parking rooftop in 2018. The library director reported that they made an average saving of 22.15% in their electricity consumption after the solar energy was utilised in their premise (SEDA Malaysia, 2021a). He also further explained that at the first 11 months of 2020, the installation of solar PV units generated about 617,005 kwh of electricity which is equivalent RM 314,056 (SEDA Malaysia, 2021a). Another self-sustainable building is Pusat Tenaga Malaysia (PTM) identified as Zero-Energy Office which is located at Bandar Baru Bangi known to be first sustainable green building in Southeast Asia (Mekhilef et al., 2014). The building equipped with Built-In Photovoltaic (BIPV) at its car park, atrium and mounted infront of the building with total solar energy capacity at 9,672.87 kwh (MGTC, 2021). This is equivalent to 567 tonnes of CO_2 (MGTC, 2021). Another building with BIPV is Energy

Commission Diamond Building has energy efficient design within its building and have received Green Mark certification from Singapore (Xin et al., 2013).

Some of the mitigation plans outlined in the 11th Malaysia Plan to overcome the challenges on growth of renewable energy are such as encourage collaborations with industries and institutes on energy planning, engaging consumers with efficient energy consumption, impose the use of green fuel in transportation sector and expanding rural electrification. Some of steps under this plan include achieving 700 Registered Electrical Energy Manager (REEM), extend energy performance contracting (EPC) with authority buildings, encourage all new government buildings to adopt energy efficient design and ensure fair developments in modernizing 100 government buildings (Gee, 2015).

2.2 Solar energy growth in other countries

Solar energy able to enhance the environment quality to better condition as it is infinite energy source and pollution free (Sharif et al., 2021). The need to expand renewable energy such as solar energy is crucial at a faster rate for the earth to meet the Paris Agreement goals (IRENA, 2018). According to International Renewable Energy Agency (IRENA), total global solar energy capacity as off 2020 are 707,494 MW. The capacity of photovoltaic solar panel installation summarized in Figure 2.1.

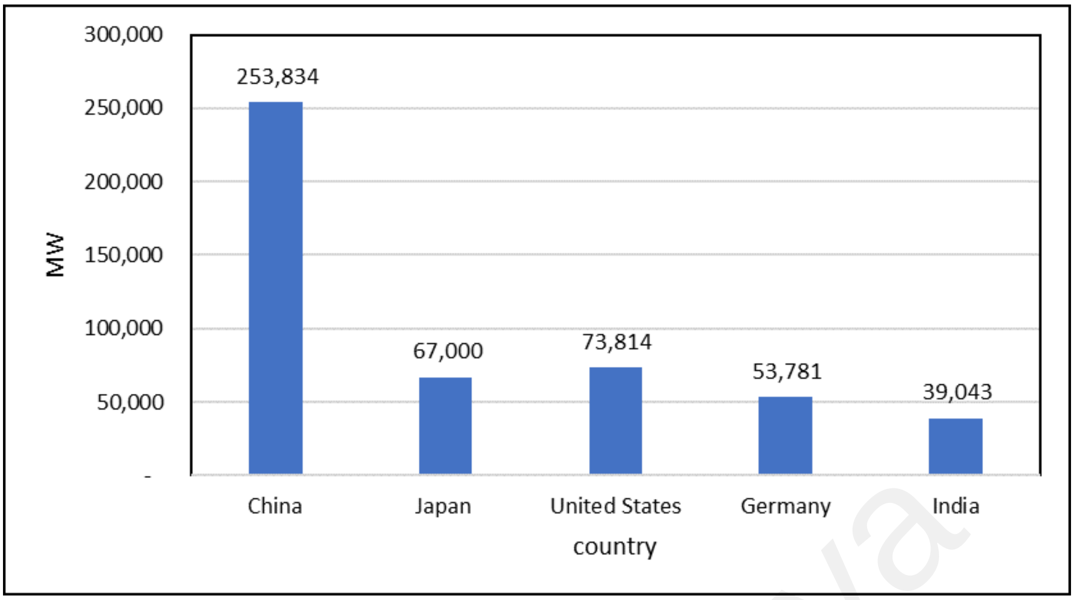

Figure 2.1: Top five countries installed solar energy in 2020 (IRENA, 2020)

The zero-emission energy not only benefit the environment by reducing carbon footprint, but it also contributes to social-economic developments (Akella, 2009). Job opportunities from solar energy manufacturing industries create income to the nations and increase the gross domestic product significantly (Kumar, 2020). The accountable factors to the development of social-economic includes employment, health wellness, education, reduced greenhouse gas emissions and changes in material consumptions (Akella, 2009).

To practice sustainable development, China government utilize the building sector for solar energy implementation which are available as solar water heater, solar heating buildings, solar refrigeration and photovoltaic system (Li, Z. S et al., 2007). Northern China receive abundant sunlight and if the solar radiation is converted to energy generation, the national annual energy demand could be met by 1% (Eftekhari, A., 2020). Besides, China also became the highest photovoltaic cells (PV) producer in the world. The total yield of PV cells in 2019 was 30.1 GW (Walton, 2021). According to research by Marabini, E. (2021), 80% of c-Si solar market controlled worldwide by China and European Union is China's main trading partner.

The solar photovoltaic installations have been in significant growth in Japan renewable energy initiatives (Taghizadeh-Hesary et al., 2021). Feed-in tariff system had encouraged the solar installers to sell the renewable energy at fixed price and it also have initiated the expand of solar modules (Taghizadeh-Hesary et al., 2021). However, United States, increased its solar ambition by doubling its growth rate at 43% since previous years which result in 19.2 GW in newly installed capacity (Schmela, 2021). As for Germany, roof top installations program was the main pillar for feed-in schemes under the structure of solar energy implementation (Schmela, 2021). This initiative was executed to promote photovoltaic system and to attract investors towards the scheme (Wen, D et al., 2021). Under National Action Plan on Climate Change, India had policy visions to install 22,000 MW solar energy through connected grid and off-grid power plants (Kapoor, K et al., 2014). The development solar energy in India drove by Jawaharlal Nehru National Solar Mission in 2010 and its government have taken many initiatives such as oversea direct financing, achieving sustainable development goals in solar park creation and Solar Renewable Purchase Obligation (Banik & Sengupta., 2021).

2.3 Solar energy management in ASEAN countries

Southeast Asia is one of the fastest growing region in the aspect of manufacturing, socio-economy, global investment and international trade (IRENA, 2018). The total GDP of all ASEAN countries is expected to reach roughly 3.08 trillion US dollars in 2020, a substantial rise gradually from prior years (Neil, 2021). Structural development, increasing population size and rapid urbanization constantly increased the energy demand in these countries. Various sectors such as transportation, industrial activities, residential, commercial and primary sector have contributed to the rising energy demand. The ASEAN countries have contributed 4.2% of greenhouse gases globally in 2017 which increased by 1.5 times from 2010 (Vidinopoulos et al, 2020). Climate change have become one of the phenomena contributed by this region due to the economic growth and increase of fossil fuels usage (Nathaniel & Khan, 2020). ASEAN region also have become the third largest emitter of greenhouse gases due to inadequate investment in sustainable energy technology and too much dependence on fossil (Nathaniel & Khan, 2020). To overcome this issue, an inter-governmental organization was developed called as ASEAN Center for Energy (ACE). The primary purpose of this organization is to provide information and coordinate the ASEAN members on energy efficiency initiatives, implement sustainable energy policies in line with economic growth and environment sustainability (Ismail, 2015). The deployment of renewable energy among ASEAN member states like Indonesia, Malaysia, Philipines, Thailand and Vietnam showed successful result by its Feed-in Tariff system, incentives for RE implementors, financing process, licensing system and technical standards especially grid connection codes (ASEAN, 2016).

According to International Energy Agency (IEA), 2019, the energy policies in the ASEAN countries varies in sectors of energy efficiency, renewable energy, and climate change. All energy policies from ASEAN countries are summarized in Table 2.1.

Table 2.1 Summary of energy policies in ASEAN countries (IEA, 2019)

Country	**Sector**	**Policies and target**
Brunei Darussalam	Efficiency	Total energy consumption reduction to be achieve by 63% in all normal business condition by 2035.
	Renewables	Achieve 10% electricity generation from renewables by 2035.
	Climate Change	Reduce 40% of CO2 emission from morning peak hours vehicles in normal business condition by 2035.
Cambodia	Electrification	Supply electricity for all rural areas and 70% electricity supply to households by 2030.
	Renewables	Achieve hydropower generation up to 2241 MW by 2020.

	Climate Change	GHG emission to reduce at 27% from baseline emission with international support.
Indonesia	Electrification	To achieve electricity supply ratio at 99.7% by 2025.
	Efficiency	Reduce energy usage by 1 % every year until 2025.
	New & Renewable energy	To achieve 23% and 31 % respectively on increased share of renewable energy by 2025 and 2030.
	Climate Change	To reduce 26% of GHG by 2020, 29% by 2030 from normal business condition and reduction at 41% by 2030 with international support.
Lao PDR	Electrification	To achieve electric supply at 98% by 2025.
	Efficiency	To achieve reduction in final energy consumption at 10% in all normal business condition.
	Renewables	To attain 30% shares of renewables in primary energy supply by 2025.
Malaysia	Efficiency	To promote energy efficiency by various methods such as standard setting, labelling, building design and energy audit in industries, building design and residential sectors.
	Renewables	Renewable's capacity to be increase at 2080 MW by 2020 and 4000 MW by 2030.
	Transport	Introduce 100,000 electric vehicles by 2020 and implement 125,000 charging stations.
	Climate Change	To reduce GHG emission by 35% by 2030 from 2005 level and achieve 45% GHG reduction with enhanced international support.
Myanmar	Electrification	Achieve electric supply at 80% nationwide by 2030.
	Efficiency	Achieve primary energy demand reduction from 2005 baseline at 8% by 2030.
Philippines	Electrification	Achieve 100% electric supply by 2022.
	Efficiency	- Reduce energy strength at 40% by 2030 from 2010 energy usage baseline. - Reduce energy usage by 1.6% by 2030 by each year from baseline forecast.

	Renewables	Achieve triple renewable energy capacity up to 15 GW by 2030 from 2010 baseline.
	Climate Change	Achieve 70% GHG reduction from normal business condition by 2030 with international support.
Singapore	Efficiency	Attain energy strength by 35% by 2035 from 2005 baseline.
	Renewables	Achieve solar PV capacity to 350 MW by 2020 and 1 GW beyond 2020.
	Climate Change	Reduce GHG by 16% below normal business condition by 2020 and maintain emission until the peak achieve in 2030.
Thailand	Efficiency	Reduce energy strength by 30% by 2036 from 2010 energy baseline.
	Renewables	- Achieve renewable energy capacity in total energy consumption at 30% by 2036. - Achieve renewable based power energy generation capacity at 36% and renewable energy generation capacity at 20% by 2037. - Achieve shares of renewable energy in transport fuel consumption by 2036 at 25%.
	Transport	To achieve 1.2 million electric vehicles and 690 charging stations by 2036.
	Climate Change	- To reduce CO_2 emission to 0.283 kg in 2037 from 0.437 in 2018 from power sector. - Reduce GHG emission by 20% in normal business condition by 2030 and increase reduction level at 25% international support.
Vietnam	Electrification	Ensure most rural areas with electricity supply by 2020.
	Efficiency	Reduce 10% in total energy consumption by 2020 in normal business condition.
	Renewables	Increase non-hydro renewable energy generation capacity at 12.5% by 2025 and 21% by 2030.
	Climate Change	Achieve GHG reduction by 2030 at 8% and at 25% from normal business condition with international support.

Based on the energy policy review, the availability of policies are important tools to ensure right energy management in a nation and it gives awareness on renewable energy roadmap and energy security (ASEAN, 2016). Besides, energy policies also act as vital foundation for investment on renewable energy. As investment requires large participation from various sectors, level of commitment towards the goals of the policy is crucial (IEA, 2019).

Among the ASEAN countries, Vietnam takes the lead in solar energy installations as of 2020 (The ASEAN Post, 2021). The total solar energy capacity of Vietnam as of 2020 is 16.5 GW and known to be world's sixth largest solar energy implementation (Rodriguez, L, 2021). The aggressive solar development in Vietnam was contributed by few factors such as appealing Feed-in Tariff rates, tax allowances, complimentary policies, and rising energy demand (Do, T. N et al., 2020). The solar energy trend followed by Thailand, Malaysia and Philippines which are among the top ASEAN countries to install solar energy at a larger scale. The total solar energy installed capacity is shown in Figure 2.2 for year 2020.

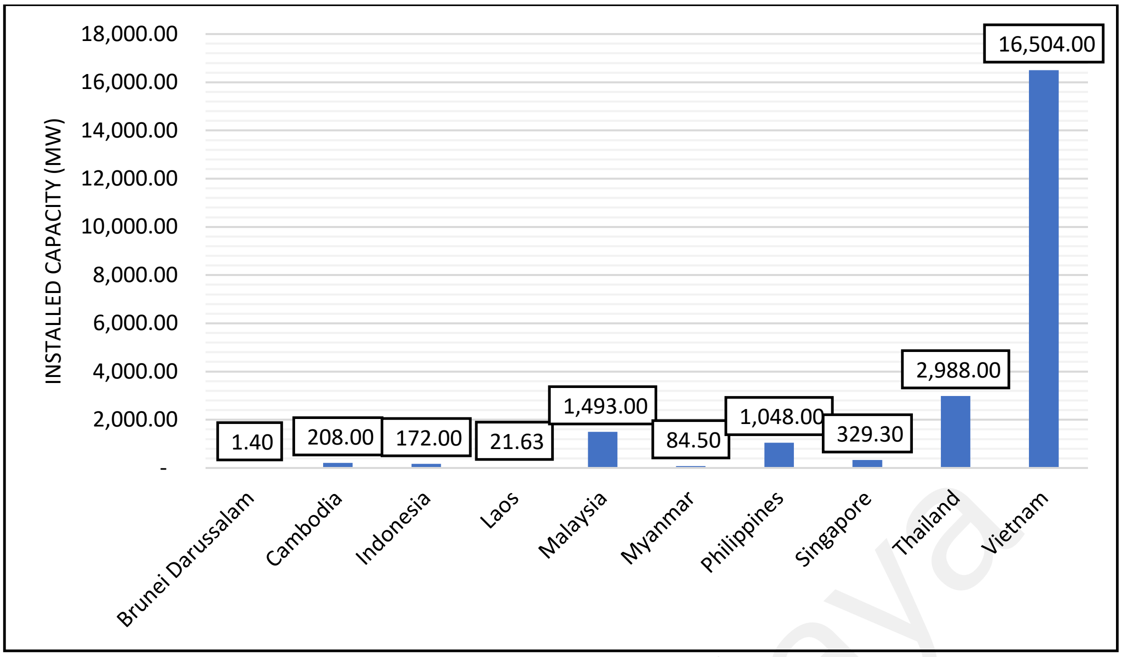

Figure 2.2: Total solar energy capacity in ASEAN countries as of 2020 (IRENA, 2021)

2.4 Criteria assessed in evaluation of perception and acceptance of renewable energy

Public perception and acceptability are the key factors to make practical implementation of renewable energy such as solar to be workable (Castelazo & Azapagic, 2014). It is crucial to understand public's attitude, acceptance, participation, and concern towards renewable energy to drive the government to achieve its target on renewable energy easily (Abdullah, W. M. Z. B. W, 2021). According to research by Qazi, A et al., (2019), the evaluation of public awareness towards renewable energy were assessed in terms of reasons to switch to green energy, identification on types of renewable energy such as solar, wind, hydro, biomass and opinions towards renewable energy technology. Another study conducted by Ali, G et al., (2019), the criteria also assessed based on socioeconomic factors such as gender, living area, number of households, income and energy conservation behaviour, energy use patterns and awareness towards the renewable energy to focus on the relationship between the income level, number of household and energy consumption.

Sustainable energy generation measures should be given attention to tackle the environmental footprints of the rising energy demand (Evan, A., 2009). The implementation of solar energy at industrial site should be considered as alternative energy sources by the management to support CO_2 emission reduction pledge. In line with the aim of the nation to achieve 31% of renewable energy capacity mix by 2025, the efficiency of solar energy implementation at manufacturing site needs to be assessed. Early efficiency assessment of sustainable energy could help in identifying mitigating climate change options, securing alternative energy resources and improve air quality (Gielen, D et al., 2019).

CHAPTER 3: METHODOLOGY

3.1 Site description

An industrial site was chosen to study the current state of solar energy implementation and evaluate the future prospect of solar energy contribution in reducing the carbon footprint in the environment. The industrial site selected is one of the manufacturers of electronic components such as transistors, capacitors, switches, and electronic chips in the global market. The site was selected based on few criteria. One of the main criteria is the accessibility of data collection solar energy generation was feasible and the site selected managed by structured organization where this will help to get the opinions of the decision maker easily. Apart from that, the manufacturing site also plays a major role in the industrial sector as it known as multinational company which responsible for tons of CO_2 emission. In efforts to reduce the electricity consumption and to support its green energy goals, the entity has outlined solar energy utilisation and energy efficient measures. The selected site is located at Shah Alam city in the state of Selangor. The geographical coordinates of Shah Alam are taken as 3.0733^{o} N latitude and 101.5185^{o} E longitude. The land area of the site is 66,955m^2 with build-up area as at 55,093m^2. There are total of 14 buildings or blocks in the site compound covering production area, warehouse, power plant, administrative offices, chemical and waste storage. The photovoltaic panels were installed on the roof top of Board of directors' car park area beside the first block of the site. The solar energy at the site was officially commissioned in end of 2018. The total roof area of solar photovoltaic system installed is 145 m^2 with 84 pieces of solar panels. The brand of the solar panels installed were Max Panasonic 325 W hit modules with total capacity of 27.3 kw. Apart from that, carpark of the premise also equipped with eight units of solar streetlight. The graphical diagram of the study is shown in Figure 3.1. The picture of solar panel site and solar streetlight are attached in Appendix A and Appendix B.

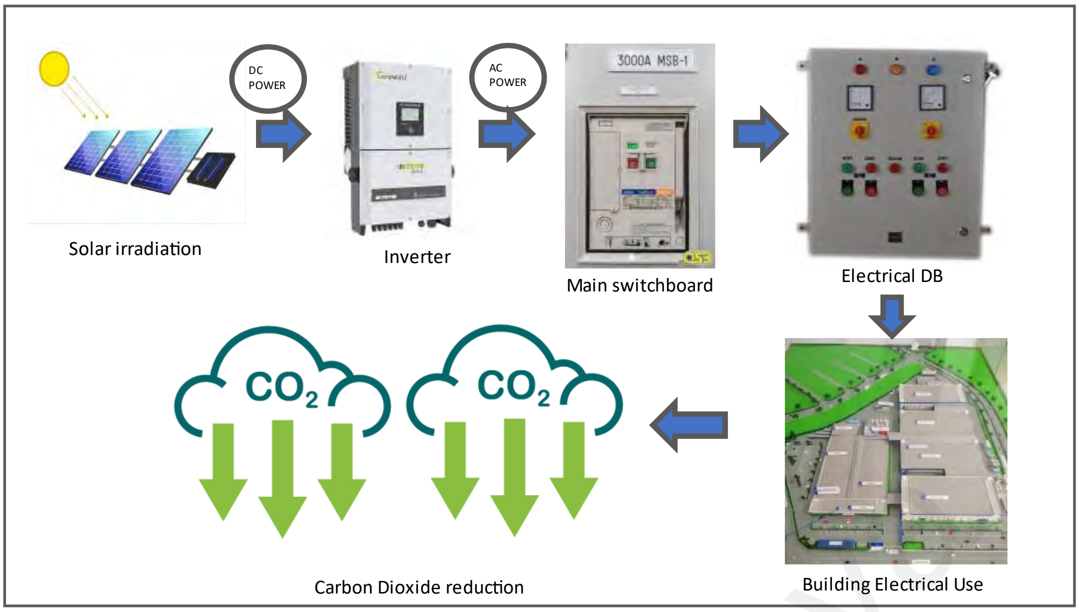

Figure 3.1: Graphical illustration of solar energy study

3.2 Real time data collection and analysis

The data collection was conducted on daily basis by the Facility Department technician for the year of 2019 and 2020. The total kWh generated from the solar energy system is displayed on main switch board which then recorded by the technician. Total energy generated record was consolidated by months for the years – 2019 and 2020 continuously. Total CO_2 reduction from energy generated was determined based on Malaysian formula referred from 2017 CDM Electricity Baseline Malaysia (Malaysia Green Technology Corporation, 2017). The electricity usage before and after solar energy installation was determined to assess on the energy usage reduction of the solar panel. The sum of CO_2 reduction was then evaluated against monthly CO_2 emission generated from total conventional energy consumption of the whole industrial operation. Total cost saving was calculated based on energy generated from solar energy system installed using current industrial tariff rate, (RM 0.355/kwh) under category Tariff E3, High Voltage Peak/Off Peak Industrial Tariff set by TNB (Tenaga Nasional Berhad, 2022). Besides, the cost saving of future solar energy generated also calculated based on the similar tariff.

CO_2 calculation formula:

$$CO_2 = Mwh*0.585$$

3.3 Interview session

The interview session was conducted to three levels of employees of the selected site organization which were from top management, manager level and executive level-below. Top management known to be as decision makers in the organization which will approve any projects to be executed. At manager level, the staff would make the necessary plans, analyses the challenges, determine the project cost, and select the right contractors for their projects. At executive and below level, the employees would become the assistant to their managers by attending the project conduct, overlook safety and environmental requirements and solve on-site issues. The virtual group discussion consists of 5 employees. The employees who participated in the virtual group discussion were 1 energy manager and 4 senior technicians. These employees are part of the main energy management team for the company who are managing the electricity consumption and energy reduction activities with the assistance of senior engineers from the factory side and have more than 3 years experience in energy management. The input of the meeting was discussion on challenges faced by the staffs during solar energy implementation. The virtual interview meeting screenshot is attached to Appendix D. One general manager as top management representative was interviewed physically. The questions asked during the one-to-one interview session were; what is the roadmap for carbon emission reduction in another 6 years, what is future prospects of solar energy in the selected site.

3.4 Acceptance, perception and barriers

To obtain information based on the knowledge, attitude and practices of the employees on solar energy at the site, a set questionnaire by Microsoft Forms platform was used. The relevant questions from the questionnaire used were adopted from the research paper of Al-Zuhair et al., (2014). The questionnaire comprises with close ended quantitative questions such as multiple choice and Likert scale. The first part of the questionnaire requires the demographic data of employees such as ID number, name, years of experience and job designation. The second part of the questionnaire was on the acceptance, perception, and the barriers on the solar energy implementation. In the purpose of extracting the respondents' acceptance of solar energy and barriers, 5-point Likert scale was used; strongly disagree (1) to strongly agree (5) (Malik & Ayop, 2020). To identify the likelihood of factors that influence switching to green energy such as solar and favourable renewable energy at industrial site, close-end questions were applied. Total 50 participants from five different departments involved in the questionnaire distribution. The number respondents for the questionnaire were chosen to conduct study case in smaller scale as a preliminary stage to assess the knowledge of renewable energy among the employees. The stratified 50 samples of respondents are taken from Information system, (7), Human resource, (7), Corporate Sales (7) and Production sites (Capacitor Business Group, (21) & Human Machine Interface Business Group, (8)) departments.

The collected data were then presented using pie chart for close-ended questions and line-bar for 5-point Likert-scale questions. Questionnaire was targeted to three levels of designation which are from assistant manager and above, executives above and executive level and below. The analyses between the relationship of demographic data of employees and acceptance and perception of the questionnaire were evaluated.

3.5 Limitation identification of current study

During the study performed there were few limitations identified. The study limitation includes restricted accessibility for solar energy data such as the build-up area of the site, pictures, and software copies of the information on current solar energy. The absence of availability of information in softcopy is another limitation to retrieve data (Conkling, 2021). The limitation was overcome by requesting permission from Information System Department for data retrieval and hard copies of solar energy information were acquired from person in charge. According to Krejcie and Morgan, (1970), if the *N* (population size) is 1700, the sample size should be 313 respondents. The total size of employees in the selected manufacturing company is 1719. However, only 50 respondents were able to achieve due to time constrain and late response of the employees. Some of the employees seem to be less responsive and takes longer time to complete the questionnaire. Frequent follow up was done via sharing name list of selected staffs who do not complete the questionnaire in email communication to speed up the completion. In addition, to tackle the of the issue who are not responding after communicating via email, close follow up been done to get their answers. The study should be treated as preliminary assessment on the perception and acceptance of renewable energy among workers as the size of research sample is limited.

CHAPTER 4: RESULTS

4.1 Total energy usage before and after solar energy implementation from 2018

Total energy (MW) usage was determined from year 2018 to 2020 to compare the energy consumed in the whole industry operation before and after solar energy implementation accordingly and shown in Table 4.1. The trend of energy usage was depicted in Figure 4.1 to show the significant reduction achieved from the consecutive years.

Table 4.1: Total Energy (MW) usage for Year 2018, 2019, 2020

YEAR	Energy Usage (MW)	CO2 EMISSION (MW*0.585)
2018	51,682.00	30,234
2019	45,986.00	26,902.37
2020	40,774.00	23,852.79

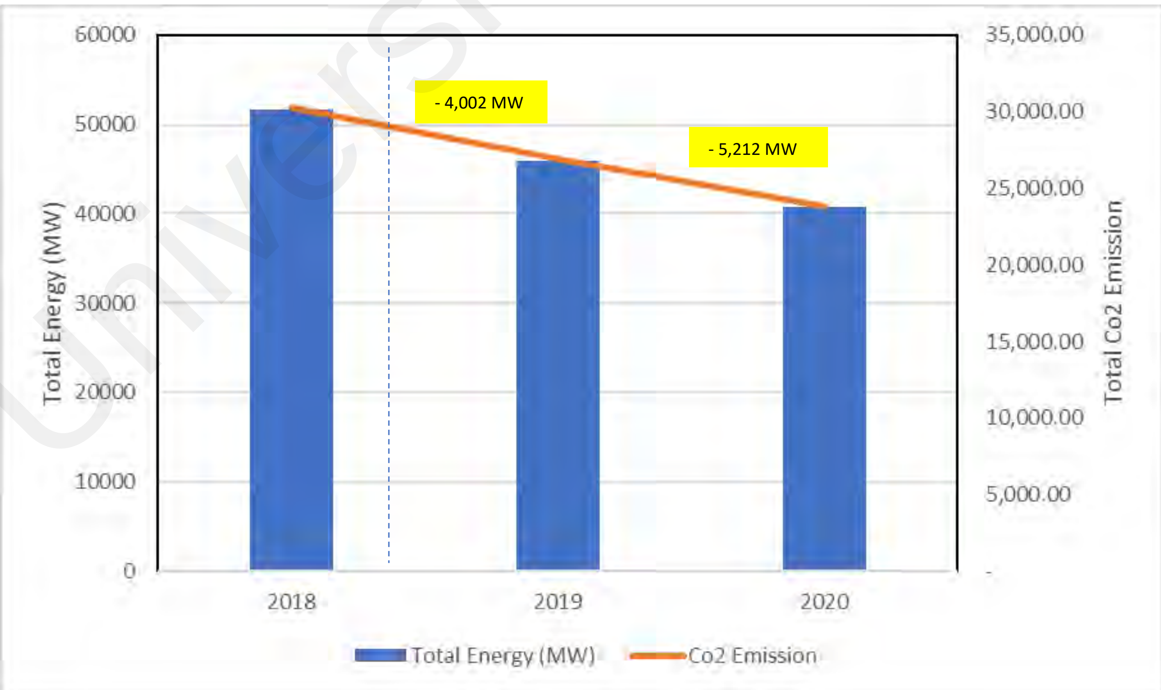

Figure 4.1: Total Energy (MW) generation for year 2018 until 2020 before and after solar energy

4.2 Total energy generation (MW), CO_2 reduction and emission for year 2019 and 2020

There was no energy generation recorded for 2018 as the official commissioning of solar energy implementation was started in 2019. The total energy generated by solar energy implementation and conventional energy usage was consolidated for year 2019 and 2020 are shown in Table 4.2 and 4.3.

Table 4.2: Total Energy (MW) generation and conventional energy usage 2019

MONTH	Total Solar MW generation	Total CO_2 reduction (ton)	Conventional energy usage (MW)	Total CO_2 generation (ton)
		MW * 0.585		MW* 0.585
Jan-19	0.9108	0.5328	4027.06	2355.83
Feb-19	0.8941	0.5230	3369.43	1971.12
Mar-19	0.8813	0.5156	3718.11	2175.09
Apr-19	0.8703	0.5091	3960.96	2317.16
May-19	0.8932	0.5225	4041.03	2364.00
Jun-19	1.0130	0.5926	3588.76	2099.43
Jul-19	1.0029	0.5867	4121.60	2411.13
Aug-19	0.9218	0.5393	3977.00	2326.55
Sep-19	0.9135	0.5344	3830.00	2240.55
Oct-19	0.8914	0.5215	3829.00	2239.97
Nov-19	0.8290	0.4850	3735.00	2184.98
Dec-19	0.8080	0.4727	3789.00	2216.57
Total	**10.83**	**6.34**	**45,986.95**	**26,902.37**

Table 4.3: Total Energy (MW) generation and conventional energy usage 2020

MONTH	Total Solar MW generation	Total Co2 reduction (ton)	Conventional energy usage (MW)	Total Co2 generation (ton)
		MW * 0.585		MW * 0.585
Jan-20	1.1169	0.6534	3583.00	2096.06
Feb-20	1.0903	0.6378	3518.00	2058.03
Mar-20	1.0771	0.6301	2519.70	1474.02
Apr-20	1.0664	0.6238	1591.00	930.74
May-20	1.0938	0.6399	3451.30	2019.01
Jun-20	1.2440	0.7277	3689.00	2158.07
Jul-20	1.2276	0.7181	3778.00	2210.13
Aug-20	1.1266	0.6590	3757.00	2197.85
Sep-20	1.1187	0.6544	3699.00	2163.92
Oct-20	1.0903	0.6378	3718.00	2175.03

Nov-20	1.0143	0.5934	3661.00	2141.69
Dec-20	0.9920	0.5803	3809.00	2228.27
Total	**13.26**	**7.76**	**40,774.00**	**23,852.79**

The total energy generation achieved in 2019 and 2020 are 10.83 MW and 13.26 MW respectively. As Malaysia is situated at the equatorial region, it receives heavy rainfall throughout the year due to its tropical climate. Average monthly precipitation approximately at 200mm in June and July while 350 mm in November and December (Climate change knowledge portal, 2021). The period of South-West monsoon (May to September) usually indicated as drier season for Peninsular Malaysia (Azhari et al., 2008). During the research conducted, from month of June to September solar energy could be harnessed at highest which are by average at 1.013 MW in 2019 and 1.244 MW in 2020. During this time, weather in Shah Alam state was low with rainfall and received more sunlight. However, lower solar generation was achieved starting from October until December due to more rainy days in these months. Due to heavy fog and precipitation in the rainy season during August to December, lower solar radiation could be harnessed (Mohammad et al., 2020).

4.3 Carbon dioxide (CO_2) emission trend 2018, 2019 and 2020

Carbon dioxide (CO_2) emission trend from the site was identified from year 2018 to 2020. Figure 4.2 shows the emission of CO_2 in the selected site.

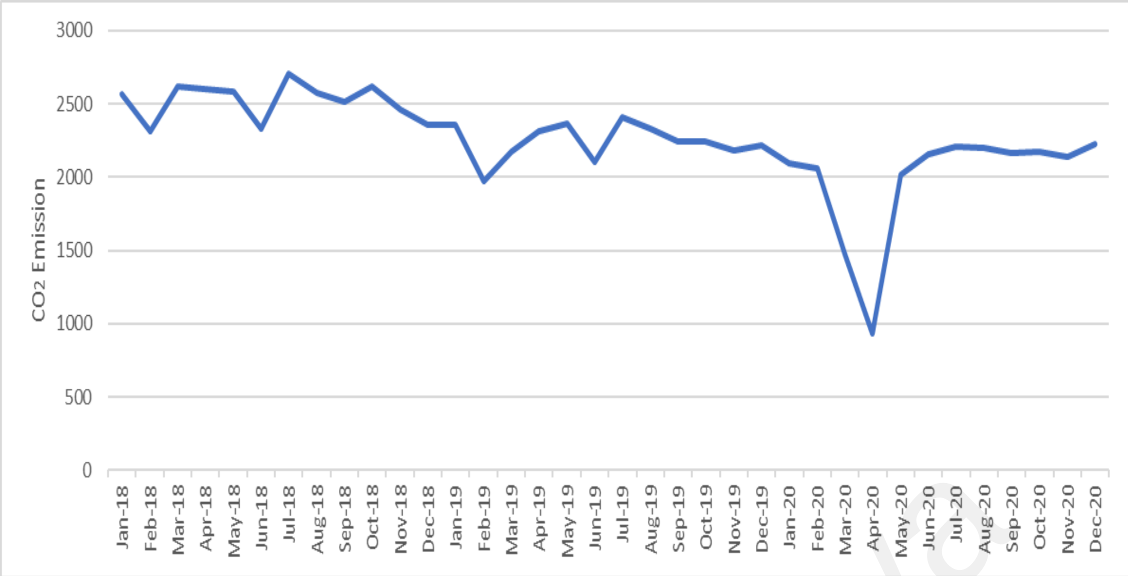

Figure 4.2: CO_2 Emission Trend in 2018, 2019 & 2020

The CO_2 emission identified from the site was from 2018 until 2020. Total CO_2 emission from 2018 until 2020 counted at 80,989 tons. The highest CO_2 emission was in year 2018 in the month of July which was 2,703 tons. The average CO_2 emissions in 2018, 2019 and 2020 were declining from 2,519 tons, 2,241 tons and 1,987 tons monthly. Minimum CO_2 emission identified on the month of April 2020 at 930 tons. The energy consumption of the site is mainly influenced by the product demands and working hours. However, in the month of April 2020, the manufacturing operation had to be stopped due to Covid-19 outbreak and movement restriction order announced by government.

4.4 Total energy generation and cost saving calculation

The total energy generation and its cost saving for solar system installed at selected site are tabulated in Table 4.4.

Table 4.4: Energy Consumption, Generation and Cost saving Calculation

Year	Energy Consumed (MW)	Total payable cost (MYR)	Solar Energy Generation at optimum sunlight	Total Cost Saving
2018	51,682	(kWh x MYR 0.355) = 51,682,000 x 0.355 = MYR **18,347,110**	- No solar energy generation	- Zero cost saving from solar system
2019	45,986	(kWh x MYR 0.355) = 45,986,000 x 0.355 = MYR **16,325,030**	Photovoltaic solar energy: Hourly Power Generation = **5.63 kW** Daily Power Generation = 5.63 kW x 6 hours = **33.78 kW** Monthly Power Generation = 33.78 kW x 30 days = 1013.4 kW/1000 = **1.0134 MW** TOTAL YEARLY ENERGY GENERATION: 1.0134 X 12 = **12.1608 MW**	Annual Cost: (kWh x MYR 0.355) 10.83 x 1000 = **10,830 kW** 10,830 x 0.355 = **MYR 3,844.65**

2020	40,774	(kWh x MYR 0.355) = 40,774,000 x 0.355 = MYR **14,474,770**	Photovoltaic solar energy: Monthly generation = **1.0134 MW** Solar Streetlight: 8 units installed (156 watt/hour) Hourly Power Generation = 156 watt x 8 unit = **1.25 kW** Daily power Generation = 1.25 kW x 6 hours = **7.5 kW** Monthly Power Generation = 7.5 kW x 30 days = 225 kW/1000 = **0.225 MW** Photovoltaic solar + Solar streetlight (energy) = 1.0134 MW + 0.225 MW= **1.238 MW** TOTAL YEARLY ENERGY GENERATION: 1.238 X 12 = **14.856 MW**	Annual Cost: (kWh x MYR 0.355) 13.26 x 1000 = **13,260 kW** 13,260 x 0.355 = **MYR 4,707.30**

Total	**138,442 MW**	**MYR 49,146,910**	Sum of energy generated for 2019 & 2020: 12.1608 + 14.856 = **27.017 MW**	Estimated sum of cost saving for 2019 & 2020: 3,844.65 + 4,707.30 = **MYR 8,551.95**

4.5 Interview session

On 24 Nov 2021, at 3 to 4 pm, a focus group discussion session was conducted with Facility Department members of the selected site. Total 5 employees from the department were interviewed in the virtual meeting. The meeting was attended by 1 manager and 4 senior technicians. The job scope of the manager at the site is to evaluate energy efficient projects on the energy savings and prepare for the documentations. Senior technicians will check on-site on the faulty energy supplies and arrange for maintenance works in the site. The topic discussed during the meeting with the employees were on the obstacles of solar energy implementation. The obstacles that present in executing solar energy system were the selection of suppliers on implementing solar energy and acquiring approvals from higher management is a time-consuming process. Besides, few revisions of solar energy study and lack of competent person to conduct the study is another challenge to realise solar energy at the industrial site. To compensate the retirement of skilled worker in the site, new person in charge has been appointed and trained to overcome the barrier. Besides, one top management representative was interviewed one to one to acknowledge the roadmap of the future solar energy implementation. From the interview outcome, FY2022~FY2026 solar energy roadmap was explained to achieve the company environment vision known as "Net zero CO_2 Emission by 2030".

4.6 Questionnaire distribution outcome

Total 50 random participants are involved in the questionnaire distribution from different departments. The size of target sample was chosen based on primary target participants who are holding their own roles in the Environmental Promotion and Protection Committee in the organisation. Three level of job designation with different working years at 20, 10, 5 and 2 years staffs were selected to respond for the questionnaire. The staffs who responded to the questionnaire were 26 staffs of above assistant manager level who are 11 persons with twenty years' experience, 8 persons with ten years' experience and 7 persons with five years' experience. For executive level staffs, total 17 staffs were selected who are 7 staffs with more than ten years' experience, 9 staffs with five years' experience and 1 staff with two years' experience. For below executive level, total 7 staffs were selected who are 2 staffs from ten years' experience category, 3 staffs from five years' experience category and 2 staffs from two years' experience category. The percentage of responses based on designation and years of experience towards the perception and acceptance of renewable energy are shown in Table 4.5, Table 4.6, Table 4.7, Table 4.8, Table 4.9, Table 4.91, Table 4.92, Table 4.93, Table 4.94

Table 4.5: Response answer for Question No.1

Question No.1:

Which of the following points influence your decision to switch to green energy?

Designation + Years of experience	Cost of purchasing;	Ease of switching (easily able to find reliable suppliers);	Incentives for switching;	Cost of purchasing;Ease of switching (easily able to find reliable suppliers);	Cost of purchasing;Ease of switching (easily able to find reliable suppliers);Incentives for	Cost of purchasing; Incentives for switching;	Ease of switching (easily able to find reliable suppliers);Incentives for switching;	Grand Total
Assistant manager and above	**27%**	**12%**	**19%**	**15%**	**19%**	**4%**	**4%**	**52%**
more than 20 years	36%	9%	27%		18%	9%		42%
more than 10 years	13%	13%	25%	25%	25%			31%
more than 5 years	29%	14%		29%	14%		14%	27%
Executive and above	**24%**	**12%**		**18%**	**24%**	**6%**	**18%**	**34%**
more than 10 years	14%	14%		29%	29%	14%		41%
more than 5 years	22%	11%		11%	22%		33%	53%
more than 2 years	6%							6%
Executive and below	**57%**	**29%**				**14%**		**14%**
more than 10 years	50%	50%						29%
more than 5 years	33%	33%				33%		43%
more than 2 years	100%							29%
Grand Total	**30%**	**14%**	**10%**	**14%**	**18%**	**6%**	**8%**	**100%**

Table 4.5 shows result of question No. 1 based on the designation and years of working experience of the staffs. According to the respondent answers, cost of purchasing holds

the highest vote which is at 30% from the whole samples retrieved. However, from the point of assistant manager level staffs compared to executive level and non- executive level, other factors too are influencing the decision making of switching to green energy which is at 18%. Among the assistant manager group with 20 years' experience, cost of purchasing is the most significant factor to switch to green energy which is at 36%. From the same group, for those more than 10 to 5 years working experience, cost of purchasing, finding reliable suppliers and getting attractive incentives are considered factors for switching to renewable energy. For executive with 10 -5 years' experience, cost of purchasing, reliable suppliers and attractive incentives were selected while 2 years' experience staff opt for cost of purchasing. For non-executive level with more than 10 years, cost and finding reliable supplier were considered and for less than 2 years staff, only cost of purchasing is considered.

Table 4.6: Response answer for Question No.2

Question No.2:

What is renewable energy that is most suitable for industrial site?

Designation + Years of Experience	Hydro energy	Solar energy	Wind energy	Grand Total
Assistant manager and above	**35%**	**42%**	**23%**	**52%**
more than 20 years	36%	64%		42%
more than 10 years	38%	25%	38%	31%
more than 5 years	29%	29%	43%	27%
Executive and above	**6%**	**82%**	**12%**	**34%**
more than 10 years		100%		41%
more than 5 years	11%	67%	22%	53%
more than 2 years	100%			6%
Executive and below	**29%**	**57%**	**14%**	**14%**
more than 10 years		100%		29%
more than 5 years	33%		67%	43%
more than 2 years	50%	50%		29%
Grand Total	**26%**	**54%**	**20%**	**100%**

Table 4.6 shows the result of question No. 2 based on the designation and years of working experience of the staffs for most suitable renewable energy at industrial site. The highest renewable energy was chosen for this question is solar energy which is at 54%. According to assistant manager and above level, 42% opt for solar and 35% select hydro energy. For more than 20 years' experience staffs, chose solar (64%) and hydro (36%) while 10 years' experience chose hydro (38%), solar (25%) and wind (38%). For more than 5 years staffs, chose hydro (29%), solar (29%) wind (43%) for suitable renewable energy. While for executive level staffs, more than 10 and 2 years' experience staffs chose solar (100%), 5 years working staff chose solar (67%), hydro (11%) and wind (22%). For non-executive staffs, more than 10 years' experience staffs opt for solar (100%), for 5 years experienced staffs selected hydro energy at 33% and wind energy at 67%. Less than 2 years experienced staffs, selected hydro and solar energy by 50% for each.

Table 4.7: Likert Scale for Statement No.1

Statement No. 1: Each one of us is responsible for reducing climate change

Designation +Years of experience	Agree	Disagree	Don't know	Strongly agree	Strongly disagree	Grand Total
Assistant manager and above	**62%**		**4%**	**35%**		**52%**
more than 20 years	55%			45%		42%
more than 10 years	75%			25%		31%
more than 5 years	57%		14%	29%		27%
Executive and above	**65%**	**6%**	**6%**	**24%**		**34%**
more than 10 years	86%			14%		41%
more than 5 years	56%		11%	33%		53%
more than 2 years		100%				6%
Executive and below	**57%**		**14%**	**14%**	**14%**	**14%**
more than 10 years	50%		50%			29%
more than 5 years	67%			33%		43%
more than 2 years	50%				50%	29%
Grand Total	**62%**	**2%**	**6%**	**28%**	**2%**	**100%**

Assistant manager group with 20, 10, and 5 years of working experience agree to the statement No.1 at 96% while 4% under 5 years working experience staff unable to judge the statement. At executive level, staffs from 10 years' experience totally agree at 100%

while 89% under 5 years' experience agree , 11% unable to judge and 100% from 2 years' experience staff do not agree to the statement. For non-executive level, 50% under 10 years' experience staffs agree and 50% unable to judge. At executive level, 100% agreed on the statement for under 5 years and under 2 years' experience category 50% agree and another 50% strongly disagree.

Table 4.8: Likert Scale for Statement No. 2

Statement No. 2: Better incentives should be given for implementation of solar energy

Designation +Years of experience	Agree	Disagree	Don't know	Strongly agree	Strongly disagree	Grand Total
Assistant manager and above	**46%**	**8%**	**12%**	**31%**	**4%**	**52%**
more than 20 years	36%		18%	45%		42%
more than 10 years	50%	13%		38%		31%
more than 5 years	57%	14%	14%		14%	27%
Executive and above	**53%**	**6%**	**24%**	**18%**		**34%**
more than 10 years	71%		14%	14%		41%
more than 5 years	44%		33%	22%		53%
more than 2 years		100%				6%
Executive and below	**29%**	**14%**	**43%**	**14%**		**14%**
more than 10 years		50%	50%			29%
more than 5 years	33%		33%	33%		43%
more than 2 years	50%		50%			29%
Grand Total	**46%**	**8%**	**20%**	**24%**	**2%**	**100%**

Under assistant manager group, under 20 years' experience category, 36% agree and 45% strongly agree, while 12 % unable to judge the statement. For 10 years' experience group, 88% agree and 13% do not agree with the statement. Under 5 years' experience group, 57% agree, 29% disagree and 14% unable to judge. At executive level, under 10 years' experience category, 86% agree to the statement and 14 % unable to judge. Under 5 years' experience group, 67% agree and 33% unable to judge. Under non-executive level, in 10 years' experience category 50% disagree and 50% unable to judge the statement. Under 5 and 3 years' experience staffs, 117% agree and 83% unable to judge.

Table 4.9: Likert Scale for Statement No. 3

Statement No. 3: The change to renewable energy is an urgent need

Designation +Years of experience	Agree	Disagree	Don't know	Strongly agree	Strongly disagree	Grand Total
Assistant manager and above	**27%**	**27%**	**19%**	**27%**	**0%**	**52%**
more than 20 years	27%	9%	27%	36%		42%
more than 10 years	13%	38%	13%	38%		31%
more than 5 years	43%	43%	14%			27%
Executive and above	**29%**	**6%**	**47%**	**18%**	**0%**	**34%**
more than 10 years	43%		43%	14%		41%
more than 5 years	22%	11%	44%	22%		53%
more than 2 years			100%			6%
Executive and below	**29%**	**14%**	**43%**	**14%**	**0%**	**14%**
more than 10 years			100%			29%
more than 5 years	33%		33%	33%		43%
more than 2 years	50%	50%				29%
Grand Total	**28%**	**18%**	**32%**	**22%**	**0%**	**100%**

The response for statement No.3 from assistant manager group under 20 years' experience staffs were 64% agree, 9% disagree and 27% unable to judge. For category 10 years above, 50% agree, 38% disagree and 13% unable to judge and under 5 years' experience staffs 43% agree, 43% disagree and 14% unable to judge. Under executive level, for 10 years' experience staffs, 57% agree, 43% unable to judge. Under 5 years' experience category, 44% agree, 11% disagree and 44% unable to judge. While staff under 2 years' experience, 100% unable to judge. For non-executive level, under 10 years' experience group, 100% unable to judge, under 5 years' experience group, 67% agree and 33% unable to judge and under 2 years' experience group 50% agree and 50% disagree.

Table 4.91: Likert Scale for Statement No. 4

Statement No.4: Renewable energy is unlimited

Designation +Years of experience	Agree	Disagree	Don't know	Strongly agree	Strongly disagree	Grand Total
Assistant manager and above	**42%**	**4%**	**12%**	**38%**	**4%**	**52%**
more than 20 years	55%			45%		42%
more than 10 years	25%		25%	38%	13%	31%
more than 5 years	43%	14%	14%	29%		27%
Executive and above	**41%**	**6%**	**18%**	**35%**		**34%**
more than 10 years	29%		43%	29%		41%
more than 5 years	56%			44%		53%
more than 2 years		100%				6%
Executive and below	**57%**		**29%**	**14%**		**14%**
more than 10 years	50%		50%			29%
more than 5 years	67%			33%		43%
more than 2 years	50%		50%			29%
Grand Total	**44%**	**4%**	**16%**	**34%**	**2%**	**100%**

For statement No. 4, assistant managers with 20 years' experience agree at 100%, under 10 years' experience agree at 63%, 13% strongly disagree and 25% unable to judge. Under 5 years' experience category, 71% agree, 14% disagree and 14% unable to judge. At executive level, under 10 years' experience 57% agree and 43% unable to judge. Under 5 years' experience category, 100% agree and under 2 years' experience category 100% disagree. At non-executive level, under 10 years' experience category, 50% agree and 50% unable to judge. Under 5 years' experience category, 100% agree and under 2 years' experience category 50% agree and 50% unable to judge.

The Likert scale from the questionnaire also applied on the assessment of knowledge on barriers that present in the selected organisation which indicate 'High' as top reason, 'Intermediate' as moderate and 'Low' as low priority. The result of barriers acknowledgement among the three different groups of staffs were presented in Table 4.92, Table 4.93 and Table 4.94 according to the given statement.

Table 4.92: Likert Scale for Statement No.5

Statement No.5: It is very costly

Designation +Years of experience	High	Intermediate	Low	Grand Total
Assistant manager and above	**77%**	**15%**	**8%**	**52%**
more than 20 years	91%	9%		42%
more than 10 years	88%	13%		31%
more than 5 years	43%	29%	29%	27%
Executive and above	**59%**	**18%**	**24%**	**34%**
more than 10 years	71%	14%	14%	41%
more than 5 years	56%	22%	22%	53%
more than 2 years			100%	6%
Executive and below	**86%**	**14%**		**14%**
more than 10 years	100%			29%
more than 5 years	100%			43%
more than 2 years	50%	50%		29%
Grand Total	**72%**	**16%**	**12%**	**100%**

For the barrier on statement No.5, on assistant manager level under 20 years' experience category, 91% selected 'High' and 9% selected 'Intermediate'. Under 10 years' experience category, 88% selected 'High' and 13% selected 'Intermediate'. Under 5 years' experience category 43% selected 'High', 29% selected 'Intermediate' and 29% selected 'Low'. Under executive level who are from 10 years' experience, 71% selected 'High' and 14% selected 'Intermediate' and 14% selected 'Low'. While for staff who are from 5 years' experience group 56% selected 'High' and 22% selected 'Intermediate' and 22% selected 'Low'. Under 2 years of working experience 100% selected 'Low'. For non-executive level, under 10 and 5 years' experience category, 100% selected 'High' while 2 years' experience category selected 50% for 'High' and 'Intermediate'.

Table 4.93: Likert Scale for Statement No.6

Statement No.6: Lack of information on renewable energy

Designation +Years of experience	High	Intermediate	Low	Grand Total
Assistant manager and above	**54%**	**38%**	**8%**	**52%**
more than 20 years	73%	27%		42%
more than 10 years	38%	50%	13%	31%
more than 5 years	43%	43%	14%	27%
Executive and above	**47%**	**47%**	**6%**	**34%**
more than 10 years	29%	57%	14%	41%
more than 5 years	56%	44%		53%
more than 2 years	100%			6%
Executive and below	**57%**	**43%**		**14%**
more than 10 years	100%			29%
more than 5 years	67%	33%		43%
more than 2 years		100%		29%
Grand Total	**52%**	**42%**	**6%**	**100%**

For the barrier on statement No.6, under assistant manager level for category 20 years' experience, 73% selected 'High' and 27% selected 'Intermediate'. Under 10 years' experience category, 38% selected 'High', 50% selected 'Intermediate' and 13% selected 'Low'. Under 5 years' experience category 43% selected 'High', 43% selected 'Intermediate' and 14% selected 'Low'. Under executive level from 10 years' experience group, 29% selected 'High' and 57% selected 'Intermediate' and 14% selected 'Low'. For 5 years' experience group 56% selected 'High' and 44% selected 'Intermediate'. Under 2 years of working experience 100% selected 'High'. Under non-executive level, for category 10 years' experience staffs, 100% selected 'High' while 5 years' experience staffs, 67% selected 'High' and 33% selected 'Intermediate'. Under 2 years' experience category staffs, 100% chose 'Intermediate'.

Table 4.94: Likert Scale for Statement No.7

Statement No.7: Return on investment is very slow

Designation +Years of experience	High	Intermediate	Low	Grand Total
Assistant manager and above	**73%**	**23%**	**4%**	**52%**
more than 20 years	100%			42%
more than 10 years	88%	13%		31%
more than 5 years	14%	71%	14%	27%
Executive and above	**65%**	**35%**		**34%**
more than 10 years	71%	29%		41%
more than 5 years	67%	33%		53%
more than 2 years		100%		6%
Executive and below	**71%**	**29%**		**14%**
more than 10 years	100%			29%
more than 5 years	100%			43%
more than 2 years		100%		29%
Grand Total	**70%**	**28%**	**2%**	**100%**

For the barrier on statement No.7, at assistant manager level for category 20 years' experience staffs, 100% selected 'High'. Under 10 years' experience category, 88% selected 'High' and 13% selected 'Intermediate'. Under 5 years' experience category 14% selected 'High', 71% selected 'Intermediate' and 14% selected 'Low'. Under executive level from 10 years' experience group, 71% selected 'High' and 29% selected 'Intermediate'. For 5 years' experience group 67% selected 'High' and 33% selected 'Intermediate'. Under 2 years of working experience 100% selected 'Intermediate'. Under non-executive level, for category of 10 and 5 years' experience staffs, 100% selected 'High' while 2 years' experience staffs, 100% selected 'Intermediate'.

The whole result of close ended multiple-choice questions for factors influencing the decision of switching to favourable green energy are shown in Figure 4.2 and Figure 4.3.

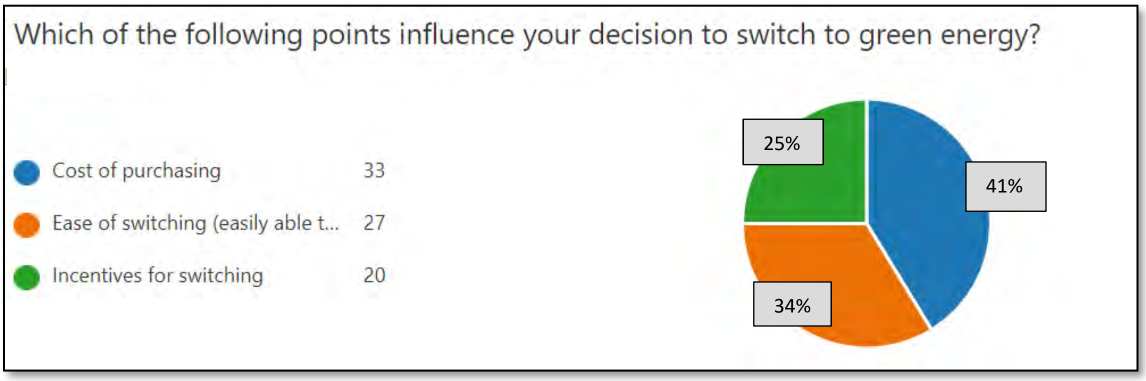

Figure 4.3: Factors influencing the decision making of switching to green energy

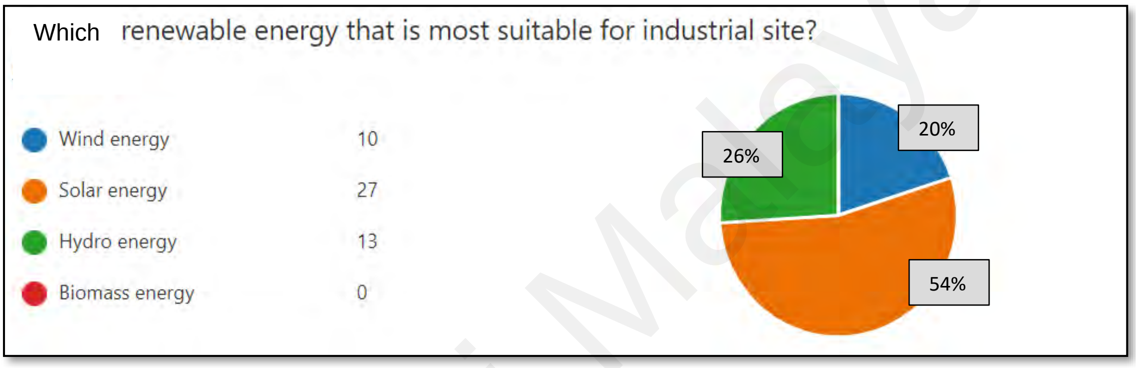

Figure 4.4: Favourable renewable energy at industrial area

The perception and acceptance of renewable energy such as solar were also measured using 5-Likert scale question. The result of the respondents is shown in Figure 4.4 and Figure 4.5.

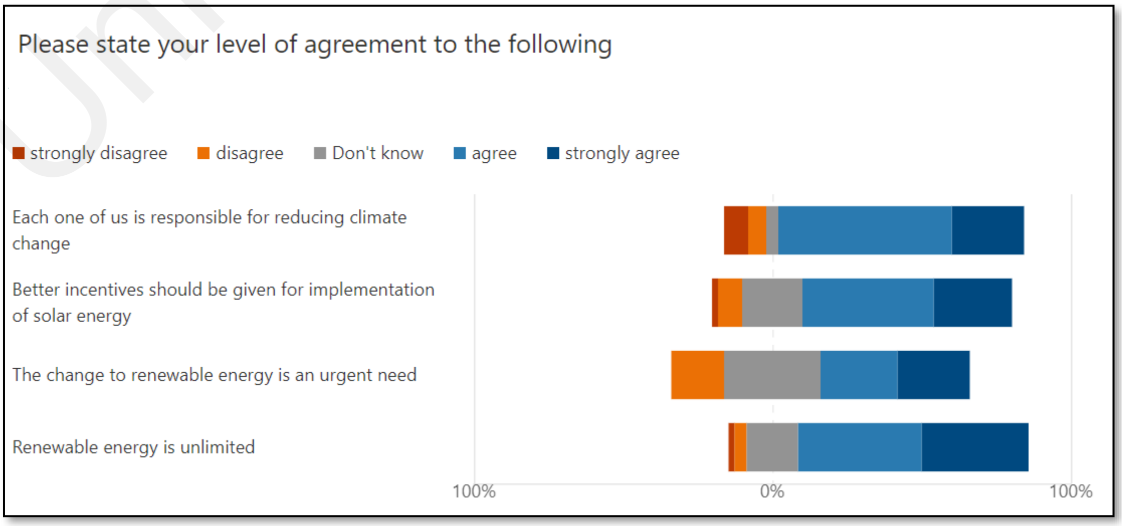

Figure 4.5: Level of agreement on renewable energy implementation

According to Figure 4.5, refering to statement " Each one of us is responsible for reducing climate change" reveals that total 90% of the respondents agree, 4% disagree and 6% unable to judge the statement. The agreement on the next statement "Better incentives should be given for implementation of solar energy" shows that 70% have accepted, 10% disagree and 20% unable to judge. On the third statement, "The change to renewable energy is an urgent need" reveals that 50% agree, 18% disagree and 32% unable to judge. On the final statement "Renewable energy is unlimited" were accepted by respondents by 78%, disagree by 6% and unable to judge by 16%.

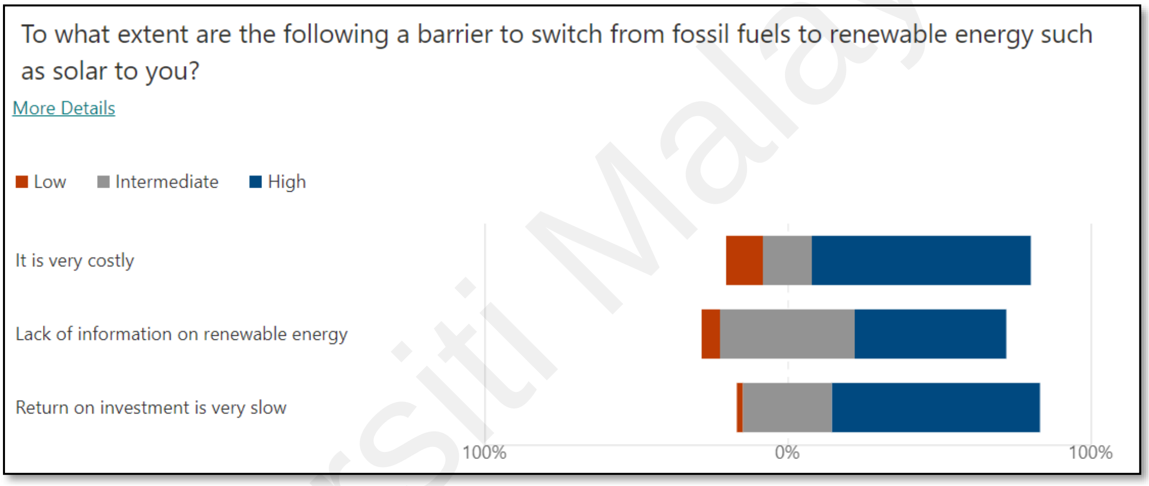

Figure 4.6: Barriers in switching to solar energy

Figure 4.6 shows the barriers that present in the selected organisation. The assessment of current barriers that occurs was evaluated among the respondents from various departments and working groups. For barrier statement on "It is very costly" shows that 72% is 'High', 16% is 'Intermediate' and 12% is 'Low'. On the statement "Lack of information on renewable energy" reveals that 52% is 'High', 42% is 'Intermediate' and 6% is 'Low'. On the final identified barrier "Return of investment is very slow" shows that 70% is 'High', 28% is 'Intermediate' and 2% is 'Low'.

CHAPTER 5: DISCUSSION

5.1 Current state of solar energy at selected site

The total energy consumed for year 2018 for the whole industrial site operation was 51,682 MW. The electricity usage declined in year 2019 to 45,986 MW and continuously plunged in 2020 to 40,774 MW with total electricity reduction of 10,908 MW from 2018 to 2020. The reduction of electricity began to show up after the implementation of solar energy in the year end of 2018. The total solar energy harnessing was identified at 6 hours at the selected site. As Malaysia is situated on the equator line, the maximum sunlight receival is calculated at 6 hours which is at peak hours at 10 am to 4 pm. The potential average sunshine is 6-7 hours daily that Malaysia, Indonesia and Colombia are receiving due to its strategic location on the equator line (Soonmin et al., 2019). The total solar energy created in 2019 was 10.83 MW while the total operation ran at 45,986 MW and in year 2020 total energy generated was 13.26 MW and full operation ran at 40,774 MW. The energy usage was from production line, server room, main office, chiller, compressor, and cooling tower. The total electricity demand from the whole operation was not fully supported by the solar energy generation as the energy created was too small. The current solar energy generated supplied to the building of Guard house for approximately 4 to 5 hours. The total cost saving achieved in 2019 from solar energy was MYR 3,844.65 and in 2020 was MYR 4,707.30 calculated manually based on MYR 0.355/kWh. The further development for solar energy investment was then freeze for year 2019 and 2020 due to low business condition and Covid 19 pandemic hit. Due to the adverse covid impact, the profit of the company went down which was a major constraint to make any investment decision. In a survey conducted by the National Association of Manufacturers (NAM) about 78.3% of the manufacturer are facing deep financial impacts, 53.1% are overlooking for a change in operations and 35.5% are facing supply chain disruptions (National Association Manufacturers, 2020).

5.2 Future prospect of solar energy at selected site

According to top management level, the solar energy implementation is quite encouraging to reduce carbon footprint. However, to initiate the project, high investment should be allocated and other improvements in the company should not be compromised as well. In the current study of solar energy execution and expansion at the selected site, the headquarters in Japan have targeted its operation sites to achieve zero CO_2 emission by 2030.

This objective was aggressively planned and drafted in a CO_2 zero emission roadmap 2020~2027 by the management of the selected site. From the interview conducted to the top management level, the response indicated that the planned total CO_2 reduction achievement able to make into reality by stages starting from year 2022. In brief, the total energy generation from solar and CO_2 emission reduction amount was planned based on company business plan and production quantity. The total carbon neutral plan for solar energy execution was presented in Table 5.1.

Table 5.1: Solar Energy Future Plan

Solar panel installation	Total Mwh generation estimated	Total CO2 (ton) reduction estimated (Mwh*0.585)	Total cost saving (MYR) (Kwh* 0.355)	Total Mwh generation in 2020	Reduction by initiatives vs 2020 energy usage (%)
Phase 1 (2022)	913	534	324,115	40,774	2.2
Phase 2 (2023)	2,737	1,601	971,635		6.7
Phase 3 (2024)	5,016	2,934	1,780,680		12.3
Phase 4 (2025)	7,753	4,536	2,752,315		19
Total	16,429	9,605	5, 828,745	-	-

In the year of 2022 to 2025, total of 16, 429 MW of solar energy generation is estimated with four stages of implementation for four continuous years. In line with this project, total 9,605 tons of CO_2 was estimated to be reduced and total cost saving estimated from the solar energy project is MYR 5, 828,745. At the first stage, Block 8 and 9 of the site with roof area of 4000 m^2 will be covered with 3360 pieces of solar panels. On the second stage, block 10 and 9 with total area of 4000m^2 will be covered with 3360 pieces of solar panels and in the third stage of the solar energy project execution, block 2,3,4, and 5 with total roof area 3255m^2 will be installed with 2576 pieces of solar panels. Finally, block 13, 14 and carpark area with total area of 200m^2 will be installed with 151 pieces of solar panels. From the larger scale solar energy implementation, the building energy consumption not only going to reduce, but the cost saving from the project is going to benefit electric bill over the long years. The estimated energy pay back period for the solar project is estimated at 12.6 years. Photovoltaic solar energy system has lifespan of 25 years (Martinopoulos, G., 2020). The energy pay back time for photovoltaic technology for multi-Si modules and a-Si modules were lower at 2.4 years and 2.1 years respectively compared to mono-Si modules at 11.8 years where all three modules have the same annual cell production of 10MW/year (Ludin, N. A et al., 2018).

Apart from that, the companies that are generating energy from any renewable resources are entitled to have Import Duty and Tax Sales Exemption for imported equipment such as machines, materials, spare parts, and consumables which are directly used in renewable energy system (Chua, 2011). In monitoring the energy consumption of the site, smart energy metering installation will give more accurate energy consumption reading. The availability of the digital meter in the functional areas can let the owner to investigate major energy consumption area and encounter any problems regard to electricity consumption (Muhamad et al., 2015). The layout plan for future solar energy installation is shown in Figure 5.1. The energy reduction activity will be further expanded with other renewable energy too such as wind energy and energy efficient measures as well to achieve CO_2 emission reduction target.

Figure 5.1: Plan Layout for Future Solar Energy Implementation

5.3 The barriers to execute solar energy

The interview topic with experienced employees from the facility department have been on the challenges of solar energy implementation from the lower management group of the selected site organization. One of the most prominent reasons for difficulties for executing solar energy, is investment by the company as per mentioned by the department manager. This is due to the organisation not only make investment in renewable energy but also allocate budget for energy efficiency measures. A larger amount of capital is a requirement to start renewable energy project (Vaka et al., 2020).

Investment constraints mainly happened due to low business condition and pandemic hit. Apart from that, certain projects also involved with advance technology which is also a contributor to constraint to investment (Vaka et al., 2020). Besides, the escalation of the PV installation price also influenced by lack of rare earth metals such as indium, tellurium and silver for the production of PV technologies (Zyadin et al., 2014). As a prerequisite for the technological advancement of solar technology and the creation of a market for solar energy with appealing prices for both users and suppliers, it is critical to remove fossil fuel subsidies too (Ab Kadir et al., 2010). Subsidies for fossil fuels are draining the initiatives to support public financial provide for large scale renewable energy execution

(Zyadin et al., 2014). Besides, the absence of internal energy management policy is one of the causes to delay the growth solar energy. Unclear goals towards energy management and lack of review could slow down the implementation of solar energy. Focusing on implementing supportive policies, such as enacting proper pricing legislation and providing practical assistance to individuals who use renewable energy technologies also support the growth of renewable energy in this country (Ab Kadir et al., 2010). Other factors that found to be barrier to solar energy growth at the selected site were difficulties in finding the reliable suppliers, change of top management representatives and other energy efficient measures were given higher priority. Apart from that, retirement of skilful worker and delay in developing substitute also contribute to the decision making in implementation of renewable energy. Lack of technical expertise in maintenance task and countermeasure failures is another barrier in improving solar energy at manufacturing company (Shahsavari & Akbari, 2018).

According to the questionnaire distribution results, the highest group of employees who took part in the questionnaire activity were Assistant Manager and above which were 52% with more than 20 years of working experience. The participation was followed by group of Executive and above at 34% and finally by group of below executive at 14%. The demographic data such as designation and years of working experience were assessed against the perception and acceptance of renewable energy among the workers. From the result of question No.1, it is known that assistant managers with 20 years of experience give priority to cost of purchasing due to at higher management level, stimulating cost buster are part of their routine job. While the lower management group such as executives and non-executives are not exposed to make decision on cost of the project but need to negotiate, find reliable suppliers, and acknowledge the benefits of the renewable energy project. Thus, the job scope of the designation influences the perception and acceptance of the staffs on renewable energy.

Furthermore, on overall picture, another multiple-choice question on suitable renewable energy at industrial sites was mostly answered on solar energy at 54%, hydro energy at 26% and wind energy at 20%. This shows solar energy is more prominent than hydro and wind energy among the workers. In addition, solar energy also attains the highest vote among all level of designations from assistant managers, executives and non-executives.

Under the 5-points Likert scale questions, respondents were measured on their perception and acceptance from strongly disagree to strongly agree of renewable energy relevant statements. For statement No.1- 4, most of the staffs agree to the statement given. However, there are minimum numbers of respondents who choose 'Disagree' and 'Don't know' from all designation categories. This is due to less exposure to renewable energy such as promotion and projects. Apart from that, educational background and nature of the job too could contribute to less exposure to renewable energy information. Furthermore, language barriers and generation gap too contribute to less understanding of renewable energy.

For statement No.6-7, shows the barriers that present in the organisation. Among the three statements, statement No.1 holds the highest percentage from all designation categories. This is due to company procedure when engaging with suppliers, the staff needs to fill up 'Application of purchasing' form with minimum two suppliers cost price comparison and justification for Head of Department approval. The respondent who chose 'Low' do not go thru this process. 'Return of investment is very slow' statement becomes the second most chosen barrier among the assistant manager level with 20 years' experience compared to 5 years experienced staffs. This is due to when developing a project, the project leader needs to calculate the return of investment and its payback period. At executive level and non-executive level, the staffs would only assist the manager to gather all relevant information from suppliers. For statement No. 2 'Lack of information on renewable energy', the survey result shows that there is very low promotion and awareness programs conducted at the site regards to renewable energy.

From the survey made, it can be concluded that more renewable energy programs should be implemented to raise the awareness of the benefits of renewable energy among the workers. Apart from that, more staff should attend renewable energy course organize by the government to learn the skills in solar energy technology especially in Photovoltaic system. An e-learning program named as SEDASEED2020 was conducted by the SEDA under Sustainable Energy e-learning Development Programme reached 24,297 participants and 92,810 viewers (SEDA, 2021c). As of 2011-2019 there were total 2,312 number of participants for Renewable Energy Training programs and 2,770 participations from industrial sector for Energy Efficient programs to raise their competency level (SEDA, 2022).

The organization also should consider developing more renewable energy competent persons to ensure the problems arise from the installation renewable energy are countered easily. Apart from that, the organization should study on developing an energy management policy and spread it horizontally to the staffs and its interested parties to ensure the direction of renewable energy especially solar energy. Besides, half yearly e-learning programs on renewable energy are suggested to educate the staff on the benefits of renewables.

In a nutshell, the renewable energy such as solar energy plays a major role in mitigating the climate change. Furthermore, nationally applicable mitigation measures can aid in the development of renewable energy technology by providing appropriate tools such as capacity building, grants and loan guarantees, green labelling, and renewable energy certificates to overcome both market and non-market barriers.

CHAPTER 6: CONCLUSION

The research identified the economic, social, and environmental benefits by evaluating the current installed solar energy and its future prospect in which the research site organisation contributes towards climate change mitigation. Relatively, even though the current condition of solar implementation seems to be contributing around 1% reduction of carbon emission from the industrial site, but the future roadmap of solar energy have compensated up to 19 % carbon reduction against the current condition of electricity usage of year 2020. The cost saving of current solar energy have been identified at 0.0002% versus total electric bill of year 2019 and 2020.

In addition, the acceptance and perspective of renewable energy among the industrial employees have been determined on their opinions and barriers comprehension. Cost purchase is one of the prominent factors in implementing solar energy project followed by finding reliable suppliers and incentives provided for renewable energy. Solar energy is more popular compared to other renewable energy such as hydro, wind and biomass among the selected respondents. The focus group discussion conducted within the energy management team, revealed that cost, finding reliable suppliers, availability of skilled workers and acknowledgment of benefits on renewable energy are challenges that present in the organisation.

Finally, the future prospect of solar energy in the selected site have been outlined on its total CO_2 reduction versus of the year 2020. The payback period of the solar energy is projected at 12.6 years.

6.1 Recommendation for future work:

Based on the limitation reviews, there are few recommendations for future mitigation measures to be consider. To handle the large quantity of questionnaire's responses, a specific software such as Typeform, Feedier, Hubspot, Survey Monkey and Crowdsignal should be applied to get more precise statistical analysis result (Haije, 2021). However, to enhance the rate of responses one should keep the survey briefed on its goal, notify the respondents on the time taken to answer the survey and optimise all communication devices to ease the respondents to answer the survey. Apart from that, an interview session with top management representatives such as directors will give more insights on other renewable energy besides solar. In line to achieve a successful renewable energy implementation, a research management team on renewable energy need to be developed to study the suitable solar energy to be installed, life span and its maintenance. An allocation of human power specifically for renewable energy for risk management techniques, effective cash flows, technologically risk factors and managing compliances practice will contribute to less mismanagement of energy and cost (Solar energy industries association, 2017).

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