

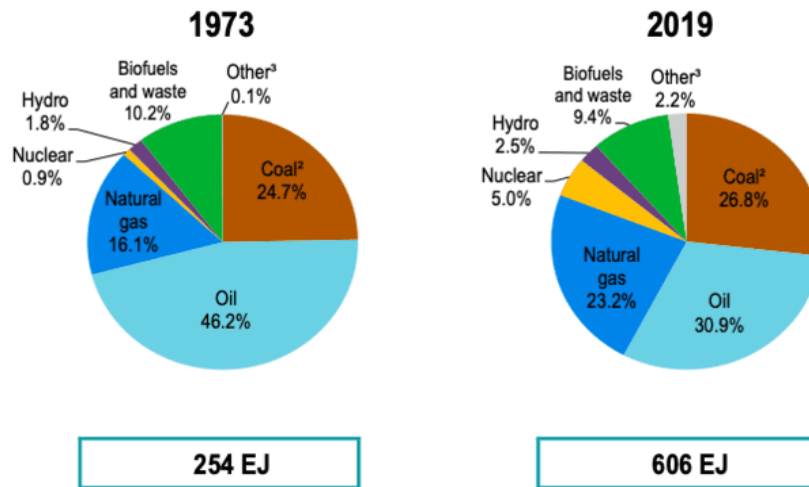
CHAPTER 1

INTRODUCTION

A. Background

Energy becomes a part of primary needs for human living. Energy has been used in human activities since the last decade. It is formed from nature, which provides main energy sources which are classified to renewable and non-renewable sources, that are sun, oil, coals, wind, and etc. Energy includes in terms and conditions for a human to live. The energy use is significantly rising following a high population for the last decades.

High uses of energy in many aspects impacts to more uses of energy sources. On the other hand, energy has a side effect on nature, that is emission. Energy has been used for many years in various facets of daily life. The technology development in the modern era is one of the main reasons which contribute to the rate of energy consumption in the world. The technology evolution and population explosion in the modern era has led to the high consumption of energy. Energy's form is not only electricity, thus, the energy sources in the world mostly come from oil and coal mining.



Source: IEA, World Energy Balances (2021)

Figure 1.1
World's Share Energy Supply by Source Year 1973 and 2019

The figure 1.1 shows the comparison of energy shares in 1973 and 2019. The graph shows most of the energy supply in the world now still placing oil and coal as the main energy sources. Moreover, the percentage of oil and coal as the main energy supply in 2019 will decrease to 30.9% for oil and 26.8% for coal. It also shows the diversity of energy supplies in the world's energy supply. In 1973, energy supply was dominated by oil and coal, 46.2% for oil and 24.7% for coal. The diversity of energy supplies that exist follows technology development and another environmental issue requiring people to use and maximize another nature's potential for energy supplies which believe more sustain.

Natural resources are a great gift that Allah SWT has given to human beings. It is not without a reason, humans are required to use the resource to support their life, as given in Surah An-Nahl verse 13:

وَمَا ذَرَأَ لَكُمْ فِي الْأَرْضِ مُخْتَلِفًا أَلْوَنُهُ إِنَّ فِي ذَلِكَ لَآيَةً لِّقَوْمٍ يَذَّكَّرُونَ

And 'He subjected' for you whatever He has created on earth of varying colours. Surely in this is a sign for those who are mindful. (16:14)

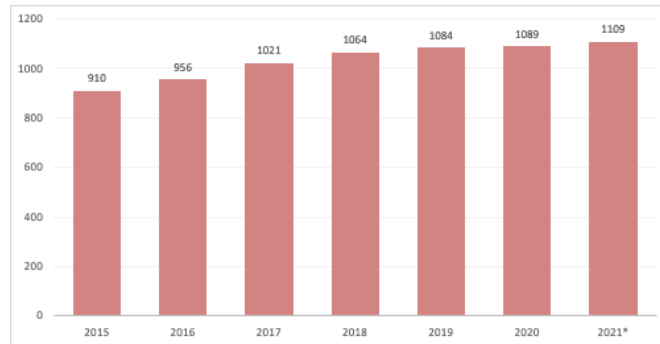
Allah SWT has created this world with all the things we will need. Allah SWT has created this world of varying colors, so human beings can use it as they want to. On the other side, we should keep the environment for present and future generations, as well stated in the Quran surah Al-A'raf verse 58:

وَالْبَلَدُ الطَّيِّبُ يَخْرُجُ نَبَاتُهُ بِإِذْنِ رَبِّهِ وَالَّذِي خَبثَ لَا يَخْرُجُ إِلَّا نَكِدًا ۗ كَذَلِكَ نُصَرِّفُ الْآيَاتِ لِقَوْمٍ يَشْكُرُونَ

The fertile land produces abundantly by the Will of its Lord, whereas the infertile land hardly produces anything. This is how We vary 'Our' lessons to those who are thankful.

Both of the surahs from the Quran above have clearly stated that as human beings, we should use the source we had in this world, at the same time we have to use it wisely. Either for the future generation or to keep the environment sustained for a long time.

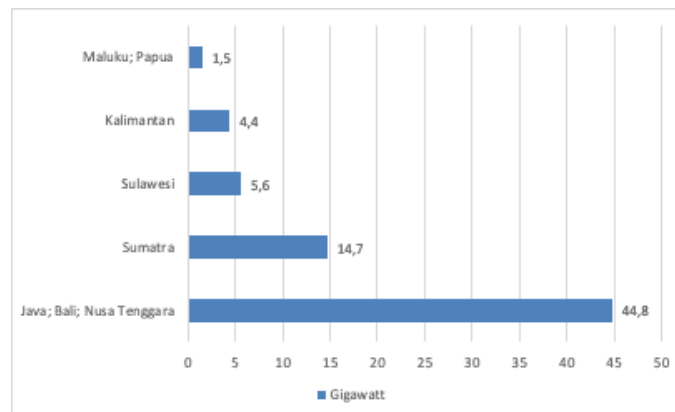
The demand for energy uses are increasing due to the rise of people and technology. As seen in the development of technology and people's needs, the consumption of energy increases every year all over the world. As the pandemic hits the world, the consumption of energy individually increases per 2020 as they are required to work from home. Indonesia, as the country that has more than 270 million people, more than half of them are using energy significantly and still increase every year.



Source: Ministry of Energy and Mineral Resource Republic of Indonesia (2021)

Figure 1.2
Indonesia's Energy Consumption in 2015-2021

The data in figure 1.2 shows that the energy consumption in Indonesia statistically increases every year. High demand of electrical energy will be followed by power plants that have been built over the island in Indonesia, shown by the figure 1.3 below.



Source: Ministry of Energy and Mineral Resource Republic of Indonesia (2020)

Figure 1.3
Number of Power Plants in Indonesia based on Island

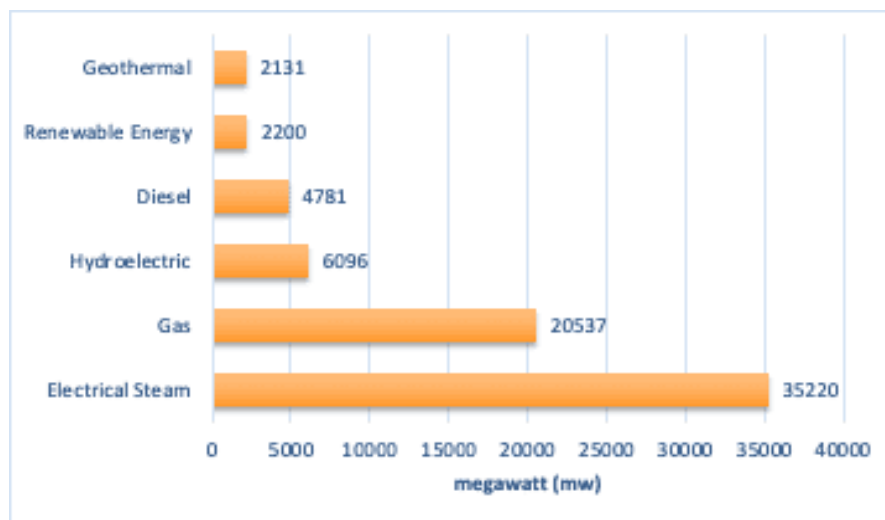
Figure 1.3 shows most of the power plants are in Java, Bali and Nusa Tenggara for 4.8 Gigawatt for its capacity, then followed by Sumatera (14.7 GW), Sulawesi (5.6 GW), Kalimantan (4.4 GW), and latest Maluku and Papua (4.4 GW).

High number of power plants in Java, Bali, and Nusa Tenggara, it can be assumed the demand for energy is the highest compared to other islands. Following a high number of people and most industrial activity are centered in Java.

According to the ministry of energy and resources data, it found that all of the provinces in Java, Bali, and Nusa Tenggara have their power plants that contribute to the power capacity. One of the provinces that does not have a power plant is Yogyakarta. Hence, Yogyakarta is the only province which does not have its own power plant. The electrical need in Yogyakarta province is fulfilled by power plants spread in Java and Bali. Every province in Indonesia has different regional characteristics. It can be assumed that Yogyakarta has different geographies conditions if compared to other places in Java. Due to the rising number of populations in Yogyakarta in following years, it can be assumed that Yogyakarta started to have other alternatives to follow the demand.

Most of Indonesia's energy came from several main materials such as oil, coal, and gas. Through the years, they add more main material due to campaigns on sustainable energy and other materials in Indonesia. Thus, the most material used as energy in Indonesia is coal. Even though coal the government started to use another energy potential that is more sustainable, coal is still the highest raw material to be used and placing oil as the second material. However, it is believed that coal and oil are not environmentally friendly as those two leaving CO² footprints (Elum & Momodu, 2017). Other than that, following the technologies and goals of Sustainable Development Goals (SDGs), Indonesia needs another alternative material for energy.

As well as another country, Indonesia's energy share is also dominated by oil and mining. Indonesia provides energy supply that comes from several coal and oil mining. The mining is supplying energy demand in local and international for many needs, transportation, household, and electricity.



Source: Ministry of Energy and Mineral Resource Republic of Indonesia (2020)

Figure 1.4
Power Capacity by Generator Type

Figure 1.4 shows shares of types of power capacity based on generators in Indonesia. Its data shows the biggest number of electricity in Indonesia supplied by electrical steam power plants (35.220 MW). High number of electrical steam power plants indicates the use of oil and coal are still main energy supplies for electricity in Indonesia. Beside electrical steam power plant as main electrical sources, Indonesia build another type of power plant with different energy source, that are Gas (20.537MW), Hydroelectric (6.069MW), Diesel (4.781MW), other renewable energy (2.200), and the latest Geothermal (2.131MW). Variety of power plants in Indonesia could be indicated. Indonesia has started to use another energy potential for electricity.

Indonesia has sun for the whole year and water resources. Thus, every place has different geographic conditions, causing several places to lack water resources when it comes to long summer. One of the natural resources they have is the sun. Sun has been utilized to be one of sustainable energy in Indonesia. Having sun for the whole, it is believed that sun is easier to use as energy in common, called as solar power cell. Even though solar cells have been campaigned and declared as part of sustainable energy in Indonesia, the contribution of this energy is still 1% compared to other energy resources, oil and coal.

Yogyakarta is not a province of coal nor oil mining. Placed in the south of Java island, Yogyakarta has been known as the second smallest province in Indonesia. Even though as a small province, Yogyakarta has almost all facilities due to high demand of people and their participation as a tourism city. The rise of people will be followed by the demand for energy consumption in Yogyakarta. However, even though Yogyakarta has a high demand for electrical energy, they do not have their own power plant. As a small province with significant development and high demand of energy, Yogyakarta at least has another alternative energy source due to the high demand for electrical energy. Otherwise, there are several houses that have switched to alternative energy as their main electrical uses, commonly, Solar PV.

Solar PV awareness apparently has been started in Yogyakarta province. Based on the Table 1.1, number of Solar PV unit in Yogyakarta increase, even though the number was not significant. The numbers show that Solar PV is a potential renewable technology to be implemented. Even though the number

increase, however, there is no increase since 2017. It can be concluded that, the number of Solar PV has not yet covered the population in Yogyakarta which significantly increase every year. Furthermore, the number possibly and potentially increase its energy supply though Solar PV project that will sustain in the long term.

Table 1.1
Total of Solar PV Unit in Yogyakarta Province

Year	Total (Unit)	Capacity (Kva/Kwh)
2010	862,00	172,60
2011	880,00	176,00
2012	889,00	196,00
2013	926,00	204,00
2014	926,00	204,00
2015	926,00	204,00
2016	1.201,00	267,00
2017	1.251,00	272,00
2018	1.251,00	272,00
2019	1.251,00	272,00
2020	1.251,00	272,00
2021	1.251,00	272,00

Source: Department of Public Works, Housing and Energy, Mineral Resources, Special Region of Yogyakarta

Every project is expecting to be sustain in the long term. Thus, there are several indicators that should being analyses and become the main factor of the project to running. These indicators/factors are based and motivate by observing issues which occurs in the society. The factors and its actors should be analyzed to know and identify what strategy that will solve and suitable to the upcoming projects. The importance to identify factors and indicators that will affect its success and conduct sustainable project also show in previous study by Nopriani et al (2022). Their study identifies factors that influence its implementation in TPS 3R program. They were using Matrix of Cross Impact Multiplications Applied to a

Classification (MICMAC) to identify key variables and Matrix of Alliance, Conflicts, Tactics Objectives and Recommendation (MACTOR) to identify the influence of actors in TPS 3R project. Noprini et al (2022) found that regulation and community participation play a significant role in influencing all variables in the system and actors who have high influence are PLN and Pertamina.

The previous study that was concern on sustainable energy issue, become the proven that factors and actors are important to sustainable energy project, especially project made by the government. These influenced factors also become the answer and key in respond to the issues regarding to the energy technology issues. It is possible that MICMAC and MACTOR can be the tools to identify factors for sustainable Solar PV project in Yogyakarta. The factors also become the key for management system in order to conduct sustainable Solar PV project in Yogyakarta. Moreover, factors conduct in Solar PV project also become the key to accelerate energy mix target in Yogyakarta.

Indonesia's government through the Ministry of Energy and Mineral has declared their concern in developing Solar PV as alternative renewable energy in Indonesia and encourages them to accelerate solar with the target of 23% New Renewable Energy (NRE) mix in 2025 by investing in them (Pribadi, 2021). Referring to the explanation, it can be clear that Solar PV is openly being implemented in Indonesia and has a high potential of energy sources for electricity in Yogyakarta. There are indicators of renewable energy development that become the guidance for its implementation. There is research about indicators of sustainable renewable energy development, hence, there is still no research that

specifically defines indicators for Solar PV. The concern of this research is the object which is Solar PV technology development. This research also conducts 5 dimensions; consist of economy, social, environment, regulation, and governance. Each of indicators and dimension were analyzed based on the Yogyakarta's characteristics that is different to another province in Indonesia. Thus, this research will analyze the indicators model of Solar PV for sustainable energy development in Yogyakarta province, which is entitled "**SUSTAINABLE DEVELOPMENT MODEL OF SOLAR ENERGY FOR ENERGY TRANSITION ACCELERATION IN SPECIAL REGION OF YOGYAKARTA**".

B. Limitation of The Study

This study will limit on:

1. Focusing in key variables research of Solar Photovoltaic (PV) development in Yogyakarta
2. The research will concern in Yogyakarta province

C. Research Problem

Based on the case studies of solar cells in Yogyakarta, this study will ask the following questions:

1. What are the key variables that can encourage Solar PV sustainability in Yogyakarta?
2. What is the interaction between actors/stakeholders in order to encourage the sustainability of Solar PV development in Yogyakarta?
3. What the policy recommendations can be made to municipalities?

D. Research Objectives

This study aims to:

1. Find out the key variables of Solar PV sustainability in Yogyakarta
2. Find out the interaction of actors/stakeholders in encouraging the sustainability of Solar PV development in Yogyakarta
3. Design the policy recommendations to Yogyakarta's government.

E. Benefits of The Study

The study is expected to be beneficial for:

1. For the authors hope it can be beneficial to sharpen critical and scientific thinking responding the cases in environment
2. For the readers hope it can be reference and increase the horizon of knowledge in facing energy potential for Solar PV in Indonesia
3. For the Yogyakarta's government it can be a reference in developing renewable energy using the following indicator models.