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POWER-UP POWER PLANTS: ENERGIZING PHILIPPINES RENWABLE ENERGY SOURCES

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Abstract

This study focused on renewable energy sources in the Philippines, including solar, hydro, biomass, wind, and geothermal. The amount of energy renewable energy power plants generates and how much it costs, how many of these power plants are operating in the Philippines, and the long-term impacts of using entirely renewable energy were investigated through data mining. Among all renewable energy sources in the Philippines, geothermal power plants provide most electricity, while wind energy has the greatest production costs. A total of 235 renewable energy generating plants are active across the country, majority of them are in Luzon. Furthermore, renewable energy sources positively affect our economy and environment as they can potentially lower electric bills, increase employment, and reduce air pollution and health risks associated with it. However, potential negative consequences include lack of food security and agricultural areas. The researchers urge the government to develop more renewable energy power plants, conduct comprehensive grid-capability assessments, including assessment of potential optimal sites for new producing assets, and properly plan and handle the environmental effects.

Keywords: Renewable Energy Sources, Power Plant, Philippines

Abstrak

Studi ini berfokus pada sumber energi terbarukan di Filipina, termasuk matahari, air, biomassa, angin, dan panas bumi. Jumlah pembangkit listrik energi terbarukan yang dihasilkan dan berapa biayanya, berapa banyak dari pembangkit listrik ini yang beroperasi di Filipina, dan dampak jangka panjang dari penggunaan energi terbarukan sepenuhnya diselidiki melalui penambangan data. Di antara semua sumber energi terbarukan di Filipina, pembangkit listrik tenaga panas bumi menyediakan listrik paling banyak, sedangkan energi angin memiliki biaya produksi terbesar. Sebanyak 235 pembangkit energi terbarukan aktif di seluruh negeri, sebagian besar berada di Luzon. Selain itu, sumber energi terbarukan secara positif memengaruhi ekonomi dan lingkungan kita karena berpotensi menurunkan tagihan listrik, meningkatkan lapangan kerja, dan mengurangi polusi udara serta risiko kesehatan yang terkait dengannya. Namun, konsekuensi negatif potensial termasuk kurangnya ketahanan pangan dan area pertanian. Para peneliti mendesak pemerintah untuk mengembangkan lebih banyak pembangkit listrik energi terbarukan, melakukan penilaian kemampuan jaringan yang komprehensif, termasuk penilaian lokasi optimal potensial untuk aset produksi baru, dan merencanakan serta menangani dampak lingkungan dengan baik.

Kata kunci: Sumber Energi Terbarukan, Pembangkit Listrik, Filipina

1. Introduction

Energy such as electrical energy is one of the most important needs of human life. People use it in every field of their life for heating, lighting, cooking and many more. Energy is produced from different sources in different forms on the Earth like solar, hydropower, geothermal, wind, and biomass energy. These sources were called "Renewable Energy Sources." Renewable energy requires natural phenomena such as sunlight, wind, tides, biomass and geothermal heat. Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from sun, or from heat generated deep within the earth. Included in the definition is electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and biofuels and hydrogen derived from renewable resources (International Energy Agency, 2002 as cited by Mindanao and Faderagao, 2012). Renewable energy resources offer important opportunities for energy efficiency over the world. Most countries around the world use the traditional energy resources like fossil fuel that are present only in a confined number of countries. Although we can say that the following alternatives are the best choice for us in generating energy, we still cannot deny the fact that they too have their own environmental issues.

The Philippines is one of the fastest growing countries in South East Asia, with an average annual GDP growth rate of over 6% between 2010 and 2016. Construction sites, rising condominiums and traffic congestion are a common sight in the country's main cities, reflecting its growing population, rising incomes and the increasing demand for electricity. The usage of alternative or renewable and absolutely natural energy sources should be increased instead of conventional sources and they can supply the Philippine's energy needs; it is also necessary for the future of our planet because there is no doubt that renewable energy sources are less harmful than fossil fuels which are still used, but should not be. People should not forget that there are useful alternatives instead of conventional sources.

In present day, numerous power plants continue to multiply to provide for the unending demand for energy. Due to the climate change concerns, the use of renewable sources for energy increased but while a large number of power plants that uses renewable energy are built all over the country, power plants that uses non-renewable energy outnumbers the latter. In view of the innumerable concerns about the use of fossil fuels, coals, gas, and other non-renewable sources to produce energy, the researchers conducted this study to state the current status of the Philippines' renewable resources, which is important in the process of bringing consciousness in the alternative options in producing energy or electricity. More importantly, this is also expected to bring a slight decrease in the negative effects of non-renewable energy source usage because if the use of these sources is lessened, the Environmental Protection Agency (2021) stated that more benefits will arise and that including the generation of energy that does not emit greenhouse gases from fossil fuels, the reduction of some types of air pollution, improved public health, and jobs for the people and other economic benefits.

Furthermore, the researchers conducted this study due to their own experiences regarding the sudden electricity loss in their location while they are having online classes and the high electricity bill even though they are not using many appliances in their home. Each of them is aware of the shortage of electricity in the country that leads to importing resources from other countries in Asia to fill the

gap. Regarding this matter, the additional knowledge that the researchers attained concerning this topic gave them the ability to provide solutions to the problems they faced about electricity in our nation and educate the Filipinos and the country on this subject.

2. Statement of the Problem

This study aimed to bring knowledge about the renewable energy sources in the Philippines. Specifically, it answered the following questions:

1. How may renewable sources of energy be described in terms of the following:
   1.1 Energy Production Generated
   1.2 Cost of Production
2. How many power plants in the Philippines are operational in terms of:
   2.1 Regional Power Plants in Luzon
   2.2 Regional Power Plants in Visayas
   2.3 Regional Power Plants in Mindanao
   2.4 Percentage of Regional Power Plants in the Philippines
3. What are the impacts of using only renewable energy in the future?

Analysis Framework

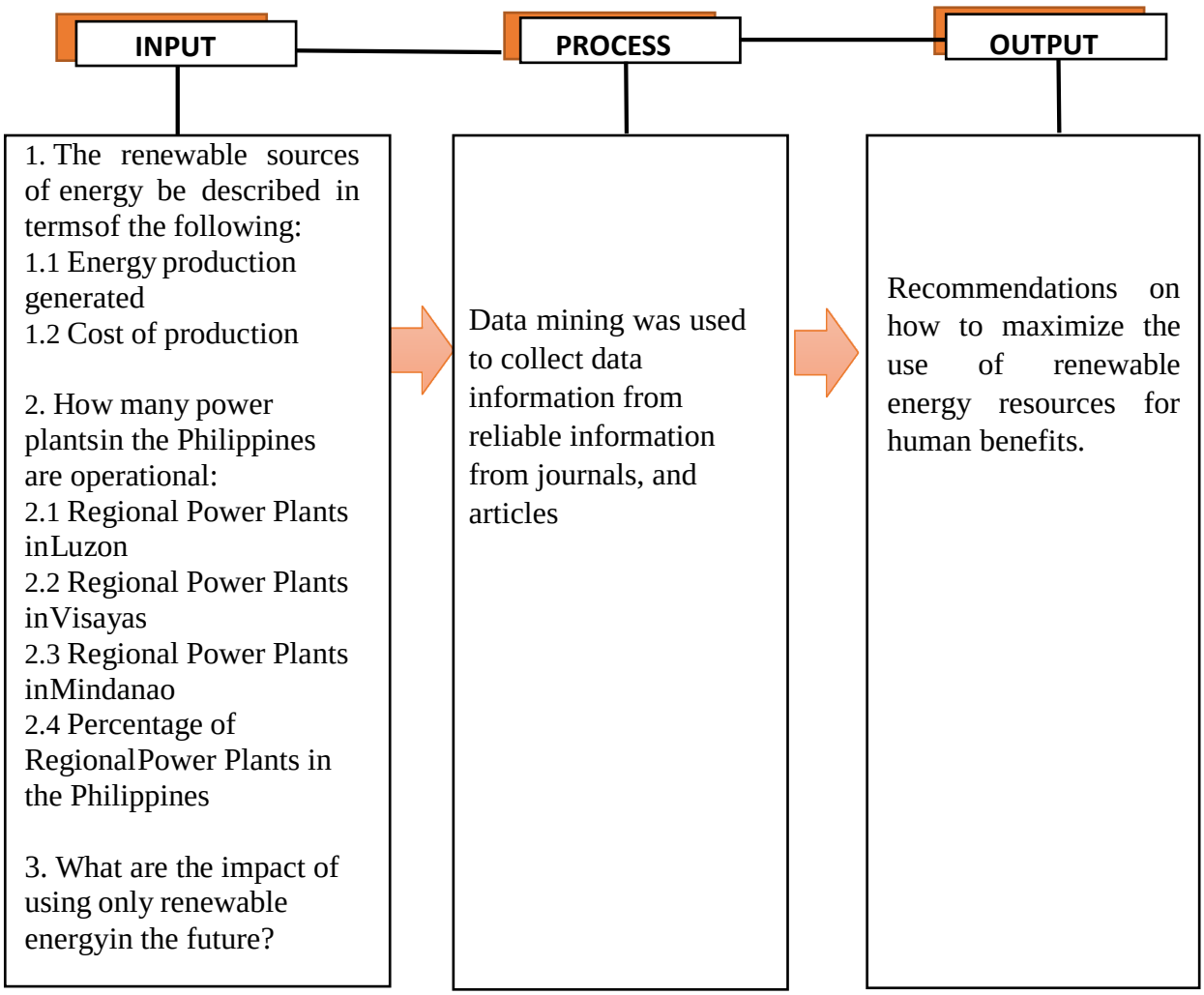


Figure 1: Research Paradigm

The research paradigm presented in figure 1 showed the input-process-output of the study. The input showed the independent variables, which consists of energy production generated from the power plants, cost production of renewable energy sources, how many power plants in the Philippines are operational, and what is the impact of using only renewable energy in the future? The process showed how the researchers gathered the data information from reliable resources such as journals and articles through data mining. The output showed the recommendations for maximizing renewable energy resources for human benefits.

3. Research Method

This chapter describes the methodology and procedures applied to attain the objectives of this research. This section includes the research design, research instrument, data gathering procedure, and statistical analysis of data.

3.1 Research Design

The researchers employed a quantitative analysis design in which numerical data was collected and analysed. This research design is applied to find the total number of power plants and the percentage of the total electricity production generated in power plants. The method that is used is descriptive-normative method to gather previous data information of the renewable energy sourcesin the Philippines. According to Davis (2021), the descriptive-normative design combines two research methods to gather information, to describe the object of study as it is, has been or is viewed (descriptive method) and critiquing of the object to identify ways to improved (normativemethod).

3.2 Research Instrument

The main research instrument that was used in this study for web-based data gathering method is synthesizing data from research results. The information gathered for this study was summarized in order to generate data-driven inferences.

3.3 Data Gathering Procedure

The researchers employed data mining as a data collection method, in which the raw data was collected from reputable websites for the fulfillment of this study. Data mining is a technique for extracting relevant patterns and evidence from large amounts of data (Ferguson, 2014). The first stage in this strategy is to collect raw data from massive databases, which include governmentwebsite, publications published on the internet, and other sources of information on renewable energy sources in the Philippines. The researchers employed visual presentations as part of this approach to demonstrate the findings of this study.

3.4 Statistical Analysis

Descriptive Statistics was used to present, interpret, and organize all the data that was gathered for this study. This included tables and graphs for the examination and presentation of the data. According to Kaushik and Mathur (2014), descriptive statistics provides us summaries of sample and observations and it includes summary statistics or simple-to-understand graphs. It mainly focuses on the methods of analysing the data and the presentation of data in tabular or graphical form.

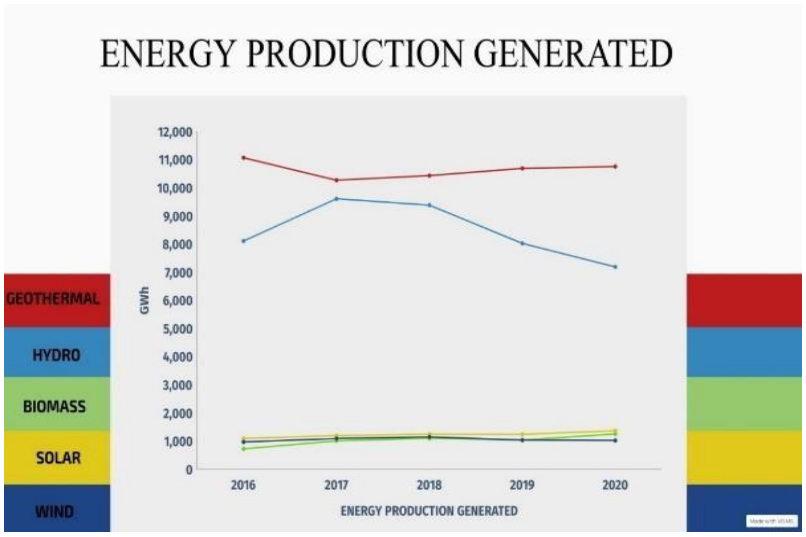
4. Discussion

4.1 The renewable sources of energy be described in terms of the following:

4.1.1 The Energy Production Generated from Renewable Energy Sources in the Philippines

Table 1. Energy Production Generated in GWh

	2016	2017	2018	2019	2020
WIND	975	1,094	1,153	1,042	1,026
SOLAR	1,097	1,201	1,249	1,246	1,373
BIOMASS	726	1,013	1,105	1,040	1,261
HYDRO	8,111	9,611	9,384	8,025	7,192
GEOTHERMAL	11,070	10,270	10,435	10,691	10,757



Source: Department of Energy (2020)

The figure 1 shows the total amount of energy generated by each renewable energy power plant in GWh between 2016 and 2020. The data gathered corresponds to the power plants listed in the Department of Energy's database. As reported by the Department of Energy (2020), geothermal power plants are the largest suppliers of electricity among all renewable power facilities. They produced 11,070 GWh in 2016, 10,270 GWh in 2017, 10,435 GWh in 2018, 10,691 GWh in 2019, and 10,757 GWh in 2020. In 2017, there is a slight drop of energy generation. As stated by Department of Energy, the outage was caused by natural disasters that struck the Visayas region, disrupting critical power, generation facilities, power lines, and equipment, particularly in the areas of Samar-Leyte, Bohol, and Cebu. Hydropower came in second, producing 8,111 GWh in 2016, 9,611 GWh in 2017, 9,384 GWh in 2018, 8,025 GWh in 2019, and 7,192 GWh in 2020. As shown in the graph, there is a huge reduction in energy generation in hydropower plants from 2019 to 2020.

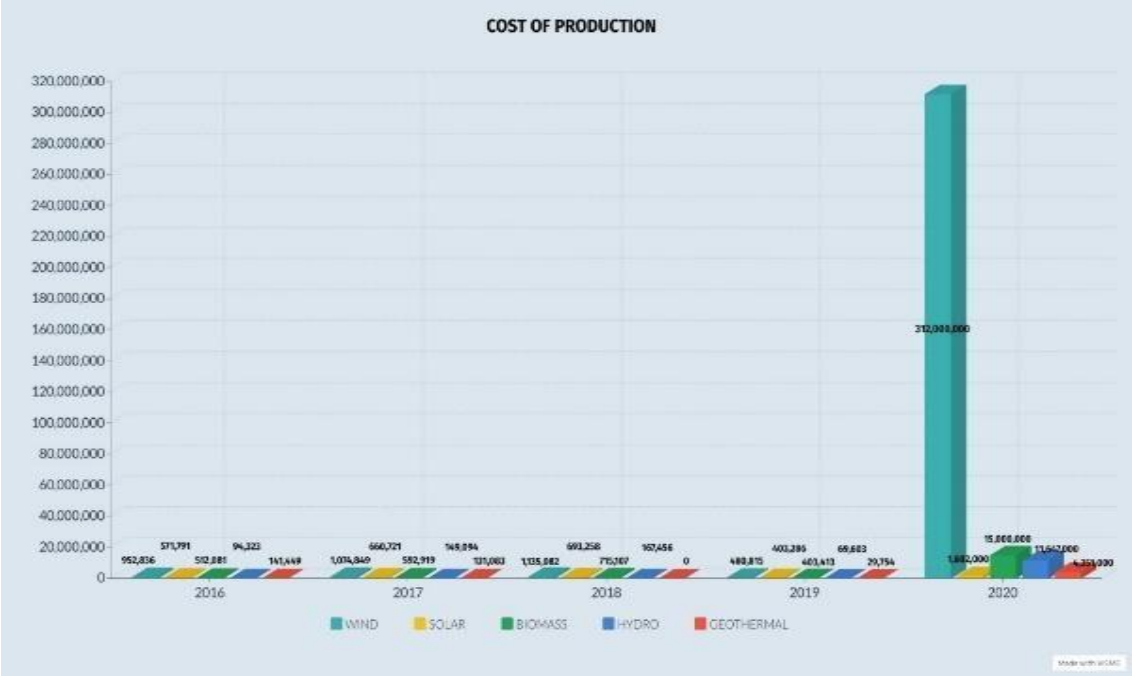
According to the Department of Energy, the El Nino condition has a significant impact on the energy generation of hydroelectric power plants during the summer months, resulting in a decrease in energy generation and a reduction in the available capacity of hydroelectric power plants on the grid. Furthermore, Biomass, solar, and wind power plants are near the bottom of the curve, as shown in the figure, because they contributed similar amounts of energy from 2016 to 2020 that are relatively low compared to geothermal and hydropower's energy produced. Biomass power plants produced the least amount of energy in 2016, with 726 GWh, followed by wind power plants with 975 GWh and solar power plants with 1,097 GWh. In 2017, biomass generated 1,013 GWh, wind power generated 1,094 GWh, and solar generated 1,201 GWh. The following year, biomass power plants contributed 1,105 GWh, wind power plants contributed 1,153 GWh, and solar power plants contributed 1,249 GWh. In 2019, there was a small amount of increase within the energy generation of biomass which gave out 1,040 GWh but minimal decrease may be seen in wind power plants' contribution of 1,042 GWh and solar power plants' 1,246 GWh. Finally, both biomass and solar power plants contributed their highest amounts in 2020 with 1,261 GWh and 1,373 GWh while wind power plants generated 1,026 GWh of electricity for that year.

4.1.2 The Cost to Produce Renewable Energy Sources Between 2016 and 2020

Table 2. Cost of Production

	2016	2017	2018	2019	2020
WIND	952,836	1,074,849	1,135,082	480,815	312,000,000
SOLAR	571,791	660,721	693,258	403,286	1,602,000
BIOMASS	512,081	592,919	715,107	403,413	15,000,000
HYDRO	894,323	149,094	167,456	69,603	11,647,000
GEOTHERMAL	141,449	131,083	0	29,754	4,351,000

Figure 2. Cost of Production



Source: Department of Energy (2020)

Figure 2 presents the renewable energy production in the Philippines from year 2016 through 2020. The data showed in the graph is from the Department of Energy (DOE). Wind energy has the highest cost of production from 2016 to 2020 when compared to other renewable energy sources, according to TransCo, 2019 and the Department of Energy, 2020. The cost of manufacturing wind energy in 2016 is 952,836 php, 1,074,849 php in 2017, 1,135,082 php in 2018, 480,815 php in 2019, and 312,000,000 php in 2020. These cost of production turned out to be the highest among the renewable energy power plants as investments to build these wind power plantsand farms are too high. As stated by Duddu 2020, Burgos wind farm in Ilocos Norte, which is thebiggest wind farm in the Philippines with 150 MW of capacity, costs an estimated amount of $450 million. Several big loans were made and grated to Energy Development Corporation (EDC) to continue this project.

The Biomass has the second largest cost of production accounting with 512,081 php in 2016, 592,919 php in 2017, 715,107 php in 2018, 403,413 php in 2019, and there is a sudden increase in 2020 which accounts with 15,000,000 php. This increase in the cost of energy production in 2020 was heavily influenced by a project approved by the Board of Investments (BOI) which is the 8 MW Biomass power plant of the Mindoro Harvest Energy Co. Inc. that costs a total of P1.22 billion as reported by the Department of Trade and Industry (2021). With this additional project in the biomass power plant industry, the power generated from these power plants significantly rose in 2020 as see in Figure 2. Since 2016, the cost of

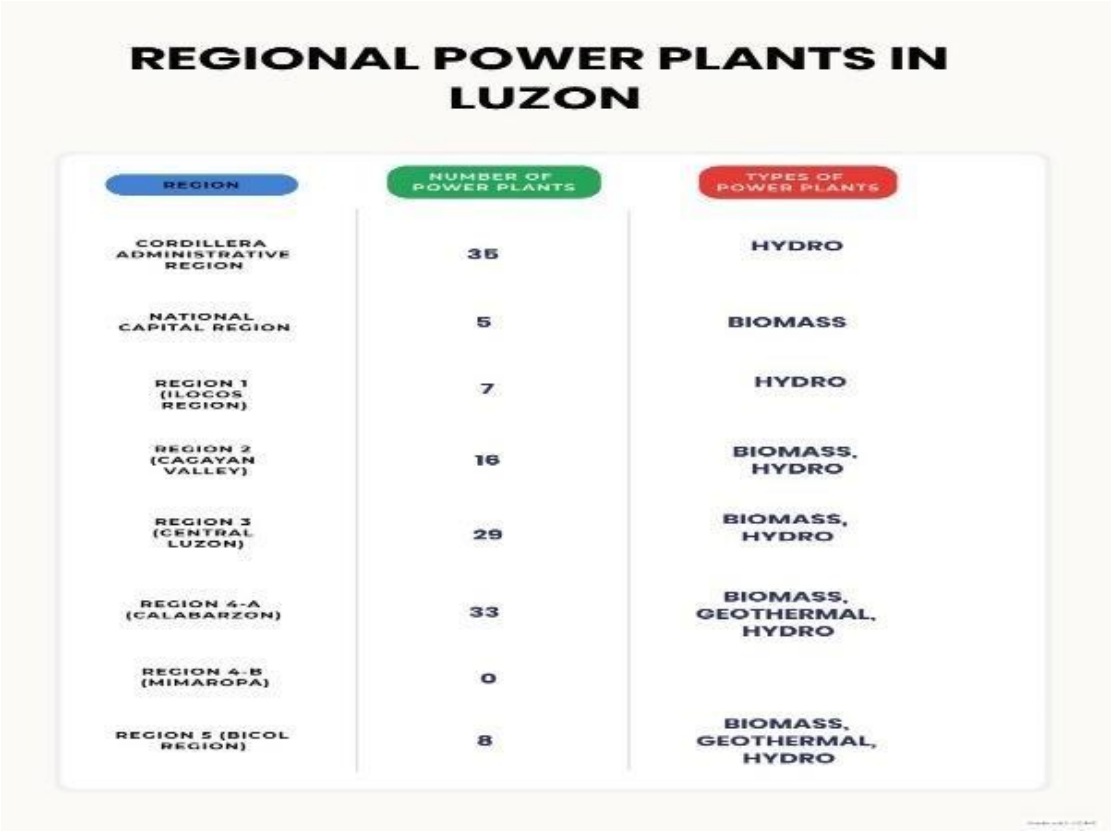
production of hydropower has risen with 94,323 php in 2016, 149,094 php in 2017, 167,456 php in 2018, 69,603 php in 2019, and 11,647,000 php in 2020. The Geothermal production costs in 2016 is 141,449 php, 131,083 php in 2017, and an undetermined amount in 2018. The cost of production continued to decrease with 29,754 php in 2019, in 2020 it drastically increased to 4,351,000 php.

Furthermore, the cost of production of solar energy in 2016 is 571,791 pesos; however, the cost of production rose in subsequent years. In 2017, it was 660,721 php, 693,258 php in 2018, 403,286 php in 2019, and 1,602,000 php in 2020. This increased in the cost of production of solarenergy is mainly caused by the price of solar panel systems. According to Si (2019), he stated thatan average solar system panel costs about Php 128,500 for a 1.62 kWp solar system which is considered "cheap". However, another report made by Solar Ai Technologies (2021) revealed that these costs also depends on the installation and maintenance. Usually, its price will range from P160,000 to P900,000.

4.2 The Number of Operational Renewable Energy Power Plants in the Philippines:

4.2.1 Regional Power Plants in Luzon

Figure 3. Regional Power Plants in Luzon

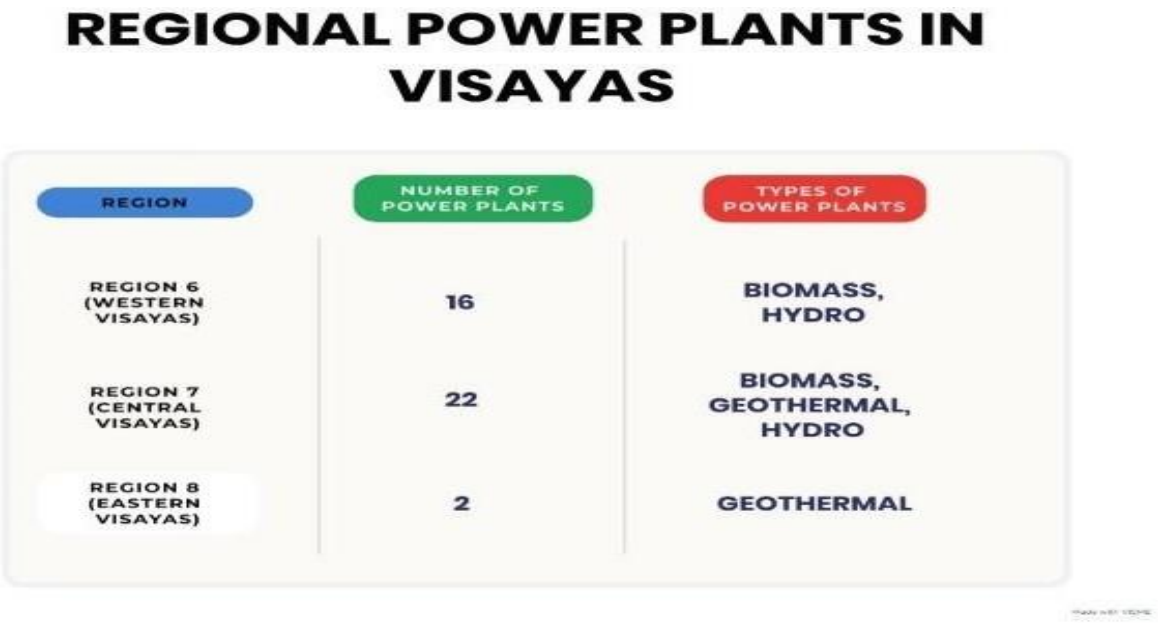


Source: Department of Energy (2020)

Figure 3 shows the regional power plants in Luzon. The data gathered correlates directly to the power plants listed by the Department of Energy. There are 133 renewable energy power plants in Luzon, which are categorized as biomass, geothermal, and hydro. According to the Department of Energy, the majority of power plants in Luzon originated in the Cordillera Administrative Region (CAR), which has 35 hydropower plants. Region 4-A (CALABARZON) came in second with 33 power plants categorized as biomass, geothermal, and hydropower plants.Region 3 (Central Luzon) comes in third with 29 power plants made up of biomass and hydropower plants, and followed by Region 2 (Cagayan Valley) with 16 power plants made up of biomass andhydropower plants. There are no power plants in Region 4-B (MIMAROPA). Furthermore, there are some regions in Luzon having solar and wind energy sources. The Region 1 (Ilocos Region) has a solar and wind sources from Ilocos Norte, Region 3 (Central Luzon) has solar energy sources comes from Bataan, Pampanga, Tarlac, and Zambales, and Region 4-A (CALABARZON) has solar energy source from Batangas.

4.3 Regional Power Plants in Visayas

Figure 4. Regional Power Plants in Visayas



Source: Department of Energy (2020)

Figure 4 depicts the number of power plants in the three Visayas regions. The informationgathered corresponds to the power plants listed in the Department of Energy's dataset. There are 40 renewable energy power plants in Visayas, which are categorized as biomass, geothermal, and hydro. According to the Department of Energy, the majority of power plants in Visayas are locatedin Region 7 (Central Visayas), which has 22 power plants that fall into either of three categories. While Region 6 (Western Visayas) accounts for

a significant portion, with 16 power plants from biomass and hydropower plants. Region 8 (Eastern Visayas) has 2 geothermal power plants. In addition, Region 6 (Western Visayas) has 2 wind energy sources from Aklan and Guimaras, as well as 2 solar energy sources from Iloilo and Negros Occidentals, Region 7 (Central Visayas) has 1 solar energy source from Cebu, and Region 8 (Eastern Visayas) also has 1 solar energy sourcelocated in Leyte.

4.4 Regional Power Plants in Mindanao

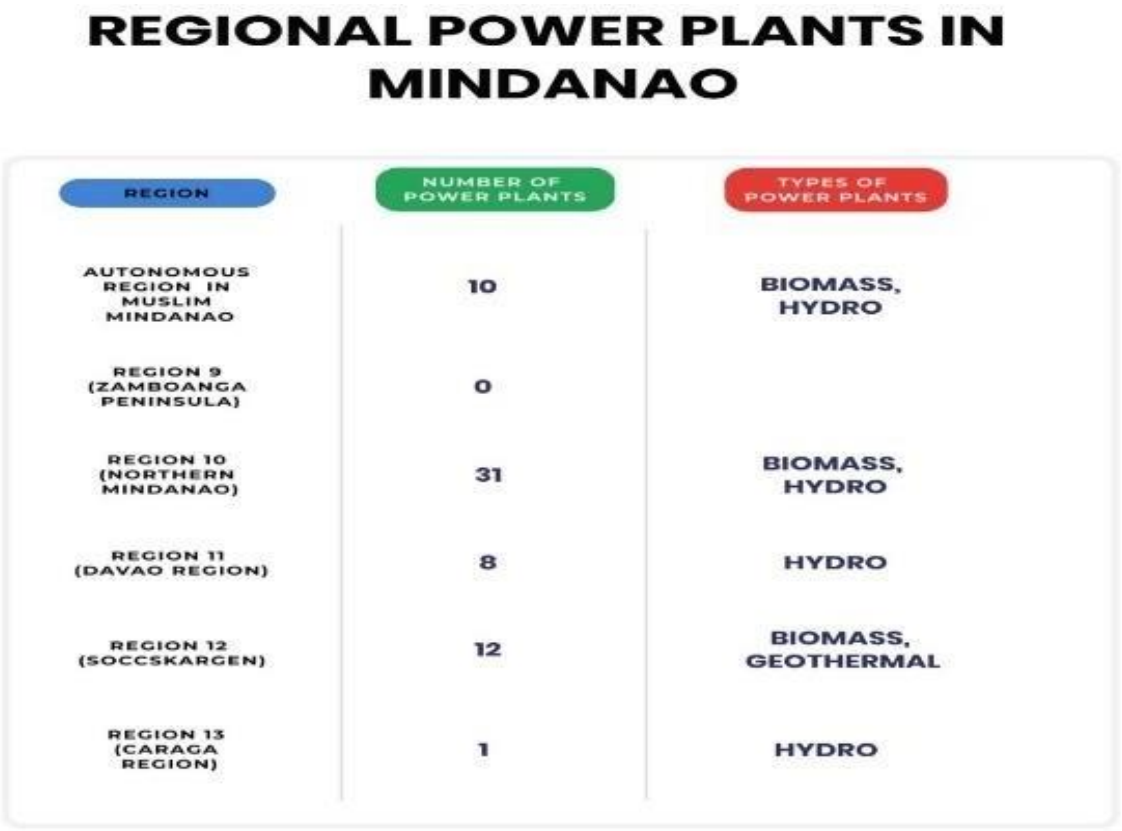
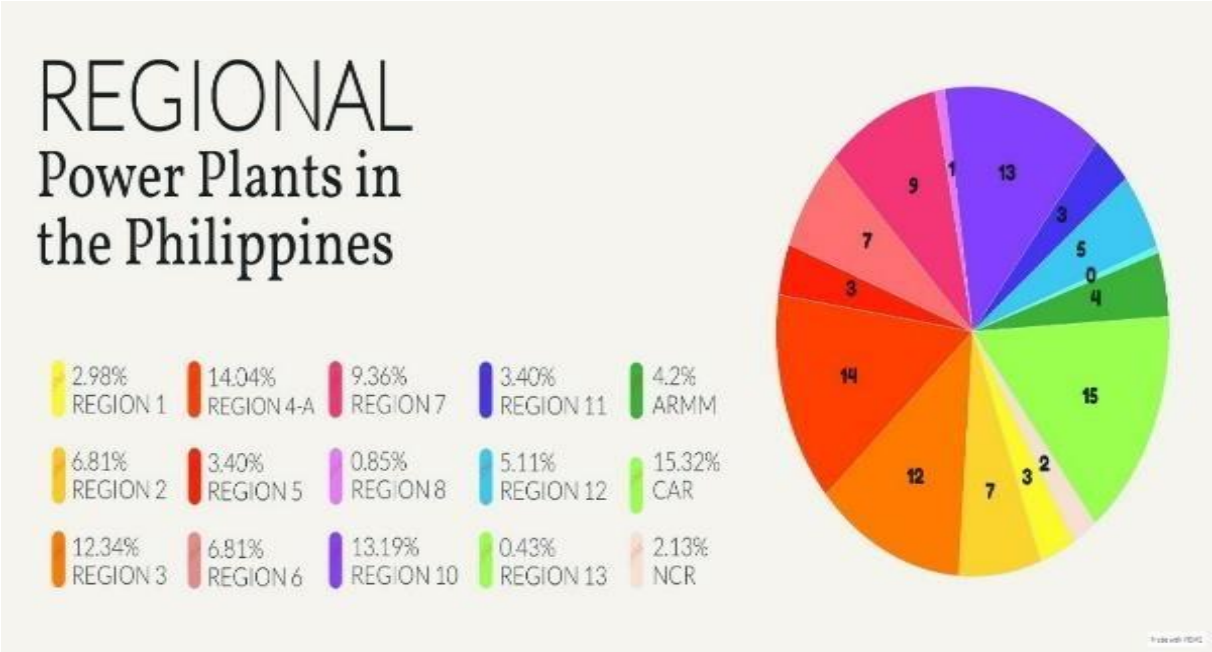


Figure 5. Regional Power Plants in Mindanao
Source: Department of Energy (2020)

Figure 5 shows Mindanao's regional power plant count. The data showed in the graph is sourced from the Department of Energy. Mindanao has 62 power plants in total, which are classified as biomass, geothermal, and hydro. According to the Department of Energy, Region 10 (Northern Mindanao) has the most power plants, with 31 totaling biomass and hydropower plants. Region 12 (SOCCSKARGEN) came in second with 12 power plants made up of biomass and geothermal power plants, and Autonomous Region in Muslim Mindanao (ARMM) came in third with 10 power plants made up of biomass and hydropower plants. Region 9 is completely lacking of power plants (Zamboanga Peninsula). Further to that, solar energy is used in some areas of Mindanao. Region 10 (Northern Mindanao) has one solar energy source in Bukidnon, Region 11 (Davao Region) has one in Davao del Sur, and ARRM has one in Maguindanao.

4.5 Percentage of Regional Power Plants in the Philippines

Figure 6. Percentage of Regional Power Plants in the Philippines



Source: Department of Energy (2020)

Figure 6 depicts the percentage of regional power plants in the Philippines between 2016 and 2020. The gathered data equates to the power plants stated in the Department of Energy's database. There are 235 renewable energy power plants in the country, which are classified as biomass, geothermal, and hydro. According to the Department of Energy, the Cordillera Administrative Region (CAR) has the most power plants of any region in the Philippines with 15.32%. The Region 4-A (Calabarzon) came in second with 14.04%, followed by Region 10 (Northern Mindanao) with 13.19%, Region 3 (Central Luzon) with 12.34%, Region 7 (Central Visayas) with 9.36%, and Region 6 and 2 with the same number of 6.81%. Moreover, two regions, Region 4-B (MIMAROPA) and Region 9 (Zamboanga Peninsula), do not have any power plants. The researchers conclude that the Cordillera Administrative Region (CAR) has an abundant supplyof renewable energy source specifically hydro because all of its power plants were came from hydropower. According to the Department of Trade and Industry, it really is the country's only landlocked region. It has a mountainous topographic features and is known as the "Watershed Cradle of North Luzon" since it is home to nine major rivers that provide continuous water for irrigation and energy to Northern Luzon. The region is rich in natural resources and has abundantmineral reserves.

4.6 The Impact of Using Only Renewable Energy in the Future

4.6.1 Advantages of Renewable Energy

The Philippines' efforts to support and develop the renewable

energy industry have been fruitful through the years. So far, its benefits do not only end in providing countless households an access to a more affordable and cleaner energy. In fact, the renewable energy industry benefits the economy, environment, and the people in the Philippines in several ways. Renewable energy power plants have made significant contributions to our economy, with Luzon and Visayas saving Php 20 billion which is equivalent to 8.6 centavos per kilowatt-hour (Nicolas, J., 2017). In addition to that, the Philippine Electricity Market Corporation (PEMC) recently produced a report which it stated that the renewable energy industry has saved the country Php 4.04 billion in energy prices (Department of Energy, 2019). Throughout the years that the Philippines have been dependent in coal-fired power plants, which led to millions of tons of carbon dioxide emissions however, the renewable energy industry has counteracted this problem. Renewable energy power plants are one of the best solutions in reducing the country's emissions of greenhouse gasses. The renewable energy sources such as geothermal, solar, wind, biomass, and hydropower does not produce greenhouse gasses which is a clear reason why it is better than fossil fuels but a remarkable proof of this is the Burgos wind farm project which generates electricity for more than two million households while offsetting a total of 200,000 tons of CO2 emissions annually (Duddu, 2020). Furthermore, the Department of Energy (2019) stated that the RE industry really helped in reducing 2.8 million tons of CO2 emissions of the Philippines as cited in a report made by the World Wildlife Fund for Nature.

Aside from the carbon dioxide emissions, one of the problems that the Philippines faces regarding the environment is the agricultural wastes. The agricultural sector is one of the biggest sectors in the Philippines, according to the Statista Research department (2021), it contributed a total of 10.2 percent in the country's gross domestic product (GDP) in 2020, equivalent to 1.78 trillion pesos of gross value added (GVA). Per annum, the agricultural sector produces an estimated amount of 16 million tons of agricultural wastes which comes from the rice, coconut, palm oil, sugar, and wood industries. This problem is resolved by the biomass industry as it uses these agricultural wastes to provide energy for the people. As cited by Shead (2017), the World Bank-Energy Sector Management Assistance Program estimated that the biomass industry can produce 90 MW, 40 MW, and 20 MW of energy respectively from the residues of sugar, rice and coconut thus, solving the country's problem regarding agricultural wastes.

Aside from the aforementioned advantages, another advantage that the renewable energy industry has brought to the country is an increase in employment. After the consecutive lockdowns because of the pandemic which forced some businesses to close, an increase in the country's employment rate was observed. As cited by Rivera (2021), IRENA stated that the numbers of photovoltaic jobs in 2019 rose from 33,700 to 41,035 in 2020 meanwhile, wind power related jobs recorded an increase of 23, 800. The large and small hydropower

sectors also reported to have employed about 53, 600 workers, geothermal power generated 8, 300 jobs while biomass contributed another 11,200. It is also important to note that IRENA stated that they can give jobs to 178,000 people if not because of the restrictions caused by the pandemic. Furthermore, a significant health benefit of renewable energy would be that our air and atmosphere would no longer be polluted not only by greenhouse gases, but also by other pollutants emitted by fossil fuelplants or by the combustion of fossil fuels in transportation. The prevalence of diseases associatedwith air pollution, such as respiratory illness and cancer, will decrease. Enhancing the use of renewable energy can help to reduce the use of fossil fuels and the negative health consequences that come with it. According to the World Health Organization (2021), together with climate change, air pollution is one of the most serious environmental threats to human health. Improving air quality can help with climate change mitigation efforts, and lowering emissions will help with air quality as well.

It will produce greater outcomes in the future if renewable energy is used continuously andthe country uses entirely renewable energy sources for its electricity. Using entirely renewable energy sources will raise the Philippines' energy savings and improve the country's environmental situation in terms of air pollution and agricultural wastes. Air pollution-related health hazards will be considerably reduced, and more jobs will be offered to the public. All of these goals, including the 7th Sustainable Development Goal of affordable and clean energy, will be met with renewableenergy.

4.6.2 Disadvantages of Renewable Energy in the Future

Up to this point, the impacts of the renewable energy in the Philippines seem to be positivehowever, we must also realize that it also has its downside. Even though the renewable energy benefits the environment, it may also harm it in some way. Building more of these power plants across the Philippines means more land should also be used. True enough, according to the Department of Energy as cited by Velasco (2021), the solar farm projects may reduce the agricultural since these are the most ideal land for solar use as it easily captures solar radiation because these are flatlands. This problem does not only apply to solar power plants but to all the other types of renewable power plants such as geothermal, wind, biomass, and hydropower. This will eventually cause in weaker food sustainability.

The renewable energy sector has already proved that it brings a lot of benefits to the country. Nevertheless, energy development projects should also be mindful of the negative impacts of the renewable energy power plants as it may cause several problems in the future like reductionof agricultural land and lack of food security if the building of these power plants went out of control.

5. Conclusion

Considering the findings of this study, the following conclusions were drawn:

1. Currently, renewable energy's share in our country's energy mix is only 24 percent while coal still leads the energy mix with 47 percent, natural gas 22 percent, and oil-based 6.2 percent (International Trade Administration, 2020). From 2016 to 2020, geothermal power plants are the largest generators of electricity among all renewableenergy sources in the Philippines.
2. Among the renewable energy sources, wind energy has the highest cost of productiondue to its high investment costs. Biomass has the second highest costs of production while solar, geothermal, and hydropower's production costs are considered the cheapest.
3. Philippines has 235 renewable power plants that are operational, 133 power plants are located in Luzon, 40 in Visayas and 62 in Mindanao. These power plants are all identified as hydropower, biomass, and geothermal power plants. On the other hand, Solar and wind farms are not considered as power plants but energy systems.
4. The renewable energy industry has already proved itself by providing positive impacts in our country may it be in our economy or in our environment. In the future, if the renewable energy continues to thrive through the government's future plans, much better benefits will be given to our country. More energy and monetary savings, more jobs, and a cleaner environment. However, the use of agricultural lands for building renewable energy power plants will cause greater problems in the future.

5.1 Recommendations

The following recommendations are formulated by the researchers after taking into considerationthe results and findings of this study.

1. Increase public awareness to ensure their long-term political commitment as awareness plays a vital role in influencing their opinions and roles. People will be more dedicated to switching and promoting renewable energy when they are well-informed about the situation of renewable energy in the Philippines and how it can benefit them by meeting their needs for power and many other things.
2. Assess the grid infrastructure of the country to determine which areas of the Philippines require more renewable energy power plants and what kind of renewable energy sources are available there that can be used. Additionally, this effort will help people have a better grasp of the infrastructures and level of service that these renewable energy sources currently offer.
3. To assess the Department of Energy Renewable Energy Management Bureau's mandates and responsibilities in implementing the Department's renewable energy programs and to assess the current capability and expertise of their staff, the institutional capacity of the Philippine renewable energy sector should be investigated. This suggested course of action focuses on the potential establishment of a third-party organization that can assist the Department of Energy with its initiatives relating to

renewable energy and the investigation of the effective utilization of these sources.

4. Examine the potential for renewable electrification through the use of mini and micro grids. This suggested course of action will concentrate on some particular geographic area,such as islands, that are not connected to the Philippines' main power grid and cannot be accessible by electricity. The envisioned small and micro grids' usage of renewable energy technologies will contribute to the provision of electricity in these remote locations.

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