Higher Education Role in Supporting Indonesian Government Policy in Developing Renewable Energy

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Abstract. Indonesia is a country blessed with natural resources potential to be utilized as the renewable energy. Actions should be taken to improve renewable energy based power generation due to the diminishing of conventional fossil fuel and its significant effects on global warming and environmental destruction. Indonesia needs a particular strategy to be able to reach the target of renewable energy utilization by 2025 and 2050. In term of energy consumption, Indonesia is one of the fastest growing countries due to its robust economic development, increasing urbanization and steady population growth. Indonesia uses 40% of the total energy in ASEAN (Association of Southeast Asian Nations) member. Between 2000 and 2014, energy consumption in Indonesia increased by around 65% and is predicted to reach 80% in 2030. This high demand for energy can be fulfilled if all the sectors in Indonesia are hand in hand reaching the targeted goal of renewable energy share. Politeknik Negeri Sriwijaya as a higher education institution should play an active role in supporting government policy in developing renewable energy. This paper discusses POLSRI roles in supporting this policy to develop renewable energy in Palembang and South Sumatra. The literature data is collected from various sources discussing the energy policies of renewable energy. The objectives of this study are to provide the renewable energy development strategies in Indonesia, especially to achieve the target of 23% renewable energy mix in 2025 and 31% in 2050 from the final energy mix following the national energy policy (Government Regulation No.79 of 2014) primarily from the power generation sector.

Keywords: Renewable energy, Government Policy, and Regulation, Energy Sustainability

1. Introduction
Energy is an inevitable necessity that is vital for the quality of human life. Industrial evolution and excessive development it caused increase the energy consumption provided by the conventional fossil fuel such as oil, coal, and LNG. Unfortunately, the excessive consumption resulted in the decrement of fossil fuels and the environmental impact in the form of CO$_2$ emission. The pollution occurs due to fossil fuels consumption came in the form of global warming that led to the increment of sea level, temperature instability, and other social impacts. The fossil fuel depletion due to higher rate of consuming it than nature can replenish it. The solution of fossil fuel depletion and environmental problem is by increasing the production and utility of renewable energy. Indonesia is islands located in equator has many potential renewable energies such as solar, water, biomass, geothermal and tidal wave [1].
In terms of energy consumption, Indonesia is one of the fastest growing countries due to its robust economic development, increasing urbanization and steady population growth. Indonesia uses 40% of the total energy in ASEAN (Association of Southeast Asian Nations) member. Between 2000 and 2014, energy consumption in Indonesia increased by around 65% and is predicted to reach 80% in 2030 [2,3].

Energy is categorized into non-renewable and renewable energy that has the virtue that non-renewable energy does not have. This kind of energy will never stop or run out during the natural cycle. It is environmentally friendly and minimizes pollution. However, the setback is that the renewable energy efficiency is less than non-renewable energy and energy production is more. Due to the insistence of fossil fuel depletion and environmental problems make the Indonesian government strives for this new energy in order to maintain the stability and energy security in Indonesia amid the decreasing non-supply. To optimize the use of renewable energy in Indonesia, the government has Government Regulation Number 79 of 2014 concerning National Energy Policy National Article 11 paragraph 2, which explains the priorities of national energy development. In Government Regulation Number 79 of 2014 concerning National Energy Policy, precisely in Article 9 letter F, Indonesia has set the energy achievement target of around 30% by 2050 [2-7].

The implementation of this government regulation until 2015 is the overall energy sources in all sectors. Petroleum is still the primary foundation of Indonesian energy the percentage of 43%, followed by coal and natural gas, with the percentage of 28.7% and 22%. This condition indicates that the utilization of renewable energy in Indonesia is not maximal up to now and unable to cover the growth of energy 3.2% and electricity consumption 6% annually. If the rate of renewable energy utilization is only 0.36% per year, then it will be difficult to reach 23% increment by 2025.

Indonesia’s electricity consumption is predicted to be more than triple by 2030. The economic growth increases energy consumption for various home appliances, and at the same time the government has to distribute electricity connection across remote areas and island, and the distribution is expected for near-100% electrification by 2026. The fastest growth is in transport and industry and becomes more than double by 2030. Motorcycles and cars are populating Indonesia streets every day. In the industry sector, cement, aluminum, paper, and ceramic are the primary growth.

The utilization of renewable energy in the business sector also is still limited due to a variety of technical, non-technical problems that hinder the development of a new renewable national energy. Besides, electricity tariffs from fossil energy (coal) are cheap because of the low world price of coal and dependence on oil-based energy sources due to subsidies provided, as well as expensive renewable energy technology components due to having to import from abroad and the limited renewable energy industry in Indonesia. Infrastructure limitations are also one of the factors that cause restrictions on public access to energy, especially renewable energy, and the global challenges faced by Indonesia. Therefore, the utilization of existing national energy resources is not efficient and is still very low when compared to the potential.

Based on the existing energy policy in Indonesia and the problem of renewable energy faced currently, a strategy is required to develop renewable energy in Indonesia in order to be able to reach the target of renewable energy utilization by 2025 and 2050. The improvement of renewable energy utilization, research and application should be supported by all the sectors including higher education institution, such as Politeknik Negeri Sriwijaya (POLSRI).

This paper analyzes the Higher Education Role in Supporting Indonesian Government Policy in Developing Renewable Energy. The literature data is collected from various sources discussing the energy policies of renewable energy tariffs and licensing, including the technological aspect analysis and factors to support the development of renewable energy to ensure the stability of energy security. The objectives of this study are to provide the renewable energy development strategies in Indonesia, especially to achieve the target of 23% renewable energy mix in 2025 and 31% in 2050 from the final energy mix following the national energy policy (Government Regulation No.79 of 2014) primarily from the power generation sector.

2. Indonesian Government Policy on Renewable
Indonesia is the country located in the equator blessed with many natural resources and minerals, and if managed and appropriately utilized will be able to meet the energy of all people in this country. Therefore, Indonesia is optimistic about setting an ambitious target to increase the use of renewable energy by up to 23% by 2025, and 31% by 2050, as shown in Figure 1. It is expected that renewable energy has the share of 17% in total final energy consumption (TFEC), upgrading from the current 6%. Figure 2 shows the TFEC in Indonesia where the most significant share is still in Java and Sumatera.

![Figure 1. NRE target in 2025](image)

The depletion of the reserved conventional energy sources and the increment of energy consumption each year encourages the government to review its energy policies to increase the use of new and renewable energy (EBT) and reduce dependence on fossil energy. In the context of the use of renewable energy, several policies to support renewable energy other than Government Policy No. 79 of 2014 has been widely issued, some of which are discussed are:

1. Regulation No. 30/2007 concerning Energy
2. Regulation No. 21/2014 concerning Geothermal
3. Regulation No. 30/2009 concerning Electricity.
4. Government Policy RI No. 70/2009 concerning Energy Conservation.
5. Presidential Regulation No. 4 of 2016 concerning Acceleration of Electricity Infrastructure Development
6. MEMR Regulation No. 19 of 2016 concerning the Purchase of Electric Power from PV-PV PLTS by PT. PLN (Persero).
7. MEMR Regulation No. 19 of 2015 concerning Purchasing Electric Power from Hydro Power Plants with Capacity of up to 10 MW by PT. State Electricity Company.
8. MEMR Minister Regulation No. 44 of 2015 concerning Purchasing Electric Power by PT. State Electricity Company (Persero) from Municipal Waste-Based Power Plants.
9. MEMR Minister Regulation No. 21 of 2016 concerning Purchasing Electric Power from Biomass Power Plants and Biogas Power Plants by PT. State Electricity Company.
10. MEMR Minister Regulation No. 17 of 2015 concerning Purchasing Electric Power from PLTP and Geothermal Steam for PLTP by PT. State Electricity Company (Persero).
11. MEMR Minister Regulation No. 10 of 2017 concerning Power Purchase Regulations Electricity.
12. MEMR Minister Regulation No. 12 of 2017 concerning Utilization of Renewable Energy Sources for Electricity Supply.
3. Energy Consumption Mapping in Indonesia

Indonesian government set a target to realize that by 2025, 23% of primary energy supply is supplied by renewable energy. This target is set as part of a collective target set by ASEAN member states. Indonesia with 250 million population becomes the largest country in ASEAN. Therefore, it has to take the critical role to meet the targeted renewable energy application. 250 million people spread out over more than 17000 islands and this condition becomes the challenges for evenly distributed electrification across the country. Indonesia’s state utility company PLN (Perusahaan Listrik Negara) aims for 98% electrification by 2022.

The share of modern renewable energy in TFEC (Total Final Energy Consumption) shows the total consumption of energy in the used-end sector of electricity including the renewable source of electricity generation and conventional one. The main sectors consuming energy are building (including residential, commercial and public sector), industry (including manufacturing and mining sectors), and transport (including the direct use of renewable energy). Indonesia has a 40% share of TFEC in ASEAN, which equals to 7.3 EJ in the year 2014. TFEC grew more than 20%, and more than half is in the Java-Bali region with 35% power generation between 2010-2014.

The largest energy providers come from petroleum product (diesel, gasoline and liquefied petroleum gas – LPG) as the largest share of TFEC (37%) in 2014, which is down 3% from year 2010 due to the increment of coal utilization (from 0.8 EJ or 14% of TFEC in 2010, to 1.4 EJ or 18% of TFEC in 2014). Electric consumption is increased by 34% between 2010 and 2014 although the TFEC share is quite the same from around 9% to 10%. 2/3 of electricity consumption is for buildings, and the rest is for industries. The electrification rate is currently 88% with a target of 97% for 2019. Figure 3 shows the electrification rate per % of the population in Indonesia in 2015.

The utilization of renewable energy in Indonesia is dominated by bioenergy for the industry, buildings, and transport. The household cooking uses 80% of those renewable energies. The modern renewable energy was 5.8% of TFEC or 426 PJ in 2014. 65% of renewable energies today is bioenergy, biodiesel is 13% for transportation, and 22% is shared between PV system, hydropower, and geothermal power. The total share of renewable energy in power generation was 12.4% in 2014. The TFEC share of renewable energy decreased from 59% in 2000 to 37% in 2013 due to the increment of coal utilization to meet society energy demand.

Buildings have a relative fix TFEC share in Indonesia although the households increase 1.5% per year with an average of 4 people per household with energy consumption around 10 MWh per household per year. This constant level of energy demand is due to the transition to a more efficient form of energy use by substituting kerosene to LPG whose efficiency is 40%-60%. Although in some places, the primary energy source is still fuelwood for cooking, mainly in West Nusa Tenggara, Sulawesi, and
Papua. The action taken to overcome this condition is by Indonesia clean stove initiative campaign, a collaboration between the Indonesian government and the World Bank initiated in 2012.

![Figure 3. Electrification rate per % of population in Indonesia in 2015](image)

The largest share of TFEC comes from industries 2.7 EJ or 36% in 2014, which increased 5% per year from 2010 and most of the energy consumption from coal utilization as the primary fuel. The largest energy users in the industry are coming from aluminum, cement, ceramics, brick, and paper producers. 22% of energy provider in the industry comes from bioenergy in 2014.

Energy consumption growth in transport is increasing very fast in recent years. Transport energy demand stood at 1.5 EJ, or 26% of TFEC from 2010, and by 2014 becomes 2 EJ or 29% of TFEC, this condition is mainly due to the immense growth of motorcycles and cars. Domestic production of motorcycles was 5.7 million units, and 85% is for domestic sales. Half of the energy consumption in Indonesia is from gasoline by road vehicles, another 40% is diesel, and about 2% is the electric car.

4. Energy Production Mapping in Indonesia

Indonesia is a fossil fuel producer country and the largest coal exporter and producer in the world by 2014. Coal reservation is estimated to be 31.270 million tons, and more than 80% is in East Kalimantan and South Sumatra. The estimated coal reserves would last for another 70 years at current production levels. When total coal resources (hypothetic, inferred, indicated and measured) are considered, this would be 272 years. Coal exports are to China, India, Japan, and the Republic of Korea. Most of the coal deposits in Indonesia are medium and low-calorific varieties of sub-bituminous coal, with low ash and sulfur content, suitable in particular for power generation. Metallurgical coal, used in iron and steel making, is found less in Indonesia (GBG Indonesia, 2014).

The natural gas reserved in Indonesia is about 149 trillion standard cubic feet of gas (tscf) with steady production of 3 tscf per year. 1 tscf of domestic production in 2014 was used in industry and power; another 1 tscf was consumed by liquefied natural gas (LNG) plants, and 0.3 tscf was exported through gas pipes. Oil reservation is around 7.4 billion barrels in January 2014, and crude oil production decreases from 517 million in 2010 to 288 million barrels in 2014 due to the reliance on mature oil fields and lacks new oil exploration.

Almost all of the biodiesel produced in Indonesia is from palm oil, which is around 11 million hectares. In 2008, the crude palm oil for domestic production was only 1% of total crop production, and it was increased to be 10% in 2014. Land clearing for palm oil production created the problem of forest fires and other adverse environmental outcomes such as CO2 emission. Up to 2014, the production of biodiesel in Indonesia increased rapidly and became the fourth most significant producers in the world, estimated at 190 million liters in 2009 and increases up to 3.961 million liters in 2014. However, export shared of total production has declined significantly due to domestic biodiesel blending. European
Union was the primary market for Indonesian biodiesel in 2012, but this condition was stopped in 2014, and nowadays, China is the primary market up to 55% of total export. Due to structural changes in Indonesia biodiesel in 2015, the national blending mandate was increased from B10 to B15; this condition was also added by the decrement of oil prices in 2014 where Indonesian biodiesel price was based on the gas-oil price. Therefore, a new price had to be set up. Although Indonesia was the 11th largest producer of biodiesel globally, the lower price makes the export decreased significantly, while the national blending mandate was not fulfilled.

In 2016, biodiesel production increased again since some subsidy problems were solved. The government implemented B20 (and B30 for the power sector), and compensation was provided by the Indonesian Palm Oil Estate Fund for subsidized biodiesel (Public Service Obligation – PSO), which is blended for use in transport. The subsidized target was set 3.2 billion liters and for non-subsidized was 1.3 billion.

4.1 Power Generation Mapping in Indonesia
Total electric generated in Indonesia was 229 TWh in 2014, and 70% belongs to PLN (State Electric Company), and another 30% from private electric companies, private power utilities (PPUs) and independent power producers (IPPs). PLN monopoly was reduced from 92% of total on-grid power in 2000. Coal was dominated the power generation by 53% in 2014 or 120 TWh, a rapid increment from 2010 (40%). Natural gas share is 25%, and petroleum products are 10% including the rental contract from the private sector (around 4 GW of the diesel generator). Renewable energy has an 11% share of total on-grid power generation in 2014, a decrement from 16% in 2010. This condition was also affected by the increment of coal utilization. Renewable power has a higher share in Sulawesi & Nusa Tenggara (39%) and Sumatra (17%), due to the utilization of hydropower resources. Oil-fired power generation was the primary source for Kalimantan and Maluku & Papua. Figure 4 shows the on-grid power generation capacity in Indonesia by 2014.

![Figure 4. On-grid power generation capacity in Indonesia (in MW installed) by 2014](image)

Hydropower capacity was 5.2 GW by the end of 2014 from 3.7 GW in 2010. All of larger than 50MW hydropower plants are located in Java-Bali, Sumatra, and Sulawesi & Nusa Tenggara. The largest hydropower plant in Indonesia is Cirata Dam Located in West Java with the capacity of 1GW. There is a significant increment for small scales hydropower plants from 14 MW in 2010 to 170 MW in 2014.

Geothermal capacity in Indonesia is limited from 1.2 GW in 2010 to 1.4 GW in 2014 despite the effort to expand the development. In 2014, 44 new plants started to operate to fulfill the target of 4000
MW, and the feed-in tariff was introduced. However, the increment is still too slow due to institutional, regulatory and tariffs constraints. It was targeted that 1.2 GW geothermal capacities installed in Java (about 1.2 GW), and currently, eight projects are ongoing for geothermal power plant starting from 2016 and 2017. Bioenergy in Indonesia is mainly from residues and waste in the palm and paper industries with 1.6 GW capacity, and 92 MW of that amount was grid-connected in 2014.

There is a relatively significant improvement of PV system installation, and utilization in Indonesia, from 42 MW in 2012 to 80 MW. 10 MW of the share is the on-grid component. The small scales of PV system are mainly off-grid system. The on-grid system started to be installed massively in 2015, located in Bali (2 MW), Kupang (5 MW) and Gorontalo (2 MW). In 2016, MoU was set up that PLN would develop utility-scale solar PV system in Indonesia. Indonesia’s state-owned Pertamina and the local government actively participate in meeting the target of PV system generated power. 9.8 MW of wind power generator was installed in 2016, and 3 PPAs were signed for the development of wind farms in Indonesia: 50 MW in Samas (Java), 60 MW in Jeneponto (Sulawesi) and 70 MW in Sidrap (Sulawesi).

The off-grid system comes from on-site industrial power capacity, mini-grids and stand-alone generation in rural areas (based on diesel generators, micro-hydropower, solar PV, biogas plants and micro-wind), and solar home systems. In 2014 the on-site industrial power capacity was about 4.4 GW including bioenergy power capacity. The most off-grid power generators are scattered in rural areas of Indonesia mostly in the form of diesel gen-sets that represent up to 900 MW, declined from 2007 (987 MW). It is about 286 micro hydropower and 220 solar PV mini-grid installation with 5 kW to 400 kW capacity with varied funded, privately or government funded, and or partnership with private companies.

4.2. Drivers for Renewable Energy in Indonesia

On account of reaching the ambitious targets of renewable energy, Indonesia has to find the drivers for improving the generation and utilization of renewable energies. The first driver would be health and environmental impacts. The utilization of conventional power generation gives terrible effects to the environment that in the end cause casualties to the people around the plant area. The effect varies between premature deaths, illness due to air and water pollutions. In 2012, it was reported around 4.3 million people died prematurely due to household air pollution, and another 3.7 million due to outdoor air pollution. The coal plants cause more than 6500 premature death every year due to energy-related Sulphur dioxide (SO$_2$) emission.

The main contributor to outdoor pollution in an urban area is the motorized vehicles creating a poor level of air quality. In 2014, major cities like Jakarta, the average cost of air pollution due to the illness ace up to USD 535 and double PM10 concentration of WHO standard. The greenhouse gas emission was at 1 800 Mt CO$_2$-eq in 2005 due to forest burning for land-use including fossil fuel resource extraction about 63% and 19% due to fossil fuel combustion. The CO$_2$ emission from this combustion estimated at 322 Mt CO$_2$ in 2005, and further increased to 425 Mt CO$_2$ by 2013, and 40% is from the power generation and 33.3% from transport area. Due to coal mining, the water quality in South Kalimantan is at risk of toxic pollution, and the coal mining activities are increasing rapidly across Kalimantan. Despite the abundance of fresh water, the demand of water-cooling for power generation also becomes a threat to the environmental sustainability.

Renewable energy is also giving macroeconomic impacts in increasing GDP, trade, employment and welfare for Indonesia. The GDP increment due to renewable deployment is predicted at around 0.3% and 1.3% in 2030. The trade balance of Indonesia could improve by an estimated 0.9% to 1.6% in the same year. This increment can improve the number of renewable energy-related jobs in Indonesia up to 1.3 million by 2030. The improvement also comes from social and environmental factors between 3.6% and 5.8% by 2030. The increment of renewable energy utilization means technology improvement and transfer that will be an additional effect on the economy as a whole. In 2015, 100 science and technology parks across the country. In order to improve the technology transfer, skill and knowledge improvement for the support it needs vocational training center in educating the green technologies and knowledge.
Indonesia is blessed with the containment of fossil fuels, however, due to the growing demand for petroleum and diesel for transport, import of petroleum product became a necessity. The implantation of renewable energy reduces the petroleum products dependence, and become a key technology in increasing electrification particularly in rural areas of Indonesia.

5. Higher education role in supporting government program in renewable energy

Higher education training is a new strategy to promote and support the government in achieving the target to increase the use of renewable energy by up to 23% by 2025, and 31% by 2050. Currently, vocational education institutes and universities in Indonesia are taking an active role in supporting government policy. At present, throughout Indonesia, training and education for renewable energy are on the ground or planning phase that is different significantly with the stage of development, teaching and content profile, financing structure and experience. The education is purely technical, engineering programmes based at a single university to a transnational setting involving taught courses at several universities, addressing renewable energy within an interdisciplinary approach.

South Sumatra Province with the capital city Palembang is blessed with natural resources for generating renewable energy such as PV system and hydro. South Sumatra also has a wide area of oil farm that can be a good source for biodiesel. One of the public vocational educations in Palembang is Politeknik Negeri Sriwijaya (POLSR). POLSRI as a vocational education supports training education and research in renewable energy by conducting a master degree program in renewable energy officially since February 3th 2016. Although POLSRI already has the undergraduate program in energy, on the master degree program, the training and research are focused on the development of renewable energy, not only in Palembang but also in South Sumatra, by conducting collaboration with other institution, such as Pertamina, PTBA and Palembang government.

POLSRI should produce engineers that are trained to plan, design, develop, operate and maintain renewable energy installations at all sizes and levels. The capacities of future policy-makers need to be strengthened to develop conducive policy frameworks that promote the use of renewable energy technologies.

Palembang as the city located near the equator is getting an abundance of sunrays whole year long making it a perfect place to install the PV system. Currently, PV systems are developed by Pertamina and Palembang government. Pertamina has a 3 KW PV system to power the managerial building shown in Figure 5.a, and Palembang government installed 200 MW PV system to support Jakabaring Sports City during Asian Games, to ensure no electrical shortage, shown in figure 6.a. Figure 5b shows the students and staffs of POLSRI were visiting PTLS belongs to PT Pertamina RU III Plaju Palembang.

POLSRI conducts a collaboration with PLTS (PV system power generation) Jakabaring by signing the Memorandum of Understanding of both parties. By this MoU, POLSRI can conduct research and study of PV system directly to the implementation and support the vocational program. Therefore, the training of human resources in Politeknik on the continent using available resources and skilled workforce is vital for the long-term sustainability of resource development. Figure 6b shows the staffs and students of POLSRI were visiting PLTS Jakabaring.

The few trained professionals with extra support regarding facilitation, can sustainably run and manage renewable energy training in higher education institutions. The training of students and staffs’ skill improvement can be conducted using the available resources, not only form the internal of POLSRI but also from the external institutions, and at the same time, POLSRI supports the research and development of external institution, forming a fruitful collaboration to support the government policy in improving the application of renewable energy in Indonesia.
6. Conclusion
The implementation of renewable energy is already urgent due to the diminishing of conventional fossil fuels and their effects on the environment in the form of CO$_2$ that causes global warming and the earth destruction. The Indonesian government has set policies and regulation concerning the utilization of renewable energy since Indonesia is blessed with so many natural resources that enable the full application of renewable energy such as PV system, hydro, biodiesel, and wind turbines. Politeknik Negeri Sriwijaya as a higher education institution supports government program by conducting the master program in renewable energy and having the collaboration in research and training with the external institution such as Pertamina and Palembang government in promoting the generation and utilization of renewable energy in Palembang and South Sumatra.

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