



Forecast of the Provision and Utilization of New Renewable Energy and its Utilization in the National Capital Region Towards a Green, Smart and Beautiful and Sustainable City

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Abstract

The role of fossil energy in national energy consumption is still very dominant, especially petroleum. In 2013, the most dominant final energy consumption in the country was the use of fuel oil (BBM), which includes aviation fuel, avgas, gasoline, kerosene, diesel oil, and fuel oil at 43%, followed by the use of coal 19%, gas 14%, and others. On the other hand, the supply of new renewable energy is not yet optimal due to the still sufficiently high economic prices, such as PLTS, PLTB, and biofuel, as well as constraints on the availability of land for PLTP development. Meanwhile, the beautiful concept includes distribution with underground cables and a futuristic design. This research analyzes the application of the concept of Energy Security, as well as the use of new, renewable energy in supporting a Smart, Green, Beautiful, and Sustainable national capital. To understand the behavior of renewable energy systems that can be optimized to meet energy demand; as well as evaluating assumptions and projections in the preparation of energy development program plans that are adjusted to the dynamics of energy supply and demand. It is also necessary to pay attention to socioeconomic and political conditions on a national scale



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1. Introduction

The role of fossil energy in national energy consumption is still very dominant, especially petroleum. In 2013, the most dominant final energy consumption in the country was the use of fuel oil (BBM), which includes aviation fuel, avgas, gasoline, kerosene, diesel oil, and fuel oil at 43%, followed by the use of coal 19%, gas 14%, and others (Kalalinggi, Hisdar, Sarmiasih, & Wijaya, 2023). The cause of high fuel consumption is due to economic growth and population increase as well as its inelastic nature and the ease of accessing this type of energy. At the same time, production levels and the availability of fossil energy reserves are decreasing due to the rate of depletion being faster than discoveries. This condition increases the risk of national energy security due to the high import of petroleum products from the global energy market which often experiences disruptions. (Pusat Data dan Teknologi Informasi Energi dan Sumberdaya Mineral Kementerian ESDM., 2016)

One of the government's efforts to conserve energy is through energy conservation measures which are cost reduction through energy management strategies. Energy conservation can be achieved through the use of energy-saving technology in the supply of both renewable and non-renewable energy sources and by implementing an energy-

saving culture in energy utilization (Hoang & Nguyen, 2021). The application of energy conservation includes planning, operation, and monitoring of energy utilization. The high level of greenhouse emissions and the decreasing amount of fossil energy have encouraged the world and the government to maintain energy security and independence, this is stated in PP No. 79 of 2014 concerning the National Energy Policy with a minimum target of a new and renewable energy mix of 23% in 2025 and 31% in 2050.(Indonesia, 2014) With all the potential resources that Indonesia has, this target is very likely to be realized.

The total renewable energy potential that can be utilized in Indonesia is 417.8 GW from various variations of NRE. With such a large potential, Indonesia is only able to realize the use of NRE for electricity generation of 10,467 GW or 14.69% of the total equivalent generating capacity of 71 GW in 2020. The minimal use of EBT for electricity is due to a lack of support and attention to the use of EBT, making it difficult for EBT plants to compete with fossil plants, especially coal, and hampering the development of renewable energy.(ARIODARMA., 2016)

The condition of fossil energy reserves such as coal, oil, and natural gas which continues to decrease is predicted to run out within the next 11 to 70 years. With all the threats to energy security, the Indonesian government should be able to anticipate them by further increasing the use of new, renewable energy (EBT) (Kammen & Sunter, 2016). Potential new renewable energy resources that are most likely to be utilized in terms of quantity include; hydropower, Ocean Thermal Energy Conversion (OTEC), solar power, and biomass. For this reason, efforts are needed to utilize technology to advance the use of new, renewable energy that is environmentally friendly. Solar Power Plants (PLTS) are one of the uses of solar cell technology that supports the use of new, renewable energy, with the sun as the primary energy source.(Effendi, 2016) The potential for utilizing Solar Power Plants (PLTS) in Indonesia is very large considering that Indonesia is located on the equator which maximizes main factors such as intensity and angle of illumination.(Erliansyah, Hiendro, & Purwoharjo, 2018) By selecting the right system, PLTS is able to provide many benefits both functionally and economically.(Martínez., 2019)

In the social sector, many people use energy inefficiently, because public understanding of the urgency of EBT is still minimal. This is reflected in the wasteful use of fossil energy every day. Another concern regarding the realization of the transfer of IKN is that it is threatened to be hampered due to the pandemic outbreak that is being experienced by all countries in the world, namely COVID-19. This resulted in delays in projects that had been designed resulting in most of the funding being diverted to dealing with the outbreak.(Aspan Latifah, Boedoyo, & Yoesgiantoro, 2021)

To understand the behavior of renewable energy systems that can be optimized to meet energy demand; as well as evaluating assumptions and projections in the preparation of energy development program plans that are adjusted to the dynamics of energy supply and demand. Developing EBT in Indonesia requires a collaborative approach to address three primary challenges (Yigitcanlar & Lee, 2014).

By working together and paying attention to socio-economic and political factors, significant progress can be made. The three aspects are regulatory policy, market incentive policy, and research and capacity development. An approach to these three aspects will accelerate the development of NRE in the future.

Referring to the description above, the problem formulation that must be answered in this research is to examine how the forecast for the supply and use of new, renewable energy and its use in the National Capital Region is towards a Green, Smart Beautiful, and Sustainable City (Bibri & Krogstie, 2020).

Renewable energy, as stated in Law No. 30 of 2007 concerning energy, is energy that comes from renewable sources, including geothermal heat, wind, bioenergy, sunlight, water flows, and waterfalls, as well as movements and temperature differences in the sea layers. Renewable energy utilizes environmentally friendly energy sources that do not pollute the environment and do not contribute to climate change and global warming. It is because the energy obtained comes from sustainable natural processes, such as sunlight, wind, water, biofuel, and geothermal. It confirms that the energy source is available, does not harm the environment, and is the primary reason why EBT is closely related to environmental and ecological problems.(Lumbangaol, 2007)

To encourage greater use of renewable energy while reducing the use of fossil energy sources, the government through the Directorate General of New, Renewable Energy and Energy Conservation (EBTKE) has launched the following five steps: (1) Increasing generating capacity for energy production. In the next few years, hydroelectric power plants (PLTA) and geothermal power plants (PLTP) will be intensified. (2) Increasing the provision of access to modern energy for isolated areas, especially rural energy development with micro-hydro, solar power, biomass, and biogas. (3) Reducing the cost of fuel subsidies, where the substitution of PLTD with EBT generators can reduce subsidies. (4) Reduced greenhouse gas emissions (5) Massive energy savings.(Kementrian ESDM., 2016)

2. Materials and Methods

Analysis technique for forecasting the supply and use of new, renewable energy and its use in the National Capital Region towards a Green, Smart Beautiful, and Sustainable City. The method used is a qualitative method with the data obtained as descriptive qualitative data. Descriptive qualitative data was obtained from interviews conducted with sources who can provide data and literature studies. (Sugiyono, 2018) In this research, researchers will try to analyze forecasts for the supply and use of new, renewable energy and its use in the National Capital Region towards a Green, Smart Beautiful, and Sustainable City.

3. Results and Discussions

Research Result

There are at least 3 aspects that are problems in developing EBT in Indonesia so measurable efforts need to be prepared to solve them in an integrated manner. The three aspects are regulatory policy, market incentive policy, and research and capacity development. An approach to these three aspects will be able to accelerate the development of NRE in the future.

Policy-Regulation.

To increase the use of renewable energy sources, the most important thing that the government must do is set targets for the use of renewable energy. Determining utilization targets is an explicit statement of targets which then becomes a reference for other policy options. In addition, when environmental impacts and social impacts have not received the attention they deserve, setting targets by the government will change the competitive arena so that it becomes more profitable for the development of renewable energy. The next regulations needed to determine the direction of renewable energy development are regulations regarding the selection of the type of energy source and the technology used. Regulations regarding the selection of types of energy sources are intended so that all potential energy sources can be utilized optimally. This regulation is primarily intended to encourage the development of all types of energy sources, including types of renewable energy that have not yet been developed due to economic and technological constraints. In line with this, regulations on the use of technology aim to provide opportunities for the development of local technology so that it can compete with imported technology by paying attention to and considering the urgency and national interests so that national independence in the context of sustainable development can be achieved.

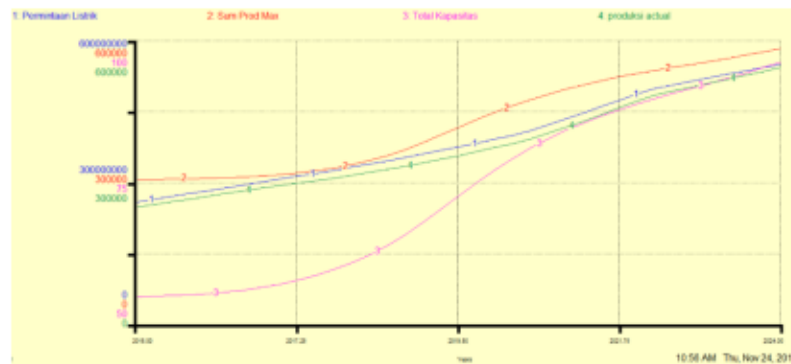
Incentive Policy.

Market Market intervention can be carried out by engaging incentives or disincentives so that market tendencies will automatically be encouraged to increase the use of renewable energy. Assuming that the reasonable cost of renewable energy depends on the price of fossil energy which is its competitor in the commercial energy market, incentives for investment in renewable energy can reduce the costs of exploiting renewable energy thereby increasing the variety and quantity of renewable energy reserves that are categorized as worthy of cultivation and can compete with fossil energy. In the current situation where non-renewable energy businesses are generally more established than non-renewable energy, setting higher energy prices can increase the competitiveness of renewable energy. Setting tariffs or prices for renewable energy can also affect the quantity produced.

Research and Capacity Development.

One of the important factors determining a country's competitiveness is mastery of technology. The number of imported components in renewable energy technology needs to be reduced immediately. For this reason, implementation activities for the use of renewable energy must provide opportunities for the development of local technology so that in time it can compete with imported technology. National research and capacity development should be prioritized on renewable energy technology, which has abundant energy sources but has not been widely utilized due to technological mastery constraints. Forcing the use of a type of renewable energy without developing the technology domestically will lead to dependency. Considering the important position of energy supply for sustainable development, research, and national capacity development are necessary to increase independence in energy supply.

Electricity demand (GWh – Giga Watt hour) must be able to be met by the capacity of existing generating capacity. The following are the results of dynamic system modeling for the national electricity system.



From the picture above, you can see a gradual upward trend in electricity demand followed by an increase in the ability of national generating capacity to produce electricity. In the period 2017 to 2021, there will be a greater increase in the number of national generating capacities compared to previous years. This shows that the plan to build power generation capacity is starting to show its impact in the future. If existing power plants are producing, there is still a gap in electricity demand. However, by using the maximum capacity factor of each generator, electricity demand can be met and even exceed existing demand, as shown by the Maximum Sum Production trend. From this simulation, the total national capacity in 2024 will reach 96.24 GW, almost twice that of 2015. Meanwhile, electricity demand will increase from 258.2 GWh to 550 GWh in 2015. The actual production that can be produced by generators is assumed to use The standard factor capacity in each generator increases from 247.6 GWh in 2015 to 543.4 GWh in 2024. Meanwhile, if the factor capacity of each generator is used to the maximum, then the total production that will be produced will reach 583.4 GWh in 2024. To optimize the role of RE, especially RE for generators in the national electricity system, this dynamic model can be used to determine trends in load demand patterns which are divided into base load, medium load (follower load), and peak load (peak load).

Indonesia's capital city, known as a political, economic, and cultural center, is facing increasing demands for environmentally friendly and sustainable energy. To achieve its vision of becoming a smart, green, beautiful, and sustainable city, the National Capital has ambitious plans to utilize renewable energy on a large scale. The following is a forecast scenario regarding how the supply and use of new renewable energy will support this transformation:

Evaluation of Renewable Energy Potential.

The National Capital Government carried out an in-depth assessment of the potential of renewable energy sources in its region, including sunlight, wind, water, and biomass. This analysis helps determine the type of renewable energy that best suits the geographic and climatic conditions of the city.

Investment in Renewable Energy Infrastructure.

The National Capital embarked on a massive project to develop renewable energy infrastructure, including:

- Construction of large-scale solar farms in open areas and on top of commercial and government buildings.
- Installation of wind turbines along the coast and in windy highlands.
- Development of hydroelectric power plants integrated with waste processing systems and ecotourism tourism.
- Implementation of a waste processing system into biomass and compost energy.
- Improved energy distribution network and advanced renewable energy storage.

Smart Grid Technology Innovation.

Cities are adopting advanced smart grid technology to integrate renewable energy production, monitor consumption, and optimize energy distribution. This system enables more efficient energy management and is responsive to changing energy demands.

Community Awareness and Education.

Governments and non-governmental organizations collaborate to increase public awareness about the importance of renewable energy and sustainable practices. This includes educational campaigns, seminars, and training for local communities and businesses.

Utilization of Renewable Energy in City Infrastructure.

- Solar street lighting: Installation of energy-efficient solar street lights throughout the city, including smart traffic lights that adapt to changing traffic.

- b. Sustainable transport: Replacement of the public transport fleet with electric vehicles and development of sustainable public transport systems.
- c. Green buildings: Encourage building owners to install solar panels and energy-saving systems and comply with green building standards.

Continuous Monitoring and Evaluation.

The government and related institutions continue to monitor the performance of renewable energy systems and their impact on the environment and economy. The evaluation results are used to continue to improve the efficiency and sustainability of renewable energy programs.

Expected results:

By renewable energy and transformation towards a smart, green, beautiful, and sustainable city, the National Capital hopes to achieve several achievements, including:

1. Reducing GHG Emissions: Significantly reduces greenhouse gas emissions and contributes to global climate change mitigation efforts.
2. Energy Efficiency: Increase the efficiency of energy use throughout the city, reduce operational costs, and improve the quality of life for city residents.
3. Environmental Conservation: Maintain and protect the city's natural environment, including the preservation of natural ecosystems and conservation of water resources.
4. Better Quality of Life: Creating a healthier and more comfortable environment for city residents and increasing its attractiveness as an investment and tourism destination.
5. Energy Independence: Reduce dependence on energy imports and increase energy independence.
6. Innovation and Jobs: Encourage innovation in renewable energy technology and create new jobs in the renewable energy and advanced technology industries.

This scenario reflects the efforts required to achieve urban transformation towards a smart, green, beautiful, and sustainable city model that can be adopted by national capitals and other cities around the world. It also shows a commitment to sustainability and a better environment for future generations.

On the other hand, the supply of new renewable energy is not yet optimal due to the still quite high economic prices, such as PLTS, PLTB, and biofuel, as well as constraints on the availability of land for PLTP development. Several new energy potentials, especially those obtained from coal processing, namely liquid coal, coal gasification, and Dimethyl Ether (DME), cannot yet be implemented on an industrial scale. Apart from that, the availability of energy infrastructure also greatly influences the level of national energy consumption. With limited existing energy infrastructure, this will limit people's access to energy. In anticipation of these conditions, the Government has committed to accelerating energy infrastructure development, including optimizing EBT development as reflected in the 2015-2019 RPJMN and APBN allocations. In connection with this, to get an overview of the conditions of energy supply and demand in the future, it is necessary to prepare energy forecast modeling with NRE optimization scenarios in the regions that are adjusted to the potential of each region so that policy recommendations are obtained that are needed to answer national energy challenges in the future.

The forms of renewable energy that can support the Smart, Green, Beautiful, and Sustainable Capital of Indonesia are:

Geothermal Energy.

As of the end of 2015, the installed capacity of geothermal power plants (PLTP) reached 1,438.5 MW (Energy Journal 2016). Indonesia has very abundant geothermal resources, spread along the volcanic belt starting from Sumatra, Java, Bali, Nusa Tenggara, North Sulawesi, and Maluku, and has the largest geothermal potential in the world. Referring to the results of geothermal investigations carried out by the Geological Agency, KESDM, up to 2013, 312 geothermal potential points have been identified spread throughout Indonesia with a total potential of 28,910 MW. However, the use of geothermal energy for generating electricity is currently still low compared to the potential of existing resources and reserves, where the development of geothermal energy has only reached 1,403.5 MW or 4.8% of the existing potential.

Bioenergy.

Indonesia, as an agricultural country located in the equatorial region, is a country rich in bioenergy potential which can be used as fuel in liquid form (biodiesel, bioethanol), gas (biogas), solid, or as fuel for power plants. Through the use of bioenergy technology, Indonesia can not only increase its energy security but also have a great opportunity to contribute to the provision of sustainable energy to the world community. As the largest palm oil producer in the world, Indonesia has the potential to become one of the largest biodiesel producers. Currently, the installed capacity of biodiesel derived from palm oil has reached 6.3 million kL/year. Apart from palm oil, waste from the palm oil

industry also has great potential to be processed into an energy source. Another industry that has the potential to develop bioenergy is the sugar industry for processes bioethanol and provides national electricity.

Water Energy.

The role of hydropower in the primary water energy mix for electricity generation in 2013 was around 7.7% where the total installed capacity reached 8,109 MW. Hydropower generation can be achieved by utilizing reservoirs or dams or simply by utilizing water flows and waterfalls without reservoirs. Utilization of existing reservoirs can be seen in the Saguling Reservoir (100 MW), Cirata Reservoir (1000 MW), and Jatiluhur Reservoir (150 MW). Generally, it has a large capacity (above 10 MW) and can utilize reservoirs that have been built. Generators that only utilize streams and waterfalls are generally small in size, namely up to 10 MW. Plants like this are known as Micro Hydro Power Plants (PLTMH). This kind of generating potential is available in remote areas and far from locations already served by PLN. The potential for PLTMH in Indonesia is estimated to be more than 500 MW.

Solar Energy.

Indonesia, which is a tropical country, has enormous solar energy potential because its territory stretches across the equator, with a radiation radiation of 4.80 kWh/m²/day. Solar energy is converted directly and the application form is divided into two types, namely solar thermal for heating applications and solar photovoltaic for electricity generation. Solar Power Plants (PLTS) is an electricity generation technology that can be applied in all regions. Installation, operation, and maintenance of PLTS are very easy so they are easily adopted by the public. The main obstacle to the PLTS market is that investment costs per watts of generated power are still relatively expensive and some raw materials for PLTS components, especially solar cells, still have to be imported. Therefore, the growth of the local solar cell industry is very strategic in the development of PLTS in the future.

Wind Energy.

Naturally, the potential for wind energy in Indonesia is relatively small because it is located in the equatorial region. However, some areas geographically are wind areas because they are nozzle effect areas or narrowing areas between two islands or mountain slope areas between two adjacent mountains. The source of wind energy comes from air movement due to changes in air temperature due to heating from solar radiation. Wind Power Plant (PLTB) is a renewable energy power plant that is growing rapidly in various developed countries. Meanwhile, in Indonesia modern wind turbine technology has not yet been fully mastered, so intensive research is still needed to develop wind turbines that are suitable for the conditions of wind energy potential in Indonesia. The government needs efforts to commercialize new PLTB technology, in addition to encouraging local manufacturers to develop their production capacity.

Ocean Energy.

Currently, the use of ocean currents to generate electricity has reached the implementation stage (pilot project) on a small scale by several institutions and universities. For oceans in Indonesian territory, with a thermal potential of 2.5 x 1,023 Joules and efficiency of A three percent conversion of ocean thermal energy can produce around 240,000 MW of power. Good marine thermal energy potential is located in the area between 6-9° South Latitude and 104-109° East Longitude. In this area, at a distance of less than 20 km from the coast, the average sea surface temperature is above 28°C and the difference between surface temperature and sea depth (1,000 m) is 22.8°C. Meanwhile, the difference in annual average surface temperature and ocean depth (650 m) is higher than 20°C. With this potential, marine thermal energy conversion can be used as an alternative to meet electrical energy needs in Indonesia.

4. Conclusion

The utilization of renewable energy in the transformation of cities into smart, green, beautiful, and sustainable cities (smart, green, beautiful, and endurable) is a key step to achieving sustainable development goals at the city and national levels. The NRE optimization scenario, especially RE (Renewable Energy) is running relatively well in the National electricity system, especially in the Sumatra System and South Sulawesi System. Opportunities for utilizing renewable energy in Indonesia are wide open. This must be utilized so that Indonesia can reduce CO₂ emissions by 29% in 2030 and increase the use of renewable energy sources to 23% of national energy consumption in 2025 as promised by President Jokowi at the COP 21 meeting in Paris in 2015. Several forms of renewable energy are available. that can be utilized in Indonesia includes energy sourced from (1) solar power, (2) hydropower, (3) geothermal (geothermal), (4) biomass and bioenergy, (5) wind energy, and (6) marine energy.

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