A Conceptual Model of Indonesia's Renewable Energy Development

Joko Sulistio[1*], *Budisantoso* Wirjodirdjo[2] , *Putu* Dana Karningsih[2]

[1] Universitas Islam Indonesia, Indonesia
[2] Institut Teknologi Sepuluh Nopember, Indonesia

Abstract. Electricity is a vital sector in global renewable energy, and countries have committed to continuously developing their policies and practices. Each country must proceed with the most effort according to its situation, economically, socially, and politically. Likewise, Indonesia is mandated by the constitution to manage its vital resources according to the five principles of economic democracy. It is a terminology that has been developing since the 20s. It outlines democratic governance within companies running in a market environment. Based on those principles, this article aims to investigate the factors that strongly influence renewable energy development in Indonesia's electricity sector. The complex systems approach is incorporated to satisfy the objective. A Systematic Literature Review was conducted to elicit perspectives on economic democracy. Lastly, a causal loop diagram was developed to describe the complex feedback loops of the different sectors in renewable energy policy and practice.

1 Introduction

In the year 2015, global leaders convened at the United Nations General Assembly and reached a consensus to formally adopt the Sustainable Development Goals (SDGs) as a comprehensive framework to guide international development efforts in the future. It is an action plan consisting of 17 goals and 169 targets to ensure it achieves the grand objective. As stated in the 7th goal, countries around the globe must provide affordable and sustainable energy in response to growing energy demands. One of the targets is to substantially increase the renewable energy share in the global energy mix [1]. The proportion of renewable energy in total final energy consumption has exhibited a consistent upward trend, rising from 16.4% in 2010 to 17.1% in 2018. However, it is worth noting that the proportion of renewable sources in the overall consumption of final energy has only seen a modest rise of 2.5 percentage points over the course of the previous decade. As a result, it has remained below the threshold of 11 percent in the year 2018. [2]. This reality is widely applicable globally, including in Indonesia.

Government Regulation, 79/2014 on National Energy Policy (NEP) regulates energy governance in Indonesia. The primary objective of this rule is to achieve Energy Independence and National Energy Security in order to facilitate the sustainable progress of the nation. NEP contains policy targets as indicators of success, one of which is achieving an optimal energy mix with the utilization of New and Renewable Energy (NRE) of at least 23% by 2025 [3]. The renewable energy mix is the percentage between total renewable and total energy consumption. The renewable energy mix is an indicator to determine how much renewable energy is used in total energy. The renewable energy target will be achieved if growth reaches an average of 2% from 2019 onwards. However, energy procurement from renewable sources only increases at an average rate of 1% per year. With this rate of procurement of renewable energy sources, the renewable energy mix target is in danger of not being achieved under the Business as Usual (BAU) scenario [4]–[9].

Of all the final energies, electricity plays a crucial role in greenhouse global emission reduction efforts for the following reasons. The electricity mix in the global energy system 2017 had a significant mix in all seven measures. Total electricity demand ranks second to oil products, growing faster than two-thirds of total final energy consumption. In addition, consumers pay for electricity at 39% of their total energy consumption. It has intensified investment in the sector to $750 billion, more than investments in oil and natural gas combined. However, electricity also has a downside, as 42% of CO2 and 48% of Sulfur Dioxide (SO2) emissions are generated from this energy sector. As such, electricity is a crucial energy sector in mitigating global climate change [10].

Electricity impacts sustainable development and growth in every region [11]. Electrical energy is one of the most critical and influential commodities in the lives of Indonesian people. According to Article 33 of the 45th Constitution, it is explicitly stated that the state shall exercise control over all sectors of production that hold significant importance in the societal functioning within the territorial boundaries of the Republic of Indonesia. This power is intended to be utilized for the

* Corresponding author: jokosulistio@uii.ac.id

betterment and welfare of the Indonesian populace.. Branches of production that are important to the state are defined as the production or provision of goods and services that are strategic, namely (1) branches of production processing strategic raw materials; (2) directly have an interest in national defense and national security; (3) branches of production related to the manufacture of goods or services to maintain the stability of the monetary and financial sectors; and (4) used for the benefit of society in general [12].

Article 33 of the Constitution mandates that the governance of electrical energy should follow the principles of economic democracy. There is no standardized definition of economic democracy. This term originated in the business world. Worker participation in company decision-making is required to improve their welfare. It is only possible when workers own the company and are entitled to a share of the profits. At a macro level, economic democracy is a socioeconomic order in which local economic institutions are democratically controlled. Economic democracy does not reject the role of the market but slightly reduces the profit maximization motive among economic decision-makers [13]. The reduction of capitalism and class inequality is a condition for economic democracy. Thus, all parties have an equal opportunity to play an economic role. With the broad scope and number of actors in the implementation of economic democracy, the role of an accountable government is a critical factor in this success [14].

One of the changes in the Fourth Amendment of the 1945 Constitution was the addition of two paragraphs to Article 33. The additional fourth paragraph contains five principles of economic democracy that must be met in implementing strategic branches of production. These principles are togetherness, equitable efficiency, Sustainability, environmental soundness, and independence. However, there is no explanation of the meaning and intent of these principles. The fifth paragraph only states that the implementation of Article 33 will be regulated by law [15].

Electricity involves the involvement of many actors, objects, and the environment. Electricity consumers, investors, generating, transmission, selling, and distribution companies are direct actors in electricity. At the same time, the government plays a vital role as a policymaker. Electricity requires appropriate technology under the selected location and available infrastructure. In addition, policymaking always involves political, economic, social, and even cultural processes. These things show that electricity is a complex system [16]. Numerous studies have also observed that energy systems exhibit the characteristics commonly associated with complex systems. The conversion of energy sources into usable energy in different situations is primarily influenced by the interplay of a wide range of players [17]. The energy system has been empirically demonstrated to possess attributes commonly observed in complex systems, including (1) the presence of uncertainties within the system, (2) non-linear associations between variables within the system, (3) the existence of feedback mechanisms, and (4) the presence of causal links. The user has provided a numerical reference [18], [19].

The modeling of electrical systems is a significant challenge owing to the intricate nature of feedback loops within the modules. The system further establishes connections with both the economy and the environment [20]. A multitude of modeling methodologies and models have been employed to tackle diverse energy policy-related concerns [19]. Energy scholars have indicated that system dynamics is an appropriate methodology for representing the dynamic nature and feedback mechanisms inherent in energy policy systems [21]. System dynamics (SD) is highly appropriate for addressing intricate and evolving issues [22].

The first objective of this study is to outline the meaning and intent of the principles of economic democracy in the context of the governance of electrical energy as a strategic production branch in Indonesia. The elaboration also includes how these principles are applied at the Strategic level. In addition, the study aims to establish a conceptual framework to provide a holistic perspective on electricity policy in achieving NEP objectives.

2 Literature Review

2.1 Economic Democracy

Democracy is composed of the words demos and cratos, which means of, for, and by the people. Thus, in simple terms, economic democracy is the organization of the economy from, by, and for the people. The founding fathers saw that after many practices from the Political State or Legal State that had existed before, few brought misery to the people, especially from the weak economic class. Thus, the concept of the Welfare State aspired to be associated with the country's economic system. This system is known as a hybrid economic system or economic democracy. The state's role in the welfare state is to modify various market forces to control and limit these forces. Economic democracy includes three aspects, namely, (1) access to economic resources, (2) the level of people's income related to purchasing power, and (3) the participation of workers in economic activities. The 1945 Constitution lists five principles of economic democracy.

The first is the principle of togetherness. This principle shows the alignment of efforts toward Social Welfare that applies collectively to all Indonesian people and is not just the welfare of individuals or groups. The principle of togetherness is fundamental because it is a normative foundation. After all, the essence of social and economic life is collective life [23], [24].

The second premise pertains to the concept of equitable efficiency. The implementation of economic democracy is guided by the notion of emphasizing equitable efficiency in order to provide a fair and friendly business climate that fosters healthy competition. This principle aims to create an atmosphere of fair, reasonable, and equitable competition. Thus, economic activities do not lead to the concentration of

economic power in certain business actors. Furthermore, it can open opportunities for medium and small businesses and even micro businesses to advance and develop their business activities. The concept of "equitable efficiency" can be interpreted as an effort to increase economic growth and expand the equitable distribution of income. Both must be implemented sustainably, so it is not permissible to prioritize one in any form [25].

The third principle is Sustainability. This principle is an adaptation of the concept of sustainable development in the 1992 Rio Declaration and the 2002 Johannesburg Declaration. Sustainability is a planned principle that pursues the development process through economic activities. The goal is to ensure the welfare of the Indonesian people in all aspects of life. Every person bears obligations and responsibilities towards his or her generation and future generations by trying to preserve the ecosystem's carrying capacity and improve the environment's quality. This notion can alternatively be understood as sustainable development, which refers to a form of development that is designed to fulfill the requirements of the current generation while simultaneously safeguarding the capacity to fulfill the requirements of future generations [26].

The fourth principle pertains to the aspect of environmental sustainability. It is imperative for all facets of national development to conform to the evolving strategic landscape, encompassing both domestic and global contexts. The primary obstacles encountered are to the impact of globalization, which fosters the promotion of democratization, regional autonomy, human rights, environmental concerns, technology advancements, information advances, intellectual property rights, and necessitates an augmented involvement of the private sector and society. The principle of environmentally sound is the principle of economic democracy development carried out while paying attention to and prioritizing protecting and maintaining the environment [27].

The fifth principle is independence. The principle of independence is an activity carried out without much dependence on other parties regarding human resources and capital. This principle is carried out by continuing to prioritize the potential of the nation and state by not closing itself to foreign parties to realize economic growth. These activities must be carried out while maintaining and prioritizing the potential, capabilities, by efficiently maximizing the potential of national resources to face global competition. The principle of independence is developed by fostering the ability to stand alone with its strength without depending on other parties [28]

2.2 Policy on renewable energy

A policy refers to a conceptual or technological tool used to address certain issues that have a direct or indirect impact on society within various temporal and spatial contexts [29]. Policies are closely related to organizational goals, and effective policies can lead the organization to the goals it wants to achieve. The definition of policy is used to influence the behavior of a manager or managed object derived from management objectives. Furthermore, the policy defines the desired behavior of the organization and the system that works [30]. Implementing policies in that country greatly influences the success of a country's EBT development. Long-term government support in the form of policy formulation, implementation, and supervision is a determining factor in the success of EBT development.

Many researchers in several countries have studied the effectiveness of policy instruments on renewable energy development. Dong investigated the effectiveness of implementing the Renewable Portfolio Standard (RPS) in China with a mathematical model [31]. RPS is a renewable energy development policy through the implementation of regulations that bind power generation companies with targets and consequences. Doris examined the correlation between several policy instruments and the development of the energy market mix [32]. Doris set up two sets of statistical tests. The first set is testing policy instruments individually. At the same time, the second set tests a combination of policy instruments categorized using market transformation theory. The study found that several policies significantly affect the renewable energy market mix development. RPS and production incentives are the policy instruments that have the most significant influence. Collectively, policies that reduce barriers to entry into the market (barrier reduction) have a significant influence on the development of the EBT market mix.

In contrast, Carley's study concluded that despite increasing the amount of renewable energy generated, the RPS does not statistically impact the market mix of renewable energy [33]. Carley also found that states with open energy markets still have a lower percentage of renewable energy mix. However, these states have better renewable energy deployment. The RPS policy shows different responses between publicly owned companies and companies with limited ownership in America. Limited companies respond more positively to RPS implementation than publicly owned companies [34]. In addition to RPS, other studies have also not shown consensus regarding policy instruments that effectively increase the market mix of renewable energy. Selecting the right policy instrument will determine the government's success in developing EBT.

Energy issues must be studied comprehensively due to their characteristics involving many sectors and parties. The renewable energy mix is a percentage of the total energy available in the market. Supply, demand, and market are factors that have a direct impact on the renewable energy mix. This approach is known as energy economics. In its early development in the 1970s, energy economics tried to understand the industrial aspects of conventional energy and the possibility of substituting renewable sources. In the 1980s, environmental issues colored the analysis in this study area. Then, in the 1990s, liberalization and restructuring of energy markets began to develop globally. It added to the complexity of policy discussions in energy economics [35]. This approach has a broad enough perspective to address the growing

phenomenon in Indonesia's renewable energy management.

According to the IEA database, there are 79 types of renewable energy policies, with 69 policies still in force and 16 no longer in force. However, these policies can be categorized into three due to their similarities. The first is regulatory instruments. Regulatory instruments are coercive policy instruments to encourage the acceleration of renewable energy development [36]. The second is an instrument related to payments, finance, and taxation. This instrument aims to provide economic or monetary incentives to reduce costs in renewable energy production [37]. Several studies have shown positive results regarding the effectiveness of subsidies and the positive relationship between tax incentives and desired behavior [38]. The last one is voluntary approaches. These instruments come from the industry to promote sustainable development voluntarily. Voluntary approaches include negotiated agreements and voluntary public schemes. This policy introduces several new approaches to sustainable energy supply systems, including renewable energy policy and planning [37].

3 Methods

The conceptual framework is achieved by developing a cause-and-effect diagram (CLD) through a literature review of journal articles, proceedings, reports, legislation, and other relevant sources. The causal loop diagram (CLD) illustrates the interconnections between system parts through the use of arrows, denoting causal relationships. The presence of a positive sign at the beginning of the connecting arrow signifies that the interaction between the two parts is unidirectional. In contrast, a negative sign indicates that the two elements are reversed, which means the elements change in opposite directions. A decrease in the prior causes an increase in effect and vice versa.

Critical feedback loops are also identified in the CLD. The loops in question are denoted by a loop symbol, which serves to identify whether the loop represents positive (reinforcing) or negative (balanced) feedback. Positive feedback means that a change in the causal element will strengthen itself. In contrast, Negative feedback will balance the element.

4 Results

4.1 Supply-demand sector

The sector started with economic growth, leading to increased electricity demand. The government wants to meet part of this demand from renewable energy sources by setting electricity generation targets through RUPTL[41]. Investment opportunities arise from the difference between REE demand and actual REE generation. After a feasibility analysis, the plant realizes its investment if it is feasible. The process takes some time until it becomes operational and generates the required electricity [39]

The figure shows that the sector has two feedback loops. First, REE supply-demand gap - REE investments opportunity - installed capacity - REE generation. This loop shows that REE generation will try to balance REE demand and REE generation. The second loop is REE supply-demand gap - REE investments opportunity - REE installed capacity - REE generation - GDP - Electricity - Demand - REE demand. This loop shows that REE generation will positively impact economic growth, which will cause electricity demand to continue to increase.

4.2 Investment sector

The increasing demand for REEs opens investment opportunities to build REE generation facilities. However, a feasibility analysis is still required to determine whether the investment will provide the expected return [20]. Return on investment (ROI) is a standard instrument for assessing investment feasibility [40]. ROI measures the profit earned on an investment relative to the amount invested. It is expressed as a percentage and is calculated by taking the profit from REE generation and dividing it by the cost of REE generation [41].

This sector has three feedback loops: positive and negative feedback loops. From the three feedback loops, investors will engage in REE investments if the rate of return is equal to or exceeds their expectations. The ROI will be high when the revenue from generation exceeds the costs. In addition, REE price tends to follow the changes in REE installed capacity, REE generation, and REE generation cost. Meanwhile, the amount of REE generation cost will accompany the electricity generated.

4.3 Price sector

This sector shows the classic relationship between price and demand. Through a long path, it is seen that a price change will result in a change in REE demand in the opposite direction. This relationship shows a dynamic and non-linear interaction between the two elements. Nonetheless, the government issued a policy to provide subsidies to lower REE prices. Thus, public access to REE is increasingly open.

4.4 Subsidized sector

The Indonesian government provides direct and indirect subsidies and is designed to encourage the development of renewable energy sources in Indonesia. Direct subsidies are given to producers to reduce the cost of producing renewable energy, making renewable energy more affordable. At the same time, indirect subsidies are provided to consumers, but through price subsidies, the government pays a certain percentage of the electricity bill for households, businesses, and public facilities [42].

4.5 Environmental sector

The main objective of converting conventional energy sources to renewable energy is the reduction of carbon emissions. The emission reduction element represents the average weight of CO2 released into the air from electricity generation of 1 kW h (kgCO2/kW h). According to PT PLN, in 2022, with 1 kWh of electricity in the electricity system in Indonesia, which PLTU still supports, emissions will be around 0.85 kg CO2e [43].

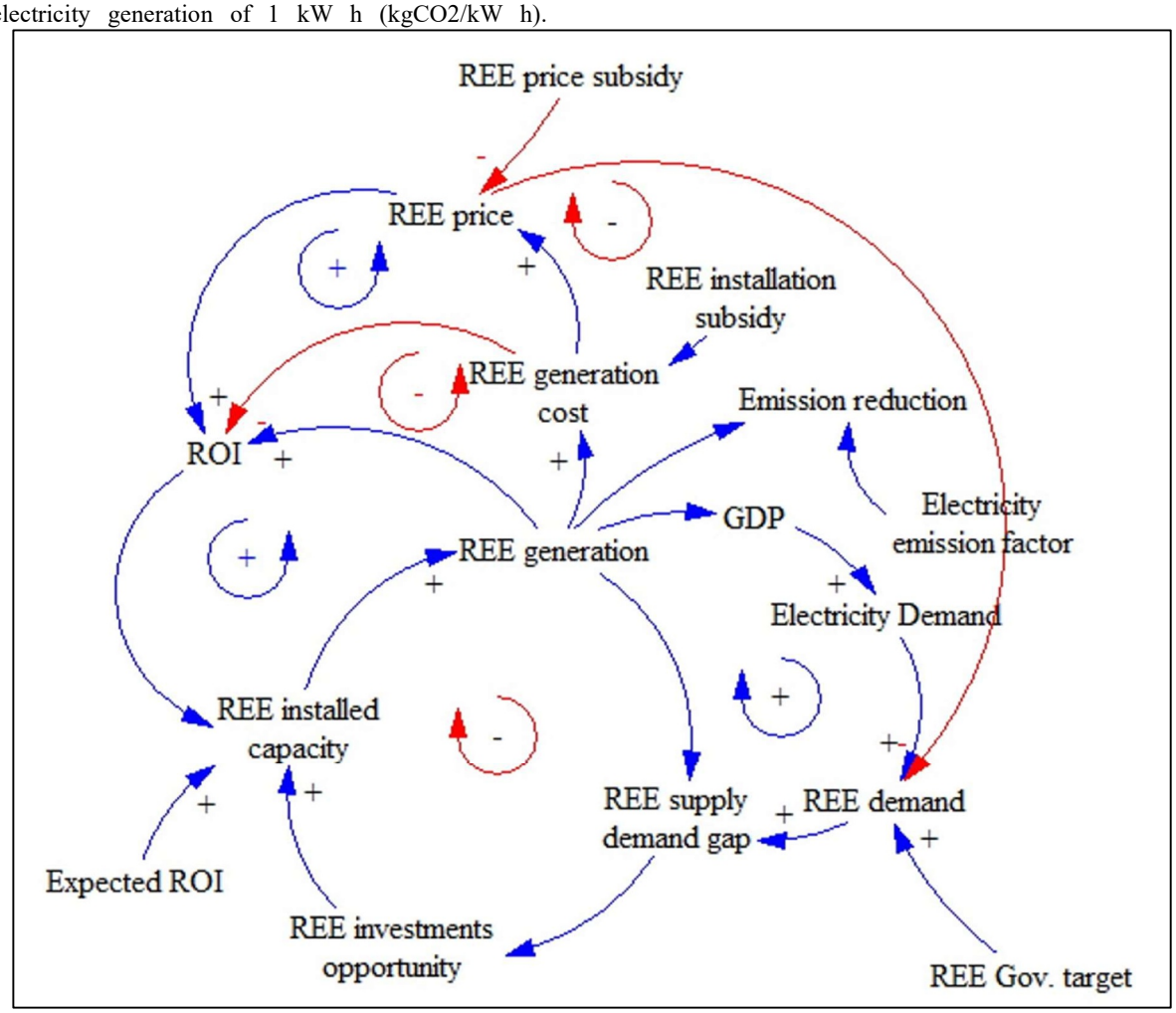

Fig. 1. Causal Loop Diagram of Renewable Energy Electricity

5 Discussion

As shown in Fig. 1, the gap between REE demand and supply creates investment opportunities for existing and new players entering the industry. According to the 2019-2028 Electricity System General Plan (RUPTL), Indonesia aims to build 35 GW of renewable power generation capacity by 2028. With this target, the private sector and PLN require an investment injection of 128.7 trillion annually [43]. However, investment realization in this sector has not yet reached its target. Until October 2021, investment realization reached only 58 percent of the set target [44]. Investment in this sector is not very attractive, partly due to high investment costs. The investment cost of renewable power projects in Indonesia varies depending on the type of project and location. However, the investment cost of renewable power projects in Indonesia is generally higher than that of power projects using conventional energy sources. For example, a solar power project in Indonesia requires an investment cost of approximately USD 1 million - USD 2 million per megawatt (MW). On the other hand, wind power projects in Indonesia require an investment cost of around USD 1.5 million to USD 2 million per MW [45].

ROI is essential in investment decisions with renewable energy sources in the power generation industry. The generating company will evaluate the project by calculating the investment cost ratio to the project's expected profit. The company will proceed with the project if this ratio is sufficiently favorable. However, if this ratio is unfavorable, the company will discourage investment in the project. A high ROI will increase the possibility of investment realization [41].

To increase ROI, the government has provided several fiscal policies for renewable power plant projects in Indonesia in the form of income tax exemptions, import duty exemptions, land and building tax exemptions, and financing and guarantees through state-owned enterprises assigned by the government. Presidential Regulation No. 112 of 2022 on the Acceleration of Renewable Energy Development for Electricity Supply states that the fiscal policy will follow

the laws and regulations in taxation and customs [46]. Thus, with a series of policies, REE generation costs will decrease and ultimately increase the ROI in this industry.

Subsidies are also popular policy instruments to support EBT. Tariff subsidies are one of them. This subsidy is not given directly to consumers but through REE price adjustments [47]. Tariff setting is also applied on the producer side. The government regulates the purchase price of renewable energy-based power plants through the Feed in Tariff (FiT) mechanism. This mechanism aims to increase investment in the EBT sector by offering long-term contracts to EBT producers. FiT has effectively increased investor preferences to invest in the EBT generation sector in many countries. In the end, it will increase the EBT mix [48]. However, the implementation of FiT in Indonesia does not show the same success.

The determination of the FiT aims to provide long-term certainty for investors. FiTs are supposed to ensure that renewable energy producers receive a fixed price or a price set by the government for each unit of energy produced and delivered to the grid [49]. However, since the implementation of the FiT, the amount of tariff determined by the government has often changed. For example, in 2013, the purchase price of electricity from Photovoltaic sources was as high as 30 cents/kWh [50]. The government revoked the regulation three years later and replaced it with Regulation of the Minister of Energy and Mineral Resources No. 19/2016. In this regulation, the purchase price of electricity from Photovoltaic sources in the territory of Indonesia varies between 14.5 cents / kWh on the island of Java to 25 cents / kWh in Papua and West Papua [51]. Subsequently, this regulation was revoked through Regulation of the Minister of Energy and Mineral Resources No. 9/2018 [55]. Those revokes signaled the uncertainty of government regulation in terms of tariff setting.

Uncertainty is also evident in regulatory changes related to energy purchases from independent power plants. In 2017, the government issued a regulation stipulating that PT PLN must purchase all energy from independent power plants [52]. The regulation underwent its first amendment in the same year through Regulation of the Minister of Energy and Mineral Resources No. 49/2017 [57]. Furthermore 2018, the regulation underwent a second amendment through Regulation of the Minister of Energy and Mineral Resources No. 10/2018 [53]. The uncertainty of this frequently changing and unstable regulation will make it difficult for companies to plan and invest in renewable energy projects in Indonesia.

6 Conclusion

The flow of investment funds determines the development of electricity from renewable sources into the industry. The investment will be attractive with ROI parameters when REE generation costs can be reduced. It can be achieved by exempting import duties on capital goods for REE generation projects. The price as an interface between producers and consumers is sought to be set at a level where the public can afford REE while providing a profit that is attractive enough for companies. Instruments used for this purpose are FiT on the producer side and price subsidies on the consumer side. In addition to these instruments, the government must provide certainty for investors by providing consistent regulations.

Much of this research explores the supply side of REEs and very little on the demand side. Demand is only seen as an exogenous element using an economic approach. REE demand can be approached with other consumer behavior theories as an alternative and future research opportunity. An ongoing study applied the theory of planned behavior to further investigate the REE demand side. In addition, future research can also develop this conceptual model into a stockto-flow diagram to analyze it more deeply and sharply. Thus, the research will be able to produce more measurable recommendations.

The author wishes to express gratitude for the assistance provided by the following institutions in facilitating the execution and delivery of this study and presentation: The LPDP, also known as the Indonesia Endowment Fund for Education, is a program that provides financial support for education in Indonesia. Institut Teknologi Sepuluh Nopember as a renowned academic institution in Indonesia. Universitas Islam Indonesia (UII) as an academic institution that is dedicated to providing higher education within the context of Islamic principles and values.

References

1. "THE 17 GOALS | Sustainable Development." https://sdgs.un.org/goals (accessed Apr. 05, 2022).
2. "Renewable energy consumption (% of total final energy consumption) | Data." https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS (accessed Apr. 05, 2022).
3. Government of the Republic of Indonesia, *Government Regulation No. 79/2014 on National Energy Policy (NEP)*. 2014.
4. National Energi Council, "Indonesia Energy Outlook 2014," 2014.
5. National Energi Council, "Indonesia Energy Outlook 2015," 2015.
6. National Energi Council, "Indonesia Energy Outlook 2016," 2016.
7. National Energi Council, "Indonesia Energy Outlook 2017," 2017.
8. National Energi Council, "Indonesia Energy Outlook 2018," 2018.
9. National Energi Council, "Indonesia Energy Outlook 2019," 2019.
10. International Energy Agency, "World Energy Outlook 2018," 2018.
11. H. Qudrat-ullah, "Green power in Ontario : A dynamic model-based analysis," *Energy*, vol. 77, pp. 859–870, 2014, doi:10.1016/j.energy.2014.09.072.

12. A. M. Anggraini, “Aspek Monopoli Atas Cabang Produksi yang Menguasai Hajat Hidup Orang Banyak Berdasarkan Hukum Persaingan Usaha,” *J. Huk. Prioris*, pp. 196–219, 2010.
13. L. Iuviene, Nicholas; Stitely, Amy; Hoyt, "Sustainable economic democracy: worker cooperatives for the 21st Century," *Building*, no. October, p. 30, 2010.
14. C. Panayotakis, "Capitalism, socialism, and economic democracy: Reflections on today's crisis and tomorrow's possibilities," *Capital. Nature, Social.*, vol. 21, no. 4, pp. 7–33, 2010, doi:10.1080/10455752.2010.523533.
15. R. Winarno, “Penerapan prinsip demokrasi ekonomi, keadilan dan kepastian hukum dalam hukum penanaman modal,” vol. X, no. 4, pp. 385–398, 2007.
16. C. S. E. Bale, L. Varga, and T. J. Foxon, "Energy and complexity : New ways forward," *Appl. Energy*, vol. 138, pp. 150–159, 2015, doi:10.1016/j.apenergy.2014.10.057.
17. S. Basu, C. S. E. Bale, T. Wehnert, and K. Topp, "A complexity approach to defining urban energy systems," *Cities*, vol. 95, no. March, p. 102358, 2019, doi: 10.1016/j.cities.2019.05.027.
18. M. Mutingi, C. Mbohwa, and V. P. Kommula, "System dynamics approaches to energy policy modelling and simulation," *Energy Procedia*, vol. 141, pp. 532–539, 2017, doi:10.1016/j.egypro.2017.11.071.
19. H. Qudrat-Ullah, "Modelling and Simulation in Service of Energy Policy," *Energy Procedia*, vol. 75, pp. 2819–2825, 2015, doi:10.1016/j.egypro.2015.07.558.
20. H. Qudrat-Ullah, "Understanding the dynamics of electricity generation capacity inCanada: A system dynamics approach," *Energy*, vol. 59, pp. 285–294, 2013, doi: 10.1016/j.energy.2013.07.029.
21. N. Ansari and A. Seifi, "A system dynamics model for analyzing energy consumption and CO2 emission in Iranian cement industry under various production and export scenarios," *Energy Policy*, vol. 58, pp. 75–89, 2013, doi: 10.1016/j.enpol.2013.02.042.
22. J. D. Sterman, *Business dynamics: systems thinking and modeling for a complex world*, no. HD30. 2 S7835 2000. 2000.
23. *Capital Investment Law No. 25*. 2007.
24. *Microfinance Institutions Law No. 1*. 2013.
25. B. Nongtji, “Konsep Efisiensi-Berkeadilan Dalam Demokrasi Ekonomi Menurut Pasal 33 Ayat (4) UUD NRI 1945 Dalam Perspektif Perlindungan Bagi Usaha Kecil,” *Masal. Huk.*, vol. 42, no. 2, pp. 251–260, 2013.
26. *Environmental Protection and Management Law No. 32*. 2009.
27. *Micro, Small and Medium Enterprises Law No. 20*. 2008.
28. M. Mukeri, “Kemandirian Ekonomi Solusi untuk Kemajuan Bangsa,” *Maj. Ilm. Univ. Pandanaran*, vol. 10, no. 24, 2012.
29. M. A. Ruiz Estrada, "Policy modeling: Definition, classification and evaluation," *J. Policy Model.*, vol. 33, no. 4, pp. 523–536, 2011, doi:10.1016/j.jpolmod.2011.02.003.
30. R. Wies, "Policy Definition and Classification: Aspects, Criteria and Examples," *Proc. IFIP/IEEE Int. Work. Distrib. Syst. Oper. Manag.*, no. October, pp. 1–12, 1994.
31. F. Dong, L. Shi, X. Ding, Y. Li, and Y. Shi, "Study on China's renewable energy policy reform and improved design of renewable portfolio standard," *Energies*, vol. 12, no. 11, 2019, doi:10.3390/en12112147.
32. E. B. Doris, S. Busche, S. Hockett, and J. M. Loring, "The role of state policy in renewable energy development," in *Proceedings of the ASME 3rd International Conference on Energy Sustainability 2009, ES2009*, 2009, vol. 1, pp. 21–31, doi: 10.1115/ES2009-90089.
33. S. Carley, "State renewable energy electricity policies: An empirical evaluation of effectiveness," *Energy Policy*, vol. 37, no. 8, pp. 3071– 3081, 2009, doi: 10.1016/j.enpol.2009.03.062.
34. M. A. Delmas and M. J. Montes-Sancho, "US state policies for renewable energy: Context and effectiveness," *Energy Policy*, vol. 39, no. 5, pp. 2273–2288, 2011, doi: 10.1016/j.enpol.2011.01.034.
35. S. C. Bhattacharyya, *Energy Economics: Concepts, Issues, Markets and Governance*. Springer London, 2011.
36. Z. Abdmouleh, R. A. M. Alammari, and A. Gastli, "Review of policies encouraging renewable energy integration & best practices," *Renew. Sustain. Energy Rev.*, vol. 45, pp. 249–262, 2015, doi:10.1016/j.rser.2015.01.035.
37. G. Muhammed and N. Tekbiyik-Ersoy, "Development of Renewable Energy in China, USA, and Brazil: A Comparative Study on Renewable Energy Policies," *Sustainability*, vol. 12, no. 21, 2020, doi: 10.3390/su12219136.
38. M. Kant, "The effectiveness of renewable energy policies in the American and German wind turbine industry : a mixed methods approach." Nov. 2019, [Online]. Available:http://essay.utwente.nl/80010/.
39. S. Ahmad, R. Mat Tahar, F. Muhammad-Sukki, A. B. Munir, and R. Abdul Rahim, "Application of system dynamics approach in electricity sector modelling: A review," *Renew. Sustain. Energy Rev.*, vol. 56, pp. 29–37, 2016, doi: 10.1016/j.rser.2015.11.034.
40. A. Atieh and S. Al Shariff, "Case study on the return on investment (ROI) for using renewable energy to power-up typical house in Saudi Arabia," *Sustain. Cities Soc.*, vol. 17, pp. 56–60, 2015, doi:10.1016/j.scs.2015.03.008.

41. C. W. Hsu and S. P. Ho, "Assessing feed-in tariffs on wind power installation and industry development in Taiwan," *Renew. Sustain. Energy Rev.*, vol. 58, pp. 548–557, 2016, doi:10.1016/j.rser.2015.12.255.
42. Ministry of Energy and Mineral Resources, *Regulation of Minister of Energy and Mineral Resources No 32*. Indonesia, 2018.
43. Ministry of Energy and Mineral Resources, *PT PLN Electricity System General Plan 2021 - 2030*. 2021.
44. Ministry of Energy and Mineral Resources, "Kementerian ESDM Raih Anugerah Layanan Investasi Terbaik Tahun 2021," 2021.
45. Ministry of Energy and Mineral Resources, "Pedoman Investasi Pembangkit Listrik Tenaga Bioenergi," 2021.
46. J. Widodo, *Presidential Regulation No 112*. 2022.
47. Ministry of Energy and Mineral Resources, *Regulation of the Minister of Energy and Mineral Resources Number 32 of 2018 concerning Amendment to the Regulation of the Minister of Energy and Mineral Resources Number 29 of 2016 on the Mechanism of Providing Electricity Tariff Subsidies for Households*. 2018.
48. M. J. Bürer and R. Wüstenhagen, "Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international cleantech investors," *Energy Policy*, vol. 37, no. 12, pp. 4997–5006, 2009, doi: 10.1016/j.enpol.2009.06.071.
49. H. Dehghan, M. R. Amin-Naseri, and N. Nahavandi, "A system dynamics model to analyze future electricity supply and demand in Iran under alternative pricing policies," *Util. Policy*, vol. 69, no. December 2020, p. 101165, 2021, doi: 10.1016/j.jup.2020.101165.
50. Ministry of Energy and Mineral Resources, *Regulation of The Minister of Energy and Mineral Resources of The Republic of Indonesia Number: 17/2013 about Purchase of Electricity by PT Perusahaan Listrik Negara (Persero) from Solar Photovoltaic Power Plants*. 2013.
51. Ministry of Energy and Mineral Resources, *Regulation of the Minister of Energy and Mineral Resources No. 19/2016 on the Purchase of Electricity from Solar Photovoltaic Power Plants by PT Perusahaan Listrik Negara (Persero)*. 2016.
52. Ministry of Energy and Mineral Resources, *Regulation of the Minister of Energy and Mineral Resources No. 10 of 2017 concerning Principles in the Electricity Sales and Purchase Agreement*. 2017.
53. Ministry of Energy and Mineral Resources, *Minister of Energy and Mineral Resources Regulation Number 10 of 2018 concerning Second Amendment to the Regulation of the Minister of Energy and Mineral Resources Number 10 Year 2017 on the Principles of Electricity Sales and Purchase Agreement*. 2018