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Research Article

CLEAN AND RESILIENT LONG-TERM RENEWABLE ENERGY STRATEGIES TO POWER INDONESIA'S NEW CAPITAL CITY:

Capacity Expansion Modeling of Kalimantan Island

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Abstract

In response to solve the crucial urban problems and severe environmental threats, the government of Indonesia announced plans to relocate the country's government capital city from Jakarta (Java Island) to the Penajam Paser, East Kalimantan (Borneo island) starting from 2024. Moreover, decision-makers are exploring long-term pathways to power the new Capital City (Nusantara) and broader Kalimantan Island to support clean energy transition commitment objectives. This study will analyze the potential energy transition pathways with a planning horizon to 2040 for expanding power generation capacity across Kalimantan and Nusantara to support this relocation. It aims to investigate the achievable renewable energy penetration levels in the generation mix and pathways to reach zero emissions for the capital city energy system. This study utilizes data-driven decision-making by computationally modeling the existing Kalimantan power system using the Engage™ open-access energy system planning tool. It explores future capacity expansion options by optimizing generation capacity, transmission investments, and integrating energy storage systems. The results are presented by discussing implications for energy sector planning and long-term energy scenarios for Nusantara and the island of Borneo. The results indicate that achieving a 100% renewable energy share in Borneo's energy mix is possible by 2040, with 94.2% of electricity supplied from large hydro reservoirs. However, the lowest Levelized Cost of Electricity (LCOE) is not achieved under the 100% renewable energy scenario but rather under the 75% renewable energy share scenario, as the cost of some renewable options may exceed the cost of the cheapest fossil fuel power generation. The 100% renewable energy scenario in 2040 could increase the LCOE by 41% compared to the Business-as-Usual (BAU) scenario and it would require the highest investment costs. Moreover, the heavy reliance on large hydro reservoirs in the future energy systems of Nusantara and Borneo Island could lead to challenges related to land acquisition, *social conflicts, and environmental degradation. This study also explores opportunities for clean energy development and investment in the new capital city plan, including potential infrastructure to support the energy transition, such as renewable energy sources, smart grids, and large-scale energy storage systems.*

Keywords:
Renewable energy, new capital, Nusantara, energy transition, financing

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INTRODUCTION

Indonesia, as the world's largest archipelagic country, is home to approximately 17,504 islands with a total area of 1.9 million square kilometers. It is the fourth most populous country globally and has developed into the 16th largest economy by Gross Domestic Product (GDP). The archipelago's strategic geographical position, coupled with its vast natural resources and growing economy, has made it a significant player in the Southeast Asian region. Historically, Jakarta has served as the capital city since Indonesia's independence in 1945, functioning as the center of government administration and economic activities. Jakarta was appointed as an Indonesian capital city during the age of Dutch colonialism in the 1600s. This city, known as Batavia, became the center of economic activity and administration at that time (Syaban & Appiah-Opoku, 2023). However, the development of Batavia is speeding up, and the area is 3 times increasing to support the trade between locals and Dutch traders. This is the reason why the development of Batavia or Jakarta is increasing significantly these days. Jakarta also entitled as the most populated city in the country, with 8-10 million of people commuting daily around the city. However, as Jakarta evolved into a metropolitan hub with a population of over 10.6 million people and a density of about 15,726 people per square kilometer, the city has faced numerous urban challenges, including severe traffic congestion, air pollution, inadequate public transportation, frequent flooding, and the depletion of groundwater levels due to excessive consumption (Rachim et al., 2022). These issues have raised concerns about the sustainability of Jakarta as Indonesia's capital, prompting the government to explore alternative solutions.

According to the Jakarta Statistics Bureau, the Jakarta population reached 10,6 million in 2022, and more than 30 million more people live in this city (Rachim et al., 2022). This city is overcrowded, with a density of about 15.726 people/km2 which lead to many problems. Indonesian government realizes that Jakarta's situation is insufficient to support its capital city burden. The idea of moving the capital city to a less vulnerable place would bring more safety and stability for government administration as well as create equitable economic development in the country. Creating a green concept of the new capital city with a smart and sustainable vision is a challenge for the government.

The Indonesian government's decision to relocate the capital city from Jakarta to Nusantara in East Kalimantan is driven by the need to alleviate the urban burden on Jakarta while promoting more equitable economic development across the archipelago. The relocation is legally mandated by Law No. 3 of 2022 on the Capital City, reflecting Indonesia's strategic vision to become one of the world's most advanced economies by 2045 (Octaleny, 2022). The new capital city is envisioned to embody the principles of a smart, green, and sustainable urban environment, powered entirely by renewable energy sources. Positioned in Penajam Paser Utara, strategically located between Balikpapan and Samarinda, Nusantara spans 256,000 hectares and is designed as a forest city with at least 50% of its area preserved as green space (Susmiyati et al., 2023). This area will be divided into three parts: the capital city area, which consists of 51 villages; the surrounding capital city area, with an area of 56,000 hectares; and the core government center area, with an area of 6,000 hectares. Moreover, the geographical advantages of Kalimantan, such as its central location within Indonesia, abundant land availability, addequate supporting infrastructure, the presence of developed supproting cities, and low seismic risk, further support the feasibility of the new capital city. The relocation will bring benefits in the provision of more equitable access to development throughout Indonesia, promotion of more development in the underdeveloped eastern part of Indonesia, shifting of the Java-centric development concept to more Indonesia-centric and reducing the burden on crowded Java Island and the Jakarta metropolitan area.

Nusantara is expected to be built as a smart, green and sustainable city. It aims to serve as a blueprint for future sustainable urban developments, leveraging advanced digital infrastructure, smart city technologies, and clean energy solutions. The city is projected to rely on renewable energy sources such as solar, hydropower, and bioenergy, thereby promoting energy security, reducing carbon emissions, and enhancing resilience against climate change impacts. The ambitious vision of creating a zero-carbon, fully sustainable capital city underscores Indonesia's commitment to environmental stewardship and sustainable development. The target is that the installed capacity of renewable energy will meet 100% of the energy needs in the capital city, there will be a 50% energy saving in the form of energy conservation in buildings, and a commitment to net zero emissions in the capital city by 2045(Rino, 2023). This urban model aligns with Indonesia's commitment to reducing carbon emissions under the Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC). Kalimantan Islands has two large grids, which are the Khatulistiwa System and Kalseltengtimra (Widodo & Putri, 2020).

Nusantara will be connected to the Kalseltengtimra System. Despite its promising potential, the implementation of renewable energy in Nusantara poses significant challenges, particularly given the current energy landscape in Kalimantan, which remains heavily dependent on fossil fuels. The data in 2021 shows that the power installed capacity is about 1.695 MW, peak load 1.221 MW, and the power reserve is almost 51% with 574 MW. Especially for East Kalimantan, there are several electricity infrastructure development plans through 462 MW powerplant development, 4.081 kmc transmission development, and 2.280 MVA substation development, and almost 10 kmc and 500 MVA of distribution development. Nusantara will be supported by four existing substations, Petung, Karangjoang, Manggarsari, and Senipah, and two new substation plans in Samboja and Sepaku, as shown in Figure 1.

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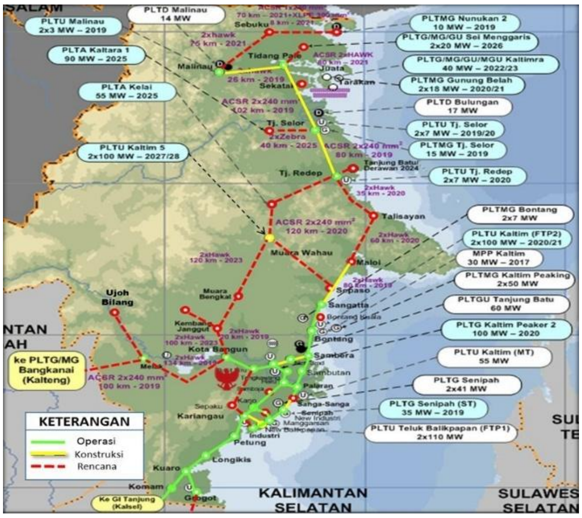
Figure 1.

East Kalimantan Power System and New Capital City (Red Garuda Symbol)

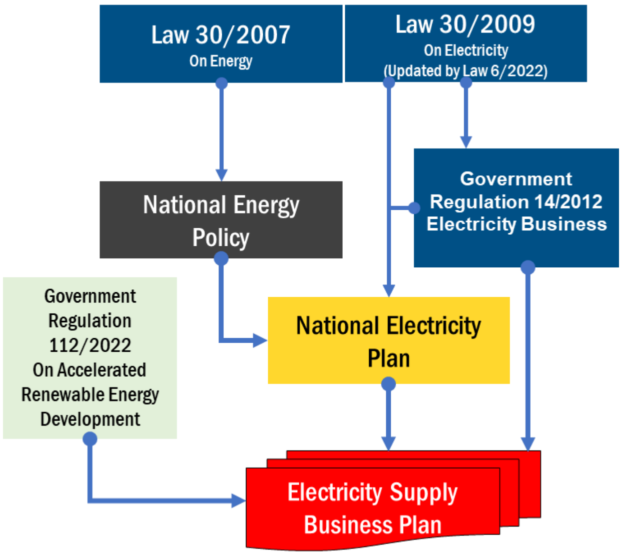


Indonesia also plans to develop a 500 kV HVAC Plan with a looping route through the northern and southern sides of Kalimantan to increase reliability and bring more renewable energy to the grid. This grid will be operated as the backbone of the system. The energy mix in 2021 shows that Kalimantan has been dominated by coal (76%), followed by Natural Gas (16%), Hydro (10%), Biodiesel (8%), VRE (1,3%), and Oil (0,7%) (Kementerian ESDM, 2022). This energy mix indicates that fossil fuels account for almost 93% of the energy mix in Kalimantan. As for Indonesia's point of view, currently, the energy system in Indonesia is dominated by the utilization of coal, oil, and natural gas, with about 90% of the total energy mix (Winarno et al., 2016). The renewable energy mix is targeted to reach 31% in 2050, with the abundant potential of renewable energy not being fully tapped.

This reliance on fossil fuels underscores the need for substantial infrastructure investments, policy reforms, and technological advancements to facilitate the energy transition towards renewable sources. Furthermore, the integration of renewable energy into the existing grid system requires strategic planning to enhance grid reliability, efficiency, and capacity. Indonesia renewable energy policy rooted in the issuance of Energy Law Number 30 Year 2007 regarding energy which provide the basis of the Indonesia energy policies including the national energy management and the achievement of sustainable energy security and development. Besides that, Indonesia also abide to the electricity law Number 30 Year 2009 regarding electricity (Resosudarmo et al., 2012).

Figure 2.

Indonesia Renewable Energy Policies and Regulations



Both regulations are the basis for the National Energy Policy and National Energy Plan, which evolve the paradigm on the high dependence on fossil fuels into the introduction of clean and renewable energy. The number of renewable energy shares shall be increased to 23% in 2025 and 31% in 2050. Indonesia also issued the Nationally Determined Contribution (NDC) as part of its commitment to decrease the GHG emission and bring more clean energy sources to the system. The target is to reduce the number of GHG emissions by 29 percent in 2030 (Hastuti, 2024).

However, the existing share could only reach 13.3% in 2024 (Putra, 2022). Despite the abundance of renewable energy potentials in geothermal, solar, and wind energy, the implementation of renewable energy projects was hindered due to the difficulties of policy inconsistency, unattractive electricity prices, and complicated license procedures (Maulidia et al., 2019).

Currently, the Indonesian government has introduced new regulations to increase the attractiveness of renewable energy projects by addressing the ceiling price of renewable energy projects and bringing more simple procurement mechanisms in the issuance of Presidential Regulation Number 112/2022 (Kesumadiksa, 2023). It opens the possibility of a direct appointment and direct selection mechanism for RE projects without any bidding process for a competition with another RE developer. Furthermore, it is also set a new policy of early retirement for the existing coal power plant, which has been the main actor of the GHG emitter in the energy sector. The objective is to give room for more renewable energy projects in replacing coal domination in the energy mix.

As a derivative policy from the National Energy Policy, the national electricity plan has been prepared to address the increasing electricity demands and the way to achieve sufficient and sustainable electricity. It echoes a comprehensive way to optimize the supply based on the available technology, fuel prices, techno-economic aspects, and the emission factor with a least-cost approach. It aims to meet the Net Zero emissions target in 2060 with measures for decarbonization stages and the achievement of a 100% electrification ratio (Kartika & Muhyidin, 2024). This document encourages the shifting of coal domination to more diverse renewable energy sources such as hydro. Geothermal, bioenergy, solar, wind, and green hydrogen.

Ambitious commitment to renewable energy transition is also reflected in the issuance of the electricity supply business plan (RUPTL) of the national utility company (PLN) for 2021-2030, with 52% of new additional powerplant will be based on renewable energy, including the deletion of 8.7 GW of coal powerplant projects from the previous document. There will be no new additional coal power plant development unless the one that is already in the construction stage.

Especially for Nusantara, the government has issued Law Number 3 Year 2022, where the New Capital City is planning to be developed as a green, sustainable, and zero-carbon emission in the future. The city shall be supplied with 100% electricity from renewable energy sources (de Vries & Schrey, 2022).

The relocation of the capital city to Nusantara in Kalimantan not only offers a strategic solution to Jakarta's environmental challenges but also presents an opportunity to redefine Indonesia's urban and energy landscape. Kalimantan islands is one of the biggest islands in the world with massive potential for renewable energy resources. It is blessed by enormous amounts of hydro, solar, wind, and bioenergy potentials. Around 21.5 GW hydro potentials mostly located in the northern side of the island, followed by almost 20 GW in the southern and western side of the island (Putra, 2022). This potential is attributed to the island’s geographical condition characterized by hilly terrain with rapid river flows. However, unfortunately, no significant hydroelectric power plant (HEPP) development has been undertaken by Indonesia within this island. The project delays caused by permit and regulatory issues and the social impacts are the main reasons for the low success ratio of hydro project implementation.

Wind power is another available option that can accelerate renewable energy development in Kalimantan. The estimated price is projected to decrease significantly in the next ten years and might reach 5.8 cents USD/kWh with a potential of about 408 TWh/year (Langer et al., 2021). Several factors need to be considered for the wind development, including minimum wind speed, land use restriction, and the proximity distance to the existing infrastructure. The wind energy potential in Kalimantan Island is located around the southern coast of Kalimantan, particularly in the Tanah Laut region.

Kalimantan possesses substantial bioenergy potential, with the Indonesian government estimating a theoretical biomass capacity of 32.7 GWe, of which approximately 16% is in Kalimantan. The biomass power generation potential varies across provinces, with Central Kalimantan leading at 1,499 MW, followed by West Kalimantan at 1,308 MW and South Kalimantan at 1,290 MW (Putra, 2022). Biomass resources in Kalimantan include residues from oil palm, rubber wood, logging, sawn timber, plywood production, sugarcane, and rice. A study conducted in the tropical swamp-peat forest of Kutai Kertanegara could produce 2.96 MWh per ton of dry biomass (Amirta et al., 2019). Despite the significant solid biomass potential in Central, West, and South Kalimantan, concerns arise regarding the sustainability of increased biomass use for electricity generation, as it may contribute to deforestation and hinder environmental goals. Furthermore, the availability of biomass during normal years is dependent on the continuation of waste from the oil palm and wood industries.

For the solar power potentials, Kalimantan is accounted to have approximately 25% of Indonesia's photovoltaic (PV) power capabilities. East, West, and Central Kalimantan are the biggest provinces with over 1,000 GW of solar potential. Typically, Solar PV systems could foster high irradiance and generate electricity for approximately

12 hours daily, peaking between 11 a.m. and 1 p.m. However, several constraints need to be addressed in the implementation of Solar PV in Kalimantan including the land acquisition and restriction issues, and the environmental and social impacts from the deforestation that are essential for sustainable development.

Kalimantan islands are also considered to be one of the appropriate places to develop a nuclear power plant. The island acknowledges as less earthquake risk due to its geological conditions compared to the other islands in Indonesia. A study recommends Small Modular Reactors (SMRs) for nuclear power plant development in West Kalimantan, especially at the Pantai Gosong site (Alimah et al., 2024). It suggests the SMR could be developed with a capacity of 50-300 MW with the support of a cooling system coming from the surrounding river and sea. Most of the local people also agreed to the development of the plant based on the survey result in 2019 (Putra, 2022).

However, those opportunities of RE usage in Indonesia may also bring a more complicated approach to the existing system where the combination of intermittent renewable energy sources and existing thermal power has shown conflict in the demand for system flexibility (Brouwer et al., 2014). To bring more integration of intermittent renewable energy sources, the combination of flexible power generation, robust transmission, and energy storage is crucial (Ueckerdt et al., 2015). The fluctuation of the energy supply shall be compensated with sufficient flexible power generation and capacity. The supply from flexible power generation will be dispatched immediately during low generation from the Solar PV or Windpower. Robust transmission will help improve demand and supply balance, while energy storage could be utilized to store the possible curtailed energy from the VRE and release it during nighttime (Cebulla et al., 2017).

Several studies have been conducted to investigate the optimization of renewable energy penetration, especially in the way of analysing the impact of a higher share of variable renewable energy in the system. Simaremare et al., (2018) have investigated the impact of renewable energy penetration in Tomia Island, where the optimization using multi-energy scenarios has significantly reduced the utilization of fossil fuel consumption and strengthened the reliability of the system. The increasing renewable energy penetration also improves the cost efficiencies of the system and its environmental performance (Jin, 2023).

However, limited studies have comprehensively analyzed the implications of the new capital city's development on Indonesia's energy transition, sustainable urbanization, and regional economic integration. This research aims to bridge this gap by examining the most possible renewable energy sources that are suitable for Kalimantan Islands conditions. Least-cost potentials, including supporting technologies, will be prioritized over the expensive RE sources. Furthermore, the introduction of nuclear power development is not analyzed due to no existing regulatory frameworks that could enable its implementation in Indonesia.

The objective of this study is to create a long-term renewable energy strategy for the Kalimantan System with a new capital city. This study will also generate a broad range of scenarios for the renewable energy penetration in the energy mix. The result of each scenario will be analysed and supported with a policy implication. The research question in this study is how to develop long-term energy strategies for the Kalimantan system using Engage as an optimization tool and how a broad range of renewable energy scenarios could influence the electricity policy in the Kalimantan system. Engage software developed by the National Renewable Energy Laboratory (NREL) and the US Department of Energy (DOE) (Gadzanku, 2022). The study process will start with the initiation of research questions and the collection of required data and information related to the new capital city energy development and the Kalimantan system in general. The study will continue with the setting up of a time frame, model objectives, and necessary constraints. The time frame will be in the range of 2018-2040. Then, it will be followed by the development of a renewable energy scenario.

RESEARCH METHODS

The optimization model will be conducted through a linear programming method using Calliope. If the model satisfies the required objective and constraints, then it will produce the result with a certain energy mix, levelized cost of electricity (LCOE), additional capacity expansion, and the total investment planning requirement. If the result has not satisfied the objective and constraints, then it will reiterate back through a linear programming process until it gets some results.

Modeling Equations and Softwares

The objective function is to minimize the total cost for capacity expansion with the following equation:

$$min, v_{obj} = \sum_{c,r,a,g,t} (C_{a,g,t}^{carrier} + C_{a,g,t}^{yearlyO\&M} + C_{a,r,g,t}^{cap} \quad (1)$$

$C_{a,g,t}^{carrier}$: carrier production costs for generation technology (g) in area (a) at time (t)

$C_{a,g,t}^{yearlyO\&M}$: yearly O&M cost for generation technology (g) in area (a) at time (t)

$C_{a,r,g,t}^{cap}$: cost of energy capacity in the new generation technology (g) in area (a) at time (t)

The constraint will be determined through several equations below:

1. Supply and Demand Balance

   Electricity production (P_t^f) = Demand (D_t^f):

$$\sum_r P_t^f = \sum D_t^f \quad (2)$$

2. Technology Constraint

   Electricity production ($P_{g,t}^f$) ≤ Electricity production from existing, committed, and additional expansion:

$$\sum_g P_t^f \leq \sum_{existing} P_t^f + \sum_{committed} P_t^f + \sum_{additional} P_t^f \quad (3)$$

3. Potential Constraint

   Electricity production ($P_{g,t}^f$) ≤ Availability of energy potential:

$$\sum g{\sim}f,t\, P_{g,t}^f \leq A_f \quad (4)$$

4. Renewable Energy Share shall meet the target share

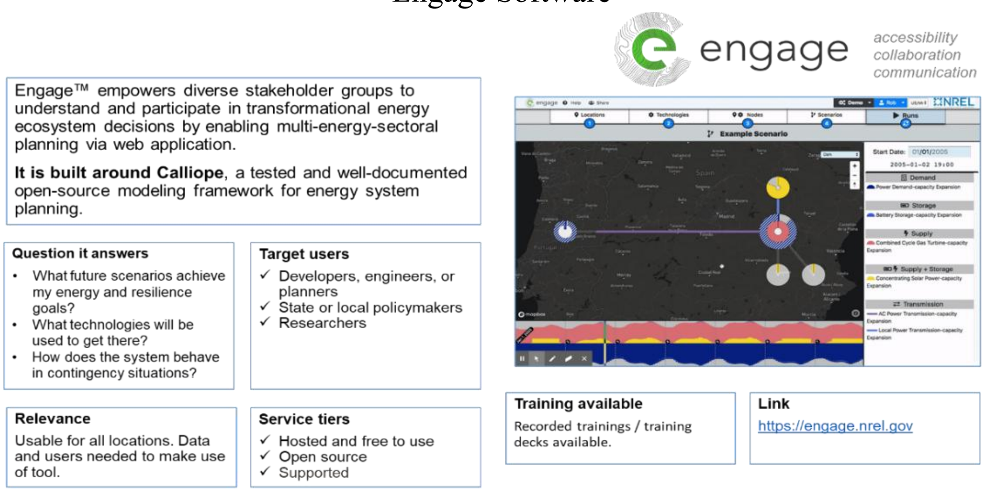
$$S^{RE} + S^{Coal} + S^{Gas} + S^{Diesel} = 1$$
$$S^{RE} = S^{Hy} + S^{Ge} + S^{Bio} + S^{Wind} + S^{Solar} \geq sRE\ Target \quad (5)$$

The model simulation will use Engage™ software developed by the National Renewable Energy Laboratory (NREL) and the US Department of Energy (DOE). Engage™ software will support diverse stakeholder groups to understand and participate in transformational energy ecosystem decisions by enabling multi-energy-sectoral planning. It is built around Calliope, a tested and well-documented open-source modeling framework for energy system planning. It has a feature that determines future scenarios of energy planning and goals, the selection of available technologies, and how to solve the reliability issue at the planning stage. There are two models in Engage that can be utilized: in a capacity expansion model and an economic dispatch model or production cost model.

The simulation will optimize the generation and transmission capacity cost within the given assumption of demand, fuel prices, technology cost, and efficiency and support policy and regulation. The model will try to optimize the development of power generation and transmission at the lowest possible LCOE with maintained reliability factors in several situation and a lot of technical, commercial or environmental constraints. Engage will develop the energy supply, storage, and conversion as a model of supply and demand through the transmission with a certain efficiency or losses. The model will be illustrated in the composition of several energy carriers, demand, and conversion technology.

Figure 3

Engage Software

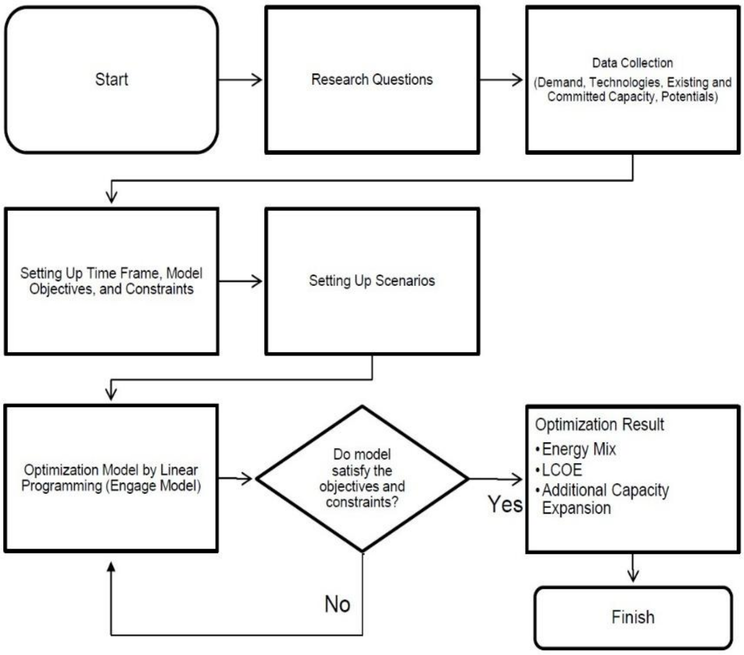


Source; (https://engage.nrel.gov)

The optimization with linear programming is built around Calliope with a ground-up multi-scale energy system modelling framework designed to answer the transition from fossil fuel to renewable energy (Pfenninger & Pickering, 2018The model is easy to use with the support of building blocks and interactive visualization, and it is also equipped with free and open-source software. Calliope creates a model framework of energy systems to analyse the transition from fossil-based energy to renewable energy. It was widely used in several published integrated energy studies ranging from the small isolated system to the continental-size system (Del Pero et al., 2019; Laha & Chakraborty, 2021; Lombardi et al., 2020)

Figure 4

Logical Framework of the Study

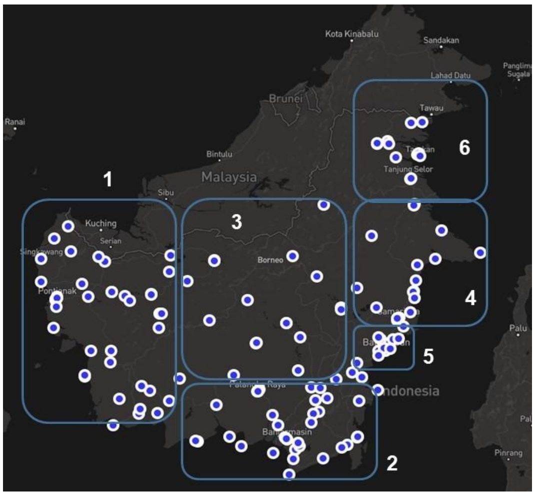


Data Settings and Scenario

The modeling process started with the setting up the location of demand and supply on Kalimantan Island. This study has developed 270 nodes as the base of the models. It will be categorized through its location and local government authority. There are six areas including West Kalimantan, Central Kalimantan, South Kalimantan, North Kalimantan, and Nusantara. The demand will be based on Kalimantan Island's existing demand, consisting of 196 Substation locations. The daily demand profile and the renewable energy potential will be determined at each substation location.

Figure 5.

Setting up 270 demand or supply nodes in Kalimantan Island



The process continues with the setting up of the available supporting energy technologies, including the existing and future additions. The technologies will include the development of primary fuel supply through coal, diesel, natural gas, biogas, and biomass supply. Then, the determination of existing technologies will be classified into several groups, which are IPP Coal Powerplant, PLN Coal powerplant, Excess Coal Powerplant, PLN/IPP Gas Turbine Powerplant, Combined Cycle Powerplant, Diesel Powerplant, Mini hydro Powerplant, and Import of existing hydro plant from Sarawak Malaysia by 100 MW. The model will also be supported by energy storage technologies to optimize the penetration of VRE through a hydropower reservoir (pump storage), battery, and hydrogen if possible.

The additional expansion of powerplants in the future energy mix will be selected from several technologies that will be dominated by renewable energy technologies with biogas powerplants, biomass powerplants, IPP coal powerplant, Gas Turbine, Combined Cycle powerplant, Solar powerplant, Mini hydro powerplant, Wind Onshore and Offshore, Geothermal powerplant and Reservoir Hydro powerplant with storage.

All data Input, including efficiency, installed capacity, lifetime, carrier production cost, yearly O&M cost, and ramping rate, will be determined through each technology option, including constraints in resource, technology, and monetary aspects. This study also gathered data from the relevant sources with the details as follows:

Table 1.

Data Collection

Data	Sources
Existing Powerplant Capacity	RUPTL PLN 2019-2028(PT PLN, 2019)
Electricity Demand	RUPTL PLN 2019-2028(PT PLN, 2019)
Fuel Price (Carrier Production Cost)	Statistik PLN 2020 (PLN, 2020)
Technical and Cost of Powerplant	Indonesia Technology Data for Indonesia Power Sector 2021 by ESDM and Denmark Energy Agency

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Energy Potential	RUPTL PLN 2019-2028(PT PLN, 2019), RUEN, RUKN, Indonesia Wind ESP3 Danida-ESDM, Solar (NREL), Local Government

This study also considers the future utilization of hydropower potential that will dominate the renewable energy portion. Kalimantan has almost 19,8 GW of hydropower potential, especially in the East and North Kalimantan. However, due to the low growth of the demand, this potential has not been fully optimized. The potential of hydropower in Kalimantan Island is described as follows:

Table 2

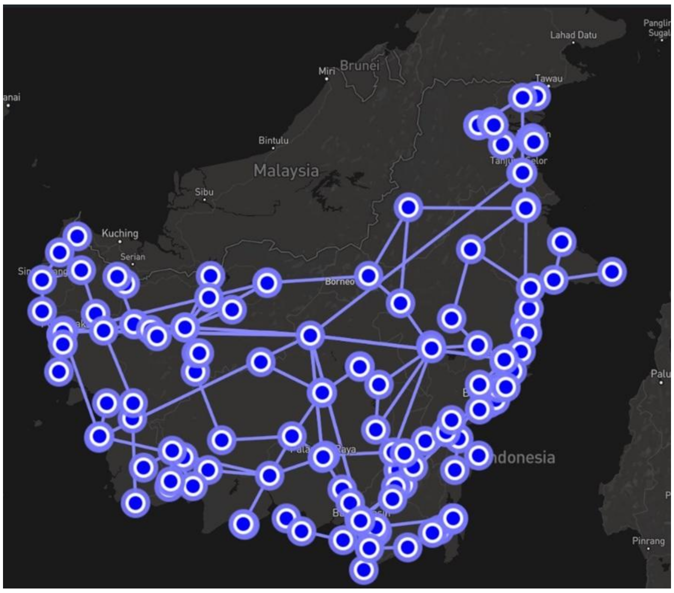
Kalimantan Hydropower Potentials

No	Provinces	MW	Location Name
1	South Kalimantan	65	Kusan
2	Central Kalimantan	72	Riam Jerawi
3	Central Kalimantan	284	Muara Juloi
4	East Kalimantan	270	Boh
5	East Kalimantan	20	Long Bangun
6	East Kalimantan	300	Mentarang 1
7	East Kalimantan	240	Tabang
8	North Kalimantan	660	Kayan 1
9	North Kalimantan	500	Kayan 2
10	North Kalimantan	1500	Kayan 3
1	North Kalimantan	240	Mentarang 2
12	North Kalimantan	200	Sei Tubu
13	North Kalimantan	250	Sembakung
14	North Kalimantan	7900	Mentarang
15	North Kalimantan	1000	Malinau
16	North Kalimantan	1124	Bahau
17	North Kalimantan	1800	Kayan 4
18	North Kalimantan	3300	Kayan 5
19	East Kalimantan	55	Kelai
	Total	**19,780**	

At the beginning, the model will connect all the supply, demand, and energy potential nodes from the Khatulistiwa System and Kalseltengtimra System. However, after 2025, these systems are interconnected as one Kalimantan system. All the nodes will be connected through 500 kV and 150 kV HVAC transmission lines. All the expected growth of the demand will be determined as stated in PLN RUPTL and distributed in all the connected nodes. The interconnection of the Kalimantan System in 2025 is shown as follows:

Figure 6

Interconnected Kalimantan System Simulation in 2025-2040



The scenario analysis will be determined during 2018-2040 based on relevant parameters, including generation optimization, renewable energy targets, storage options, and the usage of coal power plants in the future. The result will include the LCOE, investment cost, installed capacity and share by technology type, and production amount of electricity.

There are five scenarios in this study. The first is the BAU Scenario, where all the assumptions are developed without any policy intervention; the second is the BAU Scenario with production constraints, where the energy mix will be kept at a fixed percentage until 2040. In these two scenarios, PLN and IPP Coal Power Plant have a capacity factor constraint for existing and committed additions of 65% and 80%, respectively.

The other three scenarios are the least-cost optimization with additional storage to increase renewable energy penetration. Scenario 1 will increase the renewable energy shares to 31% in 2040, as stated in the National Energy Plan. For Scenario 2, the renewable energy share will increase to 75% in 2040, and Scenario 3 will achieve 100% of the RE share in 2040. All three scenarios will remove PLN and IPP capacity factor constraints to allow 100% of RE share.

Table 3

Scenarios Planning

Parameter	BAU Scenario	BAU w/ Production Constraints	Scenario I	Scenario II	Scenario III
Generation-optimization	• Committed generation 10 years then optimizati	• Committed generation 10 years • Optimized with	Least cost optimization with storage	Least cost optimization with storage	Least cost optimization with hydrogen and storage

	on • Annual average growth	constraints that assume 2020 production shares continue to 2040: • Coal – 60% • Gas – 14% • Biodiesel (biomass + biogas) – 2% • Diesel – 8 % • Wind+Solar – 1% • Hydro – 13% • Geothermal – 0%			
Renewable energy target	No target (committed power plant for 10 years continue with average yearly growth)		23% by 2025 26% by 2030 28% by 2035 **31% by 2040**	23% by 2025 40% by 2030 58% by 2035 **75% by 2040**	23% by 2025 49% by 2030 74% by 2035 **100% by 2040**
Storage	No storage		Battery storage	Battery storage	Battery storage
Coal	IPP and PLN coal CF constraints for existing and committed additions, not for cap exp.		Remove PLN capacity factor constraints starting 2030 and IPP CF constraints starting 2040 (to allow for 100% RE scenarios)		
Result	(1) LCOE, (2) Investment Cost, (3) Installed capacity and share by technology type, (4) production amount and share by technology type				

RESULTS AND DISCUSSION

Simulation Results

The scenarios in 2018 show the dominance of fossil energy with coal at 78% and natural gas at 15%. The share of renewable energy is only about 5% with the dominance of hydroelectric reservoir from imported electricity. This is the base year analysis and the LCOE shows only about 4.06 cents USD/kWh.

The result in 2025 has shown that the BAU scenario still has 68% of coal but the share of renewables has increased to 31%. The LCOE shows that the figure drops to 3.17 cents USD/kWh. However, the BAU scenario with production constraint shows a higher LCOE of 4.22 cents USD/kWh. It shows that if there is no improvement in the energy mix, it will lead to higher LCOE. For scenario 1, 2 and 3, the result is identical because there is no different target in 2025. The LCOE also shows a lower value compared to the BAU with production constraint by getting 3.18 cents USD/kWh.

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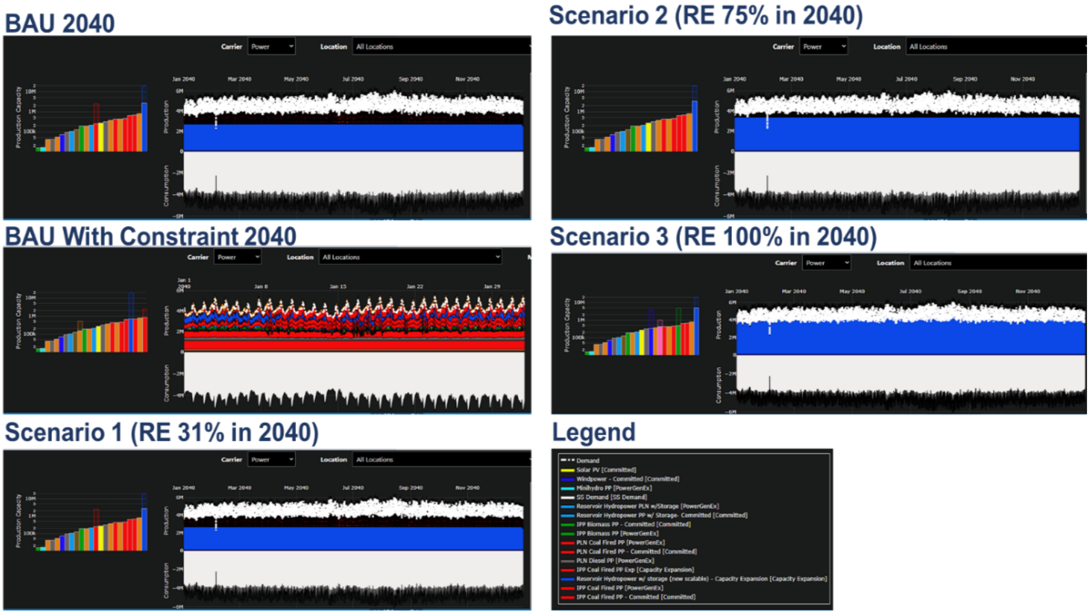
Figure 7

Results Summary in 2040



The result in 2040 has shown that the BAU scenario has changed its dominance of RE with a 60% share, while coal is around 40%. The RE shares are in the range of 31.07%-59.09% in 2025-2040. The LCOE shows a decrease of 3.10 cents USD/kWh. The BAU scenario with production constraint shows a similar situation in 2025, with a higher LCOE of 5.01 cents USD/kWh. For Scenario 1 with 31% RES as a constraint, the simulation shows that the RES is increased to 60% and the LCOE is 3.10 USD/kWh. Scenario 2 shows 75% RES and a lower LCOE of 2.98 USD/kWh. The other results are in Scenario 3, where the RE share is 100%; the study found that the LCOE increases again, reaching 4.44 cents USD/kWh. The policy of 100% renewable energy will not always result in the lower LCOE.

The BAU scenario with energy mix constraint showed the highest LCOE between 0.042-0.050 USD/kWh due to the fixed energy mix target with the assumption that 2020 will continue until 2040 and the lowest RE share will be only 17.99% in 2040. The current energy mix in Indonesia is projected to lead to higher electricity supply costs. Without improvements to the existing energy mix policy, the rising LCOE is likely to be passed on to ordinary people through higher electricity tariffs.

On the other hand, the lowest LCOE in 2040 is found in the 75% renewables by 2040 scenario. This indicates that the optimal LCOE for the system will be reached at a point where all the renewable energy potential that is more cost-effective than fossil fuels has been fully exploited. This point is highly dependent on the reduction in the capital cost of renewable energy technologies and the prevailing price of fossil fuels. At this point, the capital cost of renewables will have fallen below the combined capital and fuel cost of fossil fuels. Consequently, the pursuit of a 100% RE share becomes less critical as it would lead to an increase in the LCOE of the system.

The model result shows that the target of 100% RES in 2040 can be achieved by Scenario 3. However, this decision may increase the LCOE by USD 0.013/kWh or 41% compared to the BAU scenario in 2040.

Table 4
LCOE and RE Share Comparison on each Scenarios

Year	LCOE Scenarios (USD/kWh)				
	BAU	**BAU with Constraint**	**Sc. 1 31% RE by 2040**	**Sc. 2 75% RE by 2040**	**Sc. 3 100% RE by 2040**
2025	0.032	0.042	0.032	0.032	0.032
2030	0.031	0.047	0.031	0.031	0.031
2035	0.031	0.042	0.031	0.031	0.031
2040	0.031	0.050	0.031	0.030	0.044

Year	RE Share (%)				
	BAU	**BAU with Constraint**	**Sc. 1 31% RE by 2040**	**Sc. 2 75% RE by 2040**	**Sc. 3 100% RE by 2040**
2025	31.07	17.99	32.50	32.50	32.50
2030	43.76	17.99	44.70	44.70	48.90
2035	52.83	17.99	53.40	57.90	73.97
2040	59.09	17.99	60.20	75.00	100.00

The RE composition also shows that the highest share of renewable energy comes from hydro reservoir, due to the massive hydro potential and lower LCOE among other RE sources. The target of 100% renewable energy by 2040 will increase the share of reservoir hydropower to 94.24%. This shows that hydropower will be an important source to be preserved in the future. Furthermore, high capital cost, long lead time and approval process, and environmental impact concerns should be well addressed in Kalimantan's energy development perspectives. Other RE sources will also contribute to the system through wind power with a share of around 1.35% - 4.12%, followed by solar PV in the range of 0.82% - 1.49%.

Although Kalimantan has a significant amount of biomass potential, the uncertainty of feedstock continuity is the issue that needs to be resolved to increase its utilisation. Biomass only reached the share between 0.01% - 2.07%. The existence of Run off River (RoR) hydropower has different result with low share of 0.31% - 0.54% due to the potential of hydropower tend to be developed in massive dam rather than small ROR hydropower sites.

Table 5
RE Share Composition on each Scenarios

Year	Type of RE	RE Share Scenario (%)				
		BAU	**BAU with Constraint**	**Sc. 1 31% RE by 2040**	**Sc. 2 75% RE by 2040**	**Sc. 3 100% RE by 2040**
2025	Biogass	-	-	-	-	-
	Biomass	0.3	2.0	0.2	0.2	0.2
	Geothermal	-	-	-	-	-
	Res_Hydro	28.3	13.1	27.9	27.9	27.9
	RoR_Hydro	0.3	0.3	0.5	0.5	0.5

Year	Type of RE	RE Share Scenario (%)				
		BAU	BAU with Constraint	Sc. 1 31% RE by 2040	Sc. 2 75% RE by 2040	Sc. 3 100% RE by 2040
	Solar PV	0.8	1.0	1.5	1.5	1.5
	Wind	1.4	1.6	2.4	2.4	2.4
2030	Biogass	-	-	-	-	-
	Biomass	0.4	2.0	0.3	0.3	1.3
	Geothermal	-	-	-	-	-
	Res_Hydro	39.8	12.5	40.7	40.7	40.7
	RoR_Hydro	0.4	0.5	0.4	0.4	0.4
	Solar PV	1.2	1.0	1.2	1.2	1.2
	Wind	2.0	2.0	2.0	2.0	2.0
2035	Biogass	-	-	-	-	-
	Biomass	0.4	2.0	0.4	2.0	0.0
	Geothermal	-	-	-	-	-
	Res_Hydro	49.3	13.4	49.4	52.9	71.5
	RoR_Hydro	0.4	0.4	0.4	0.4	0.3
	Solar PV	1.0	0.9	1.0	1.0	0.8
	Wind	1.7	1.4	1.7	1.7	1.4
2040	Biogass	-	-	-	-	-
	Biomass	0.4	2.0	0.4	2.1	0.4
	Geothermal	-	-	-	-	-
	Res_Hydro	56.8	13.2	57.1	70.2	94.2
	RoR_Hydro	0.3	0.3	0.3	0.3	0.3
	Solar PV	0.9	0.9	0.9	0.9	0.9
	Wind	1.5	1.5	1.5	1.5	4.1

Energy Transition Investments.

Table 6
Investment Cost and RE Share Comparison on each Scenarios

Year	Investment Cost (Million USD)				
	BAU	BAU with Constraint	Sc. 1 31% RE by 2040	Sc. 2 75% RE by 2040	Sc. 3 100% RE by 2040
2025	-	164	221	221	221
2030	358	98	362	362	391
2035	504	288	505	535	888
2040	648	299	644	750	1276
Year	**Investment Cost (Million USD)**				
	BAU	**BAU with Constraint**	**Sc. 1 31% RE by 2040**	**Sc. 2 75% RE by 2040**	**Sc. 3 100% RE by 2040**
2025	31.07	17.99	32.50	32.50	32.50
2030	43.76	17.99	44.70	44.70	48.90

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2035	52.83	17.99	53.40	57.90	73.97
2040	59.09	17.99	60.20	75.00	100.00

Table 6 shows the investment cost needed to implement each scenario. From an investment perspective, it is concluded that the highest investment cost will be generated by Scenario 3 in 2040 at USD 1,276 million, where the options of expensive RE sources are chosen by the model due to the constraint of 100% RE target. The option of 75% renewable energy in 2040 will generate an investment cost of 750 million USD or 70% lower than the investment cost of 100% RE in 2040. This situation indicates that the setting of renewable energy (RE) share targets will significantly influence the RE investment requirements to achieve the desired penetration of RE in the system.

A high RE target aimed at facilitating the transition to clean energy does not necessarily guarantee the most optimal investment decision. It may also lead to a lock-in of high-cost investment options. The availability of finance is a critical factor in the development of renewable energy, where a high RES target may not be achievable if certain financial resources are available for the purchase of existing technologies. The study also found that the BAU with constrained energy mix will result in the lowest investment cost, in the range of USD 164-299 million, as no additional massive RE investment is required to keep the energy mix at a constant share. A total comparison of LCOE for each scenario can be seen in Figure 8.

Figure 1

LCOE Comparison in 2040

BAU LCOE = $USD 0.031 /kWh

Generation_Type	carrier_prod(kWh)	%_carrier_prod	energy_cap(kW)	%_energy_cap
Coal	1.667222e+10	3.978292e+01	2.498304e+06	30.473139
Diesel	1.227472e+02	2.928969e-07	4.308800e+05	5.255672
Gas	1.216883e+08	2.903702e-01	1.806400e+06	22.033618
RE	2.511407e+10	5.992671e+01	3.462797e+06	42.237571

BAU w/ Constraints LCOE = $USD 0.0501 /kWh

Generation_Type	carrier_prod(kWh)	%_carrier_prod	energy_cap(kW)	%_energy_cap
Coal	2.438635e+10	60.0	3.057949e+06	44.022146
Diesel	3.251513e+09	8.0	4.308800e+05	6.202936
Gas	5.690148e+09	14.0	1.957642e+06	28.182160
RE	7.315904e+09	18.0	1.499917e+06	21.592759

Scenario 1 (31%) LCOE = $USD 0.031 /kWh

Generation_Type	carrier_prod(kWh)	%_carrier_prod	energy_cap(kW)	%_energy_cap
Coal	1.637165e+10	3.947131e+01	2.499284e+06	30.542247
Diesel	1.227472e+02	2.959380e-07	4.308800e+05	5.265526
Gas	1.292116e+08	3.115232e-01	1.806400e+06	22.074929
RE	2.497648e+10	6.021717e+01	3.446475e+06	42.117298

Scenario 2 (75%) LCOE = $USD 0.0298 /kWh

Generation_Type	carrier_prod(kWh)	%_carrier_prod	energy_cap(kW)	%_energy_cap
Coal	3.998380e+08	24.995877	2.256600e+06	26.322985
Diesel	0.000000e+00	0.000000	4.308800e+05	5.026167
Gas	6.594676e+04	0.004123	1.806400e+06	21.071453
RE	1.199712e+09	75.000000	4.078856e+06	47.579395

Scenario 3 (100%) LCOE = $USD 0.0444 /kWh

Generation_Type	carrier_prod(kWh)	%_carrier_prod	energy_cap(kW)	%_energy_cap
Coal	0.000000e+00	0.0	2.256600e+06	20.543516
Diesel	0.000000e+00	0.0	4.308800e+05	3.922623
Gas	0.000000e+00	0.0	1.806400e+06	16.445009
RE	4.294161e+10	100.0	6.490608e+06	59.088852

CONCLUSIONS

Key Points

To achieve 100% renewable energy by 2040 on the island of Kalimantan, the model uses 94.24% of the electricity production from the hydro reservoir. The lowest LCOE in 2040 will be in the 75% RE by 2040 scenario (0.030 USD/kWh). Meanwhile the 100% RE scenario in 2040 would increase the LCOE by USD 0.013/kWh or 41% compared to the BAU scenario in 2040. It can therefore be concluded that increasing the share of renewable energy (RE) does not directly lead to lower electricity supply costs.

A least-cost approach will identify the price at the lowest possible point, which may not be consistent with a 100% RES share. A 100% RES policy in a given power system requires further evaluation, as it does not necessarily correlate directly with the least-cost principle. If implemented inappropriately, the power system may choose more expensive RE sources over cheaper fossil fuel alternatives once low-cost RE options are exhausted.

Scenario 3 has the highest investment costs in 2040 at USD 1,276 million. While scenario 2 with achieving 75% renewables in 2040 will generate investment costs of USD 750 million, or 70% lower than the highest investment cost in Scenario 3 (100% renewables in 2040).

Certain percentages of renewable energy could result in lower investment costs with optimal RE penetration. 100% RE is an important target for any government in the world, including Indonesia. The government should carefully determine the implementation strategy to achieve the renewable energy target, including prioritising the development of specific renewable energy sources based on their potential and the availability of adequate funding to finance large investment costs.

However, this study also has several limitations, such as not considering the limitation in transmission line development, the limitation in obtaining sufficient data on Kalimantan's hydropower profile and not considering the operating parameters of the power system. This study expects further research to focus on the 100% renewable energy share only in Nusantara to make it independent from the perspective of energy security.

Policy Recommendations

This study recommends several policies that need to be implemented to improve the implementation of green energy in Nusantara as a new capital city of Indonesia and Kalimantan in general, as follows:

1. A phased and sustainable energy policy for the development of renewable energy is needed. The pursuit of 100% renewable energy mix in the Nusantara shall be achieved to ensure a reliable and affordable electricity supply. The grid requirements in the new capital shall be provided with sufficient capacity, meet the required reserve margins and ensure zero downtime. The introduction of smart grid development is critical to effectively manage the intermittency issues caused by renewable energy generation while ensuring optimal system stability.
2. The possibility of increasing LCOE due to increased RE development shall be addressed by appropriate government incentives. It will attract more investors and developers and encourage renewable energy investors and developers to deploy state-of-the-art RE technologies at competitive prices. The introduction of a futures mechanism in RE procurement could help ensure that the price of electricity from RE sources does not increase significantly and burden consumers' electricity tariffs. The current RE sales price is based on the ceiling mechanism, which is stipulated in the Presidential Decree No. 112 Year 2022 on Accelerating the Development of Renewable Energy Sources for Electricity. The sales price is higher than the previous policy of 85% of the local LCOE. However, the number of RE projects has not yet shown a significant growth rate since the implementation of this policy.
3. The construction of large-scale renewable energy power plants such as hydroelectric power plants to support Nusantara will take a considerable amount

of time, so a more comprehensive policy is needed to oversee the development of renewable energy power plants from the planning, procurement, financing, construction and operation stages.

4. Cooperation and technology transfer among the private sector, government and international partners in the development of renewable energy can help Nusantara achieve its goal of using 100% renewable energy by 2040. It is important for Indonesia to develop cooperation with developed countries that have experience in implementing 100% renewable energy in new urban development.
5. Priority should be given to accelerating transmission development to ensure that the evacuation of renewable energy sources can be transmitted to Nusantara and other demand centres in Kalimantan. The Government of Indonesia will provide an opportunity for private investors to participate with PLN (national utility) in transmission development.

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REFERENCES

Alimah, S., Ariyanto, S., Dewita, E., Salimy, D. H., Haifani, A. M., Nurmayady, D., Sulistyo, F. Y., & Al-Hakim, E. E. (2024). Techno-economics of desalination cogeneration with SMR: Case study for prospective NPP in West Kalimantan. *Case Studies in Chemical and Environmental Engineering*, *9*, 100603.

Amirta, R., Haqiqi, M. T., SAPARWADI, S., Septia, E., Mujiasih, D., Setiawan, K. A., Sekedang, M. A., YULIANSYAH, Y., Wijaya, A., & Setiyono, B. (2019). Searching for potential wood biomass for green energy feedstock: A study in tropical swamp-peat forest of Kutai Kertanegara, Indonesia. *Biodiversitas Journal of Biological Diversity*, *20*(6).

Brouwer, A. S., Van Den Broek, M., Seebregts, A., & Faaij, A. (2014). Impacts of large-scale Intermittent Renewable Energy Sources on electricity systems, and how these can be modeled. *Renewable and Sustainable Energy Reviews*, *33*, 443–466.

Cebulla, F., Naegler, T., & Pohl, M. (2017). Electrical energy storage in highly renewable European energy systems: Capacity requirements, spatial distribution, and storage dispatch. *Journal of Energy Storage*, *14*, 211–223.

de Vries, W. T., & Schrey, M. (2022). Geospatial approaches to model renewable energy requirements of the new capital city of Indonesia. *Frontiers in Sustainable Cities*, *4*, 848309.

Del Pero, C., Leonforte, F., Lombardi, F., Stevanato, N., Barbieri, J., Aste, N., Huerto, H., & Colombo, E. (2019). *Modelling of an Integrated multi-energy system for a nearly Zero Energy Smart District*. 246–252.

Gadzanku, S. (2022). *Enabling Floating Solar (FPV) Deployment: Policy and Operational*
Considerations. National Renewable Energy Lab.(NREL), Golden, CO (United States).

Hastuti, I. S. (2024). *Assessing Indonesia's Enhanced Nationally Determined Contributions (NDC) to The Paris Agreement: Identifying The Obstacles Indonesia has in Addressing Climate Change*. 154–167.

Jin, B. (2023). Impact of renewable energy penetration in power systems on the optimization and operation of regional distributed energy systems. *Energy*, *273*, 127201.

Kartika, H. S., & Muhyidin, A. (2024). Breaking Coal Lock-In: Unravelling the Policy Hurdles to Decarbonising Indonesia's Energy Sector. *Journal Homepage*, *10*(2).

Kesumadiksa, K. (2023). The IMPLEMENTATION OF GREEN INVESTMENT UNDER PRESIDENTIAL DECREE NUMBER 112 YEAR 2022. *Journal of Interdisciplinary Legal Issues*, *1*(1), 119–139.

Laha, P., & Chakraborty, B. (2021). Cost optimal combinations of storage technologies for maximizing renewable integration in Indian power system by 2040: Multi-region approach. *Renewable Energy*, *179*, 233–247.

Langer, J., Quist, J., & Blok, K. (2021). Review of Renewable Energy Potentials in Indonesia and Their Contribution to a 100% Renewable Electricity System. *Energies*, *14*(21), 7033. https://doi.org/10.3390/en14217033.

Lombardi, F., Pickering, B., Colombo, E., & Pfenninger, S. (2020). Policy decision support for renewables deployment through spatially explicit practically optimal alternatives. *Joule*, *4*(10), 2185–2207.

Maulidia, M., Dargusch, P., Ashworth, P., & Ardiansyah, F. (2019). Rethinking renewable energy targets and electricity sector reform in Indonesia: A private sector perspective. *Renewable and Sustainable Energy Reviews*, *101*, 231–247.

Octaleny, E. (2022). *Moving The Capital of Indonesia in A Decentralization Perspective*. 177–181.

Pfenninger, S., & Pickering, B. (2018). Calliope: A multi-scale energy systems modelling framework. *Journal of Open Source Software*, *3*(29), 825.

PLN, P. P. (2020). *PLN Electricity Statistics, 2020*. Statistics Indonesia.

PT PLN, P. (2019). PLN RUPT 2019-2028. *2019*, *1*.

Putra, H. D. (2022). Energy Transition in the Kalimantan Power System. *Delft University of Technology*.

Rachim, D. K. N., Firdaus, A., & Saputro, A. G. W. (2022). Analysis of the Impact of Population

Growth in DKI Jakarta Using Logistic Model. *Jurnal Pendidikan Matematika (Kudus)*, *5*(1), 69–78.

Resosudarmo, B. P., Alisjahbana, A., & Nurdianto, D. A. (2012). Energy security in Indonesia. In *Energy Security in the Era of Climate Change: The Asia-Pacific Experience* (pp. 161–179). Springer.

Rino, M. (2023). Scenario Planning for Renewable Energy Development towards Net Zero Emission in Indonesia's New Capital City "Nusantara." *European Journal of Business and Management Research*, *8*(6), 77–86.

Simaremare, A. A., Tambunan, H. B., Pramana, P. A. A., & Munir, B. S. (2018). *Optimization of Renewable Energy Penetration for Microgrid System–Case Study of Tomia Island*. 180– 183.

Susmiyati, H. R., Harjanti, W., & Al Hidayah, R. (2023). Development of the Nusantara Capital, Sustainable Extraction for East Kalimantan. In *Assembling Nusantara: Mimicry, Friction, and Resonance in the New Capital Development* (pp. 151–164). Springer.

Syaban, A. S. N., & Appiah-Opoku, S. (2023). Building Indonesia's new capital city: An in-depth analysis of prospects and challenges from current capital city of Jakarta to Kalimantan. *Urban, Planning and Transport Research*, *11*(1), 2276415.

Ueckerdt, F., Brecha, R., & Luderer, G. (2015). Analyzing major challenges of wind and solar variability in power systems. *Renewable Energy*, *81*, 1–10.

Widodo, E., & Putri, W. M. P. (2020). *Power generation and transmission system analysis by using cooperative game theory (case study: Electricity in Kalimantan)*. *2217*(1).

Winarno, O. T., Alwendra, Y., & Mujiyanto, S. (2016). *Policies and strategies for renewable energy development in Indonesia*. 270–272.