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Renewable Energy on Islands: Lessons for Indonesia to Apply

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Abstract

The purpose of this article is to review and analyse the development of applied renewable energy in Indonesia. Indonesia has achieved 91.16% electrification rate in 2016, and in 2024 planned to achieve 100% electrification for its population. Lack of electricity access, however, is common throughout Indonesia. Provinces in eastern Indonesia such as Nusa Tenggara Timur and Papua Barat has the lowest electrification ratio, while provinces such as Nusa Tenggara Barat, Sulawesi Tenggara, Kalimantan Tengah, Kalimantan Utara, and Kepulauan Riau has less than 80% electrification rate. Out of the 34 provinces, only Bangka Belitung, Jawa Barat, and Jakarta have the electrification ratio above 99% in 2016. Providing electricity access to the population is proven to be difficult due to Indonesia's archipelagic geography which acted as a barrier and poses a challenge in electrification efforts. Studies, however, have shown the potential use and application of renewable energy to provide electricity to islands and archipelagos. It is therefore important for Indonesia to take note that renewable energy initiatives, particularly on islands and archipelagos, are not only yielding positive results socially, economically, and environmentally, but it is also viable and feasible to implement.

Keywords: *energy policy; islands; renewable energy;; sustainable energy*

Abstrak

Tujuan artikel ini adalah untuk mengkaji dan menganalisis pengembangan energi terbarukan yang diterapkan di di Indonesia. Indonesia telah mencapai rasio elektrifikasi sebesar 91,16% pada tahun 2016, dan pada tahun 2024 direncanakan akan mencapai 100% elektrifikasi bagi penduduknya. Kurangnya akses listrik, bagaimanapun juga, adalah umum terjadi di seluruh Indonesia. Provinsi di Indonesia Timur seperti Nusa Tenggara Timur dan Papua Barat memiliki rasio elektrifikasi terendah, sementara provinsi seperti Nusa Tenggara Barat, Sulawesi Tenggara, Kalimantan Tengah, Kalimantan Utara, dan Kepulauan Riau memiliki rasio elektrifikasi kurang dari 80%. Dari 34 provinsi, hanya Bangka Belitung, Jawa Barat, dan Jakarta yang memiliki rasio elektrifikasi tertinggi di atas 99% pada tahun 2016. Menyediakan listrik untuk penduduk Indonesia adalah tugas yang berat karena bentang wilayah kepulauan Indonesia merupakan hambatan dan tantangan dalam upaya elektrifikasi. Studi, bagaimanapun, telah menunjukkan potensi penggunaan dan penerapan energi terbarukan di pulau-pulau dan wilayah kepulauan. Oleh karenanya, penting bagi Indonesia untuk memperhatikan bahwa inisiatif energi terbarukan, terutama di pulau-pulau dan wilayah kepulauan, tidak hanya memberikan hasil positif secara sosial, ekonomi, dan lingkungan, tetapi juga mungkin dan layak untuk diterapkan.

Kata kunci: kebijakan energi; kepulauan; energi terbarukan; energi berkelanjutan.

INTRODUCTION

Indonesia is an archipelagic state, consisted of 17.504 islands with 2.342 (12.38%) inhabited islands (Badan Pusat Statistik, 2013), and according to United Nations Convention on Law of the Sea's (UNCLOS) provision article 46 (a), an archipelagic state is a state constituted wholly by one or more archipelagos and may include other islands. Despite being an archipelagic state, Indonesia has achieved some degree of success in providing electricity to its

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population by improving access to electricity in recent years.

Indonesia's electrification ratio was 88.30% in 2015, increased to 91.16% in 2016 (Direktorat Jenderal Ketenagalistrikan-Kementerian Energi dan Sumber Daya Mineral, 2017) and according to the draft of *Rencana Umum Ketenagalistrikan Nasional Tahun 2015-2034* (The National Electricity General Plan of 2015-2034), Indonesia planned to achieve electrification ratio of 100% in 2024 (Kementerian Energi dan Sumber Daya Mineral, 2015).

Lack of electricity access, however, is common throughout Indonesia. Provinces in eastern Indonesia such as Nusa Tenggara Timur and Papua Barat have the lowest electrification ratio of 58.93% and 47.78% respectively, while provinces such as Nusa Tenggara Barat (77.22%), Sulawesi Tenggara (74.47%), Kalimantan Tengah (73.08%), Kalimantan Utara (77.37%), and Kepulauan Riau (76.37%) have electrification ratio of less than 80%. Out of the 34 provinces, only Bangka Belitung, Jawa Barat, and Jakarta have the highest electrification ratio of above 99% in 2016 (Direktorat Jenderal Ketenagalistrikan-Kementerian Energi dan Sumber Daya Mineral, 2017).

In order to achieve 100% electrification ratio, it is therefore important to provide electricity to the islands and archipelagic regions of Indonesia. Hence, this article reviews and analyse the renewable energy that is developed in Indonesia. Providing electricity to islands and archipelagos by utilizing renewable energy is challenging, but it is not new. Studies have shown the potential use and application of renewable energy on islands not only in Indonesia but also from around the world. Hybrid technology (Kahar & Hantoro, 2016; Senjyu, Nakaji, Uezato, & Funabashi, 2005) and implementation model have also been studied and developed to increase the application of the renewable energy (Duić, Krajačić, & Carvalho, 2008). Although barriers exist (Bunker, Doig, Hawley, & Morris, 2015; Ciriminna, Pagliaro, Meneguzzo, & Pecoraino, 2016; Lidula, Mithulananthan, Ongsakul, Widjaya, & Henson, 2007), it is important for Indonesia to consider that renewable energy would result in positive impacts to the society, economy, and the environment, and it is viable and feasible to be implemented (Brown et al., 2018; Mandefro, 2017).

DISCUSSION

Indonesia's Energy Resources and Balance

To meet the final national energy demand, Indonesia's national primary energy supply is dominated by non-renewable energy sources (coal, oil, and natural gas) with coal holds the highest share due to its low price that leads to wide usage in power plants and industrial sector (Badan Pengkajian dan Penerapan Teknologi, 2017).

In 2015, Indonesia's final energy consumption was 1.14 billion barrels of oil equivalent which was divided by crude oil and its products (542 MBOE[1]), coal (364 MBOE), and natural gas (279 MBOE) as the source of primary energy supply and accounted for 74.6% of energy supply (95.4% if biomass is excluded). Renewable energy resources such as biomass (309 MBOE), hydropower (35 MBOE), geothermal (16 MBOE), and biofuel (5 MBOE) were accounted for 25.4% of primary energy supply. However, if biomass is excluded, the numbers that the renewable resources contributed fell drastically to only 4.6%.

The share of final energy consumption on Indonesia's total primary energy (excluding biomass) was the transportation (40.63%) followed by the industry (34.97%), households (14.62%), commercial use (5.44%), and other sectors (4.34%). Out of the final energy consumption in 2015, fuel was the highest consumed source of energy (Kementerian Energi dan Sumber Daya Mineral, 2017). It is also important to note that the use of traditional biomass is prevalent for cooking and thermal purposes among millions of rural households in Indonesia (Asian Development Bank, 2016b).

Non-renewable energy resources are widely used in Indonesia. However, oil resource decreases, and it is estimated that in 11 years, Indonesia's proven oil reserve will be depleted (Badan Pengkajian dan Penerapan Teknologi, 2017). The total oil production growth of Indonesia in from 2005 to 2015 has annually decreased by 2.6% in average, while the total proved oil reserve was 3.6 billion barrels in 2015, down from 4.4 billion barrels in 2006 (British Petroleum, 2017). Crude oil production has also been decreasing in recent years, from 517 million barrels in 2010 to 288 million barrels in 2014, due to the reliance on mature oil fields and to a lack of investment in new oil exploration. Imports, as a consequence, increased. Between 2000 and 2014, crude oil imports increased from 79 million barrels to 122 million barrels, while refined product imports increased from 91 million barrels to 209 million barrels (International Renewable Energy Agency, 2015). In addition, change of policies and low oil prices tends to make a reduction in national oil and gas exploration and exploitation activities which has an impact on the decline in reserves. Other than oil, natural gas will be depleted in 36 years under current reserve and production rate, while coal will be depleted in 70 years, if there is no exploration for new reserves (Badan Pengkajian dan Penerapan Teknologi, 2017). Furthermore, for energy security reasons, Indonesia opted to restrict coal production to only around 400 million metric tons by 2019, of which 60% will be used domestically to stimulate domestic demand (Kementerian Energi dan Sumber Daya Mineral, 2015).

[1] Million barrels of oil equivalent (MBOE)

In contrast, the majority of Indonesia's renewable energy resources have not yet been utilized to the maximum. Geothermal, hydro, mini-micro hydro, biomass, solar energy, wind energy, wave energy and other sources, are in abundant (Badan Pengkajian dan Penerapan Teknologi, 2017). It is regretfully, however, to see that renewable energy only makes up to about 4% of total primary energy in Indonesia (Dewan Energi Nasional, 2014). Table 1, shows substantial new and renewable energy resources in Indonesia. It also shows the potential and the installed capacity of each energy type.

Table. 1 New and Renewable Energy Resources, Potential, and Installed Capacity

Energy Type	Resources	Potential	Installed Capacity
Geothermal	-	29,544 MW	1,438.5 MW
Hydro	75,091 MW	45,397 MW	8,671 MW
Mini-Micro Hydro	-	19.385 MW	2,600.76 kW
Biomass	32,654 MWe	-	1,626 MW (off-grid) 91,1 MW (on-grid)
Solar Energy	4,80 kWh/m^2/day	-	14,006.5 kW
Wind Energy	970 MW	-	1,96 MW
Uranium	3,000 MW	-	30 MW
Shale Gas	574 TSCF	-	
Coal Bed Methane	456.7 TSCF	-	-
Wave Energy	17.989 MW	-	-
Ocean Thermal Energy Conversion	41,012 MW	-	-
Tide and Tidal Power	4,800 MW	-	-

Source: Indonesia Energy Outlook 2017 (Badan Pengkajian dan Penerapan Teknologi, 2017).

The underutilized renewable resources are significant compared to the installed capacity and if they are utilized to the fullest, they could play a larger role in Indonesia's development, especially to improve the electrification rate. The role of renewable energy in the province of Papua, for example, will be important given that all supplies of fuel and liquefied petroleum gas (LPG) to this province come from outside of Papua. Fuel is obtained from the main depots in Maluku, and LPG is still dependent on supplies from the Java region. The existence of the Kasim refinery in Sorong is unable to meet the needs of the Papua Province, and the refinery only produces fuel. On the other hand, the use of renewable energy sources is local and not economical if they are transported between regions. This condition causes the development of renewable energy sources to be suitable for increasing energy utilization in remote and isolated areas around Papua Province (World Wildlife Fund Indonesia, 2015).

National Energy Policy

In order to overcome high energy consumption and to ensure energy security in the future, Indonesia implemented its national energy policy to conserve energy on the demand side and to diversify energy sources on the supply side. The Presidential Decree No. 5/2006 *(Peraturan Presiden Nomor 5 Tahun 2006)* mandated that the optimum primary energy mix of Indonesia in 2025 with the role of each type of energy in national energy consumptions are: oil would be less than 20%, gas would be more than 30%, coal would be less than 33%, and renewables would become 17% on primary energy mix. However, the revised National Energy Policy in 2014 under the Presidential Decree No. 79/2014 (*Peraturan Presiden Nomor 79 Tahun 2014 Tentang Kebijakan Energi Nasional*) emphasizes more on diversification, environmental sustainability, and maximum use of domestic energy resources. It also set a higher target for utilizing new and renewable energy in the national energy mix; minimum of 23% and 31% in 2025 and 2050 respectively, while lowering the use of non-renewables (Tharakan, 2015). Renewable energy resources, unfortunately, have not been utilized to the maximum and it requires efforts to accelerate their use to maximize non-fossil energy contributions in the national energy mix (Dewan Energi Nasional, 2014). Table 2, shows Indonesia's national energy mix in 2015, and the targeted share of new and renewable energy, oil, gas, and coal in the national energy mix in 2025 and 2050.

Table. 2 Indonesia's Energy Mix 2015, 2025, and 2050

National Energy Mix	New and Renewable	Oil	Gas	Coal
2015	10%	34%	24%	32%
2025	23%	25%	22%	30%
2050	31%	20%	24%	25%

Source: Dewan Energi Nasional (2014); Presidential Decree No. 79/2014.

Nevertheless, this shift in energy policy provides an opportunity to increase the use of Indonesia's renewable energy potential. The increased targeted share of renewable energy in the revised energy policy indicated a sign of commitment to further harness clean renewable energy. The commitment also shows that the archipelagic state is moving towards green energy in the future by aiming for sustainability and reducing dependency from non-renewable.

Renewable Energy on Small Islands

Most small islands are dependent on imported fossil fuels for their energy needs, especially for transport and electricity production (Dornan, 2015; Energy Transition Initiative, 2015; (International Renewable Energy Agency, 2016; Jensen, 2000). Because of the small size and isolated location of many islands, infrastructure costs and energy are three to four times higher than on the mainland. The high price for fossil fuels combined with the limited demand increases the unit cost of production for conventional power. This creates a competitive situation for renewable energy technologies on the islands (Jensen, 2000). Furthermore, most islands are endowed with good renewable resources, primarily the sun and the wind with other renewable resources such as hydropower, geothermal, waves, tidal, and biomass on some islands. The potential for renewable energy use on islands is, therefore, vast (Garcia & Meisen, 2008; Jensen, 2000; Maldonado, 2017).

Renewable energy technology such as hybrid power generator consising diesel generators can also be expected to reduce fossil fuel consumption on islands for electricity needs (Kahar & Hantoro, 2016). A study even proposed a new power-supply system that uses renewable energy in small isolated islands. The system consists of wind turbine generators, diesel generators, fuel cells, and aqua electrolyzers. Aqua electrolyzers are used to absorb the rapidly fluctuating output power from wind turbine generators and generate hydrogen. The generated hydrogen is stored in the hydrogen tank and used as fuel for fuel cells. The output power from wind turbine generators, diesel generators, and fuel cells is produced to meet the load demand. The proposed system does not need batteries and thus, improves the efficiency of the system (Senjyu et al., 2005). Off-grid renewable energy, on the other hand, which includes stand-alone systems and mini-grids, could also offer a unique opportunity to expand modern energy access services to islands. The distributed nature of these systems allows them to be tailored to local conditions, tap into available renewable resources, deliver diverse energy services, and utilize local capacity to ensure long-term sustainability (International Renewable Energy Agency, 2017).

Many small islands in every region in the world such as the Azores and Canary Islands in the North Atlantic, Gotland and Samsoe in the Baltic, Sardinia and Sicily in the Mediterranean, Mauritius and Reunion in the Indian Ocean, Fiji and the Hawaiian Islands in the Pacific, as well as Dominica and the Guadeloupe islands in the Caribbean have used and developed the renewable energy (Garcia & Meisen, 2008). Sumba Island (Asian Development Bank, 2016a; Hivos, 2015; Lomi, 2016), the Galapagos (Dove, 2014), Reunion Island (Selosse, Garabedian, Ricci, & Maïzi, 2018), and Sicily's remote islands are also some of the islands that utilize renewable energy in generating clean electricity for its population. Sicily's island of Vulcano, for example, has been hosting large photovoltaic (PV) field since 1984 on its island (Ciriminna et al., 2016).

Small islands can make the transition to use renewable energy. Islands, such as Samsoe Island in Denmark, generate 100% of their electricity consumption from renewable energy, while some islands produce 75% of total heating supply from renewable energy, such as Lolland and Falster. Other islands have committed to the initiatives to produce energy from renewables such as 79% in Fiji or 48% in Dominica. Renewable energy production on many other islands varies, although goals are in place. In total, over 30 inhabited small islands have some source and percentage of production from renewable energy. In Denmark, several islands participated to move the nation towards a significant level of renewable energy, in fact, 100% capacity of renewable energy installation. Such a goal could only encourage the local people, not only to make the transition, but also to prove to the world that small islands can achieve their independence from fossil fuel. Some of these islands that have a surplus of electricity production actually sell the surplus back to the mainland through underwater cables, making a profit and enhancing the benefit of their installed capacity (Garcia & Meisen, 2008).

A report on the European Union Outermost Region (EU OR) also suggested that smaller islands (islands such as Guadeloupe, French Guiana, Martinique, Mayotte, Reunion, Saint-Martin, the Azores, Madeira and the Canary Islands in the EU OR) are prime candidates for becoming self-sufficient communities based on renewable energy. Some islands could be the leaders of the transition towards a renewable energy future, becoming lighthouse projects for other regions in Europe. These small islands in the EU OR should thus be seen as good opportunities for the on-site development of these future sustainable energy systems and become energy-efficient communities rather than to be seen as a cost and a burden on the national and at the EU budgets (Maldonado, 2017).

Indeed, islands and archipelagos should not be viewed as a cost and a burden or as a disadvantage, but rather, as a possibility. A dramatic shift to renewable energy on a large scale on a continent or mainland is unrealistic in the short and medium-term in regard to technology, financing, and organization. However, it would be of high interest to demonstrate the possibilities of smaller communities to base their entire energy supply on renewable energy sources. Islands can be cheaper, faster, and easier to reach a higher share of renewable energy in its energy balance than a much bigger mainland. The small size of the islands, that often is seen as a disadvantage, is in this context, actually an advantage (Jensen, 2000).

Case studies regarding the utilization of renewable energy sources by International Renewable Energy Agency (IRENA) on Small Islands Developing States (SIDS), Rocky Mountain Institute (RMI) Casebook, Sumba Iconic Island (SII) initiative, and renewable energy in Sicily's remote islands, offer a view of what renewable energy could provide to islands.

SIDS Case Studies

In The Bahamas, the implementation of sustainable solar energy project involving the installation of 134 solar water heaters and 33 photovoltaic solar systems in homes are expected to decrease fossil fuel imports and reduce transportation costs within the archipelago. The Cabeolica Wind Project at Cabo Verde involved 30 turbines in four wind farms on Boa Vista, Sao Vicente, Sal, and Santiago Islands. It was expected to generate approximately 25% of the country's energy, thereby diversifying the energy mix and protecting the electricity sector from oil price volatility. As a result of the project, an additional 50.000 citizens were connected to the national electricity grid and power generation costs are expected to be approximately 20% less than before with oil imports expected to be greatly reduced by up to 20.000 tonnes. In the Republic of Fiji, LaKaRo Solar Fuel Saving Project implemented in Lakeba, Kadavu and Rotuma islands increased electricity supply, reduced imported conventional fuel, and supplied 900 additional homes with clean energy electricity for lighting, air conditioning, home appliances, and water desalination, significantly improving living conditions (International Renewable Energy Agency, 2016).

Rocky Mountain Institute Casebook

The casebook explores several remote, islanded micro-grids from around the globe, sharing examples of communities transitioning from one resource (oil) to a diverse set of resources including micro-grids for different reasons. The examples include small micro-grids serving fewer than 100 people, and larger micro-grids serving over 10.000 people, with a peak demand range from 60 kW to 27 MW. The casebook highlights benefits earned by communities transitioned from a conventional source of energy (oil) to renewable energy (wind and solar energy). The Caribbean Island of Bonaire's electricity, for example, comes from 12 wind turbines that provide 44% of the island's electricity, and up to 90% during times of high wind. In Kodiak, Alaska, with above 99% annual renewable generation, the community is relying less on diesel fuel which stabilizes the electricity rate and saves the community USD 4 million-per-year. The Falkland Islands receive the same benefit through wind farm to harness wind energy. The community experiences reduced electricity rates, and the diesel fuel use is reduced by 1.4 million liters in average per year. In-depth interviews of individuals involved with the renewable transition program for these islanded micro-grids also pointed three drivers of the transition. These drivers are mainly: costs due to expensive imported fossil-fuel; environmental considerations due to concerns over the future impacts of climate change, desire to reduce carbon emissions, and deep cultural connections to land and nature; and abundant local energy resources for electricity generation such as wind and solar energy (Bunker et al., 2015).

Sumba Iconic Island Initiative

The Sumba Iconic Island Initiative is a multi-actor intervention that seeks to serve the energy needs over half a million people in the remote Indonesian island of Sumba through 100% renewable energy sources within ten years. The initiative positioned a small island in the developing countries at the forefront of a campaign intended to inspire interest and raise public awareness on renewable energy, climate change, and energy access (Hivos, 2015).

The Government of Indonesia launched the Sumba Iconic Island (SII) initiative in 2010 jointly with the support of Hivos, a non-government organization (NGO) based in the Netherlands. The initiative aims to achieve the following by 2025: increase the electrification ratio on the island of Sumba from a current level of approximately 30% of households to 95%, and increase the share of electricity produced from renewable resources on Sumba from approximately 15% to 100%. In addition to providing the people of Sumba with sustainable, universal access to electricity, the SII initiative is intended to provide a model for renewable energy-based access to policymakers and development practitioners, and showcasing renewable energy as a solution to the problem of energy access in small and mid-sized islands in the developing countries that can be replicated elsewhere in Indonesia (Asian Development Bank, 2016a; Hivos, 2015; Lomi, 2015).

Renewable Energy in Sicily

Sicily's islands, like many other remote islands in the world, renewed interest to diminish reliance on expensive and difficult to transport fossil fuels using renewable energy. The use of solar water heaters became a common practice in most Sicily's islands, translating in significant fossil fuel and financial savings, as most inhabitants of Sicily's islands continued to use electricity to generate hot sanitary water. Sicily's remote islands share a number of pioneering achievements in the utilization of solar energy. Installed and connected to the island grid in 1984 in Vulcano, part of the Eolian archipelago, the 180 kW PV plant comprising of 9% efficient monocrystalline silicon PV modules, has shown remarkable stable performance. Lipari, the largest of the Eolian islands, hosts one of the world's largest PV plants installed on remote islands. Since it was built in 2013, the PV field has 1120 kW nominal power to supply at least 20% of the electricity needed by desalination plant. The use of seawater desalination in five out of fourteen Sicily's remote islands has partly solved significant issues of water supply traditionally met by water transportation with tankship (Ciriminna et al., 2016).

Barriers and Challenges

Despite the compelling evidence in support of renewable energy and its technologies, its utilization for electricity generation remains marginal due in part to technical limitations (Asia Pacific Energy Research Centre, 2004). A case study in Makalehi Island, Indonesia, for example, concluded that significant barriers for developing renewable energy sources on the island are the technical limitation in spare parts and limited operational skill level of technicians which resulted in poor maintenance of installed solar power systems (Rumbayan, 2017). Other barriers are the intermittent nature of electricity from wind and PV as well as the efficiency of energy storage technology (Chen, Duić, Alves, & Carvalho, 2007; Duić et al., 2008; Warmburg, 2006). Existing regulatory barriers (such as restrictions on siting, access to grid, and construction) in most economies are also not supportive for new and renewable energy technologies ((Asia Pacific Energy Research Centre, 2004), while various market barriers such as lack of funding or financing difficulties, no market infrastructure, high investment cost, fossil fuel subsidies, and poor regional regulations; also become major barriers in promoting renewable energy (Ciriminna et al., 2016; Lidula et al., 2007).

Other than that, there are three main challenges of integrating renewable energy (Bunker et al., 2015). These challenges are:

1. Grid Stability: maintaining grid stability with renewable integration also proved to be challenging in many cases. Maintaining a reliable electricity system for the community's residents is essential, so system operators must incorporate renewable energy sources, especially those that are varied, in a way that preserves the operation of the overall system. Using a phased integration approach, operators were able to see how to initially bring a small number of renewable technologies online, work with these while balancing the system, and then continue to step up the renewable energy penetration by integrating more resources alongside energy storage and advanced controls.
2. Remote Location: procuring and transporting new technologies and equipment as well as getting actual construction crews on-site present another challenge for remote locations. Often, only one or two operators live nearby, so if major technical issues arise, teams must fly in to address the problems.
3. Administrative and Bureaucratic Requirements: many communities transitioning to renewable energy faced challenges stemming from the fund or grant application processes, onerous documentation requirements, and the need to align bureaucratically imposed requirements with the overall energy transition timeline.

CONCLUSION

The purpose of this paper is to review and analyse the development of applied renewable energy to drive its use in Indonesia. Case studies presented have shown the potential application of renewable energy on islands to provide electricity and other benefits (lower electricity rate, reduce fossil fuel use and imports, increased access to electricity, lower carbon emission, and improve living conditions). Case studies from the Bahamas, Cabo Verde, Fiji, the Caribbean Island of Bonaire, Kodiak in Alaska, the Falkland Islands, Sumba Island in Indonesia, and Sicily's remote islands, have concluded that islands can make the transition from nonrenewable to renewable energy. Although the benefits differ from island to island due to variation in the availability of renewable resources, Indonesia should reflect on these case studies and implement similar initiatives across its archipelago to improve electrification access, increase the benefit, and provide long-term sustainability to its population. Even though barriers and challenges exist, Indonesia could adopt a holistic and tailored approach to the local context in the design of its island renewable energy initiative in the future.

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