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by Abraham Lomi

Chapter 19
The Role of Renewable Energy: Sumba Iconic Island, an Implementation of 100 Percent Renewable Energy by 2020

Abraham Lomi

Abstract Sumba Iconic Island is a pilot project. This project is initiated for the development of the Sumba Island as the iconic island of renewable energy. The aim of this project is to improve the access to energy through the development and utilization of new renewable energy resources. By the year of 2020, the 100 % realization of this project should be achieved. The initiative of Sumba Iconic Island on Renewable Energy has been started since 2010 by the Ministry of Energy and Mineral Resources, together with Bappenas and Hivos, a non-Governmental International organization. In November 2012, ADB also joined to accelerate the realization of this initiative. In 2013, the Norwegian Embassy in Indonesia has also taken a role in supporting the implementation of initiatives of Sumba Iconic Island. The selection of Sumba as an iconic island is based on studies. Those studies showed that the potential of renewable energy in Sumba is very large. The potential can be used as one of the main tools to drive the economic community in Sumba Island. Since it was initiated in 2011, the project has installed renewable electricity with capacity of about 5.87 MW. They consist of Micro-hydro power plant, solar power plant, Solar Water Pumping, Wind turbine generator, Biomass, Biogas, and Energy efficient furnaces.

Keywords Hivos · Off-grid · Renewable energy · Rural areas · Sumba Iconic Island · Urban area

19.1 Introduction

Global warming and the depletion of fossil fuel reserves have raised a lot of concern for utilizing renewable energy sources. This energy creates green environment as well as preserve the earth for future generations. In addition to hydropower, the

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F. Pasila et al. (eds.), *Proceedings of Second International Conference on Electrical Systems, Technology and Information 2015 (ICESTI 2015)*,
Lecture Notes in Electrical Engineering 365, DOI 10.1007/978-981-287-988-2_19

energy which is generated from wind, photovoltaic and biomass have great potential usage to meet the energy needs, especially in the remote areas. Those areas are far from the State Electricity Company ("Perusahaan Listrik Negara"–PLN) grid. The latest developments and trends in electrical power consumption indicates the use of renewable energy is increasing. The electrification of rural and remote areas is potentially a desirable investment. However, there has been considerable discussion about the social economic and other benefits as well as the costs of the electrification of these areas in developing countries. Apart from the benefits related to the improvement of the living conditions, the potential benefits include (1) socioeconomic, (2) sociopolitical, and (3) environmental benefits [1]. Solar energy and wind energy are two sources of renewable energy that are most commonly used. Wind energy has become the most expensive technology. Many scientists are interested in doing research in that field. Solar cells convert energy from sunlight into DC electricity. Photovoltaic (PV) offers many advantages over other renewable energy in the absence of noise and minimal maintenance.

The island of Sumba is located in eastern part of Indonesia archipelago. It is located between Sumbawa Island to the Northwest and West Timor to the East and Australia to the far South at a distance of about 700 km.

The island is part of East Nusa Tenggara province (Nusa Tenggara Timur), and one of the four largest islands in NTT. The total land area is approximately 11,052 km^2, and has population of only 656,259 inhabitants and density of 58.62 inhabitants per km^2. The island is mountainous with small pockets of flat land, and its highest point is Wanggameti Mountain (1,225 m), as shown on the base map of Sumba (Fig. 19.1).

Administratively the island is divided into four regencies (Kabupaten), East Sumba (7000.5 km^2), Central Sumba (1,868.19 km^2), West Sumba (737.42 km^2), and Southwest Sumba (1,445.32 km^2) [2]. The biggest city is Waingapu, which is the capital city of East Sumba district. Like many developing regions, not only are the effects of climate change felt more acutely, but also electricity is not widely available, and where it does exist, it is supplied with polluting, expensive, imported resources in Sumba's case, diesel and kerosene [3]. The Sumbanese are among the

Fig. 19.1 Map of Nusa Tenggara

billions of people on this planet who do not have access to clean energy. They are forced to cook over unhealthy wood fires and their source of light is only smoking oil lamps. In most of the villages on the island, life stops as soon as the sun goes down.

HIVOS [4], a non-Governmental International organization first visited the island of Sumba in 2009. This organization was looking for a location where they could show the access to renewable energy that can alleviate poverty even in remote and isolated areas. Sumba was an ideal candidate and located in one of the poorest areas of Indonesia. Its inhabitants are without prospects of economic advancement and the island has one of the lowest electrification ratios in Indonesia.

Sumba Iconic Island initiative was launched through the effort of HIVOS at the Indonesia-Netherlands Joint Energy Working Group in 2010. This program is aimed at developing a "model" island supplied entirely by renewable energy. With this initiative, Sumba Island has been selected as a pilot example of scaling up access to energy by renewable resources utilization due to its existing energy profile: (1) low level of access to modern energy (less than 30 %); (2) high dependence on fossil energy (Diesel); and various types of renewable energy resources exist: hydro, solar, wind, and biomass resources. Sumba Iconic Island initiative sets ambitious targets to reach 95 % electrification ratio and meet 100 % energy demand by 2020.

Sumba Iconic Island Road Map was formally released during a "National Seminar & Stakeholder Meeting on Sumba" on February 13–15, 2013 in Jakarta. This Road Map distinguishes 15 activities classified by renewable energy technologies of which each activity is divided into a uniform 5 sub-activities, namely, (a) Renewable energy technology Installation; (b) Supporting regulations and policies; (c) Institutional framework and stakeholder roles; (d) Investment and funding; and (e) Research and development [5].

Based on the SII roadmap, the total capacity to fulfil the need of energy 2025 of about 32.57 MW, while the total installed capacity of renewable energy in Sumba island from 2011 to 2014 is about 4.87 MW or about 15 % from target. The electrification ratio target on Sumba Iconic Island will be 100 % in 2020. The existing electrification ratio for Sumba Island is about 37.41 %, while the contribution of EBT is about 9.76 %. This shows that the construction of new EBT plant in the next 5 years is about 24 MW.

19.2 The Global Electrification Challenge

The World Energy Outlook 2013 of the International Energy Agency (IEA) states that access to electricity is still lacking for some 1.3 billion people-some 20 % of the world's population. Those people are located mostly in Asia and sub-Saharan Africa. Most of these people live in rural and remote areas of the developing countries. In the past few decades, the donor community, development banks, the private sectors, nongovernmental organizations (NGOs), and other organizations

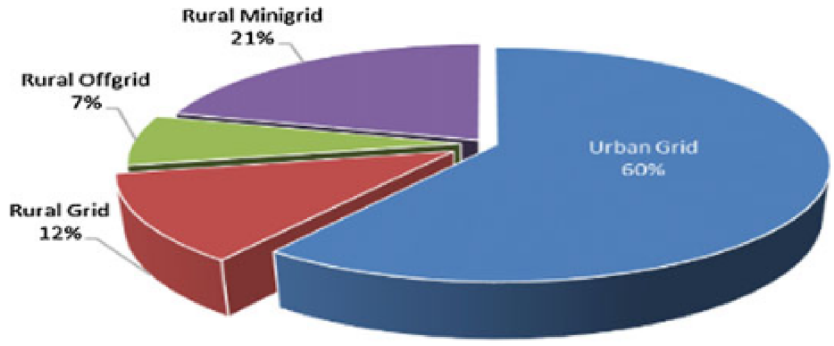

Fig. 19.2 Universal electrification and expected share connections by type

have developed and implemented a number of initiatives to help improve modern energy supplies to deprived regions in the developing world.

The electrification of rural areas has often been based on the electricity supply from a central grid. But currents renewable energy technologies offer enhanced opportunities for off-grid power systems and include photovoltaic (PV) systems, wind turbines, bio-mass fueled combined-heat-and-power units, hybrid systems, storage facilities, and fuel cells. Off-grid options include solar home systems (SHS), portable battery kits, and similar solutions that can satisfy initial electricity needs. To achieve universal access by 2030, it is estimated that the period 2010–2030 some 550 million households need to be provided with electricity services; this figure takes into account expected population growth to 2030. Some 60 % (330 million) of the new connections will be needed in urban areas, and 40 % (220 million) must be installed in rural areas (see Fig. 19.2) [6].

19.3 Indonesia Renewable Energy Policy

A Strategy on Renewable Energy will be developed to achieve the goals, objectives and set out into a practical implementation plan. A number of important investigations will be undertaken during the strategy development. The strategy includes how the renewable energy target will be periodically reviewed with respect to the different primary energy carriers, the mechanism in the selection electricity's feed-in which is generated from the renewable resources, into the national electricity grid, and the modalities of the various financial, legal and regulatory instruments to be employed as part of the enabling framework of mechanisms to support the promotion of renewable energy (Fig. 19.3).

The main aim of the policy is to create the conditions for the development and commercial implementation of renewable technologies. Government will use a phased, managed and partnership approach to renewable energy projects that are well conceived and show the potential to provide acceptable social, environmental and financial returns for all investors and stakeholders. Renewable energy will

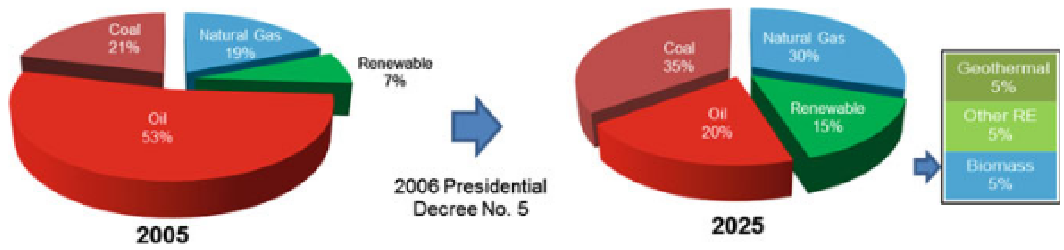

Fig. 19.3 Current energy mix versus future energy goals

contribute to the diversification of energy resources through the implementation of a properly managed programme of action that will provide sufficient incentive for the sustainable development of the renewable energy-based industries. Today, renewable energy accounts for a small but growing portion of Indonesia's electricity portfolio. Most renewable energy comes from the hydropower and geothermal industries. Presidential Decree No. 5 mandates an increase in renewable energy production from 7 to 15 % of generating capacity by 2025 [7].

19.4 Indonesia Renewable Energy Potential

Indonesia is a country which is rich of natural resources. The Indonesia primary energy source can be managed and used to meet national energy needs, especially for the remote communities. However, the dependency to the energy derived from fossil attenuated the opportunity to develop environmentally friendly energy sources, i.e., sources of energy derived from new and renewable energy sources. Based on ESDM data (2013), Indonesian geothermal reserves amounted to 16,502 MW and geothermal potential of about 29 MW. The installed capacity of geothermal power plant (until May 2013) is 1,341 MW. Electricity potency from large scale hydro power amounted at 75 GW, while the potential of mini/micro hydro was about 769.69 MW. Meanwhile, the potential of electricity from biomass amounted to 13,662 MWe and the installed capacity of on grid power plant is 75.5 MWe.

Hydropower energy resource is grouped into large scale (can be developed for power plants above 10 MW per location) and small-scale/micro (potential electricity generation less than 10 MW). The potential for large-scale hydropower and small-scale/micro estimated respectively at about 75 GW and 450 MW. The potential is fairly spread in various parts of Indonesia. The use of hydropower resource is still relatively low at 4.2 GW of large-scale and small-scale of about 84 MW. Utilization of hydropower resources should be developed primarily with small-scale power spread schemes to meet local electricity needs.

Indonesia has a potential possibility for developing biomass power. Currently, only 443 MW have been commercially developed and the 49,810 MW biomass energy is undeveloped. By 2025, Indonesia has targeted to install about 810 MW of biomass power, an increase of 80 %. That amount is still far less than the potential contribution. Large-scale biomass projects would likely require new infrastructure to gather and deliver what is now considered as a waste item.

As a tropical country, the potential of solar power in Indonesia is quite high with an intensity of 4.8 kWh/m^2/day and current installed capacity of solar power plant is 42.78 MW. Indonesia offers significant solar power resources (4.8 kilowatt-hours per square meter per day [kWh/m^2/day]), but the country has yet to develop a strong market. In 2013, Indonesia has installed 12.1 MW of solar power, which is mostly from roof-mounted solar photovoltaic (PV) cells in urban areas. The use of solar energy in Indonesia is still very low at about 8 MW in the form of Solar Home System for the supply of electricity in rural areas. The low utilization of solar energy potential due to the cost of equipment (solar panels) is still expensive. With the growing market demand for solar panels in the world, estimated future prices of solar panels will tend to fall. Therefore, solar energy utilization in Indonesia should be developed including the possible use of the integrated scheme with grid. The total installed capacity of solar energy from 2005 to 2009 of 31.94 MWp and in 2009 is increased of 4.83 MWp (or 35.8 %) [8].

19.5 Renewable Energy Potential in Sumba Island

Even though the island of Sumba clearly has a significant renewable energy potential, the electrification ratio in 2009 has lagged behind other provinces and is amongst the lowest in Indonesia with i.e. 24.55 %.

Delivering power on an island with a unique topography and its people living scattered around this large island is costly and logistically challenging. In order to increase the number of households that enjoy some form of electrification, national and local governments have supplied a variety of small RE power systems to those area which not served by the PLN grid. Desk research and field validation uncovered that Sumba has a significant renewable energy resources potential. Hydro, solar, wind and biogas (from cattle) resources have been identified on the islands and compared to many other island in Indonesia, Sumba Island really stands out [9]. Although Renewable Energy sources were found abundantly, similarly to other islands the development of renewable energy in Sumba Island has stayed behind in terms of growth and capacity compared to diesel fueled power generation which is still the main source of electric power. Figure 19.4 shows the renewable energy resources locations in Sumba Island.

Fig. 19.4 Map of Sumba Island with renewable energy resources identification

19.6 Hydro Resource Potential Assessment

The hydro energy resource potential is concentrated mostly in the western part of Sumba Island and in addition some sites are located in the central and eastern part Sumba Island. Sites in West Sumba with the most significant potential are the Lapopu and Lokomboro waterfall, which have a measured net 'head' of 70 and 45 m respectively. Both this hydro potential has been operated since 1999 with the total capacity of 3.9 MW. Meanwhile, in the East Sumba, the site with the most significant hydro potential site is the Lukat/Maidang water, which has a measured head of 15 meters and is located about 30 km up river Kambaniru. Kambaniru Dam (see Fig. 19.5) located just outside the capital of Waingapu was planned to be utilized for a micro hydro installation with an electric capacity of a total of 2 MW. The potential of hydro power resources in Sumba Island as shown in Table 19.1.

Fig. 19.5 Kambaniru dam, Lokomboro waterfall, and Lapopu waterfall

Table 19.1 Hydro energy potential

Site name	Debit (m^3/s)	Head (m)	Predicted power (kW)
Luku Waiwuang/Wanokaka River Waterfall Lapopu	1.12–20.6 Average 5.38	70	1,107
Luku Mareha/Kalada River Waterfall Lokomboro	0.38–6.48 Average 2.59	43.5	330
Waterfall Lukat	3.83	25	282
Waterfall Lowa	1.82	10	54
Luku Panggulamba River Waterfall Memboro	12.84	25	944
Kambaniru Dam	13.6–85.7 Average 38.9	5.4	618

19.7 Wind Resource Potential Assessment

The large potential of wind energy has been found at Hambapraing, Tanjung Mondu, and Lawola. Lawola is expected to have even better wind resources although the local grid is relatively far from this site (see Fig. 19.6). This site is closed to Lukat waterfall which poses some interesting options to combine hydro and wind resources in one system [10]. These three sites have a potential of about 129 to 181 MW. It is fair to conclude that the wind energy could play a very significant role in electrification of Sumba. A prediction of theoretical wind energy power potential on the island of Sumba as shown in Table 19.2.

Fig. 19.6 Wind energy farm at Kamanggi

Table 19.2 Prediction of wind energy potential

Wind Speed (m/s)	Power per square meter (W/m^2)	Available Area (km^2)	Power (GW)	Annual Energy (TW.h)
4.3–5.0	1.51–2.37	n/a	–	–
5.0–5.5	2.37–3.16	924	2,194–2,920	19,219–25,580
5.5–6.3	3.16–4.75	1.193	3,770–5,667	33,030–49,641
6.3–7.0	4.75–6.52	364	1,727–2,369	15,130–20,754
7.0–8.2	6.52–10.47	170	1,107–1,779	9,695–15,585
8.2–9.1	10.47–14.31	178	1,863–2,546	16,319–22,304

19.8 Solar PV Resource Potential Assessment

Being a tropical country, most of locations in Indonesia have a good solar radiation. The average daily solar insolation map above shows that Sumba has 5 kWh/m^2/day which means that sun shines 5 h a day with a solar radiation 1000 Watt/m^2. If Sumba Island has an area of 11,153 km^2, therefore the solar energy potential on the island is about 55,765 GW. On practically all locations in Sumba it is technically feasible to install either a stand-alone PV systems, such as solar home systems or grid connected PV systems, as all locations have good solar insolation. According to data from ESDM, up to 25 thousands PV modules have been installed in Sumba altogether. Figure 19.7 shows the installed PV in different locations.

19.9 Biogas Resource Potential Assessment

Domesticated animals are an integral part of Sumba's society which becomes apparent to anyone that travels through the island; villages a diversity of pigs, horses, goats, cows and buffaloes roam around either freely, or are held in open stables and even under the traditional Sumbanese houses that are built on a raised platform; the animals stay here during the night. Herds of cows and horses roam freely in Savanna alike grasslands in which a large part of the island and is covered [11]. In order to estimate the biogas potential in the different regencies in Sumba 2014 data was obtained from the statistical agency BPS on live stock. As expected, it was found that cattle density per capita on the island of Sumba in 2014 is shown in Table 19.3 (Fig. 19.8).

19.10 Biofuels Resource Potential Assessment

Sumba was planned to be targeted for large scale development of particularly Jatropha in 2007. Although coconut was dismissed by the head of the Agriculture and Plantations agency, it seems to be the most likely candidate for biofuels production on the island of Sumba. Sumba produces about 7,491 tons of coconut on a

Fig. 19.7 Installed solar panel system

Table 19.3 Large livestock population by kind and regency 2014

No	Regency	Cow	Buffalo	Horse	Pig	Goat/Sheep	Total	Inhabitants	Cattle/capita
1	West Sumba	2,585	16,611	5,526	81,003	4,173	109,898	103,481	1.06
2	Southwest Sumba	2,717	11,930	4,713	43,426	10,838	73,623	302,241	0.24
3	Central Sumba	7,788	7,920	7,341	47,225	4,674	74,921	65,606	1.14
4	East Sumba	50,435	34,469	29,336	97,933	52,815	264,985	241,416	1.09
	Total 2013	50,453	70,930	46,916	269,587	72,500	523,427	712,744	0.73

Fig. 19.8 Livestock population

yearly base and as it is such a common commodity it would be relatively easy to expand. In addition excess shell and peat could, once dried, be used for biomass boilers to generate electricity. A total of 12,074 ha of coconut is already yielding and another 15,143 ha has been planted which if exclusively used for biofuel could yield 75 million liter of Crude Coconut Oil. The largest producer of coconut is now South West Sumba producing almost 3600 ton in 2013, a figure that is likely to triple as almost double of the current yielding area is classified as not yielding yet. Coconut oil is suitable for the production of biodiesel and therefore it would potentially serve the demand for fuel for (1) diesel generating sets for power generation (2) diesel trucks and (3) diesel engine power boats. Harvested area for Cassava, a main feedstock for Bioethanol, which could power small generator sets, motorcycles and cars, is currently about 10,736 ha equivalent a total of 113,458 ton of cassava [6, 11].

19.11 Conclusion

To achieve the goal of implementation 100 % of renewable energy resources in Sumba Island, these three actions should be as follows:

1. Implementation of Sumba Iconic Island with the multi actors (government, private, Banking Institutions, NGOs, and Community) and multi-funding (APBN, Private Sector, Foreign Grants, and Community), which encourages stakeholders in the renewable energy sector contribute to the development renewable energy in Sumba.
2. The multi actors and multi funding have to synchronize the detail program with the Sumba Iconic Island road-map, that by 2020, the implementation of renewable energy resources is fully implemented in Sumba Island.
3. Through a multi-party strategic cooperation, it is hoped the program can be implemented and can be replicated to other areas, especially in the eastern part of Indonesia.

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