ICLEI Local Governments for Sustainability

100% RENEWABLES CITIES & REGIONS ROADMAP

Supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

based on a decision of the German Bundestag

100% Renewables Cities and Regions Roadmap

Initial Status Report of Deep-Dive Region: West Nusa Tenggara Province

ICLEI Indonesia

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ICLEI - Local Government for Sustainability

Jakarta, Indonesia

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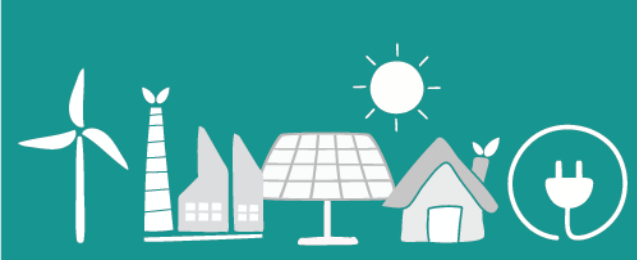

Executive Summary

ICLEI has selected West Nusa Tenggara as the deep-dive region for the 100% Renewables Cities and Regions Roadmap program. This Initial Status Report aims to learn the current renewable energy status of the deep-dive regions/cities; to understand the legal frameworks for project cities and regions; to identify the sources of funding and the processes for applying for financial support, and to evaluate the limitations and opportunities towards a 100% renewable energy transition in the deep-dive cities/region.

West Nusa Tenggara consists of two main islands, which are Lombok Island in the western part and Sumbawa Island in the eastern part. Sumbawa Island makes up two-thirds of the region, yet the density population in this area is quite low. The agriculture, forestry, and fisheries sectors have the highest contribution to the Gross Regional Domestic Product, while the tourism sector and the mining, energy, and electrical sectors have the highest investment realization in the region. In the last decade, West Nusa Tenggara faces several environmental challenges, particularly the increasing amount of municipal solid waste.

Both electricity generation and transportation sectors in West Nusa Tenggara are mostly powered by fossil fuels. However, the region relies on the other region to fulfill its fossil fuel demand. Consequently, energy security in the region is vulnerable. The electricity sector is provided by the Lombok grid system and the Sumbawa-Bima grid system. PLN, a state-owned electricity company, has an exclusive power for electricity transmission, distribution, and retailing in the area. In the electricity generation sector, private entities have a small proportion of electricity provision in the area. Surprisingly, the greenhouse gas emission in the region mainly comes from the agricultural sector, followed by the energy sector.

Energy governance in the region follows national and local frameworks. Energy Law No.30/2007 and Electricity Law No. 30/2009 are the basis for the development of the National Energy Plan (RUEN) and PLN's electricity provision plan (RUPTL) document. Under the RUEN, the Provincial Government is mandated to develop the Regional Energy Plan (RUED). West Nusa Tenggara enforces its RUED since 2019.

West Nusa Tenggara has abundant and diverse renewable energy potential. Solar radiation in the region is among the highest in Indonesia. However, the wind speed in the region is much lower compared to other countries in the Asia Pacific Region. The Sumbawa Regency has the highest hydropower potential in the region. Ocean's current energy and Ocean Thermal Energy Conversion (OTEC) in West Nusa Tenggara is quite abundant too, yet there is no development of this kind of power plant in the region. Interestingly, the region has remarkable bioenergy and waste energy potential. Despite its abundant renewable energy potential, the installed capacity in the region is still low.

Stipulated in its local energy general plan (RUED), West Nusa Tenggara has commitments to increase renewable energy share in the electricity generation. To achieve this, the local government develops a matrix activity plan. Although the commitment is there, under PLN's RUPTL 2019-2028 the number of on-going and planned renewable energy plants in the region is still low.

The development of renewable energy projects in West Nusa Tenggara can be implemented through three different business models: public-private partnership (PPP), IPP's project under PLN's regular program, and small-scale electricity business in rural and isolated areas. The ownership of this business can be purely a public asset, purely a private asset, or a combination of public and private share. The financial access for renewable energy projects in West Nusa Tenggara can be obtained from regional income (with limited allocation), from private entities, or by submitting a proposal through several national financing schemes, such as through the Non-Government Budget Equity Financing (PINA), IIGF for PPPs, Viability Gap Fund for PPP, or the Infrastructure Financing Fund. While access to financing is not the only barrier to implementing renewables in the region, several opportunities are available to enable RE projects development and deployment.

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List of Abbreviations

ADB	Asian Development Bank
BAPPEDA	Regional Development Planning Agency
BAPPENAS	National Development Planning Agency
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
BPS	Statistics Indonesia
BUMN	State-owned Enterprise
BUMD	Regional-owned Enterprise
BUMDes	Village Enterprise
COD	Commercial Operation Date
DEN	National Energy Council
DESDM	Regional Energy Agency
DPR	House of Representatives
EBTKE	New and Renewable Energy and Energy Conservation
EE	Energy Efficiency
EPC	Engineering, Procurement, and Construction
ER	Electrification Ratio
FiT	Feed-in-tariff
GHG	Greenhouse Gases
GoI	Government of Indonesia
GR	Government Regulation
GRDP	Gross Regional Domestic Product
GWh	Gigawatt-hours
IPP	Independent Power Producers
KEN	National Energy Policy
kl	Kiloliters
kWh	Kilowatt-hours

LPG	Liquefied Petroleum Gas
MEMR	Ministry of Energy and Mineral Resources
MoF	Ministry of Finance
MoSOE	Ministry of State-Owned Enterprises
MoPW	Ministry of Public Work
MTOE	Million Tons of Oil Equivalent
MW	Megawatts
Pertamina	National Oil Company
PLN	State-Owned Electricity Company
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PR	Presidential Regulation
RE	Renewable Energy
RUED	Regional Energy Plan
RUEN	National Energy Plan
RUKD	Regional Electricity Plan
RUKN	National Electricity Plan
RUPTL	PLN's Electricity Provision Plan
SPC	Special Purpose Company
sq.km	Square Kilometers
UPTL	Small-scale Electricity Supply Business
WNT	West Nusa Tenggara
WQI	Water Quality Index

Chapter 1 Region Overview

West Nusa Tenggara (WNT) Province has been chosen as the deep-dive region for 100% Renewables Cities and Regions Roadmap, supported by the Ministry of Energy and Mineral Resources (MEMR) through its Geothermal Directorate. The selection of the province as the deep-dive region is important to accelerate the achievement of renewable energy (RE), energy efficiency (EE), and electrification ratio (ER) targets, and to match the continuous energy demand in the future and the replication potential of the project to other provinces. Mataram City and Sumbawa Regency have been selected as the deep-dive cities for 100% Renewables Cities and Regions Roadmap.

The provision of this **Initial Status Report** serves as a starting point for planning the 100% Renewables Cities and Regions Roadmap of West Nusa Tenggara. The objectives of this report are:

- to learn the current RE status and projects of the deep-dive regions/cities;
- to understand the legal frameworks for project cities and regions;
- to identify the sources of funding and the process of applying for finance; and
- to evaluate the limitations and opportunities towards a 100% RE in the deep-dive cities/region.

West Nusa Tenggara is one of 34 provinces in Indonesia. The following Table 1 presents the summaries of the population, economy, energy status, and social indicators of West Nusa Tenggara.

Table 1 General overview of West Nusa Tenggara. Source: BPS of WNT 2020 [1].

Sector	Notes
Geography	
Location	The province has boundaries as follows: North – Java Sea; South – Indian Ocean; West – Bali Province; East – East Nusa Tenggara Province.
Area	The total area of the province reaches 20,124.48 sq.km in which Sumbawa Island makes up two-thirds of the province area.
Climate/Weather	Tropical climate; mean annual temperature of 27 °C and ranges between 21°C and 36°C. West Nusa Tenggara has relatively little rainfall compared to the western region of Indonesia.
Population	
Inhabitant	5,070,385 inhabitants with 51.5% female and 48.5% male, or a sex ratio of 94.36 in 2019.
Population Density	252 people per sq.km
Age Distribution	0-14 years (29.2%), 15-64 years (65.5%), 65+ years (5.3%)
Number of Households	1,407,554 with a mean household size of 3.6
Government	
Capital	Mataram City
Number of Cities/Regencies	West Nusa Tenggara has 2 (two) municipalities and 8 (eight) regencies spreading over 2 (two) main islands. These include Mataram City, West Lombok, Central Lombok, East Lombok, and North Lombok at Lombok Island;

	and Bima City, Sumbawa, Dompu, West Sumbawa, and Bima at Sumbawa Island.
Economic	
Dependency Ratio	52.61%
Resources	Agriculture, Forestry, Fisheries, Mining
Main Economic Activities/Industries	Dominant primary sector economy: Food Crops Agriculture, Livestock, Fisheries, Tourism, Ore Mining, Food and Beverage Manufacturing, Tobacco Products Manufacturing, Wholesale and Retail Trade.
Infrastructure	Lombok International Airport, Sultan Kaharudin Airport Sumbawa, Sultan Salahudin Airport Bima, Bima Port, Badas Port, Lembar Port
Education	
Number of Institutions	3,223 (Primary School), 958 (Junior High School), 333 (Senior High School), 325 (Vocational High School)
Enrolment	63,842 students (Primary School), 175,307 (Junior High School), 105,398 (Senior High School), 80,032 students (Vocational High School)
Tertiary Institution	1 Public Universities and 54 Private Universities
Health	
Health Facilities	34 Hospitals, 76 Polyclinics, 169 Public Health Centers, 520 Subsidiaries of Public Health Center, 258 Pharmacies
Prevalent Diseases	Malaria, Tuberculosis, Leprosy, Diarrhea, Dengue Hemorrhagic Fever, AIDS
Access to Energy	
Grid Electrification Rate	99.55% in 2019
Electricity Consumption	1,778.8 GWh as at the year 2018
Energy Sources	The use of gas/LPG, kerosene, and firewood for cooking is prevalent in the Province at 58.20%, 18.97%, and 21.44% respectively.

1.1 Population

The annual population growth rate in the province from 2018 to 2019 was approximately 1.13% [1]. Table 2 shows that Mataram City has the largest population density, at 7,940 people per sq.km, while Sumbawa Regency has the lowest population density, at 69 people per sq.km in 2019 [1]. This population density difference can have an impact on the energy profile and energy provision's strategy in both deep-dive cities.

Table 2 Total area and population by Regency/Municipality in West Nusa Tenggara 2019. Source: BPS of WNT 2020 [1].

Regency/Municipality	Area (sq.km)	%	Population (people)	%	Population Density (people per sq.km)
Lombok Island					
1. Mataram City	61.30	(0.30)	486,715	(9.60)	7,940
2. West Lombok	1,053.87	(5.24)	694,985	(13.71)	659
3. Central Lombok	1,169.58	(5.81)	947,488	(18.69)	810
4. East Lombok	1,605.55	(7.98)	1,200,612	(23.68)	748
5. North Lombok	809.53	(4.02)	220,412	(4.35)	272
Sumbawa Island					
6. Bima City	222.25	(1.10)	173,031	(3.41)	779
7. Sumbawa	6,643.98	(33.01)	457,671	(9.03)	69
8. Dompu	2,320.00	(11.53)	252,288	(4.98)	109
9. West Sumbawa	1,849.02	(9.19)	148,606	(2.93)	80
10. Bima	4,389.40	(21.81)	488,577	(9.64)	111
Total	**20,124.48**	**(100)**	**5,070,385**	**(100)**	**252**

1.2 Geographical and Location

West Nusa Tenggara lies between 115°46'-119°5' East longitude and 8°10'-9°5' South latitude [1]. The province consists of two main islands, which are Lombok Island in the western part and Sumbawa Island in the eastern part (Figure 1). In addition to the main islands, the province has hundreds of small islands. Of the 421 islands that exist, only 39 of these are inhabited [2]. According to Table 2, Sumbawa Regency has the largest area, at 6,643.98 sq.km, while Mataram City has the smallest area, at 61.30 sq.km [1, 2].

Figure 1 West Nusa Tenggara consists of two main islands. Source: Google Map 2020.

The land area in West Nusa Tenggara can be classified into several categories based on its utilization (Table 3). As shown in Table 3, both Mataram City and Sumbawa Regency had different land-use coverage in 2017 [3]. Settlement areas cover more than half of Mataram City. In contrast, less than a quarter of the land area in the Sumbawa Regency was used for settlement. More than one-third of the regency area was a primary forest in 2017 [3]. The difference in land utilization in Mataram City and the Sumbawa Regency can impose different RE strategies in both places.

Table 3 The land usage and its area of the deep-dive cities/regions in 2017. Source: BPS of WNT 2017 [3].

Land Usage	WNT Province (sq.km)	Mataram City (sq.km)	Sumbawa Regency (sq.km)
Agricultural and Forestry			
1. Rice Fields	2,801.25	19.27	613.46
2. Dryland Cultivation	3,909.50	0.72	944.55
3. Pastureland	233.50		35.38
4. Primary Forest	7,166.44		2772.24
5. Secondary Forest	1,276.81		869.41
6. Temporary Unused Land	473.17		161.72
7. Other	1066.65	4.04	252.93
Non-Agricultural and Forestry (Settlements)	3197.20	37.27	994.29
Total	**20,124.48**	**61.30**	**6643.98**

1.3 Economy

The Gross Regional Domestic Product (GRDP) of West Nusa Tenggara in 2019 amounted to 132.67 trillion Rupiah, while in 2018 it was 123.97 trillion Rupiah [1]. Generally, the GRDP of West Nusa Tenggara had a growth between 2016 and 2019. In 2019, agriculture, forestry, and fisheries sector dominated the economy of the province followed by the wholesale and retail trade sector (Table 4). The contribution of the agricultural, forestry, and fisheries sector in 2019 reached 22.89% [1].

Table 4 Gross Regional Domestic Product at 2010 constant market prices by industry (billion rupiahs), 2015–2019. Source: BPS of WNT 2020 [1].

Sector	2016	2017	2018	2019
Agriculture, Forestry, and Fisheries	24,661.77	27,183.24	29,067.12	30,368.89
Mining and Quarrying	26,231.97	24,108.62	17,317,57	17,995.65
Manufacturing	4,511.47	4,918.19	5,111.38	5442.73
Electricity and Gas	73.73	90.62	97.50	106.27
Water Supply and Waste Management	98.35	105.62	101.75	105.46
Construction	9,892.83	10,961.23	11,809.06	13,986.70
Wholesale and Retail Trade	14,506.18	16,387.95	17,955.03	19,795.66
Transportation and Storage	8,209.18	9,000.93	9,312.57	9,650.36
Accommodation and Food Services	2,503.44	2,747.48	2,660.23	2,696.56
Information and Communication	2,045.15	2,303.21	2,456.65	2,598.26
Financial and Insurance	3,701.24	4,245.90	4,692.48	4,840.13
Real Estate	3,498.44	3,793.67	4,099.76	4,363.71
Business Activities	193.12	211.10	226.62	245.13
Public Administration and Defense	6,991.65	7,437.80	7,818.22	8,174.65
Education	5,152.31	5,680.64	6,122.06	6,700.49
Human Health and Social Work	2,006.42	2,186.85	2,450.13	2,685.38
Other Services	2,187.54	2,459.70	2,667.80	2,918.13
Gross Domestic Product	**116,464.76**	**123,822.77**	**123,965.94**	**132,674.15**

Between 2016 and 2018, West Nusa Tenggara received a significant amount of funding (Table 5). The province received a total of 9.9 trillion Rupiah in 2016 [4], 11.3 trillion Rupiah in 2017 [5], and 13.5 trillion Rupiah in 2018 [6]. While agricultural, forestry, and fisheries sector had the highest share of GRDP between 2016 and 2018, the tourism sector and the mining, energy, and electrical sector were two sectors that had the highest investment realization during that period.

In 2018, 7,089 billion Rupiah of domestic investment and 2,524 billion Rupiah of foreign investment was spent on the mining, energy, and electricity sectors [6]. Additionally, 1,447 billion Rupiah of domestic investment and 597 billion Rupiah of foreign investment was allocated for the tourism sector in 2018 [6]. It indicates that both sectors were emerging in West Nusa Tenggara. Additionally, Mandalika in Lombok Island has been chosen as one of the Special Economic Zones in Indonesia focusing on tourism development. The Investment Coordinating Board (BKPM) estimated that Mandalika can attract 28.63 trillion Rupiah of investment until 2025 [7]. Therefore, the 100% Renewables Cities and Regions Roadmap can be designed to accommodate the energy needs in these sectors, such as the provision of renewable energy systems for ecotourism.

Table 5 Domestic and foreign investment realization by economic sector from 2016 to 2018. Source: Investment Agency of WNT 2016, 2017, and 2018 [4, 5, 6].

Sector	Domestic Investment			Foreign Investment		
	2016	2017	2018	2016	2017	2018
Agriculture				3 Billion		170 Billion
Plantation	177 Billion					
Husbandry						
Fisheries	72 Billion		38 Billion	173 Billion	63 Billion	63 Billion
Forestry						
Mining, Energy, and Electricity	50 Billion	8,259 Billion	7,089 Billion	6,582 Billion	147 Billion	2,524 Billion
Manufacturing	11 Billion	125 Billion	155 Billion	4 Billion	13 Billion	38 Billion
Tourism		284 Billion	1,447 Billion	2,110 Billion	1,434 Billion	596 Billion
Transportation	36 Billion		774 Billion			0.1 Billion
Service	1 Billion	245 Billion	394 Billion	606 Billion	510 Billion	144 Billion
Trading	64 Billion	162 Billion	75 Billion	9 Billion	38 Billion	17 Billion
Total	**411 Billion**	**9,075 Billion**	**9,972 Billion**	**9,487 Billion**	**2,205 Billion**	**3,552 Billion**

1.4 Current Environmental Challenges

West Nusa Tenggara is facing several environmental issues. According to the Information on Regional Environmental Management Performance Document published in 2019, there are three priority issues in the province [8].

1.4.1 Land-use Change

In the last decade, the government of West Nusa Tenggara promoted the corn plantation program in the region. The presence of this program increased corn production dramatically from 786,864 tons in 2014 to 2,959,22 tons in 2018 [8]. However, the program has also led to the expansion of the crop areas into forests, causing land degradation and damage to natural ecosystems. In 2018, the size of critical land in the province was around 657 sq.km in which about 481 sq.km of the area was the forestry area [8].

1.4.2 Water Contamination

The Water Quality Index (WQI) in West Nusa Tenggara was 53.50 in 2014 [8]. This number then decreased significantly by approximately 40% to 31.34 in 2018 [8]. The monitoring result showed that two rivers in the province, Rabajalu, and Padolo rivers, were heavily contaminated by domestic waste. It happened due to the lack of awareness of the community in the surrounding areas.

1.4.3 Solid Waste Management Issue

Figure 2 shows the existing solid waste management in the region. In 2018, only 20% of the total solid waste generated in the region was treated (went to landfills) while the rest of the waste was untreated [8]. Therefore, in 2019, the government of West Nusa Tenggara launched the Zero Waste Program. This program aims to reduce solid waste generation by 30% and to increase the proportion of treated waste, up to 70%, by

2023 [8]. To reach the objective, the government of West Nusa Tenggara proposes a new solid waste management flowchart (Figure 3). Furthermore, they consider the development of the waste-to-energy plants as one measure to achieve the target [8].

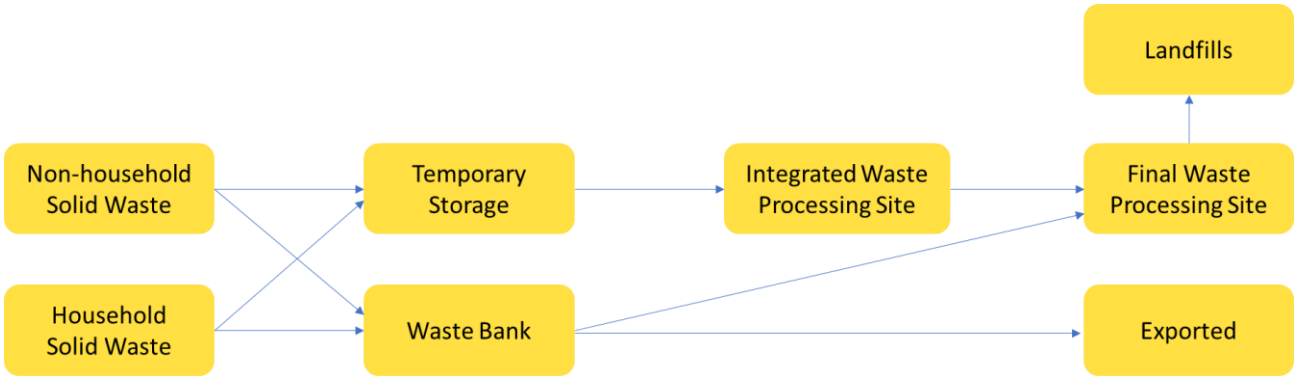

Figure 2 Existing solid waste management practice in the region.
Source: Environmental and Forestry Agency of WNT 2019 [8].

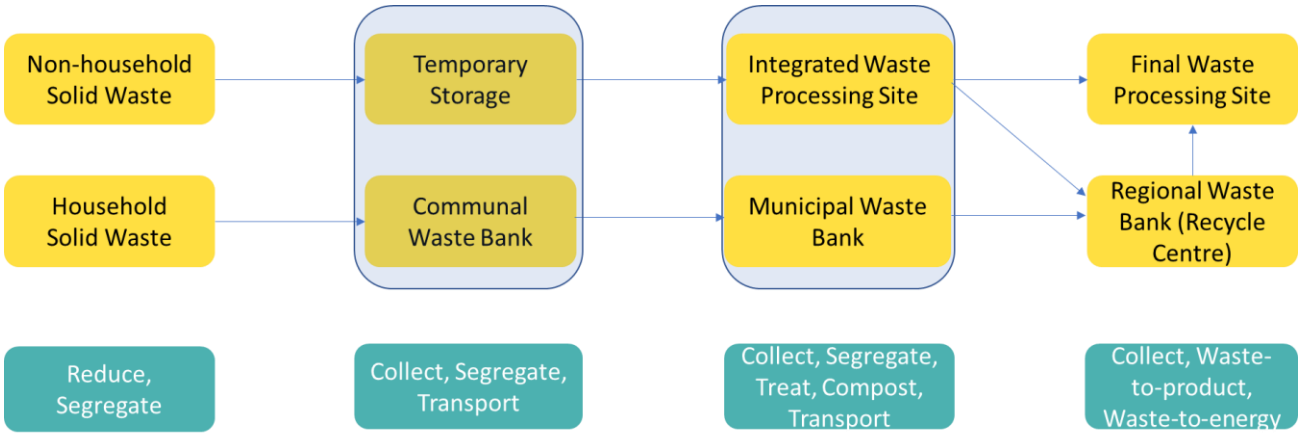

Figure 3 Future solid waste management practice in the region.
Source: Environmental and Forestry Agency of WNT 2019 [8].

Chapter 2 Energy Profile of West Nusa Tenggara

2.1 Current Electricity/Energy Consumption

2.1.1 Electricity Sector

The electricity sales in West Nusa Tenggara are performed by the state-owned electricity company (PLN). Table 6 compares the electricity sales in the region from 2015 to 2018 in three different PLN branches [9, 10, 11, 2]. According to the table, the Mataram branch had the highest demand comprising of almost three quarters of electricity demand in West Nusa Tenggara. Additionally, electricity consumption in these three branches always increased between 2015 and 2018.

Table 6 Electricity consumption in West Nusa Tenggara by locations.
Source: BPS of WNT 2016,2017,2018, and 2019 [9, 10, 11, 2]

	2015	2016	2017	2018
Mataram	998.45 GWh	1,152.26 GWh	1,206.46 GWh	1,252.50 GWh
Sumbawa	194.75 GWh	208.12 GWh	227.47 GWh	264.40 GWh
Bima	209.09 GWh	230.95 GWh	243.62 GWh	259.91 GWh
Total	**1,402.29 GWh**	**1,591.33 GWh**	**1,677.54 GWh**	**1776.81 GWh**

The electricity consumption based on consumer groups is shown in **Error! Not a valid bookmark self-reference.** [12, 13, 14, 15]. The household sector is the top consumer, using approximately 63% of electricity produced in the region. The electricity consumption in most categories always increased, except for that used for public street lighting. There was a significant rise in electricity demand in the industrial sector from 85.52 gigawatt-hours (GWh) in 2017 [14] to 105.82 GWh in 2018 [15].

Table 7 Electricity consumption in West Nusa Tenggara by sector of customers.
Source: Directorate General of Electricity 2016,2017,2018, and 2019 [12, 13, 14, 15]

Sector	2015	2016	2017	2018
Household	919.76 GWh	1,026.96 GWh	1,074.58 GWh	1,129.51 GWh
Industrial	68.93 GWh	77.17 GWh	85.52 GWh	105.82 GWh
Commercial	280.67 GWh	331.30 GWh	352.40 GWh	367.90 GWh
Social	46.67 GWh	56.92 GWh	62.53 GWh	69.02 GWh
Government Office	29.45 GWh	37.96 GWh	49.02 GWh	45.93 GWh
Public Street Lighting	56.82 GWh	61.01 GWh	53.49 GWh	58.63 GWh
Total	**1,402.29 GWh**	**1,591.33 GWh**	**1,677.54 GWh**	**1776.81 GWh**

Figure 4 depicts the monthly electricity profile of the region from January to December for four years, between 2015 and 2018 [9, 10, 11, 2]. It can be seen from the figure that the electricity consumption always decreased in February. Another interesting phenomenon is that electricity consumption in 2018 dropped in August and

September. It happened after a 6.4-magnitude earthquake struck the island of Lombok on 29 July 2018. It indicates that natural disasters can disrupt the energy system in the region.

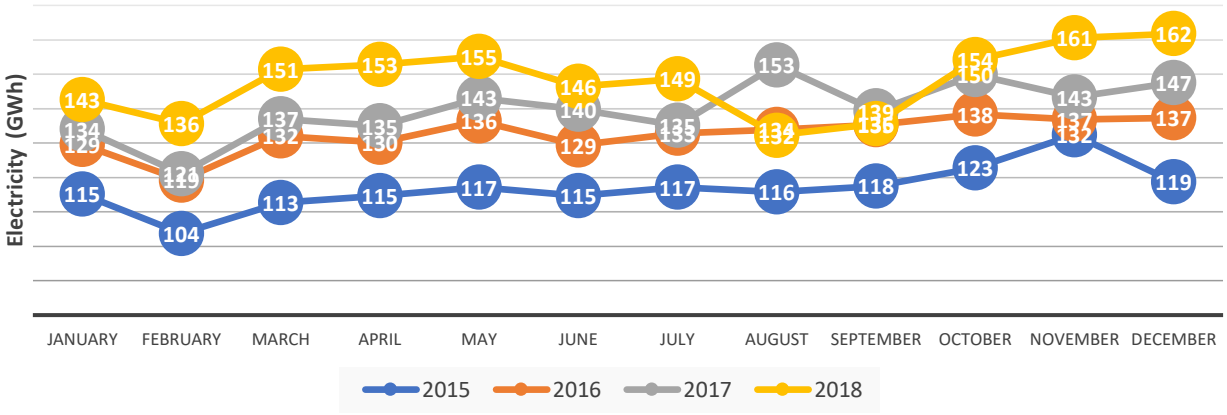

Figure 4 Monthly electricity profile in West Nusa Tenggara. Source: BPS of WNT 2016,2017,2018, and 2019 [9, 10, 11, 2]

2.1.2 Heating and Cooling Sector

The percentages of households that utilize gas/LPG, kerosene, and firewood for cooking are at 58.20%, 18.97%, and 21.44%, respectively [1]. In 2017, 39,000 kiloliters (kl) of kerosene was consumed [16]. From April to October 2019, around 61,916 metric tons of LPG was used in the province [17]. The kerosene and LPG consumption data are provided by Pertamina as the official distributor.

2.1.3 Transportation Sector

The fuel consumption data is provided by Pertamina as the official distributor of fuels. West Nusa Tenggara still relies on fossil fuels for its transportation sector. There are three types of fuels consumed in the region in the transportation sector, namely RON 88 (Premium), RON 90 (Pertalite), and Diesel. RON 88 means that 88% of the contents are octane while RON 90 means that 90% of the contents are octane. The higher the octane number, the higher the oil ability to fight auto-ignition.

The consumption of fuel in the region is dominated by gasoline, particularly RON 88 (Premium) which is subsidized by the government. While the subsidies for RON 88 are meant to financially support low to middle-class citizens, the lack of government regulation means above-middle class citizens would also avail of this subsidized fuel. In 2018, the consumption of RON 88 gasoline in the Sumbawa Regency and Mataram City was 41,304 kl and 40,712 kl, respectively [18]. Mataram City had lower consumption of RON 88 consumption than the Sumbawa Regency, yet they had the highest consumption of RON 90 in the region in 2018, at 27,165 kl [18]. Meanwhile, Sumbawa Regency had the highest consumption of diesel fuel at 28,143 kl in 2018 [18]. Diesel is commonly used for trucks and heavy industry vehicles.

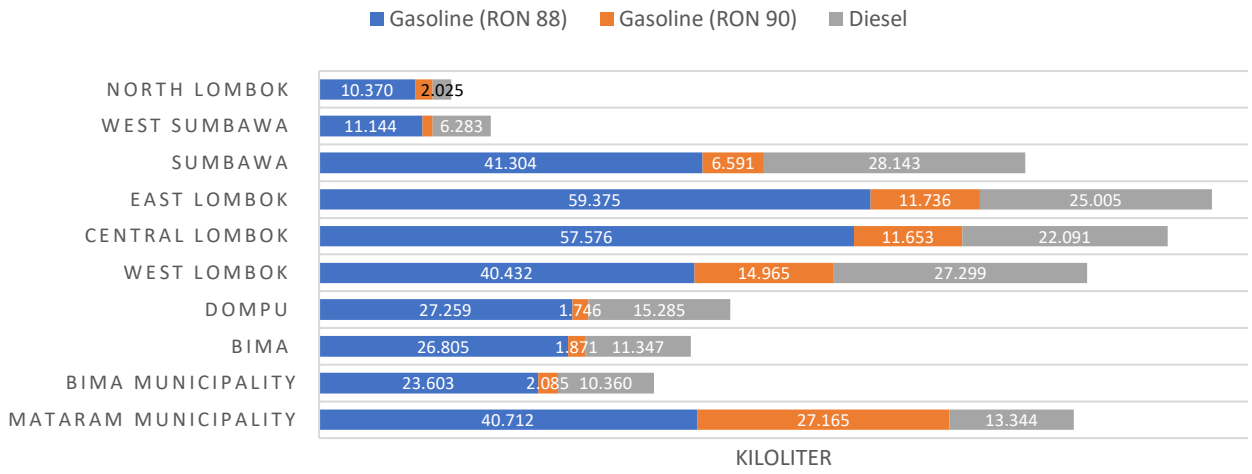

Figure 5 Fuel consumption in West Nusa Tenggara in 2018. Source: Pertamina 2019 [18].

2.2 Electricity/Energy mix for the Installed Generation Capacity

2.2.1 National Level

The total installed capacity in Indonesia in 2018 is 64,924.80 megawatts (MW) [15]. Approximately 63% of this installed capacity is developed by PLN, which has the mandate to produce and supply electricity. Independent Power Producers (IPP) own about 23% of the generation. Unfortunately, renewable energy accounts for only 15.04% of Indonesia's generation mix [15].

2.2.2 Electricity Generation in West Nusa Tenggara

Total electricity generation in West Nusa Tenggara in 2018 was 1,992.6 GWh, where 74% of the generation came from PLN [15]. There is no electricity import or export in the region. Diesel power plants dominate the electricity generation of PLN followed by the steam power plants. Solar power plants and the hydro ones have a lower share in the electricity generated by PLN (Figure 6).

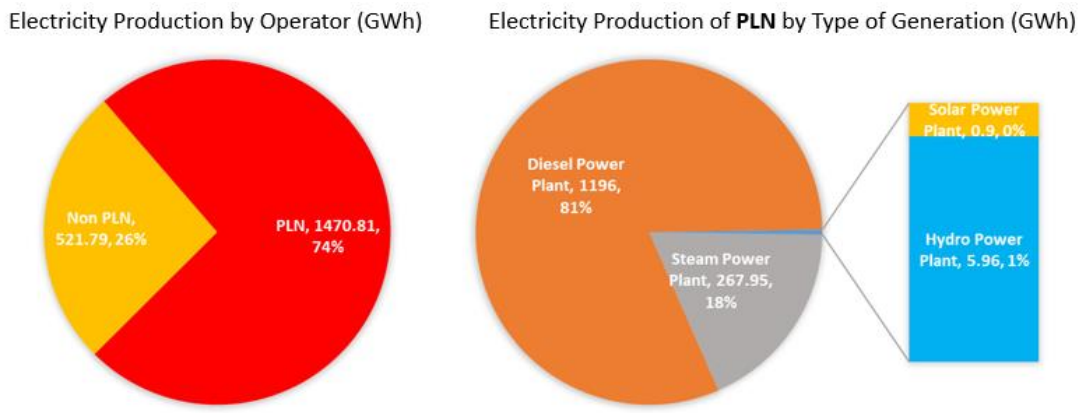

Figure 6 Electricity generation in West Nusa Tenggara in 2018. Source: Directorate General of Electricity 2019 [15]

West Nusa Tenggara still relies on fossil fuels either for supplying the final energy demand or for generating electricity. To generate electricity in 2018, PLN required 302,400 kl diesel fuel, 35,758 kl fuel oil, and 229,175 tons of coal [15]. Because there are no crude oil deposits and oil refineries in the province, they are depending on imports from other regions. Consequently, it has a significant impact on the energy security of the province.

2.3 Electrical/Energy Actors

2.3.1 Electricity Generation

The regional power grid in West Nusa Tenggara has an installed capacity of 612.48 MW as of 2018 [15], in which approximately 63% of this installed capacity is owned by PLN (Table 8). Diesel power plants constitute 73.39% of PLN's total installed capacity, at 283.62 MW of 386.44 MW [15]. The peak demand in 2018 was 226.17 MW in Lombok Island and 86.79 MW in Sumbawa Island.

In addition to PLN, three other groups develop power plants in the province. The **Ministry of Energy Mineral Resources** (MEMR) had built a total of 1.96 MW communal hydro and solar energy by 2018 [15]. Additionally, 63 MW of power plant has been established by **Independent Power Producers** (IPP) in which 50 MW is diesel power plants [15]. 161.08 MW of diesel power plants have been developed by **Operating License Holders** (IO) [15]. Operating license holders are entities that have permits to develop power plants for personal usage.

Table 8 Electricity generation in West Nusa Tenggara based on installed capacity in 2018.
Source: Directorate General of Electricity 2019 [15]

Operator		Installed Capacity (MW)						
		Steam PP	Gas PP	Diesel PP	Mini Hydro PP	Micro Hydro PP	Solar PP	Total
PLN		50.00	50.00	283.62	1.50	0.50	0.82	**386.44**
Non-PLN	MEMR					0.44	1.52	**1.96**
	IO	161.08						**161.08**
	IPP	50.00			1.30	11.70		**63.00**
Total		**261.08**	**50.00**	**283.62**	**2.80**	**12.64**	**2.34**	**612.48**

2.3.2 Electricity Transmission, Distribution, and Retailing

PLN has exclusive powers over the transmission, distribution, and sales of electricity to the public in the West Nusa Tenggara. The province has two grid systems, namely Lombok Grid System (Figure 7) for Lombok Island and Sumbawa-Bima Grid System (Figure 8) for Sumbawa Island. Lombok Grid System is a 150-kV network stretching from Mataram to East Lombok [19]. Sumbawa Grid System consists of a 70-kV network stretching from Taliwang to Alas and a 20-kV network serving Sumbawa Besar [19]. Bima Grid System is a 70-kV network serving Bima Municipality, Bima, and Dompu [19]. Several small and isolated systems are distributed over small islands in the region. The power systems in Gili Trawangan, Gili Meno, and Gili Air have been connected to the mainland Lombok Grid System through a 20-kV sea cable since 2012. The details of the transmission and distribution system in the region are shown in Table 9.

Table 9 Electricity transmission and distribution. Source: Directorate General of Electricity 2019 [15]

Type	Network	Length (Km-Circuit)	Transformer (Units)	Capacity (MVA)
Transmission	High Voltage 150 kV	405.02	19	700.00
	High Voltage 70 kV	138.67	6	150.00
Distribution	Medium Voltage (15 – 20 kV)	6,003.70	5,310	667.69
	Low Voltage (< 6 kV)	6,838.55	-	-

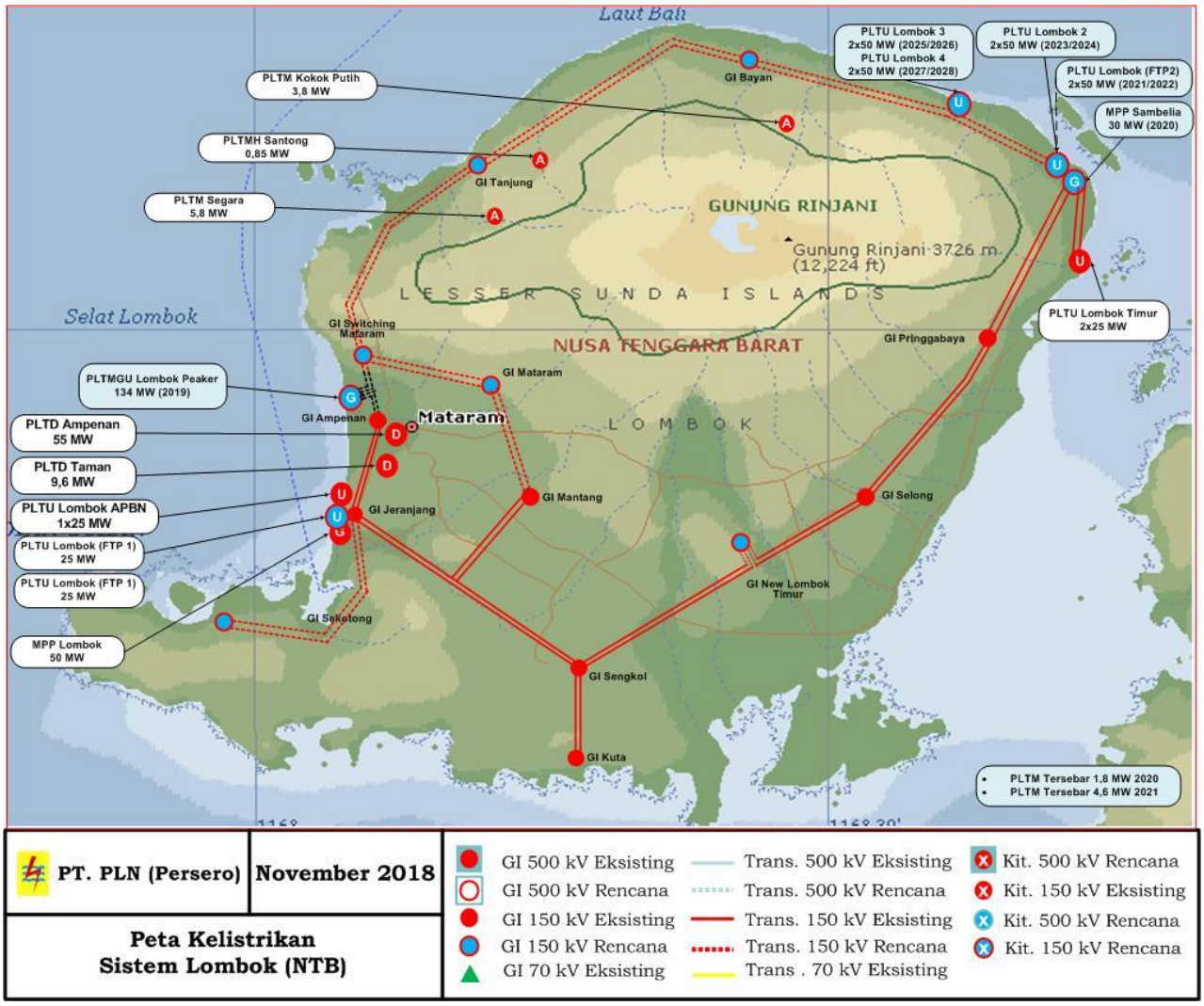

Figure 7 Lombok grid system. Source: PLN 2019 [19]

2.3.3 Non-Electricity Provider

The distribution of petroleum-derived liquid, such as gasoline and diesel, and liquified petroleum gas (LPG) is provided by Pertamina. The oil-fuel provision in West Nusa Tenggara Province is supplied from other regions through three depots: Ampenan, Badas, and Bima depots [20]. Those depots are in charge to distribute oil fuel (gasoline, kerosene, avtur) for three regions, including Lombok, Sumbawa, and Bima.

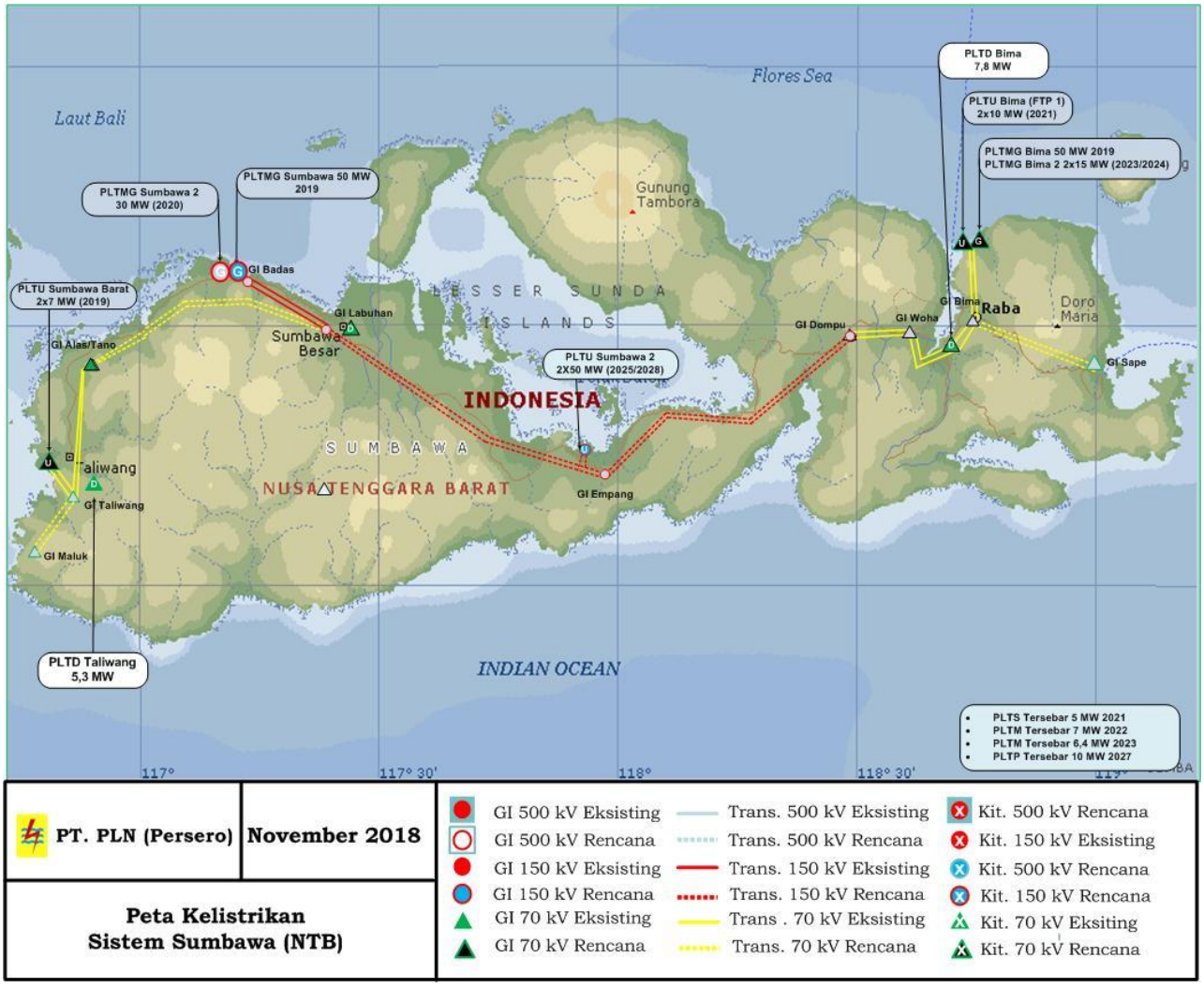

Figure 8 Sumbawa-Bima grid system. Source: PLN 2019 [19]

2.4 Electrical Energy and Fuel Pricing

2.4.1 National Level

2.4.1.1 Electricity Tariff

The electricity retail tariff in Indonesia is regulated by the Ministry of Energy and Mineral resources (MEMR) Regulation No. 28/2016 [21]. Table 10 shows the electricity retail tariff in Indonesia.

Table 10 Electricity Retail Tariff in Indonesia. Source: PLN 2020 [21]

Code	Customer	Capacity	Unit	Tariff
R-1/TR	Small Household	< 450 VA/900 VA	IDR/kWh (0-30 kWh) IDR/kWh (30-60 kWh) IDR/kWh (60+ kWh)	169/275 360/445 495/495
R-1/TR	Small Household	900 VA-RTM	IDR/kWh	1,352.00

R-1/TR	Small Household	1300 VA/2200 VA	IDR/kWh	1,467.28/1,467.28
R-2/TR	Medium Household	3500 VA – 5500 VA	IDR/kWh	1,467.28
R-3/TR	Large Household	>6600 VA	IDR/kWh	1,467.28
B-1/TR	Small Business	900 VA	IDR/kWh (0-108 kWh) IDR/kWh (108+ kWh)	420 465
B-1/TR	Small Business	1300 VA/2200-6600 VA	IDR/kWh	966/1100
B-2/TR	Medium Business	6600 VA – 200 kVA	IDR/kWh	1,467.28
B-3/TM	Large Business	>200 kVA	IDR/kWh (peak) IDR/kWh (off-peak) IDR/kVArh	K x 1,035.78 1,035.78 1,114.74
I-1/TR	Small Industry	3,500 VA – 14 kVA	IDR/kWh	1,112
I-2/TR	Small Industry	14 kVA – 200 kVA	IDR/kWh (peak) IDR/kWh (off-peak) IDR/kVArh	K x 972 972 1,057
I-3/TM	Medium Industry	>200 kVA	IDR/kWh (peak) IDR/kWh (off-peak) IDR/kVArh	K x 1,035.78 1,035.78 1,114.74
I-4/TT	Large Industry	>30000 kVA	IDR/kWh IDR/kVArh	996.74 996.74
P-1/TR	Small Government Office	6600 VA – 200 kVA	1,467.28	
P-2/TM	Large Government Office	>200 kVA	IDR/kWh (peak) IDR/kWh (off-peak) IDR/kVArh	K x 1,035.78 1,035.78 1,114.74
P-3/TR	Street Lighting		1,467.28	
L/TR, TM, TT	Special Service		1,644.52	
Peak Hour (18.00 – 22.00); Off-peak Hour (22.00 – 18.00); K is a constant between 1.4 and 2				

2.4.1.2 Electricity Supply Cost

The **average generation cost** (BPP) of electricity in Indonesia is **7.86 cents US$/kWh** [22]. BPP is a benchmark used to determine the tariff regimes for renewable electricity generation.

2.4.1.3 Fuel Cost

The fuel cost in Indonesia is regulated by the Ministry of Energy and Mineral resources (MEMR) Decree No. 187K/10/MEM/2019 [23]. Like in any other country, the prices of petroleum products in Indonesia are subject to fluctuations. These prices are constantly updated by Pertamina over short periods and the prices are varied depending on the location [23].

2.4.2 Local/Regional level

2.4.2.1 Electricity Tariff

The electricity retail tariff in West Nusa Tenggara follows the national tariff as depicted in Table 10. According to 2018 PLN Statistics, **the average tariffs per consumer sector in West Nusa Tenggara** were 374 rupiahs for residential sector, 1,152 rupiahs for industrial and commercial sectors, 647 rupiahs for social sector, 1,186 rupiah for government offices, and 1,459 for streetlighting.

2.4.2.2 Electricity Supply Cost

The average generation cost (BPP) of the province is among the highest in all of Indonesia. The region does not have significant fossil fuel resources and a connection to any of the other major grids in Indonesia. The combination of lack of fossil fuel resources, the dependency of diesel for power generation and low economies of scale results in **power prices in Lombok at 14.35 cents US$/kWh**, while **in Sumbawa the power prices at 19.18 cents US$/kWh**, which are considerably higher than the **national average** [22].

2.4.2.2 Fuel Cost

The fuel cost in West Nusa Tenggara is 6,450 rupiah/liter for RON 88 (Premium), 7,650 rupiah/liter for RON 90 (Pertalite), 9,400 rupiah/liter for diesel, and 11,550 rupiah/liter for kerosene [23].

2.5 Greenhouse Gases (GHG) Emission Profiles and Trends

Figure 9 shows the emission profile in West Nusa Tenggara in all sectors while Figure 10 shows the emissions in the energy sector [24]. The agricultural sector had the highest emission share from 2000 to 2014 (except in 2007) followed by the energy sector. In the energy sector itself, the main source of emission during the period came from the transportation sector followed by the power generation sector.

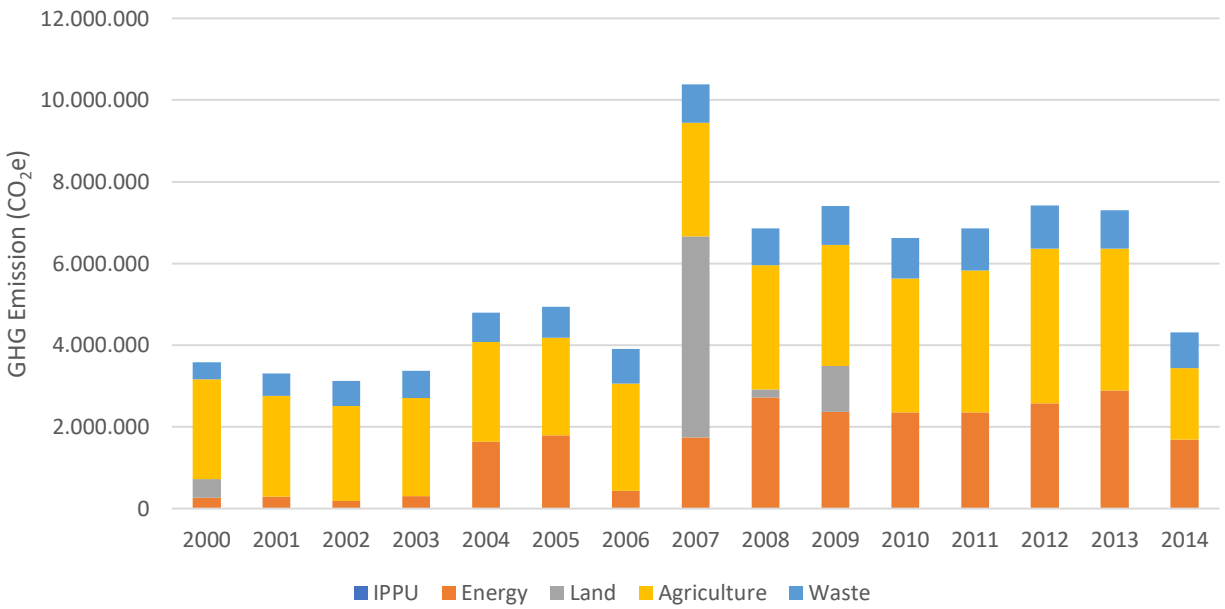

Figure 9 GHG emission profile in West Nusa Tenggara. Source: Directorate of GHG Emission Inventory [24]

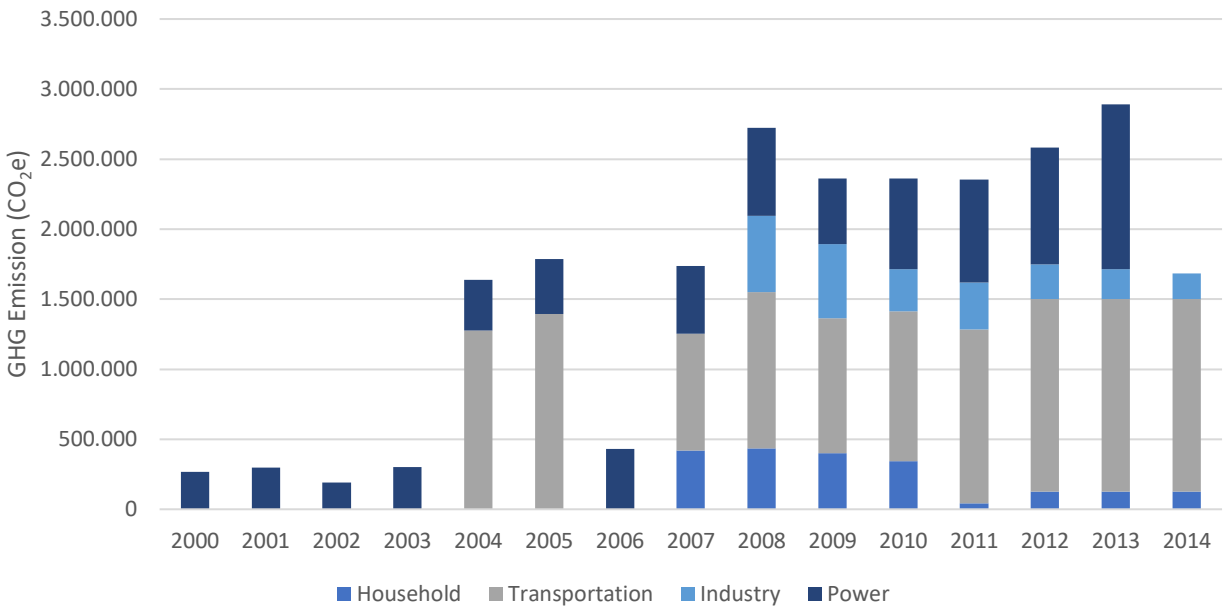

Figure 10 GHG emission profile in the energy sector of West Nusa Tenggara.
Source: Directorate of GHG Emission Inventory [24]

Chapter 3 Renewable Energy-based Enabling Regulatory, Policy, and Legal Frameworks

3.1 National Level

3.1.1 Regulatory Framework

Energy organizational structure describes how energy policies are developed and implemented by multilevel government bodies. Figure 11 illustrates the energy organizational structure diagram at the national level concerning electricity and Table 11 depicts the key stakeholders at the national level.

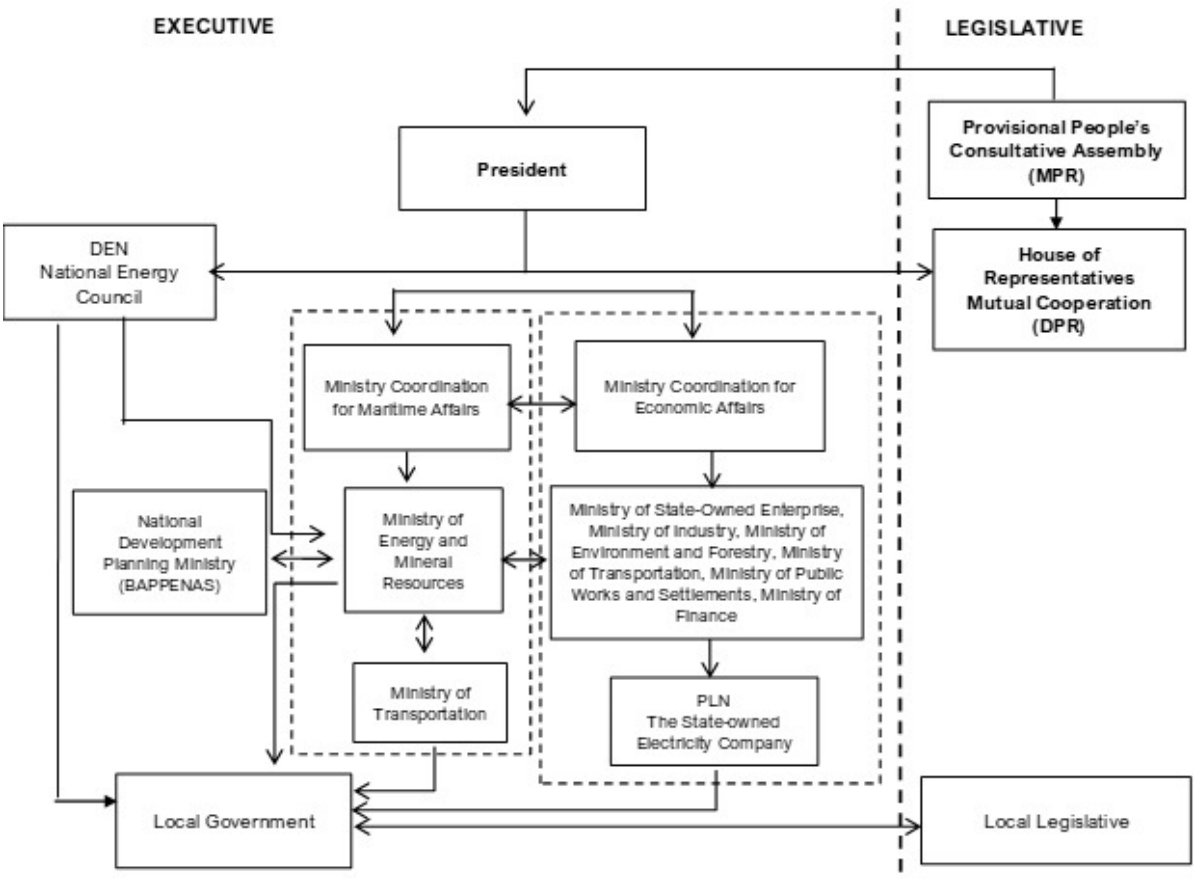

Figure 11 Energy organizational structure in Indonesia. Source: Personal Identification 2019

Table 11 National stakeholders. Source: PWC 2018 [25]

Entity	Role
House of Representatives (DPR)	Commission VII of the DPR is responsible for developing regulation in the areas of energy and environment. They are also responsible for the approval of energy-related legislation [25].

Ministry of Energy and Mineral Resources (MEMR)	Develops and implements Indonesia's energy policy including the National Electricity General Plan (RUKN). They are also responsible for endorsing PLN's Electricity Provision Plan (RUPTL).
National Energy Council (DEN)	Has a key role in determining the energy direction through the provision of National Energy Policy (KEN) and National Energy Plan (RUEN).
National Development Planning Agency (**BAPPENAS**)	Responsible for planning the national development under prevailing laws and regulations [25]
Ministry of Finance (MoF)	Approves fiscal incentives that may be offered by the government.
Indonesia Infrastructure Guarantee Fund (IIGF)	Provides and administers guarantees for infrastructure projects under the PPP scheme.
PT Sarana Multi Infrastructure (PT SMI) and **PT Indonesia Infrastructure Finance** (PT IIF)	Supports investors obtain domestic financing for the debt and equity funding of infrastructure development.
The State-owned Electricity Company (**PLN**)	Has exclusive authority over transmission, distribution, and retailing electricity. PLN is supervised by the **MEMR**, **Ministry of State-Owned Enterprises** (MSOE), and **Ministry of Finance** (MoF)
Indonesian Renewable Energy Society (**METI**)	A forum focuses on the development of renewable energy in Indonesia consisting of the Heads of the Association of Geothermal, Hydro, Solar, Biofuel, Biomass, Biogas, Wind, Nuclear and Ocean Energy.

3.1.2 Key Policies and Strategies Applicable to the Renewable Energy Sector

Figure 12 illustrates the energy policy relation in Indonesia while Table 12 shows the explanation of each policy.

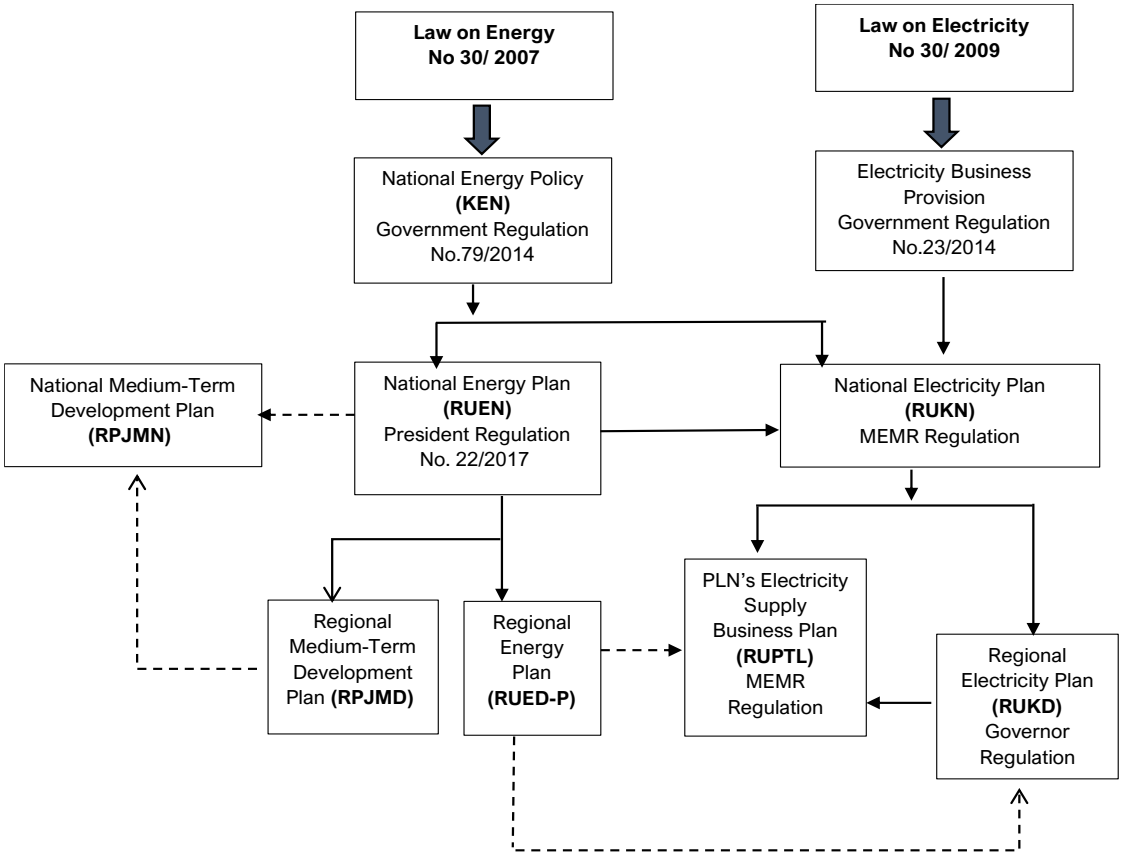

Figure 12 Energy legal framework in Indonesia. Source: Personal Identification 2019

Table 12 Energy and electricity policies in Indonesia

Policy	Content
Energy Law No. 30/2007 [26]	The law emphasizes several priorities in the energy sector including energy independence, national energy availability, sustainable energy management, energy efficiency, and energy accessibility, especially for those residing in isolated islands/areas and having financial difficulties [26].
Government Regulation (PP) No. 79/2014 on the National Energy Policy (KEN) [27].	The KEN is an energy roadmap of Indonesia 2010-2050 which provides general energy directions. The KEN shows that Indonesia has an optimal energy mix of (1) Renewable Energy of at least 23%, oil of less than 25%, coal of at least 30% and natural gas of at least 22% by 2025; (2) NRE of at least 31%, oil of less than 20%, coal of at least 25% and natural gas of at least 24% by 2050 [27].
PP No. 22/2017 on the National Energy Plan (RUEN) [28]	Issued by the president, to achieve the KEN target. The RUEN is a general energy management direction in Indonesia that depicts the energy vision and status, GHG emission impact reduction, energy availability for national needs, energy development priority, energy utilization, and energy reservation [28]
Electricity law No. 30/2009 [29]	Passed to strengthen the 2007 Energy Law. The law emphasizes the role of PLN in the electricity supply business and promotes a greater role for private enterprises, cooperatives, and self-reliant community institutions to participate in the business [29].
PP No. 14/2012 (as amended by No. 23/2014) on Electricity Business Provision [25]	Passed to support the 2009 Electricity Law. The law states that the MEMR can determine **the National Electricity Plan (RUKN)** after consultation with DPR.
National Electricity Plan (RUKN) 2015-2034 [25]	The development of RUKN is based on KEN and RUEN as a reference. The RUKN sets out a projection of electricity demand and supply for 20 years. It acts as a guideline in electricity generation, distribution, and transmission. It also states the electrification ratio target, which must reach 100% by 2024, the electricity status per province and consumption growth, the electricity demand, and electricity investment needs.
PLN's **Electricity Provision Plan (RUPTL)** [19]	A 10-year electricity development plant in the operating areas of PLN. RUPTL is an **important document for investors** in the Indonesian electricity sector because it contains demand and supply forecast, future expansion plans, and procurement's route for IPP [19].
MEMR Regulation No. 50/2017 (as amended by No. 4/2020) on Utilization of Renewable Energy Sources for Power Supply [30].	This regulation regulates the tariff regimes, project financing, and procurement model for renewable electricity generation.

3.2 Local Framework

3.2.1 West Nusa Tenggara Stakeholders

Figure 13 illustrates the energy organizational structure diagram in West Nusa Tenggara regarding electricity. the **Energy and Mineral Resources Agency (DESDM)** is responsible for developing and implementing West Nusa Tenggara's energy policy including the Regional Energy Plan (RUED). **National Energy Council** (DEN) has a key role in facilitating local government in developing RUED. **BAPPEDA** has responsibility for planning the regional development under prevailing laws and regulations. BAPPEDA is also the General Chairman of the **RUED Implementation Working Group** in addition to the Energy Agency as the Daily Chairman. There are several stakeholders in the Regional Energy Plan Implementation Working Group,

including the **PLN Regional Unit of WNT** as an electricity provider that should coordinate with the Energy Agency.

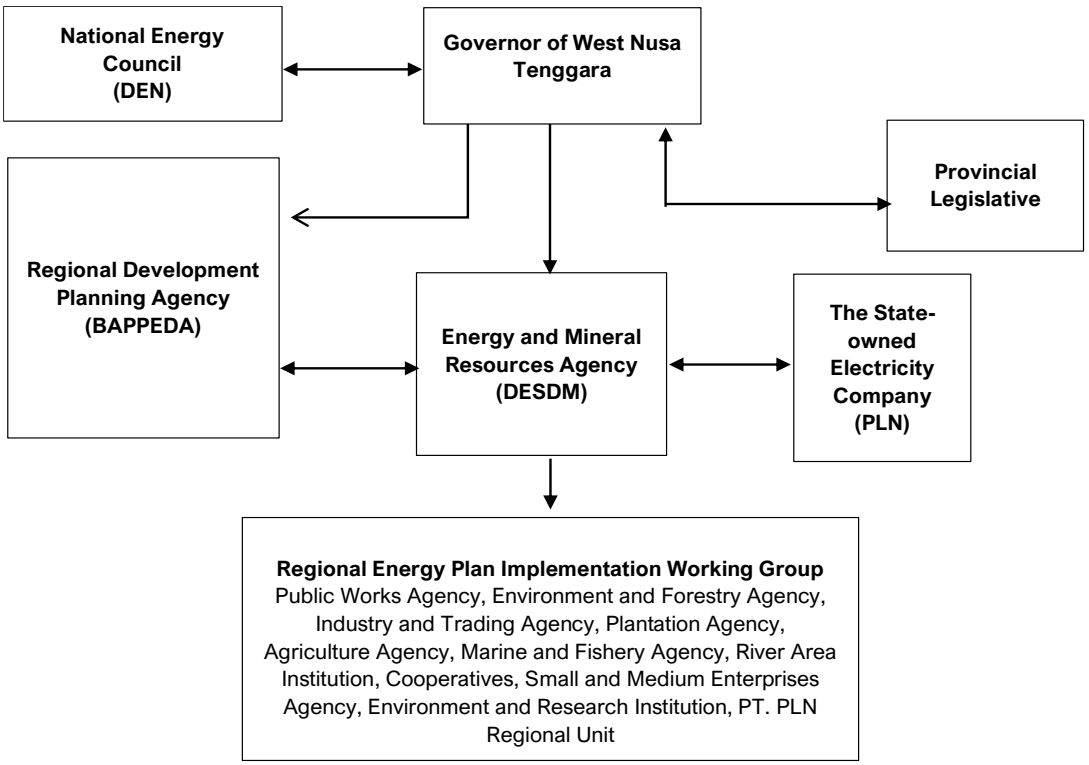

Figure 13 Energy organizational structure in West Nusa Tenggara. Source: Personal Identification 2019

3.2.2 West Nusa Tenggara Laws and Regulations

Figure 14 summarizes the energy legal framework in West Nusa Tenggara. Under the RUEN, the Provincial Government is mandated to develop the **Regional Energy Plan (RUED)** which sets out the provincial target on energy mix, including the renewable energy by 2025 and 2050. Meanwhile, the city or regency level will follow the regulation which has been enacted. West Nusa Tenggara has stipulated the Regional Energy Plan (RUED) in **Regional Regulation No. 3/2019** [31]**.** The regulation has been enforced in West Nusa Tenggara since 9 May 2019.

Regional Regulation No. 3/2019 on RUED of WNT [31] is a general energy management direction in West Nusa Tenggara which shows the region's energy vision and status, energy availability for regional needs, and energy development priority. **Article 7** of the regulation states that RUED can be used as a reference to create the Regional Development Plan, Regional Electricity Plan, and/or Regional Government Budget, and can be used as guidelines by local governments to make Strategic Plans or by communities to participate in energy development [31]. **Article 13** of the regulation states that West Nusa Tenggara governor can collaborate with other provinces, third parties, or international organizations in implementing RUED [31]. Hence, this **RUED can be used as the starting point for the 100%RE Roadmap project**. The details of renewable energy commitment and target under RUEN will be explained in Chapter 5.

Additionally, the province also has other regulations that will support the implementation of RUED, such as Energy and Electricity Management, Business License Procedures in New and Renewable Energy and Electricity, and Regional Electricity General Plan.

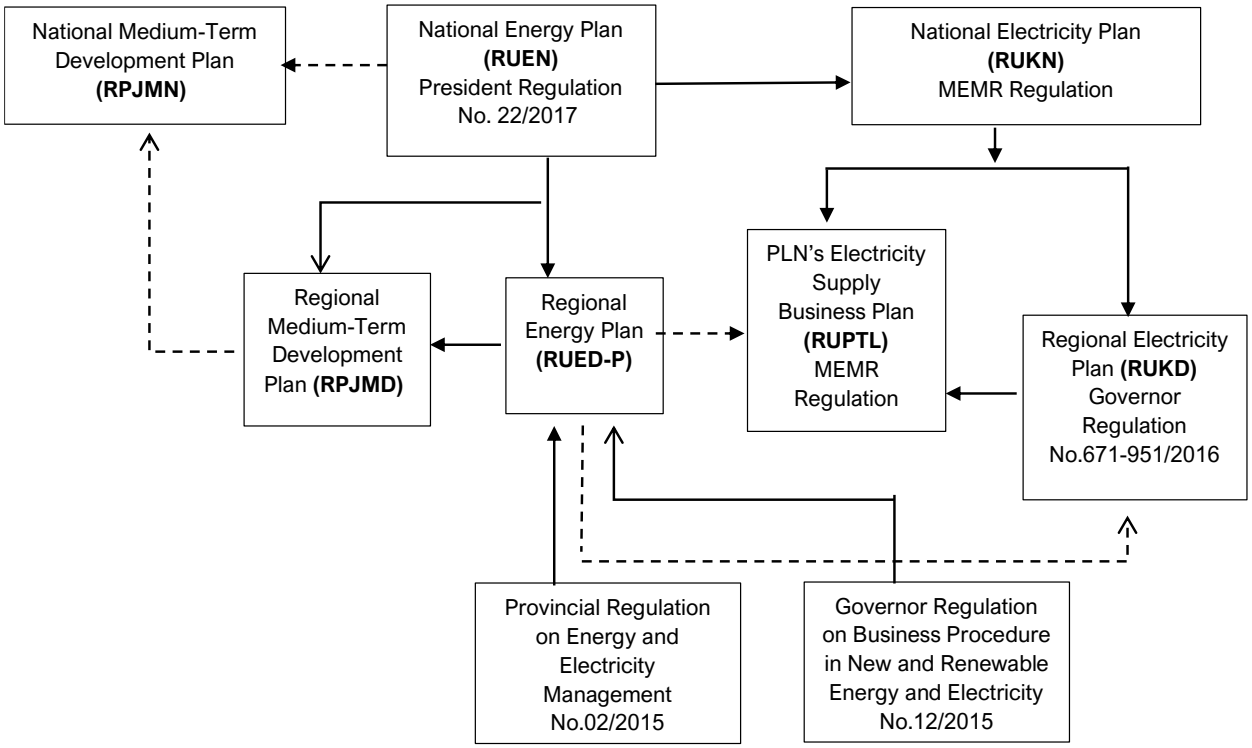

Figure 14 Energy legal framework in West Nusa Tenggara. Source: Personal Identification 2019

Chapter 4 West Nusa Tenggara Renewable Energy Resource Potential

4.1 Renewable Energy Resource Potential of West Nusa Tenggara

4.1.1 Overview

Although West Nusa Tenggara relied on fossil fuel either for electricity generation or transportation, the region has abundant and diverse renewable energy sources. West Nusa Tenggara is included in the top ten provinces with the largest renewable energy potential in the country. The main source for the estimation of renewable energy potential in the region is RUED [31].

Table 13 depicts the technical potential of renewable energy in the region. The **renewable energy potential** in West Nusa Tenggara is almost **22 GW** in which 9.9 GW of the potential comes from solar (Table 13). Wind potential in the region is around 2,605 MW [31]. Hydro energy potential in the region is about 212 MW spreading all over the region.

Table 13 Renewable energy potential in West Nusa Tenggara. Source: RUED 2019 [31]

Energy Source	Technical Potential (MW/MW_e)	Location
Solar	9,931	All regions of WNT
Wind	2,605	All regions of WNT
Hydro	212	All regions of WNT
Ocean Currents	8,644	Lombok and Alas Strait
Ocean Thermal	23	South Sumbawa Island to Timor Island; North Flores Sea to Bima
Wave	100	Gili Trawangan
Geothermal	145	Sembalun, East Lombok; Maronge, Sumbawa; Hu'u, Dompu

4.1.2 Solar Energy

The average daily **solar radiation** in West Nusa Tenggara is **4.51 W/m^2/hour** which is **among the highest** in Indonesia [31]. Figure 15 shows that the exploitable solar resource in the region is between 1,100 and 1,800 kWh/kWp [32]. The areas with the highest radiation are located in the south and east of Lombok Island and on the northeast coast of Sumbawa Island while mountain regions have the lowest radiation (Figure 15). Although the technical potential is quite high (9.9 GW), the practical potential is probably much lower because the region is dominated by primary forests.

4.1.3 Wind Energy

The average wind speed at 100 meters in West Nusa Tenggara is below 5 m/s which is much lower compared to other countries in the Asia Pacific Region [33]. Figure 16 shows that the wind power density in the region is mostly between 25 and 219 W/m^2 [33], which is categorized as **Wind Power Class 2 (Poor).** The

areas with power density greater than 219 W/m^2 (purple colored) are located in the southwest of Lombok Island and on the northeast coast of Sumbawa Island (Figure 16). Although the technical potential is quite high (2.6 GW), the practical potential is probably much lower.

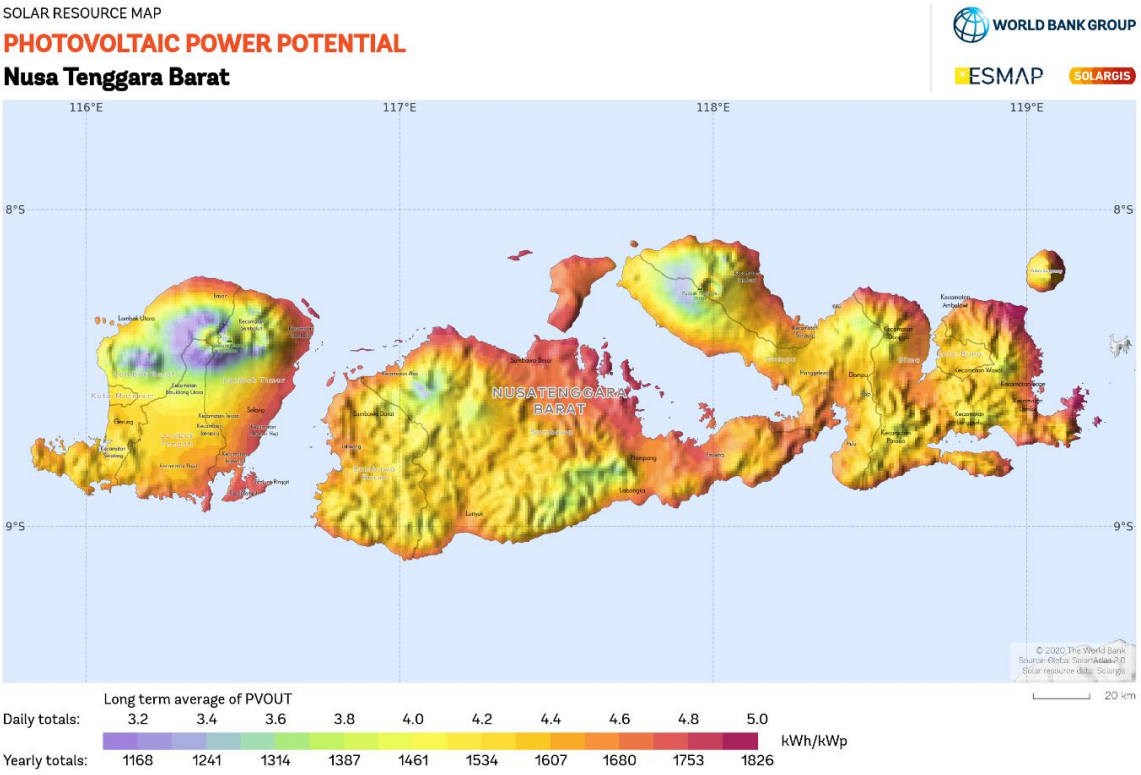

Figure 15 Photovoltaic power potential in West Nusa Tenggara. Source: Global Solar Atlas 2020 [32]

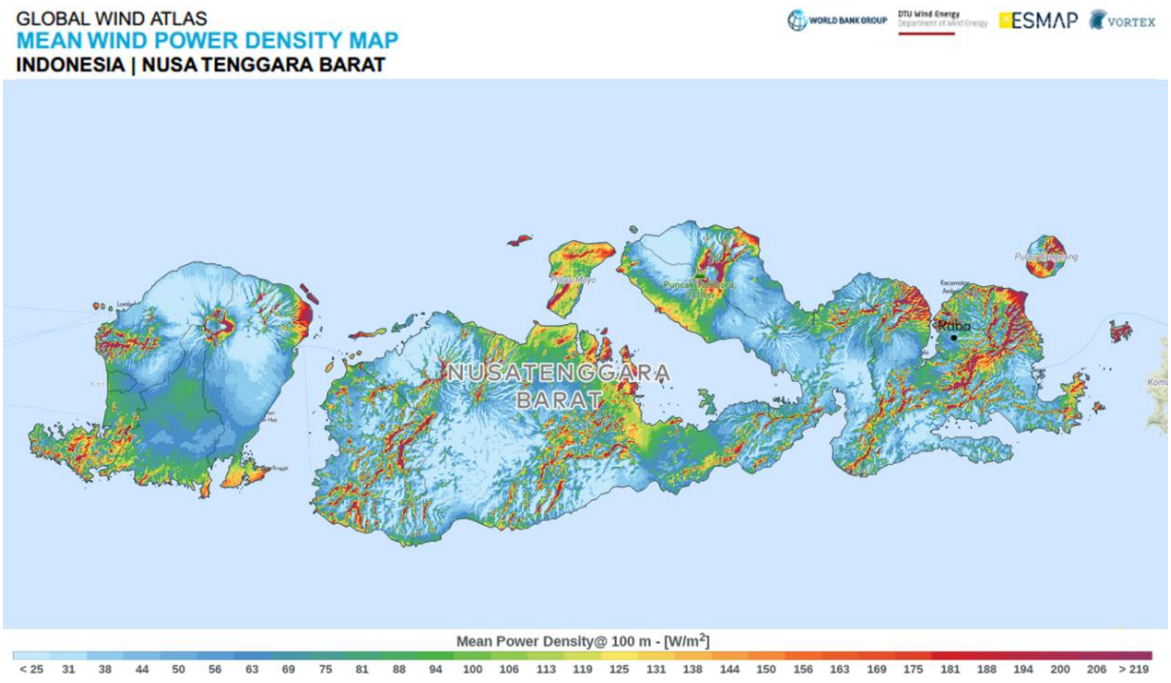

Figure 16 Mean wind power density map in West Nusa Tenggara. Source Global Wind Atlas 2020 [33].

4.1.4 Hydro Energy

Figure 17 shows the distribution of renewable energy in West Nusa Tenggara, particularly geothermal, hydro, and biogas energy potential. The hydropower potential in the region originates from both run-of rivers and reservoirs. There is 13.73 MW run-of-river potential (<1 MW) and 198.75 MW reservoir potential (>1 MW). Sumbawa Regency has the largest hydropower potential in the region, at 119.5 MW reservoir potential and 4.82 MW run-of-river potential [31].

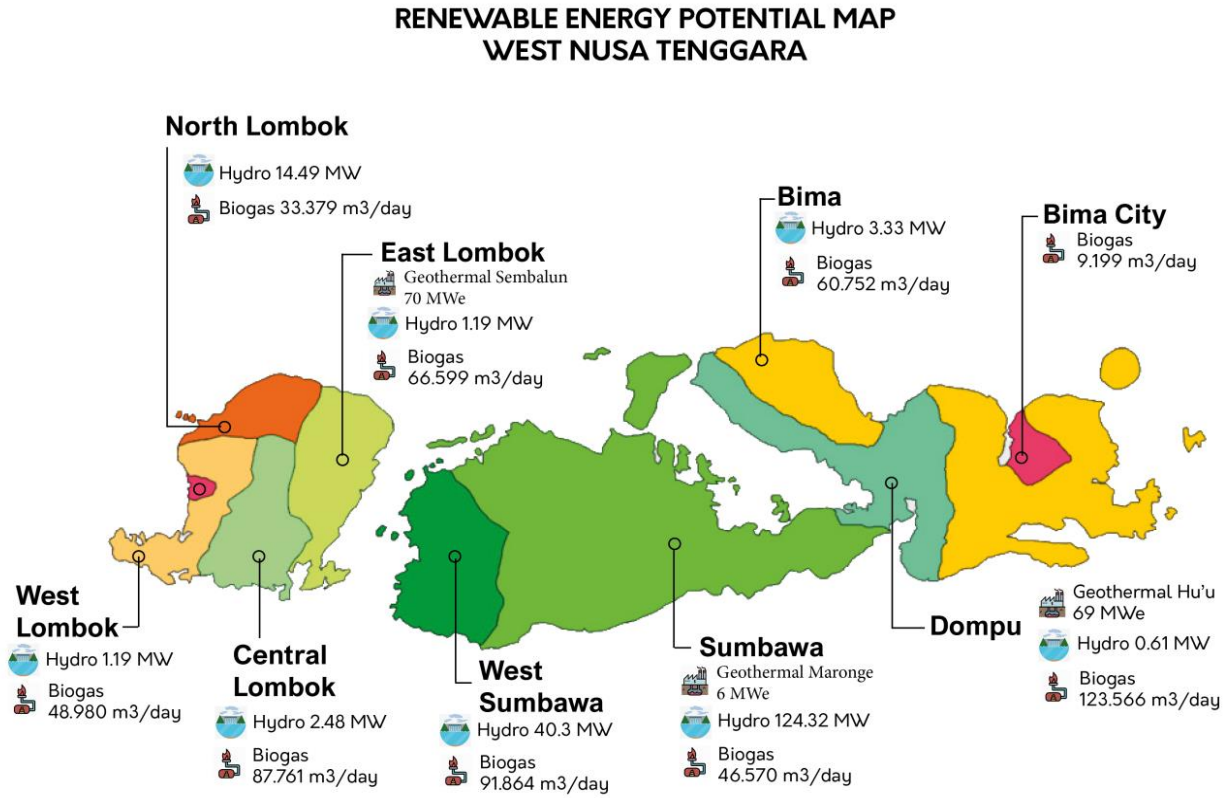

Figure 17 Renewable energy potential in West Nusa Tenggara. Source: Personal Identification 2019.

4.1.5 Ocean-related Energy

The potential sites for ocean current energy in the region are in Lombok Strait and Alas Strait. Lombok Strait has a potential area of 19,107,438 m^2 with a maximum ocean current speed at 2.44 m/s with a power density of around 7.44 kW/m^2 [31]. The Alas Strait has larger potential than the Lombok one. The strait has a potential area of 60,853,994 m^2 with a maximum ocean current speed at 2.90 m/s with power density around 12.50 kW/m^2 [31].

The Flores Sea and the Indian Ocean are the potential sites for Ocean Thermal Energy Conversion (OTEC). The temperature difference in the Indian Ocean is around 22-23 degrees Celsius located 10-20 kilometers from the coastline (169 km wide) [31]. Meanwhile, the temperature difference in the Flores Sea is around 22-24 degrees Celsius situated 10-30 kilometers from the coastline (950 km wide) [31].

4.1.6 Geothermal Energy

According to the information from RUED [31], geothermal resource in the region is situated in three locations namely Sembalun in Lombok Timur Regency (70 MW_e), Maronge in Sumbawa Regency (6 MW_e), and Hu'u in Dompu Regency (69 MW_e).

4.1.7 Biomass, Biofuel, and Biogas Energy

The biomass feedstock in West Nusa Tenggara is obtained from rice husk and corn residue, while the biofuel resource is originated from *Jatropha curcas*. Jatropha's seed is commonly used as biofuel sources in the world. As for biogas, the resource can be obtained from cattle farms on the island.

Table 14 Bioenergy feedstock in West Nusa Tenggara. Source: RUED 2019 [31]

Area	Biomass		Biofuel	Biogas
	Rice Husk (tons)	Corn Residue (tons)	Jatropha Curcas (ha)	Volume (m^3/day)
Mataram City	8,668.80	-	-	1,037
West Lombok	44,748.76	12,455	245.50	48,989
North Lombok	16,616.60	19,626	21.50	33,379
Central Lombok	112,113.68	12,264	1,769.18	87,761
East Lombok	87,272.36	49,464	1,699.70	66,599
West Sumbawa	24,823.40	25,243	873.00	91,864
Sumbawa	112,379.96	172,355	992.50	46,570
Dompu	39,160.80	112,275	612.89	123,566
Bima City	8,139.32	2,132	8.00	9,199
Bima	79,227.12	65,705	1,213.00	60,752
Total	**533,150.80**	**471,518.40**	**7,435.27**	**569,707**

Considering the calorific values of rice husk and corn residue are 14.2 GJ/tons and 16.8 GJ/tons [34], the yield of Jatropha is 1.59 tons-oil/ha [35] with calorific value 37.8 GJ/tons-oil [36], and the calorific value of biogas is 6 kWh/m^3 [37], subsequently

$$Biomass\ energy = \left(533{,}150.8\ tonnes\ x\ 14.2\frac{GJ}{tons}\right) + \left(471{,}518.40\ tonnes\ x16.8\ \frac{GJ}{tons}\right) = 15{,}492{,}250.48\ GJ$$

$$Biofuel\ energy = 7{,}435.27\ ha\ x\ 1.59\frac{tons}{ha}x37.8\frac{GJ}{tons} = 446{,}874.59\ GJ$$

$$Biogas\ energy = 569{,}707\frac{m3}{day}\ x\ 365\ day\ x\ 6\frac{kWh}{m3}x0.0036\frac{GJ}{kWh} = 4{,}491{,}569.99\ GJ$$

Therefore, the potential energy from **biomass** is approximately **15,492 TJ/year**, from **biofuel** is about **446 TJ/year**, and from **biogas** is around **4,491 TJ/year**. It is equivalent to the energy generation of a 491-MW biomass plant, a 14-MW biofuel plant, and a 142-MW biogas plant, respectively (assuming the plant working continuously). However, the efficiency of the system is not incorporated yet in the calculation so that the practical potential can be much lower.

4.1.8 Waste Energy

Because there is no waste energy information in RUED, the information is taken from the Directorate General of Various New, Renewable Energy, and Conservation Energy [38]. There are about **9 MW_e of waste potential** in the region, calculated from the waste capacity in three Final Waste Processing Sites (TPA). They are TPA Gapuk (35,393 tons/2.11 MW_e), TPA Oi Mbo (58,400 tons/3.49 MW_e), and TPA Kebon Kongo (54,750 tons/3.27 MW_e). This number could be potentially higher considering that 3,388.76 tons of solid waste is generated in the region daily [8].

4.2 Implemented Renewable Energy Projects in West Nusa Tenggara

Although West Nusa Tenggara has abundant renewable energy resources, the installed capacity was only **17.88 MW by 2018** [15]. According to the consultation with the energy and mineral agency of WNT, **in 2019, there is an additional 20-MW renewable energy electricity** coming from four (4) new solar power plants, namely Pringgabaya, Selong, Sengkol, and Sambelia (each power plant has 5-MW capacity) presented in **Annex A**. Figure 18 shows the implementation of renewable projects spreading over ten.

Solar power plants and hydropower plants in Lombok Island are mostly connected to the grid. The largest capacity of on-grid solar power plants is in East Lombok, by 10 MWp [31]. Additionally, North Lombok has the largest capacity of on-grid hydropower plants, by 8 MW.

On the other hand, Sumbawa Regency has no on-grid renewable system. Yet, Sumbawa Regency has the largest off-grid solar power systems, by 0.15 MWp, as well as the largest off-grid hydropower plants, by 0.445 MW. Sumbawa Island is still lack of electricity and the local grid does not cover the entire area.

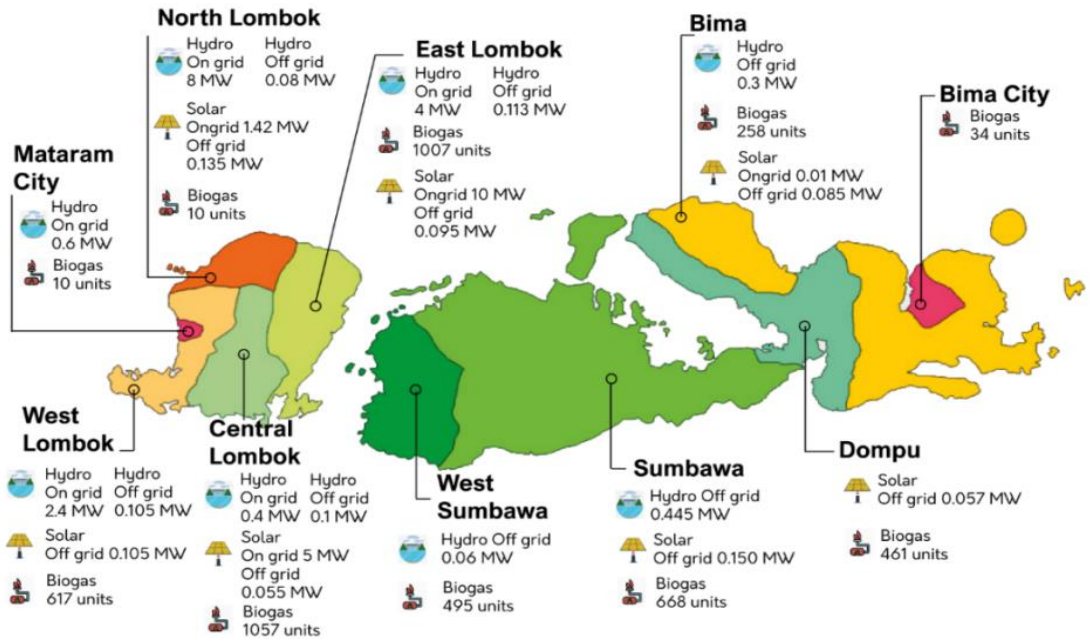

Figure 18 Implemented renewable energy projects in West Nusa Tenggara.
Source: Personal Identification 2019 based on information from DESDM of WNT.

Chapter 5 Local Renewable Energy Targets and Commitments in West Nusa Tenggara

West Nusa Tenggara has enacted the Local Energy General Plan (RUED) as of 2019. This chapter tries to encompass the potential of renewable energy resources, energy projects implementation, projection of future energy demand, and the targets in energy development in the RUED.

5.1 Power Plant Capacity Target

Following RUED, the province has set targets for power plant capacities from 2020 until 2050 through modeling. They aim to achieve **renewable energy share in the electricity generation** by **35% in 2025** [31]. Figure 19 illustrates that every five years renewable energy increases by 2-3%. Therefore **in 2050**, the West Nusa Tenggara province could achieve **50% renewables capacity** for their power generation with an approximate capacity of 1,191 MW [31]. Solar PP is projected to have the highest share in the renewable energy mix (Figure 20).

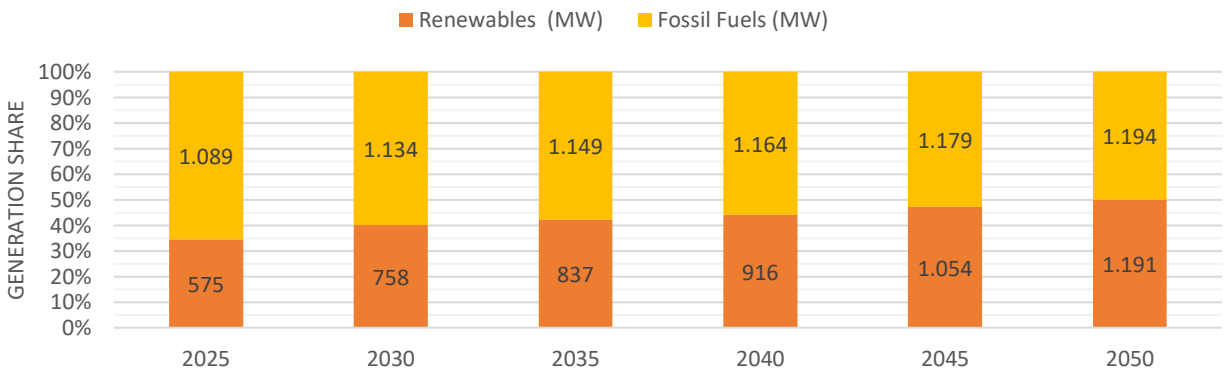

Figure 19 The projection of power generation capacity in West Nusa Tenggara. Source: RUED 2019 [31].

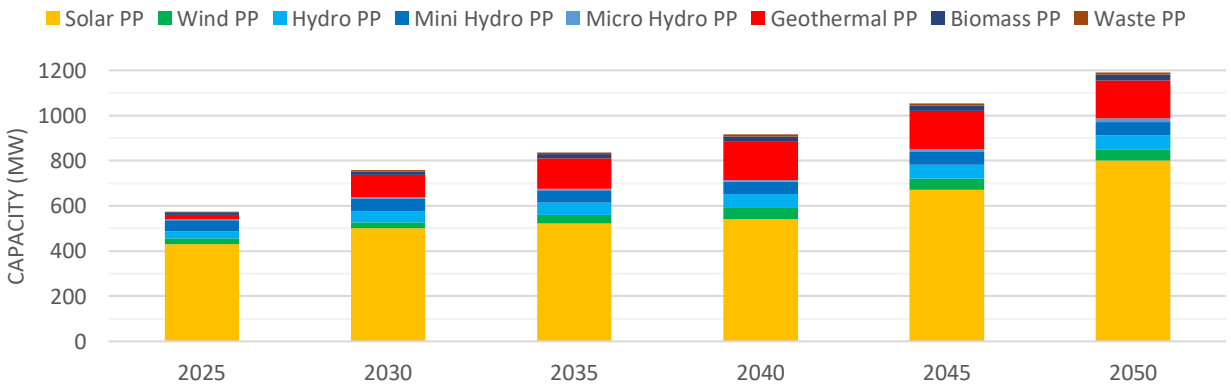

Figure 20 The projection of renewable capacity in West Nusa Tenggara. Source: RUED 2019 [31].

5.2 Fossil Fuel Reduction Target

Through the Local Energy General Plan (RUED), West Nusa Tenggara has planned to reduce fossil fuel consumption in the electricity sector. Together with PLN, they want to reduce diesel power plant capacity to 50 MW in 2025, and there will be zero diesel power plant in 2050 [31].

5.3 Energy Consumption Scenario

To fulfill the final energy demand between 2025 and 2050, petroleum products, such as gasoline, diesel, and avtur, will still be part of the final energy demand. LPG demand is projected to increase beyond 2025 to support the national program, which is the conversion of kerosene to LPG for household use.

5.4 Energy Development Activity Plan

The government has a strong commitment to developing renewable energy and energy efficiency in the region. The commitment is expressed under the activity matrix of RUED summarized in **Annex B** [31]. The activity matrix consists of several aspects, including study and research, policy, capacity building and empowerment, infrastructures, energy efficiency, energy diversification, and institutional framework. Table 15 outlines the matrix activity plans that align with the aims of the 100%RE project.

Table 15 Several actions under Activity Plan Matrix that align with 100%RE project. Source: RUED 2019 [31].

Assess Local Renewable Energy Potential
• Study of renewable energy resources potential and mapping (1.1.1.1)
Increase Local Awareness and Stakeholder Engagement and Create Opportunities for Peer-learning
• Education and society awareness building regarding energy savings (3.1.5.1) • Enhancement capabilities of energy management for civil servant and non-civil servant (7.1.1.1) • Increasing education quality in energy technology through vocational school (7.1.1.2) • Increasing the number and quality of experts in the energy sector (7.1.1.3) • Business training by utilizing local commodities for renewable energy users in rural areas (7.1.2.3)
Develop a Community-wide 100%RE Strategy and Action Plan
• Formulation of policies regarding the obligation to use PV Solar rooftop (2.1.1.1 and 2.1.1.2) • Policy formulation to utilize biofuel for transportation sector (2.9.1.1) • Compiling regulation of energy saving in buildings through the utilization of LED, more efficient AC, and reduction in electricity usage at night (3.1.1.1) • Formulation and implementation of renewable energy incentives regulation (5.2.2.1)
Develop Local Bankable Projects and Explore Access to Finance Implementation
• Establish Solar Home System (SHS) and off-grid centralized PV solar panel that total capacity is 5 MW of 2050 in the undeveloped area (2.1.2.2) • Establish on-grid PV solar panel rooftop for school, government, and commercial buildings: feasibility study and DED, as well as the construction (2.1.2.3) • Establish waste power plant with total capacity 4 MW in 2025 and 10 MW in 2050: feasibility study and DED, as well as the construction (2.2.1.1) • Establish micro-hydropower plant (off-grid) with total capacity 1 MW in 2050 for the undeveloped area (2.5.1.2) • Establish biogas with capacity 4 m^3 as many as 300 unit (minimum) annually (2.6.8.1) • Energy audit in office buildings, commercial (hotel, mall, etc.), educational buildings, hospital (3.1.2.1)

Chapter 6 Local Renewable Energy Projects

6.1 On-going and Planned Energy Projects in West Nusa Tenggara

With the completion of four 5-MW solar power plants in 2019, the following table provides information about on-going and planned renewable projects adapted from PLN's RUPTL 2019-2028 [19]. Some projects are under construction and/or procurement process in Lombok Island. Meanwhile, according to RUPTL, renewable energy generation in Sumbawa Island is still under planning stage.

Table 16 On-going and planned renewable generation projects. Source: RUPTL PLN 2019 [19].

No	System	Type	Location	Capacity (MW)	COD Target	Status	Developer
1	Lombok	Mini hydro PP	Batu Bedil	0.6	2019	Under Construction	IPP
11	Lombok	Mini hydro PP	Sedau Kumbi	1.3	2019	Under Construction	IPP
12	Lombok	Mini hydro PP	*Distributed*	1.8	2020	Planned	Unallocated
15	Lombok	Mini hydro PP	Koko Babak	2.3	2020	Procurement	IPP
16	Lombok	Mini hydro PP	*Distributed*	4.6	2021	Planned	Unallocated
17	Sumbawa-Bima	Solar PP	*Distributed*	5.0	2021	Planned	Unallocated
20	Sumbawa-Bima	Mini hydro PP	*Distributed*	7.0	2022	Planned	Unallocated
22	Sumbawa-Bima	Mini hydro PP	*Distributed*	6.4	2023	Planned	Unallocated
30	Sumbawa-Bima	Geothermal PP	*Distributed*	10.0	2027	Planned	Unallocated

In addition to the data above, Table 17 shows the projects planned for commencement in 2020 obtained through personal communication with West Nusa Tenggara's energy agency.

Table 17 Renewable energy projects. Source: Personal communication with Energy Agency of WNT 2019

No	Project	IPP/Funding	Status (as of February 2020)
1	100 MW Wind Energy Power Plant	UPC Renewables	Construction begins in 2020
2	20 MW Biomass Power Plant	Danish Energy Agency (DEA)	Feasibility Study (in Lombok)
3	Geothermal Power Plant	PT. Sumbawa Timur Mining	Feasibility Study and Exploration
4	10 MW Solar Power Plant	*Will be offered to IPP*	The location will be in Sumbawa Island, yet the exact location is still unallocated

6.2 Business Model

The provision of renewable energy infrastructure in West Nusa Tenggara, particularly for electricity generation, must follow the national regulatory framework. Three (3) common business models can be implemented for renewable energy utilization in West Nusa Tenggara.

6.2.1 Public-Private Partnership (PPP) Projects

The government of Indonesia (GoI), through BAPPENAS, wants to use a PPP approach to accelerate the infrastructure development in the country, including in West Nusa Tenggara. The Government of Indonesia supports the acceleration of the PPP scheme through the implementation of **Presidential Regulation No. 38/2015** about cooperation between Government and Business entities in Infrastructure Provision [39].

Under the PPP scheme, both government and private entities collaborate in the provision of infrastructures. The Responsible Person for Cooperation Projects (called PJPK) or **Government Contracting Authority (GCA)** is minister/head of institution/head of region who **is responsible for the project**. In the case of a local government's project, the GCA can be the governor, the mayor, or the appointed person from the local institution/agency [39]. Generally, most GCA are stakeholders who influence the project.

The private sector is represented by a **special-purpose company (SPV).** The SPV agrees with GCA through the PPP contract. The SPV finds Financial Support from Equity Investor and/or Lenders and appoints Construction and O&M contractors. The SPV is **responsible to provide infrastructure and service** under the PPP contract.

The investment return for the SPV is in the form of a user charge (tariff). The tariff is determined through Power Purchase Agreement (PPA). In the case of an **on-grid system**, the SPV makes a PPA contract with PLN (the user is PLN as off-taker). Meanwhile, in the case of an **off-grid system**, the SPV makes a PPA agreement with the community. The SPV for an off-grid system is usually the funding grantee and the community itself. Figure 21 illustrates a simplified PPP scheme.

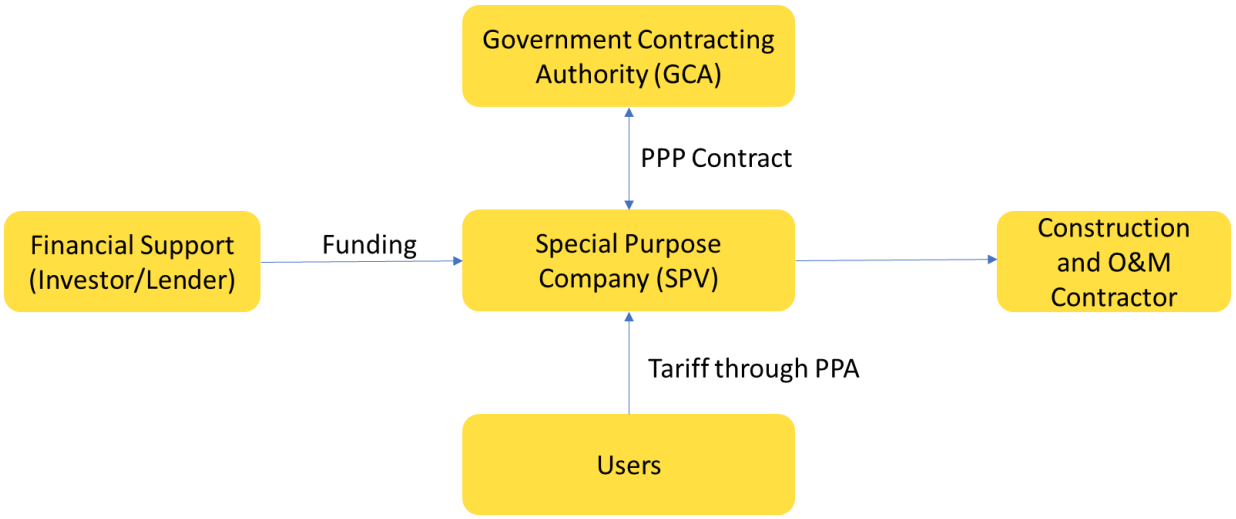

Figure 21 Simplified public-private partnership scheme. Source: Personal identification 2019.

This business model is implemented not only for electricity generation but also for other renewable projects in West Nusa Tenggara. According to the representatives from the Energy Agency of WNT, this type of business model has been implemented in developing small-scale biogas in WNT since 2012. Government of WNT, HIVOS/Yayasan Rumah Energi, and users divide the cost and responsibility among them.

HIVOS/Yayasan Rumah Energi gives subsidy as much as 2 million Rupiahs for each user, the Government provides around 3.5 million rupiah, meanwhile, users will provide the land and participate during the construction of biogas.

However, since 2016, this type of cost-sharing is not used anymore. Currently, the Government will bear all the costs once the construction is over. HIVOS/Yayasan Rumah Energi will provide users with training regarding how to use biogas, how to do simple troubleshooting, and how to produce bio-slurry that can be used as fertilizer and feedstock.

6.2.2 IPP Projects under PLN's Regular PPA Program

The IPP can propose a PPA proposal for a renewable project in West Nusa Tenggara under PLN's regular program (allocated and unallocated electricity provision projects in RUPTL). These projects then may be awarded through open tender, direct appointment, or direct selection. According to **MEMR Regulation No. 4/2020,** IPP for renewable energy generation can be selected directly under one of the following conditions: emergency, excess power, expansion of existing power plant, one bidder only, and hydropower project that already obtains location permit from the local government [40]. Direct selection for solar, wind, and ocean current power plants is based on quota capacity under RUPTL.

6.2.3 Small-Scale Electricity Supply Business (UPTL) in the Least Developed Rural, Isolated, Border and Small Populated Island Area

Regionally owned enterprises, private business entities, and cooperative businesses are offered to get involved in improving electrification in rural areas by managing an area of business (Wilayah Usaha). The interested business entities can participate in the procurement selection of Small-Scale Electricity Supply Business (UPTL) [25]. However, in the condition that no entity is interested, then the Governor may appoint regionally owned enterprises (BUMD or BUMDes) to develop small-scale UPTL. The non-subsidized electricity tariff is determined by MEMR or the Governor based on their authority, along with the existing laws and regulations.

RESCO (Renewable Energy Service Company) is also another business model that can be implemented for rural electrification in Indonesia. **RESCO** can be defined as an organization that is responsible for the operation, maintenance, and troubleshooting (OM&T) of decentralized renewable energy equipment with this service being provided throughout all the life of the equipment [41]. An entity may not be considered a RESCO if it does not fulfill all conditions mentioned in the previous definition. A RESCO can be any type of legal entity and can either own or not own the assets. It can secure funds from any of the sources that are available to this type of legal entity.

6.3 Ownership Model

6.3.1 PPP Ownership Model

The PPP structure in Indonesia (applied for West Nusa Tenggara) is classified into three schemes based on the nature of service and inherent risks transfer in the PPP contract, namely Availability-based PPP, Usage-based PPP, and O&M-based PPP (Table 18). In the **availability-based PPP** scheme, the private is typically responsible for the design, construction, financing, and operation and maintenance of the facility. On the other hand, for **O&M-based PPP**, the private company is responsible for the management, operations, and specific renewals of the contracted facility. Under the **usage-based PPP**, the private sector receives a concession contract. The private company will receive a concession right for delivering the wholesale service during the PPP period for directly providing services to end-users, where the local government acts as a regulator. Under this scheme, the private company will receive payment directly from end-users.

Table 18 Comparison of three kinds of PPP schemes. Source: Indonesia Infrastructure Guarantee Fund (IIGF) 2017 [42].

Scope	Availability-based PPP	Usage-based PPP	O & M-based PPP
Ownership during contract	Private	Private	Government
Investment	Private	Private	Government
Construction	Private and Government	Private and Government	Government
Operation & Maintenance	Private	Private	Private
Service and quotation of Costumer tariff	Private / Government	Private	Private / Government
Period	<20 years	20 -50 years	5- 15 years
Customer	Government Contracting Agency (GCA)	Government Contracting Agency (GCA)/End users	Government Contracting Agency (GCA)/End users
Income	Payment by GCA/*PJPK*	Payment by end-users	Percentage from Tarif income

6.3.2 IPP Ownerships under PLN's Regular Program

The IPP ownership for renewable energy projects under this program is Build, Own, Operate, and Transfer (BOOT) scheme except for waste-to-energy projects. Under this scheme, the IPP has the right to build, own, and operate renewable generation for a limited period as stated in the PPA with PLN. After the end of the contract, the power plant must be transferred to PLN. However, according to **MEMR Regulation No. 4/2020**, this scheme can be adjusted into a Build, Own, and Operate (BOO) scheme depending on the agreement of both IPP and PLN, referring to the applicable Land Law [40]. Under BOO scheme, the IPP still own the power plant at the end of the contract so that they can use their asset for a bank guarantee.

6.3.3 Purely Public Asset

Renewable energy infrastructure can be purely a public asset if the infrastructure is developed through a special allocation budget (DAK) or MEMR's budget through a state budget scheme. However, this scheme has a limited allocation. In West Nusa Tenggara, either central or local government commonly builds small renewable energy power plants in remote areas. The assets then will be managed by local cooperatives (a village's small institution) or BUMDes (village's enterprise).

6.4 Financial Structure

This section will outline several options available for projects in West Nusa Tenggara to access finance.

6.4.1 Local Finance

There are two sources of regional income in West Nusa Tenggara. Firstly, the income is collected originally from the retribution and taxes in the region. Secondly, the income that is allocated from the central government for the region known as balance fund. The balance fund encompasses general allocation fund, village fund (Dana Desa), special allocation fund (DAK), special autonomy fund, and profit-sharing fund. The implementation of renewable energy is rarely funded from pure regional income. **Some renewable energy projects can be funded through DAK for rural electrification programs or using village funds (Dana Desa), yet the allocation is limited and uncertain (not allocated annually)**. West Nusa Tenggara also can receive **international grants**, which are **allocated from the state budget**.

6.4.2 Private Sector Finance and Crowdfunding

According to the representatives from DESDM of WNT, some renewable energy infrastructure in West Nusa Tenggara is funded through the Corporate Social Responsibility (CSR) fund of mining companies, such as PT. Newmont Nusa Tenggara. For on-grid renewable electricity developed by the private sector through the IPP scheme is funded through debt and equity from financial institutions or international/national donors. Most of these big developers can secure their financial closing from the bank because they have the guarantee. DESDM representatives also mentioned that crowdfunding can be a funding option in West Nusa Tenggara.

6.4.3 National Finance

6.4.3.1 The Non-Government Budget Equity Financing (PINA)

One main challenge for small-scale renewable energy projects is to secure financial access because most small developers have no guarantee. Hence, **PINA can be a funding option for small-scale renewable energy projects**, including those in West Nusa Tenggara. PINA is a financial scheme under BAPPENAS that has a strategic role in facilitating project financing for Indonesia's infrastructure development. The projects that will be facilitated under PINA scheme must fulfill the following criteria: (1) projects with significant economic and social impact, (2) project possesses suitable and legal documents, (3) projects must be feasible, and (4) project is related to national development objectives.

Several steps must be performed by the project owners to be facilitated by PINA [43]. Firstly, a Letter of Intent and Project Profile must be submitted to PINA Center. Then, the preliminary project evaluation will be conducted before a feasibility study is undertaken. If the project meets the readiness criteria (Regulatory Framework, Financial Analysis, Technology Consideration, and Risk Mitigation) then the MoU will be signed by Project Owner (Investee) and PINA Center. PINA Center then will conduct a matchmaking process between

investee and investor. Subsequently, after financial close is performed, the project can start the construction and operation phase. Figure 22 illustrates the workflow under the PINA scheme.

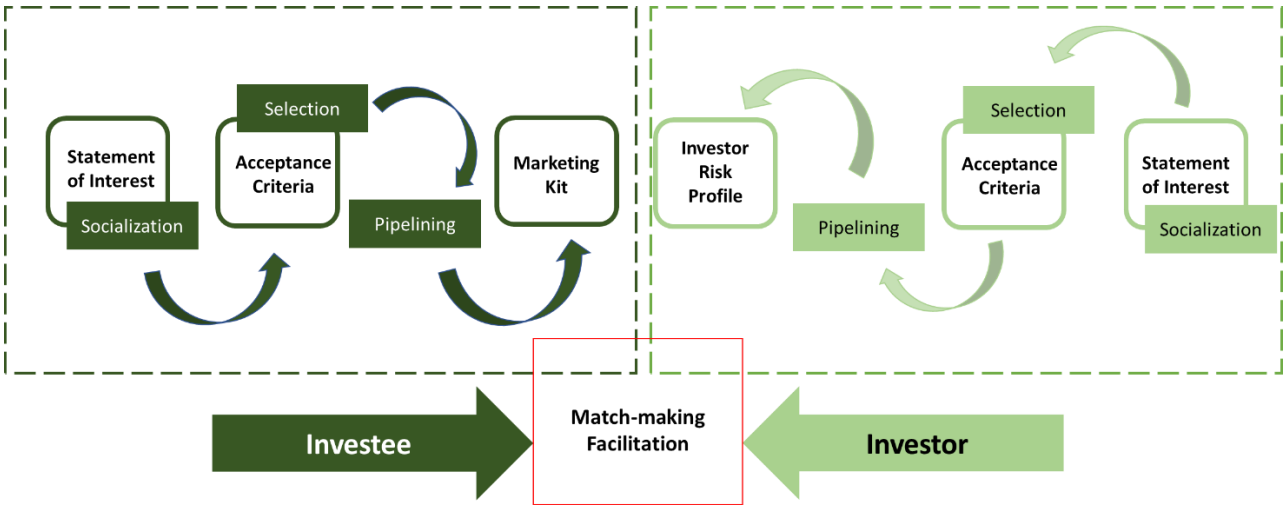

Figure 22 PINA Financial Scheme. Source: PINA 2020 [43]

6.4.3.2 IIGF – for PPPs

For renewable energy projects under the PPP business model, IIGF can be a financial facility to support the project. The IIGF has a role as an infrastructure guarantee fund for projects under PPP. The IIGF aims to accelerate the development of infrastructure projects through financial risk reduction by providing a guarantee or letters of comfort for a fee.

Through cooperation with multilateral agencies and bilateral institutions (Figure 23), the IIGF can increase its guarantee capacity. The IIGF will also have a function as the focal point for all requests for government guarantee (including regional government such as West Nusa Tenggara). To obtain the guarantee, the Government Contracting Authority submit a guarantee support proposal to the IIGF to be assessed. The IIGF then will issue a letter of Intent if the proposal agreed.

6.4.3.3 Viability Gap Fund – for PPP

If there are no practical measurements of making and economically feasible and financially viable projects, the Viability Gap Fund is available. Either central government may provide support in the form of licensing, land acquisition, and cash payments to fund some relevant construction costs, and/or in other forms to PPP projects, according to the existing laws and regulations. Most power projects are not usually eligible excepts for projects with a greater social purpose than commercial ones.

6.4.3.4 The Infrastructure Financing Fund

The renewable energy projects in West Nusa Tenggara can also be funded through this mechanism. The Infrastructure Financing Fund was established to help investors obtaining domestic finance for debt and equity funding. This fund can be accessed through PT Sarana Multi Infrastructure (PT SMI) and PT Indonesia

Infrastructure Finance (PT IIF). PT SMI is a financial institution under the Ministry of Finance and backed by multilateral agencies including the World Bank [25]. PT SMI also administers and collects the aids and grants from international donors. On the other hand, PT IIF is a private non-bank financial institution with its shareholders including PT SMI, the International Finance Corporation, ADB, Deutsche Investitions-und Entwicklungsgesellschaft GmbH, and Sumitomo Mitsui Banking Corporation [25].

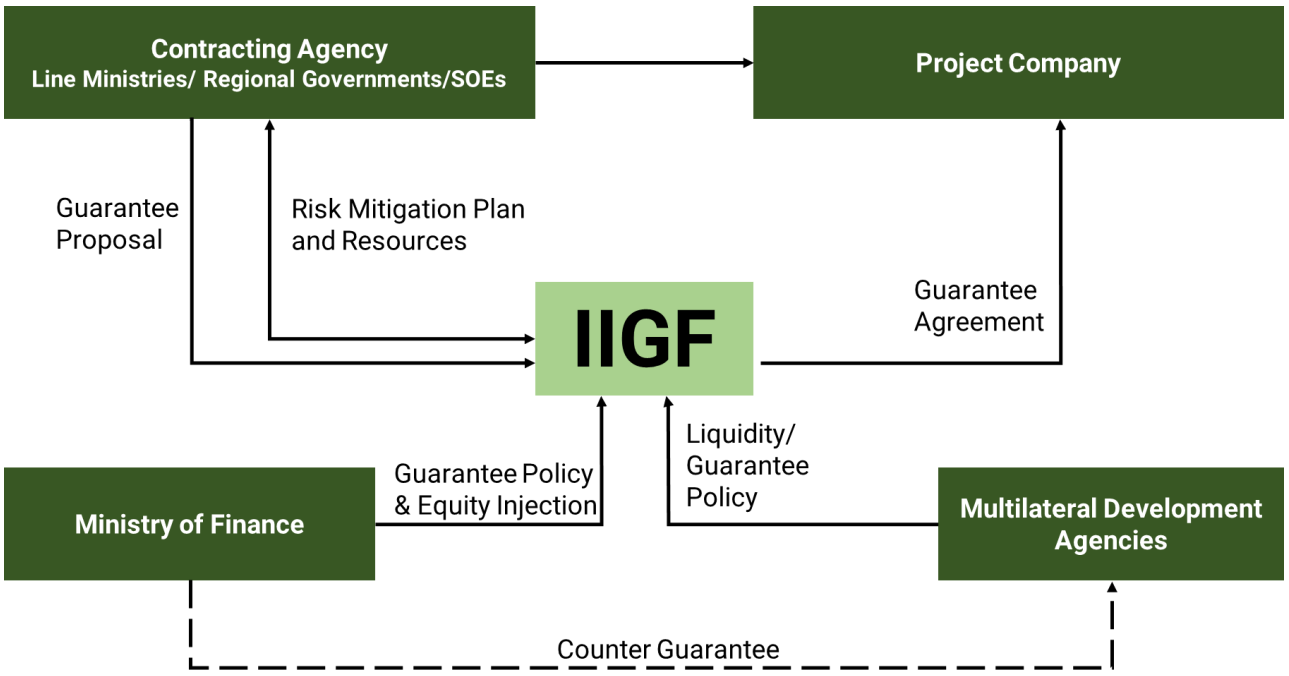

Figure 23 IIGF scheme workflow. Source: IIGF (2016) cited in PWC (2018) [25].

6.4.3.5 Other Incentives

The Government of Indonesia also offers fiscal incentives through tax provisions. Fiscal incentives related to renewable energy include import duty exemption on machinery and capital for power plant development, value-added taxes (VAT) exemption on importation of taxable goods, and income tax reduction [44]. Unfortunately, the GoI does not offer a feed-in-tariff scheme for renewable energy yet.

6.5 Challenges and Opportunities

The development of renewable energy in West Nusa Tenggara might encounter several challenges and barriers. The following Figure 24 summaries the challenges obtained through consultation with local stakeholders. Although the province has essential issues for renewable energy development, yet they also have opportunities. Figure 25 shows the opportunities in the region. To address the coordination and communication issue, the provincial government will establish an Implementation Working Group which also will strengthen the regulation and the monitoring of renewable projects.

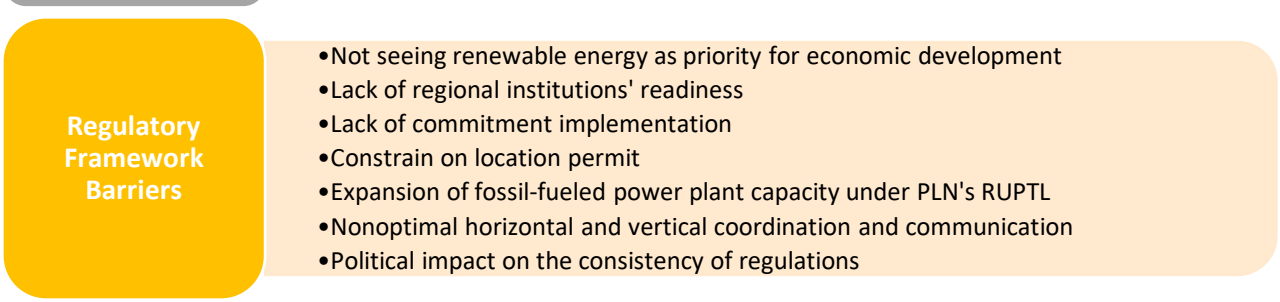

Figure 24 RE implementation barriers in West Nusa Tenggara.

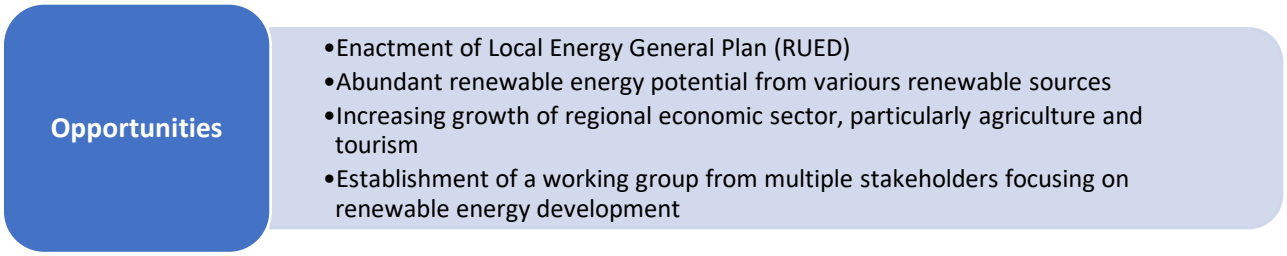

Figure 25 RE implementation opportunities in West Nusa Tenggara.

Chapter 7 Conclusion and Recommendation

West Nusa Tenggara has been selected as the deep-dive region for 100% Renewable Energy projects. The province consists of two main islands with two different profiles. Lombok Island has a smaller area than Sumbawa Island, yet the population density in Lombok Island is higher than that in Sumbawa Island. This condition can be a challenge for determining the general roadmap within the region. Despite its geographical challenge, the region has significant economic potential. The agricultural sector generates the highest contribution to regional income, while tourism and mining, energy, and electricity sectors attract the highest investments in the region. **Hence, renewable energy can be retrofitted in the development of the tourism area.**

West Nusa Tenggara is heavily dependent on fossil fuel for its electricity generation and its transportation sectors, which contributes to the highest amount of GHG emissions in the region. Moreover, the province still relies on other regions to fulfill its fossil fuel needs. Consequently, it impacts the energy security in the region. Renewable energy can significantly help the region to be a self-reliance region. The region has an abundant potential for renewable sources, which comes mainly from ocean current and solar energy. Solar energy potential in the region is known as one of the highest in Indonesia. Although the province has remarkable potential, the implementation of renewable energy in the region is still low. **Thus, the 100%RE program encourages more ambitious renewable energy targets.**

West Nusa Tenggara has a significant commitment to increasing its renewable energy share, particularly for electricity generation, stipulated under its Local Energy General Plan (RUED). This commitment is also aligned with prevailing national frameworks. Financial access can be a challenge for renewable energy development in the region. However, some financial supports are viable for this green energy development. In addition to this financial challenge, several barriers can hinder the implementation of renewable energy in the region. Yet, the presence of a working group for the implementation of RUED can help West Nusa Tenggara to achieve the commitments and targets. **Therefore, the presence of a 100% energy program can support local government in developing strategies and roadmaps.**

This Initial Status Report can be used as a baseline for the implementation of 100%RE projects as well as other projects in the future. The following actions are recommended to be taken for future works in West Nusa Tenggara.

- Capturing more detailed energy data as an input for energy modeling
- Developing new energy model using new data
- Establishing a strategic roadmap for 100%RE provisions in the region
- Identifying potential financial institutions to fund renewable energy projects
- Proposing a bankable project that can be financially funded and implemented in the region

Annex A Renewable Energy Power Plant in West Nusa Tenggara

Table 19 Renewable Energy Power Plant. Source: Energy Agency 2019 [45]

No	Name	Locations	Capacity (MW)	Developer
1	PLTMH Narmada	Desa Golong, Kec. Narmada, Kab. Lombok Barat	0.1	PLN
2	PLTM Pengga	Desa Pelambik, Kec. Praya Barat Daya, Kab. Lombok Tengah	0.4	PLN
3	PLTM santong	Desa Santong, Kec. Kayangan, Kab.Lombok Utara	1.0	PLN
4	PLTS On Grid Gili Trawangan	Desa Gili Indah, Kec. Pemenang, Kab.Lombok Utara	0.6	PLN
5	PLTS On Grid Gili Meno	Desa Gili Indah, Kec. Pemenang, Kab.Lombok Utara	0.06	PLN
6	PLTS On Grid Gili Air	Desa Gili Indah, Kec. Pemenang, Kab.Lombok Utara	0.16	PLN
7	PLTM Kokok Putih	Desa Sajang dan Desa Bilok Petung, Kec. Sembalun, Kab. Lombok Timur	3.8	PT. Nusantara Indo Energi
8	PLTM Segara	Dea Bentek, Kec. Gangga, Kab. Lombok Utara	7.0	PT. Suar Invetindo Capital
9	PLTM Cakra Negara	Kel. Sayang-Sayang, Kec. Cakra, Kota Mataram	0.6	PT. Tirta Daya Rinjani
10	PLTM Kukusan	Desa Mamben, Kec. Wanasaba, Kab. Lombok Timur	0.2	PT. Persana Karya Tama
11	PLTM Sesaot	Desa Buwun Sejati, Kec. Narmada, Kab. Lombok Barat	1.0	PT. Tirta Daya Rinjani
12	PLTM Karang Bayan	Desa Karang Bayan, Kec. Lingsar, Kab. Lombok Tengah	1.3	PT. Tirta Daya Lombok
13	PLTS On Grid Pringgabaya	Desa Pringgabaya, Kec. Pringgabaya, Kab. Lombok Timur	5.4	PT. Infrastruktur Terbarukan Adhiguna
14	PLTS On Grid Selong	Kel. Geres, Kec. Labuan Haji, Kab. Lombok Timur	5.4	PT. Infrastruktur Terbarukan Buana
15	PLTS On Grid Sengkol	Desa Sengkol, Kec. Pujut, Kab. Lombok Tengah	5.4	PT. Infrastruktur Terbarukan Cemerlang
16	PLTS On Grid Sambelia	Desa Padak, Kec. Sambelia, Kab. Lombok Timur	5.3	PT. Delapan Menit Energi
PLTMH: Micro-hydro PP; PLTM: Mini-hydro PP; PLTS: Solar PP				

Annex B Matrix Activity Plan under West Nusa Tenggara's Local Energy General Plan (RUED)

Table 20 Matrix Activity Plan. Source: RUED 2019 [31].

Matrix No	Actions	Period	Stakeholder
Study and Research			
1.1.1.1	Study of renewable energy resources potential and mapping	2016-2025	Energy Agency
Policy			
2.1.1.1	Formulation of policies regarding the obligation to use PV Solar rooftop for government office buildings	2016-2020	Energy Agency & BAPPEDA
2.1.1.2	Formulation of policies regarding the obligation to use PV Solar rooftop for hotel, apartment, luxury house through Building Permit	2016-2020	Energy agency, public works and housing agency
2.1.1.3	Formulation of Green Energy Village development policy for SAMOTA	2017-2018	Energy agency, tourism agency, agriculture agency, investment agency, BAPPEDA
2.1.1.4	Formulation of provision land policy for renewable energy development in municipality and regency (10.000 Ha by 2025 and 25.000 Ha by 2050)	2017-2018	Energy agency, settlement, and spatial planning agency, BAPPEDA
2.7.1.1	Policy formulation to accelerate the licensing process of geothermal power plants to utilize forest areas in Sembalun, Hu'u, and Maronge	2017-2050	Energy agency, Law office, BAPPEDA, environment, and forestry agency
2.9.1.1	Policy formulation to utilize biofuel for the transportation sector	2016-2020	Energy Agency. Transportation agency
3.1.1.1	Compiling regulation of energy saving in buildings through the utilization of LED, more efficient AC, and reduction in electricity usage at night	2016 - 2020	Energy agency, Public works and housing agency,
3.1.3.1	Formulation of regulation in energy utilization standard for buildings, traded equipment, and vehicles	2016 -2020	energy agency, transportation agency, public work and housing agency, and training agency
4.1.2	Formulation of regulation for air quality standard of transportation, industry, power plant (in particularly waste power plant). Including controlling and monitoring of the regulation	2016 - 2020	Environment and forestry agency
5.1.1.2	regulation and supervision of electricity tariffs in special areas	2016 - 2050	Energy agency, economics department
5.2.2.1	Formulation and implementation of renewable energy incentives regulation	2016 - 2020	energy agency, regional financial and asset management agency
Capacity Building and Empowerment			
3.1.5.1	education and build social awareness of energy savings	2016 - 2025	energy agency, educational agency
7.1.1.1	Enhancement capabilities of energy management for civil servant and non-civil servant in the energy field	2016 - 2050	MEMR, energy agency, BAPPEDA
7.1.1.2	Increasing education quality in energy technology through vocational school	2016 - 2050	Educational agency, NGO
7.1.1.3	increasing the number and quality of experts in the energy sector	2016 - 2050	Energy agency, Human Resource Development Agency
7.1.2.1	establish a technical service unit (Local Support Centre) that provides troubleshooting consulting services and the supply of solar power plant parts	2017 - 2018	Energy agency, university
7.1.2.2	training to operate and maintain renewable energy power plant for operator	2016 - 2050	MEMR, Energy agency, university
7.1.2.3	business training by utilizing local commodities for renewable energy users in rural areas	2016 - 2050	MEMR, Energy agency, university
Infrastructure Development			
2.1.2.1	Infrastructure of solar panel on grid system close to substations with minimum total capacity is 215 MW by 2025 and 400 MW by 2050.	2017 - 2050	PLN, IPP, Energy agency
2.1.2.2	Establish Solar Home System (SHS) and off-grid centralized PV solar panel that total capacity is 5 MW of 2050 in undeveloped areas	2017 - 2050	Energy agency

2.1.2.3	Establish on-grid PV solar panel rooftop for school, government, and commercial buildings: feasibility study and DED, as well as construction	2017 - 2050	Energy agency, settlement and spatial planning agency, public works and housing agency, IPP, PLN
2.1.2.4	Establish rooftop PV solar panel on the grid for transportation facilitation: feasibility study and DED, as well as construction	2017 -2050	Energy agency, transportation agency, IPP, PLN
2.2.1.1	Establish Waste power plant with total capacity 4 MW in 2025 and 10 MW in 2050: feasibility study and DED, as well as construction	2017 - 2050	Energy agency, environment, and forestry agency, BAPPEDA, IPP, PLN
2.3.1.1	Establish Wind power plant with total capacity 25 MW in 2025 and 50 MW in 2050: feasibility study and DED, as well as construction	2017 - 2050	Energy agency, BAPPEDA, IPP, PLN
2.4.1.1	Establish biomass power plant with total capacity 10 MW in 2025 and 25 MW in 2050: feasibility study and DED, as well as construction	2017 - 2050	Energy agency, BAPPEDA, IPP, PLN
2.5.1.1	Establish micro hydro power plant with total capacity 4 MW in 2025 and 15 MW in 2050: feasibility study and DED, as well as construction	2017 - 2050	Energy agency, BAPPEDA, IPP, PLN
2.5.1.2	Establish micro hydro power plant (off-grid) with total capacity 1 MW in 2050 for undeveloped area	2017 - 2050	Energy agency, BAPPEDA, IPP, PLN
2.6.1.1	Establish mini hydro power plant with total capacity 50 MW in 2025 and 60 MW in 2050 as well as hydro power plant with total capacity by 30 MW in 2025 and 60 MW in 2050: feasibility study and DED, as well as construction	2017 - 2050	Energy agency, BAPPEDA, IPP, PLN
2.6.7.2	Establish geothermal power plant with total capacity is 20 MW in 2025 and 169 MW in 2050: feasibility study and DED, as well as construction	2017 - 2050	MEMR, Energy agency, BAPPEDA, PLN
2.6.8.1	Establish biogas with capacity 4 m3 as many as 300 unit (minimum) annually	2017 - 2050	Energy agency, NGOs, animal husbandry agency
Energy Efficiency			
3.1.2.1	Energy audit in office buildings, commercial (hotel, mall, etc.), educational buildings, hospital	2016 - 2025	Energy agency
3.1.6.1	Reduce diesel power plant in 2025 only 50 MW, and 0 MW in 2050	2017 - 2050	PLN
3.1.6.2	Reduction of utilization rented fossil fuels power plant by 25 MW in 2025 and 0 MW in 2050	2017 - 2050	PLN
Energy Diversification			
3.2.7.1	Conversion of kerosene to 3 Kg of LPG	2018 -2025	MEMR, Energy agency, PERTAMINA
3.2.8.1	Utilization of 25% electric vehicle by 2025	2025	MEMR, Ministry of industry, energy agency, transportation agency, private sector
3.2.8.2	establish public electric charging station	2025	MEMR, energy agency, transportation agency, PLN
Institutional Framework			
	Establish institutional for deployment of renewable energy in accordance with the RUED	2020	

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