Chapter 3

Forecast of LNG Demand in Eastern Indonesia

January 2021

This chapter should be cited as

ERIA (2021), 'Forecast of LNG Demand in Eastern Indonesia', in Kimura, S., et al. (eds.), *Feasible Solutions to Deliver LNG to Midsized and Large Islands in Indonesia.* ERIA Research Project Report FY2020 no.18, Jakarta: ERIA, pp.11-21.

Chapter 3

Forecast of LNG Demand in Eastern Indonesia

This study focuses on delivering LNG in Eastern Indonesia to meet the requirement of natural gas–fired power plants (GPPs). It covers the eastern part of Indonesia and the provinces listed in Table 3.1. Kalimantan provinces are excluded because the requirement of GPPs will be met internally through pipelines. This chapter projects electricity demand for the designated area, and based on this, forecast LNG demand.

Table 3.1: Provinces Covered in the Study

No.	Province
1	North Sulawesi
2	Gorontalo
3	Center Sulawesi
4	Southeast Sulawesi
5	West Sulawesi
6	South Sulawesi
7	Maluku
8	North Maluku
9	Papua
10	West Papua
11	Bali
12	East Nusa Tenggara (NTT)
13	West Nusa Tenggara (NTB)

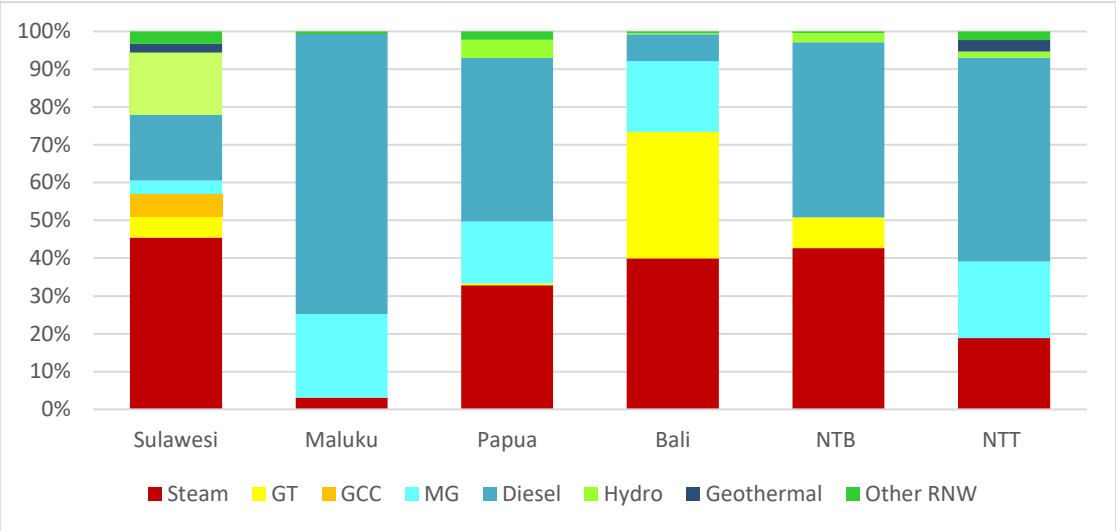
Source: Authors' calculation.

1. Current Situation

Indonesia's electricity consumption was 234.6 gigawatt-hour (GWh) in 2018 according to the Directorate General of Electricity (2019). Most of this consumption was from the residential (42%) and industry (33%) sectors. By region, Java electricity consumption accounted for about 71% of the total consumption, and Eastern Indonesia shares were 9%. These are the consumption of Sulawesi, Maluku, North Maluku, Papua, West Papua, Bali, West and East Nusa Tenggara (NTB and NTT).

Electricity supply of these regions mostly came from diesel power plants, around 71%, whilst steam and hydro power plants accounted for around 15% and 8%, respectively. The remaining supply are from GPPs, solar, wind, and geothermal. Figure 3.1 shows the distribution of power plants in the designated Eastern Indonesia regions.

Figure 3.1. Plant Capacities in Eastern Indonesia, 2018



NTB = West Nusa Tenggara, NTT = East Nusa Tenggara, GT = gas turbine, GCC = gas combined cycle, MC=machine gas, RNW=renewable
Source: Directorate General of Electricity, Indonesia (2019).

Recently, the MEMR issued Ministerial Decree No. 13 K/13/MEM/2020, mandating PT PLN, the State Electricity Company, to convert the 52 diesel power plants to gas. The programme's purpose, as noted in the decree, is to reduce the trade deficit and to support the energy diversification programme. The conversion from diesel to gas would reduce PT PLN's diesel consumption from 2.6 million kilolitres (kL) per year to 1.6 million kL per year, with estimated operational cost savings at Rp4 trillion (US$286 million).[1]

The ministry also assigned the state-owned oil company, Pertamina, to supply the gas. This includes the development of the LNG infrastructure to receive, store, and regasify LNG. PT Pertamina is obligated to set the price of the regasified gas at 'plant gate', which will result in a lower production cost of PT PLN compared to using high-speed diesel.

Of the total 52 diesel plants in the decree, 32 plants are in Eastern Indonesia with a total capacity of 801 MW. Table 3.2 shows the total capacity of the diesel plants in said region to be converted into gas.

[1] Assumption: US$1.00 = Rp14,000.

Table 3.2: Total Diesel Plants Converted to GPPs in Eastern Indonesia

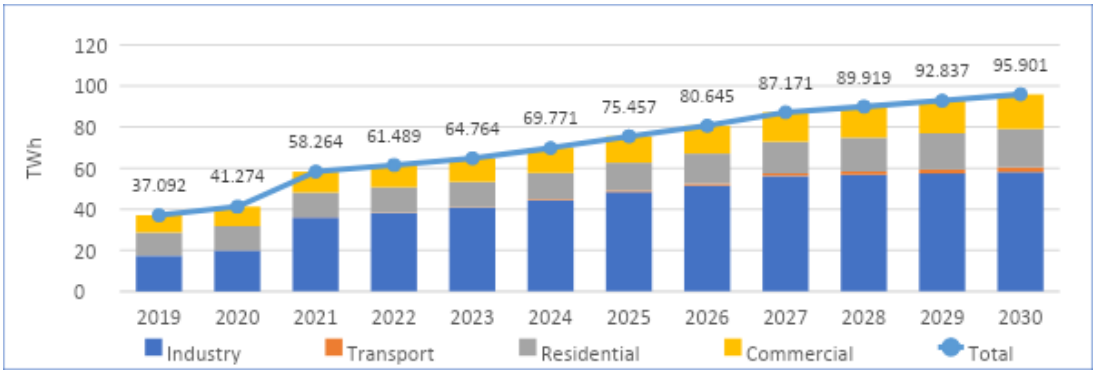
Province	Capacity (MW)
NTB (West Nusa Tenggara)	150
NTT (East Nusa Tenggara)	123
North Maluku	100
Maluku	110
Papua	100
West Papua	20
Gorontalo	100
Southeast Sulawesi	98
Total	**801**

Source: MEMR (2020e).

2. Electricity Demand Forecast

Electricity demand will continue to increase, and total electricity demand of Indonesia is projected to reach 638.8 terawatt-hours (TWh) by 2030, growing at an average rate of 7.5% per year over the 2019–2030 period. This electricity projection is from the National Electricity Plan (RUKN) 2019–2038 (MEMR, 2019). The RUKN projected electricity demand by province based on the population and GDP growth rate of each region and on the existing plan of the processing plants of mineral and mining companies. The electricity demand for these processing plants were included in the projection because the government had issued mineral laws that mandated companies to build processing plants before exporting the minerals. The mineral reserves are mostly in Eastern Indonesia, such as Sulawesi and Maluku Islands. Figure 3.2 shows the projected total electricity demand in the covered provinces of the study by subsector.

Figure 3.2: Electricity Demand Projection in Eastern Indonesia (TWh)



TWh = terawatt-hour
Source: MEMR (2019a).

The total electricity demand of the region will grow at an average of 9% per year, reaching almost 96 TWh by 2030. The region's demand is 15% of the national projection but the growth is faster. The industry sector will dominate the electricity demand of the region (61% in 2030) and the demand is projected to grow at an average rate of 11.6% per year over the 2019–2030 period. The residential sector's share (19%) in the total demand will be slightly higher than the commercial sector (18%) in 2030.

The RUKN limits the electricity demand projection at the province level. Breakdown by the regency will be estimated in the study by assuming the same level of electricity demand per capita of the province. Thus, the regency level electricity demand is calculated using the formula:

$$\boldsymbol{ED_{ij} = POP_{ij} * EDC_j}$$

where:

ED_{ij} = Electricity demand of regency i in province j
POP_{ij} = Population in regency iI in province j
EDC_j = Average electricity demand per capita of province j

The average electricity demand per capita (EDC) of the province will be the RUKN electricity demand projection of the province divided by the projected population of the province. The population figures were obtained from the Badan Pusat Statistik (BPS) or central and provincial statistical agency. The population projection of the province was based on the population projection of the National Development Planning Agency (Bappenas), BPS, and United Nations Population Fund (UNFPA) (BPS, 2013). The population projection was done only at the province level. The regional population in 2030 was calculated using the existing regency shares to its province (2017 data). The resulting population by regency and the calculated electricity demand of these regencies was the basis for selecting the location of potential GPPs.

After discussion and considerations, the study selected locations in the provinces which can potentially build the combined cycle gas turbine (CCGT) and demand in 2030 more than 100 GWh. These are three locations on the island of Sulawesi, one location in Bali Island, two locations in each province of NTB, NTT, Maluku, North Maluku, West Papua, and four locations in Papua. Table 3.3 shows the selected locations of the provinces, their population, and the total and per capita electricity demand.

Table 3.3: Electricity Consumption, 2030

Region		Total Population	Electricity Consumption	Electricity per Capita
		People	GWh	KWh/capita
North Sulawesi		2,696,228	6,719	2,492
Center Sulawesi		3,480,252	14,892	4,279
South Sulawesi		7,486,185	16,799	2,244
Bali		4,765,261	9,602	2,015
West Nusa Tenggara		5,581,818	5,219	935
1	Lombok	3,913,290	3,659	
2	Sumbawa	1,668,528	1,560	
East Nusa Tenggara		6,408,964	2,288	357
1	Flores Island	2,431,126	868	
2	Kupang/Timor Island	2,309,014	824	
Maluku		2,104,922	1,625	772
1	Buru	485,985	375	
2	Ambon	581,903	449	
North Maluku		1,499,436	13,282	8,858
1	Halmahera (South)	833,352	7,382	
2	Ternate	277,478	2,458	
Papua		3,937,992	4,001	1,016
1	Merauke	269,418	274	
2	Yapen Island (Serui)	114,583	116	
3	Biak	174,512	177	
4	Jayapura City	354,204	360	
West Papua		1,200,153	4,701	3,917
1	Manokwari	218,670	857	
2	Sorong City	885,726	3,469	

Source: Authors' calculation.

After selecting the potential locations, the next step was to identify the city where the harbour or port will be. Table 3.4 shows the city name and the abbreviations used for modelling purposes.

Table 3.4: Potential Location for CCGT

No.	Potential Location	City Name	Abbreviation
1	North Sulawesi	Manado	MND
2	Center Sulawesi	Palu	PAL
3	South Sulawesi	Makassar	MKS
4	Bali	Benoa	BNO
5	Lombok, West Nusa Tenggara	Lembar	LMB
6	Sumbawa, West Nusa Tenggara	Badas	BDS
7	Flores, East Nusa Tenggara	Labuan Bajo	LBJ
8	Kupang, East Nusa Tenggara	Kupang	KPG
9	Ambon, Maluku	Ambon	AMB
10	Buru Island, Maluku	Namlea	NLA
11	Halmahera (South), North Maluku	Weda	WED
12	Ternate, North Maluku	Ternate	TTE
13	Yapen Island, Papua	Serui	SRU
14	Biak, Papua	Biak	BIK
15	Merauke, Papua	Merauke	MRK
16	Jayapura, Papua	Jayapura	JAP
17	Manokwari, West Papua	Manokwari	MNK
18	Sorong, West Papua	Sorong	SON

CCGT = combined cycle gas turbine.
Source: Authors.

3. LNG Demand Forecast

3.1. Estimating electricity production from GPPs

The total electricity production in 2030 for the selected region (Table 3.5) was calculated as follows:

$$Production_i = Demand_i/(1-(OTD/100))$$

where:

$Production_i$ = Electricity production of location i
$Demand_i$ = Electricity demand of location i
OTD = Own use and transmission and distribution (T&D) losses

The own use and T&D losses for all selected regions were assumed to be 12.87%. This was the average of PT PLN figures in Indonesia.

Table 3.5: Electricity Production of Selected Regions in 2030

Potential Location	Electricity Demand	Own Use and T&D Losses	Electricity Production
	GWh	%	GWh
Center Sulawesi	14,892	12.87	17,092
South Sulawesi	16,799	12.87	19,281
North Sulawesi	6,719	12.87	7,712
Bali	9,602	12.87	11,020
Lombok, West Nusa Tenggara	3,659	12.87	4,199
Sumbawa, West Nusa Tenggara	1,560	12.87	1,791
Flores, East Nusa Tenggara	868	12.87	996
Kupang, East Nusa Tenggara	824	12.87	946
Buru Island, Maluku	375	12.87	431
Ambon, Maluku	449	12.87	516
Halmahera (South), North Maluku	7,382	12.87	8,472
Ternate, North Maluku	2,458	12.87	2,821
Yapen Island, Papua	116	12.87	134
Biak, Papua	177	12.87	203
Merauke, Papua	247	12.87	314
Jayapura, Papua	360	12.87	413
Manokwari, West Papua	857	12.87	983
Sorong, West Papua	1,232	12.87	1,414

T&D = transmission and distribution.
Source: Authors' calculation.

Currently, there are power plants existing to meet the electricity demand in the selected locations. The Electricity Supply Business Plan (RUPTL) of PT PLN 2019–2028 also includes the expansion of these power plants and the construction of new plants until 2028 (PLN, 2019). In addition to the planned capacity of the natural GPPs, the study assumed that the oil-based power plants in the selected region will be replaced by gas following MEMR Decree 13 K/13/MEM/2020. The coal steam power plants and renewable plants in 2030 will generate electricity based on the assumed installed capacity in the RUPTL 2019–2028 and the capacity factor shown in Table 3.6. Additionally, information on electricity production generated by coal and renewables is shown in Table 3.7.

Table 3.6: Capacity Factor of Power Generator (%)

Capacity Factor, %	
Coal	80
Hydro	65
Wind	45
Solar	15
Geothermal	85

Source: Authors' calculation.

Table 3.7: Electricity Production from Coal and Renewables (GWh)

Potential Location	Coal	Hydro	Biomass	Solar	Geothermal	Wind	Total
Center Sulawesi	14,962.78	1,262.47	0.00	0.00	0.00	0.00	**16,225.25**
South Sulawesi	6,937.92	10,295.61	105.47	6.95	0.00	559.76	**17,905.71**
North Sulawesi	4,316.93	704.01	122.64	1.76	893.52	0.32	**6,039.18**
Bali[a]	5,788.61	140.24	97.50	268.41	2,159.34	5.44	**8,459.54**
Lombok, West Nusa Tenggara	770.88	87.69	0.00	0.00	0.00	0.00	**858.57**
Sumbawa, West Nusa Tenggara	0.00	2.85	0.00	0.00	0.00	0.00	**2.85**
Flores, East Nusa Tenggara	98.11	4.56	0.00	0.00	74.46	0.00	**177.13**
Kupang, East Nusa Tenggara	441.50	1.14	0.00	1.31	0.00	0.00	**443.95**
Buru Island, Maluku	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Ambon, Maluku	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Halmahera (South), North Maluku	5,739.55	0.00	0.00	0.00	0.00	0.00	**5,739.55**
Ternate, North Maluku	280.32	0.00	0.00	0.00	0.00	0.00	**280.32**
Yapen Island (Serui), Papua	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Biak, Papua	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Merauke, Papua	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Jayapura, Papua	168.19	113.88	0.00	0.00	0.00	0.00	**282.07**
Manokwari, West Papua	84.10	17.65	0.00	0.00	0.00	0.00	**101.75**
Sorong, West Papua	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**

[a] Bali's electricity production includes the interconnection from Jawa, which comes from coal plants.
Source: Authors' calculation.

Electricity generation from the GPPs is the difference between total electricity production in the selected location minus the generation from the coal and renewable power plants.

3.2. Calculation of LNG demand

The LNG demand for each selected region will be calculated based on the gas input for the natural GPPs. The gas input is calculated using the formula:

Input = Output/Plant Efficiency

The plant efficiency of GPPs is assumed to be 39%. The electricity output in GWh will be first converted to kiloton of oil equivalent (ktoe) using the following:

1 GWh = 0.086 ktoe

The natural gas requirements will be calculated using the conversion:

1 ktoe = 0.00111 billion m^3

The conversion of natural gas from billion m^3 to million tonnes of LNG will use the following factor:

1 billion m^3 = 0.714 million tonnes

The results of the LNG demand for the electricity generation of the GPPs is shown in Table 3.8.

Table 3.8: LNG Demand Forecast for the GPPs in the Selected Locations

Potential Location	Production from CCGT		Efficiency CCGT	Gas Consumption		LNG Consumption
	GWh	ktoe	%	ktoe	billion m^3	million tonnes
Center Sulawesi	1,415.54	122	39	312	0.35	0.247
South Sulawesi	1,313.47	113	39	290	0.32	0.230
North Sulawesi	1,096.97	94	39	242	0.27	0.132
Bali	2,968.18	255	39	655	0.73	0.519
Lombok, West Nusa Tenggara	2,598.92	224	39	573	0.64	0.454
Sumbawa, West Nusa Tenggara	1,474.94	127	39	325	0.36	0.258
Flores, East Nusa Tenggara	597.32	51	39	132	0.15	0.104
Kupang, East Nusa Tenggara	565.20	49	39	125	0.14	0.099
Buru Island, Maluku	430.60	37	39	95	0.11	0.075
Ambon, Maluku	515.59	44	39	114	0.13	0.090
Halmahera (South), North Maluku	2,596.93	223	39	573	0.64	0.454
Ternate, North Maluku	2,540.66	218	39	560	0.62	0.444
Yapen Island (Serui), Papua	133.61	11	39	29	0.03	0.023
Biak, Papua	203.49	18	39	45	0.05	0.036
Merauke, Papua	292.70	25	39	65	0.07	0.051
Jayapura, Papua	130.96	11	39	29	0.03	0.023
Manokwari, West Papua	88.31	76	39	194	0.22	0.154
Sorong, West Papua	1,413.54	122	39	312	0.35	0.247

CCGT = combined cycle gas turbine, GPP = natural gas–fired power plant, ktoe = kiloton of oil equivalent
Source: Authors' calculation.

Table 3.9 shows the LNG refilling for a large ship with a capacity of 13,500 tonnes.

Table 3.9: LNG Refilling Capacity for Large Ships

Potential Location	LNG Consumption		Refilling to Large Ship
	kiloton	t/day	Refill LNG/day
Center Sulawesi	152	415	32.52
South Sulawesi	240	659	20.50
North Sulawesi	292	801	16.85
Bali	448	1,227	11.01
Lombok, West Nusa Tenggara	584	1,600	8.44
Sumbawa, West Nusa Tenggara	313	856	15.77
Flores, East Nusa Tenggara	143	392	34.41
Kupang, East Nusa Tenggara	88	241	56.13
Buru Island, Maluku	75	206	65.45
Ambon, Maluku	90	247	54.66
Halmahera (South), North Maluku	478	1,309	10.31
Ternate, North Maluku	444	1,217	11.09
Yapen Island (Serui), Papua	23	64	210.94
Biak, Papua	36	91	138.50
Merauke, Papua	55	150	89.71
Jayapura, Papua	23	63	215.21
Manokwari, West Papua	55	422	31.98
Sorong, West Papua	247	677	19.94

Source: Authors' calculation.