INTRODUCTION

1.1 Background

In the past two decades, Indonesia's population growth rate has experienced a positive upward trend of 1.36% (BPS, 2017). The population growth is in line with the national economic growth rate which grew 5.05% in the second quarter of 2019 (BPS, 2019). These trends in population growth and increased economic growth, as well as technological development, have consequences for increasing energy demand.

The growth of national energy demand averages around 4.9%/year (DEN, 2017). However, currently meeting the Indonesia's energy needs faces three main problems, namely high dependence on fossil fuels as primary energy, low electrification ratio, and the slow development of renewable energy utilization. Unfortunately, the availability of fossil energy sources has a negative trend. Petroleum reserves (proven and potential) fell 1.2% in 2016 with production of 287.30 Million barrels in 2006 down to 251.87 Million barrels in 2015 (DEN, 2016).

The decline in production was due to the aging of oil production wells while the exploration of new wells was very limited. One of the strategies adopted to meet energy demand amid a decline in domestic production is through increased petroleum imports. In 2015, imports of fossil fuels accounted for 44% of national fuel needs. However, different trends are indicated by coal and natural gas sources. Coal and natural gas production in 2015 increased by 0.65% and 1.36% respectively compared to 2014. The surplus of these two primary energy sources is due to the still small national demand compared to the level of production. In 2015 petroleum contributed 43% to the total primary energy use in Indonesia, while coal contributed 28.7%, and natural gas 22.0%. While renewable energy only accounts for only 6.2% of the total primary energy in Indonesia (DGT, 2016).

High dependence on fossil energy has caused various impacts, including threats to national energy security due to diminishing stock and environmental impacts of external uses. These environmental impacts are cross country, not only local or regional, such as global warming due to increased greenhouse gas (GHG) emissions in the atmosphere. Greenhouse gases consist of CO2, CH4, N2O, HFC, PFC, and SF6 (IPCC, 2007). The use of fossil fuels contributed to the world's largest GHG emissions in 2004 in the form of carbon dioxide (CO2) emissions by 57%.

Fossil and non-renewable fossil energy reserves require the search for alternative energy sources as future energy. There are a variety of new renewable energies, one of which is bioenergy. Bioenergy consists of various types such as biomass/ biofuel and biogas. Biomass energy is a renewable energy source that is produced from various types of raw materials that are widely available around us such as wood, agricultural waste, animal manure, manure and algae (DCR, 2008).

Wood is an important source of biomass energy. For tens of thousands of years, humans have been burning wood to produce heat and energy. Currently, wood pellets as a modern form of processed wood products have been used as a potential source of heat energy and are more environmentally friendly because they produce relatively less carbon dioxide (CO2) emissions compared to other renewable energy sources.

Wood pellets, unlike fresh wood, contain very low moisture content and produce little ash, so that almost all wood material is burned and converted to heat. Wood is also much cheaper per unit of energy compared to fossil fuels. Furthermore, as a local energy source, the price and availability of wood is more determined by domestic conditions than international forces. In this case Indonesia, with a forest area of around 131.5 million hectares, has a great opportunity in utilizing biomass energy from forest management.

1.2 Purpose

The purpose of this feasibility study is to**:**

1. Assess the potential electricity demand by PT PLN (Persero) in the target area (North Sumatra) as well as the potential for wood pellet markets;
2. Identify the availability of land for the development of energy forest plantations in North Sumatra;
3. Identify potential plant species as raw materials for wood pellets, and
4. Assess the technical and economic feasibility of developing the wood pellet industry in North Sumatra.

In connection with the analysis of electricity demand by PT PLN (Persero), the scope of the study is limited to the price of wood pellets received by the national electricity management SOE, the company's willingness to buy wood pellet products for the power plant industry and the considerations that underlie its decision making. In this case, the study conducted was not directed specifically at the feasibility analysis to produce electricity from wood pellets.

An explanation of the logical framework of the study from the feasibility analysis of the development of new renewable energy sources from biomass is shown in Figure 1.

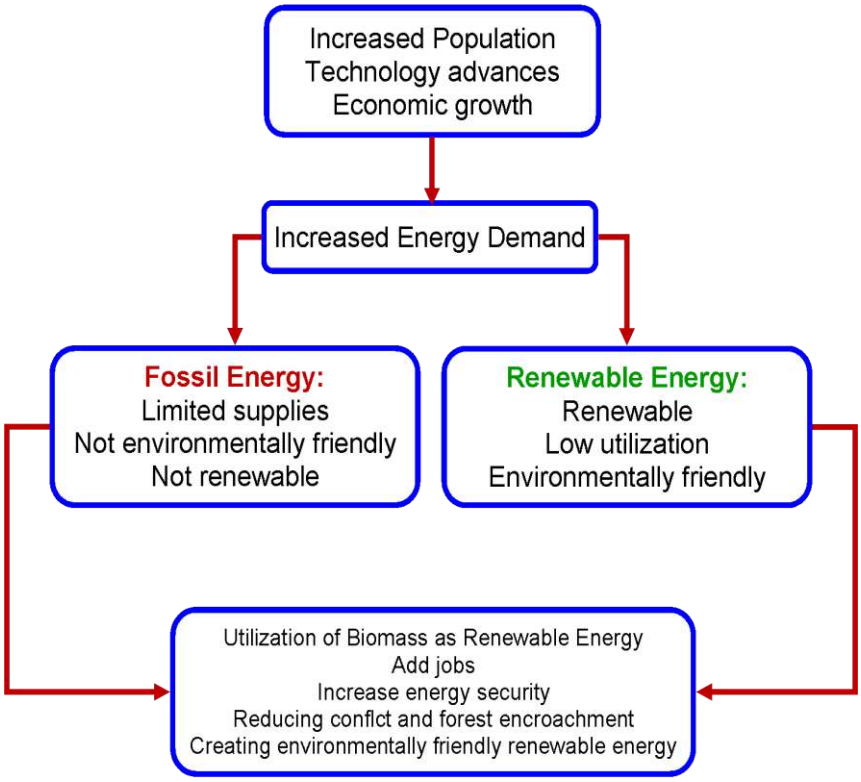


Figure 1. Logical Framework for Utilization of Biomass as a Renewable Energy Source

1.3 Comments on the TOR (see TOR in Annex C)

Items	Comments
Background	The Information is enough
Expected outputs	Foreign market demand for electricity and wood pellets is too broad, and it will be very difficult to be thoroughly analyzed for a specified period of time. It would be more meaningful if this study focused on the demand for wood pellets from the most relevant countries. The feasibility of electricity from wood pellets will be analyzed very generally, based on the current Government policy. The focus is on PLN's willingness to pay for wood pellets, and the reasons behind it. It seems that the purchase price of electricity by PLN is still too low.
The tasks that must be carried out	These tasks can be categorized into two aspects, namely technical and financial aspects.
Implementation schedule	The time given is quite adequate, but the year needs to be revised from 2018 to 2019.

METHODOLOGIES

2.1 Scope

Based on the purpose of the activity, the scope of the feasibility study conducted includes activities (i) identification of land availability for the development of energy plantations in North Sumatra; (ii) identification of potential plant species as raw materials for wood pellets, and assessing (iii) potential electricity demand by PT PLN (Persero) in the target area (North Sumatra) as well as the potential market for wood pellets and (iv) the technical and economic feasibility of developing wood pellet industry in North Sumatra.

In connection with the analysis of electricity demand by PT PLN (Persero), the scope of the study is limited to the price of wood pellets received, referring to the magnitude of the Cost of Generating Supply (BP3) of PT PLN (Persero) in 2018. Based on these provisions the BP3 value in North Sumatra is Rp 1,451/kWh (10.18 cents US $/ kWh) except Nias which is Rp 3,041/kWh or 21.34 cents US $/kWh. In this study, if the price of biomass energy pellets is unable to meet the needs of the power plant, the study will focus on the development of the wood pellet industry.

2.2 Assessment of Demand for Wood Pellets for Electricity Needs

The assessment of demand for wood pellet products for power plants is done by identifying and calculating the potential electricity needs of PT PLN (Persero), especially for the Northern Sumatra region. Data collection is done through in-depth interviews with officials of the SOE company and studying documents relating to national electricity policy, reviewing various scientific publications, and other relevant matters.

2.3 Identification of Feasibility of Developing Wood Pellet Business

The business potential of sustainable wood pellets is known by identifying and mapping the availability of land for the development of energy plantations and the location of the processing industry which will be built based on ecological, economic and socio-cultural aspects. Mapping land availability is used as a basis for formulating recommendations for business models that are developed. Mapping activities are carried out using a Geographic Information System approach, field surveys, and interviews with relevant parties, especially to find out the factual conditions in the field. The information collected is

in the form of general conditions, area, location and boundaries, natural resource data (physical and biophysical), human resource conditions (community, government, company), and other related information.

Demographic data and information collection and in-depth interviews with various stakeholders were also carried out to find out the preferences of the community, government and business community regarding plans for developing alternative renewable energy sources from biomass through the development of the wood pellet business. In this stage also mapped are readiness of the community, the government in terms of legal aspects, and the company. The information obtained is used to identify the readiness of the community to be involved in the wood pellet business activities that will be carried out. At this stage also observed and identified market potential (demand) for wood pellet products.

2.4 Sustainable Wood Pellet Business Model

The development of the wood pellet business model will use the concept of partnership with the community. This is based on the consideration that the involvement of the community and other stakeholders is an important prerequisite for the sustainability of the wood pellet business that can benefit local communities, and support the preservation of natural resources and the environment.

Some aspects that are considered in this business model include the types of investments needed, as well as the parties involved and the forms of involvement. Parties and partnerships of concern in the development and management of business sustainability are local communities, entrepreneurs/companies, governments, Non-Government Organizations, business supporters of wood pellet business activities, and the education sector.

In general, the wood pellet business process is described in**:**

a) availability of raw materials,
b) production,
c) distribution, and
d) consumption.

The business model carried out in the utilization of biomass for renewable energy is shown in Figure 2.

2.5 Investment and stakeholder involvement

The wood pellet business requires a substantial investment in the initial stages of development. This is mainly for the supply of raw materials through the development of plantation forests, processing raw materials by building a wood pellet mill to be able to produce wood pellets that are ready to be marketed. Therefore, as part of a feasibility study, it is necessary to determine the amount of capital/investment needed at each stage of development until the operation of the wood pellet processing industry. Investment

feasibility is based on Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), Payback Period and sensitivity analysis.

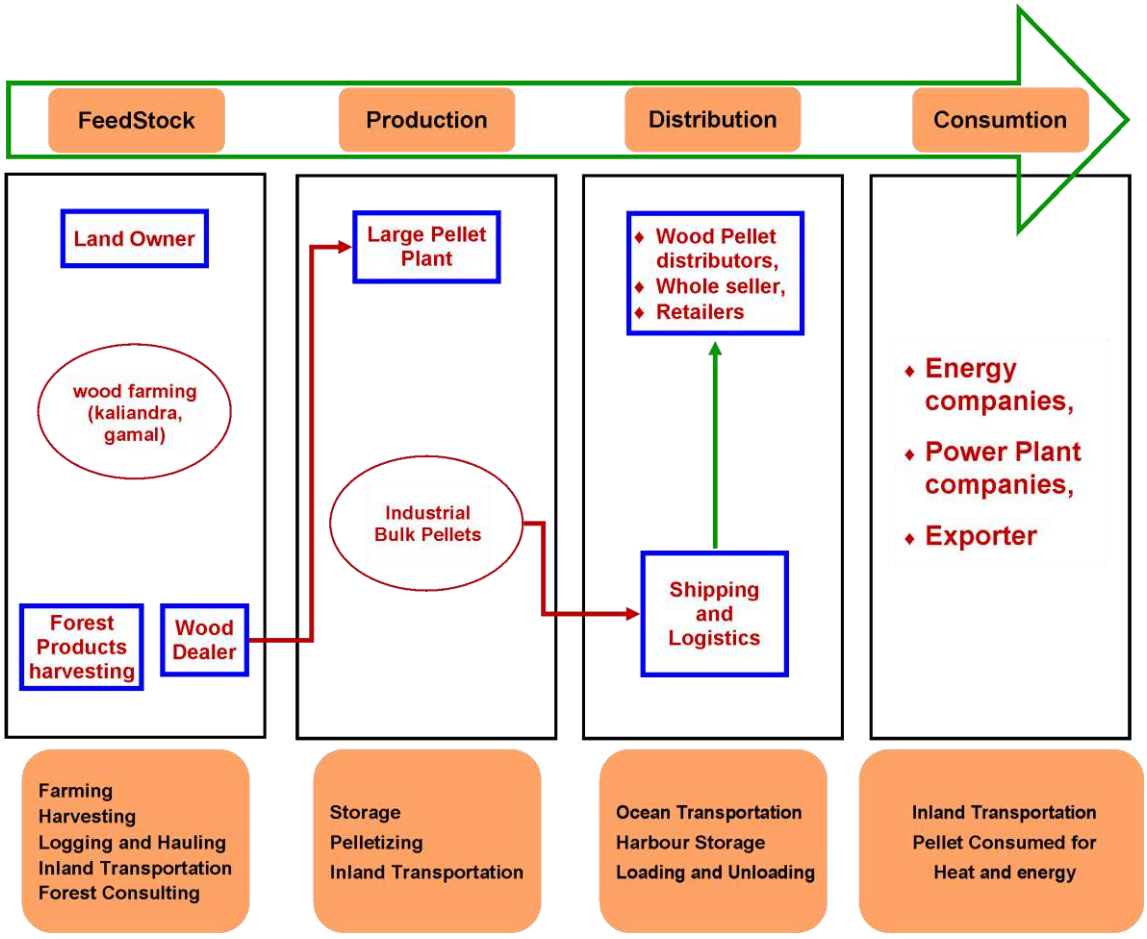


Figure 2. Business model of the utilization of biomass for renewable energy

OVERVIEW OF THE STUDY LOCATION

3.1 Area and Boundary

The study was conducted in North Sumatra, one of the provinces in the western part of Indonesia, in the geographical coordinates range of 1 - 4 North Latitude and 98 - 100 East Longitude. The North Sumatra region is bordered by the Province of Aceh to the north and to the east with the State of Malaysia in the Malacca Strait, to the south bordering Riau and West Sumatra Provinces, and to the Indian Ocean to the west. The total area covers 182,414.25 km^2 which consists of 72,981.23 km^2 land and 109,433.02 km^2 oceans.

The development of the administrative region in North Sumatra also follows the dynamics of socio-economic life and politics in Indonesia. Until the end of 2017, administratively the area covers 25 districts and 8 cities, 449 sub-districts (*kelurahan*), 5,371 villages and 742 sub districts. The breakdown of regency/city area in 2017 can be seen in Table 1, while the Map of North Sumatra Province in Figure 3.

3.2 Topography

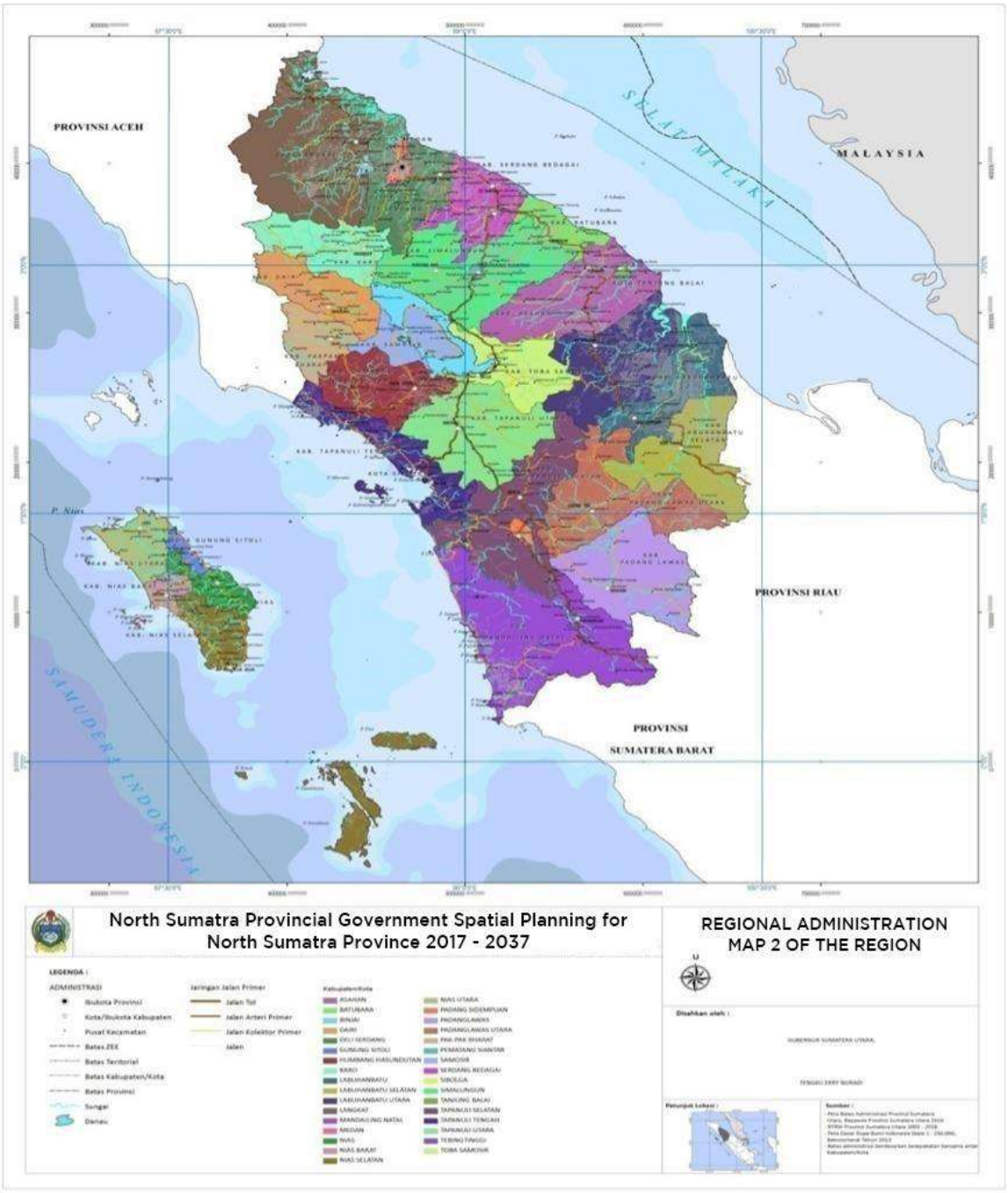
The North Sumatra region consists of coastal areas, lowlands to highlands and the Bukit Barisan mountain stretching in the middle from north to south. Land topography is very varied which is dominated by lands with a slope of 0 - 12% (flat to sloping) area of 47,810 km^2, between 12 - 40% (moderate to undulating slope) of 6,305 km^2 and steep with slopes of land above 40 percent covering 17,719 km^2 . In this area there is the largest volcanic lake in the world, Lake Toba covering an area of 1,129.20 km^2 or 1.57% of the total area. The height of the land varies from the seashore 0 to the mountains 2,200 m above sea level which is divided into 3 (three) main parts, namely the East which has relatively flat land conditions, the middle is bumpy to hilly and the western part is undulating terrain.

The East Coast region covers a lowland area of 24,921.99 km^2 or 34.77% of the area of North Sumatra which is fertile, and has relatively high humidity and rainfall. Flood disasters often hit this area due to forest and land degradation in the upstream area as well as river erosion and silting. Conversely, in the dry season water availability decreases due to many damaged reservoir areas of water both inside and outside the forest area.

Table 1. Area of Regencies/Cities in North Sumatra Province in 2017

Regency/City	Capital	District	Village	Sub. District	Area (km^2)
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
01. Nias	Gido	10	170	0	1.842,51
02. Mandailing Natal	Panyabungan	23	380	27	6.134,00
03. Tapanuli Selatan	Sipirok	14	212	36	6.030,47
04. Tapanuli Tengah	Pandan	20	159	56	2.188,00
05. Tapanuli Utara	Tarutung	15	241	11	3.791,64
06. Toba Samosir	Balige	16	231	13	2.328,89
07. Labuhanbatu	Rantau Prapat	9	75	23	2.156,02
08. Asahan	Kisaran	25	177	27	3.702,21
09. Simalungun	Pamatang Raya	32	336	77	4.369,00
10. D a i r i	Sidikalang	15	161	8	1.927,80
11. K a r o	Kabanjahe	17	259	10	2.127,00
12. Deli Serdang	Lubuk Pakam	22	380	14	2.241,68
13. Langkat	Stabat	23	240	37	6.262,00
14. Nias Selatan	Teluk Dalam	35	459	2	1.825,20
15.Humbang Hasundutan	Dolok Sanggul	10	153	1	2.335,33
16. Pakpak Barat	Salak	8	52	0	1.218,30
17. Samosir	Pangururan	9	128	6	2.069,05
18. Serdang Bedagai	Sei Rampah	17	237	6	1.900,22
19. Batu Bara	Limapuluh	7	141	10	922,20
20.Padang Lawas Utara	Gunung Tua	12	386	2	3.918,05
21. Padang Lawas	Sibuhuan	12	303	1	3,892,74
22.Labuhanbatu Selatan	Kota Pinang	5	52	2	3.596,00
23. Labuhanbatu Utara	Aek Kanopan	8	82	8	3.570,98
24. Nias Utara	Lotu	11	112	1	1.202,78
25. Nias Barat	Lahomi	8	105	0	473,73
26. Sibolga	Sibolga	4	0	17	41,31
27. Tanjungbalai	Tanjungbalai	6	0	31	107,83
28. Pematangsiantar	Pematangsiantar	8	0	53	55,66
29. Tebing Tinggi	Tebingtinggi	5	0	35	31,00
30. Medan	Medan	21	0	151	265,00
31. Binjai	Binjai	5	0	37	59,19
32. Padangsidimpuan	Padangsidimpuan	6	42	37	114,66
33. Gunungsitoli	Gunungsitoli	8	98	3	280,78

Source: North Sumatra in Figures 2018



Source: Bylaw No. 2 of 2017 concerning the 2017-2037 Provincial Spatial Planning

Figure 3. Map of North Sumatra Administration Area

Furthermore, the West Coast region covers an area of 46,758.69 km^2 or 65.23% of the total area of North Sumatra, mostly mountainous typologies with varying levels of soil fertility, mountainous climates with hilly and bumpy topography and unstable soil structures. Several lakes, rivers, waterfalls and volcanoes are found in this region. In addition, some areas were identified as being crossed by large faults, so they were prone to tectonic or volcanic earthquakes.

3.3 Geology

The Province of North Sumatra has a complex geological and rock structure due to a series of continental plate tectonic collisions. The position which is located at the confluence of the Euroasia plate in the east and the Australian plate in the west causes many series of fault lines, fractures and folds to be accompanied by volcanic activity. The fault line passes through the Alas-Karo segment along approximately 390 km which triggered natural geological disasters in the form of earthquake centers on land, tsunamis and triggers of volcanic eruptions and landslides. In addition, the fault line (subduction) located on the West Coast of Sumatra along approximately 250 km is also the epicenter on the seabed. The complex condition of the geological structure which is characterized by the shape of a hilly landscape, folded by faults in addition to being an earthquake pathway also has the potential to cause landslides for around 40-50 percent of the total area of the Province of North Sumatra.

3.4 Hydrology

Regional hydrology in North Sumatra includes surface water in the form of rivers, lakes, swamps and underground water. Overall the hydrological unit is divided into 71 River Basin Areas (DAS). Considering the broad scope of its management, as many as 20 watersheds are within the Management Area Unit (SWP) of Wampu Sei Ular Watershed, and as many as 51 watersheds are included in the Asahan Barumun SWP Watershed and 3 (three) are cross-provincial watersheds. The number of broodstock in this region reaches 99 and 783 tributaries.

If referring to Law Number 26 of 2007 concerning Spatial Planning which mandates that a minimum of 30% of the watershed area (DAS) be in the form of forest area in the context of environmental conservation, then very few watersheds in North Sumatra meet the minimum requirements stated in the Act -The law. The condition of real forests in the Wampu Sei Ular River SWP (only 20% [4 out of 20 watershed units]) has the required forest cover.

The performance of forest and land rehabilitation in North Sumatra is 85,047.77 ha for 5 years or an average of 17,009.55 ha annually. Therefore, with the extreme assumption that there is no additional critical land, it will take 145 years to rehabilitate all critical land in North Sumatra.

From the total area of the Watershed Area Management Unit (SWP) covering an area of 3,122,923.71 ha, based on the results of the last survey conducted in 2018, the critical watershed conditions in several Regencies/Cities are shown in Table 2.

The condition of the watershed in North Sumatra is very urgent to be restored. Damage does not only occur in the downstream but also in the upstream which is a buffer zone. In the upper and middle parts of the watershed there is often a change in the function of the land, where the land which is supposed to be converted into a forest area becomes a plantation area and other economic activities. This has resulted in high run-off flow, causing landslides in the upstream and flooding in the middle and downstream of the watershed.

Table 2. Condition of Critical Land in Working Area of BPDASHL Wampu Ular

No	Land critical class	Size (ha)	Percentage (%)
1.	Not Critical	643,651.68	20,61
2.	Potential Critical	253,849.96	8,13
3.	Almost Critical	1,555,767.23	49,82
4.	Critical	471,904.74	15,11
5.	Very Critical	197,750.09	6,33
Grand Total		3,122,923.70	100.00

From the total area of Asahan Barumun's unit Management Area (SWP) covering an area of 4,517,400.82 ha, there are also a number of very critical lands in several Regencies/Cities, as shown in Table 3 below**:**

Table 3. Condition of Critical Land in the Work Area of BPDASHL Asahan Barumun

No	**Land Critical Class**	**Large (ha)**	**Percentage (%)**
1.	Not Critical	559.875,16	12,39
2.	Potential Critical	1.065.612,30	23,59
3.	Almost Critical	2.235.945,76	49,50
4.	Critical	384.157,07	8,50
5.	Very Critical	271.810,53	6,02
Grand Total		4.517.400,82	100,00

Source: SK.306/MENLHK/PDASHL/DAS.0/7/2018

3.5 Climatology

The North Sumatra region has a tropical climate which is influenced by the Passat and Munson winds. As with other tropical regions in Indonesia, there are two seasons namely dry and rainy seasons in this region. The dry season usually occurs in June to September and the rainy season usually occurs in November to March, between the two seasons interspersed with transition season.

Rainfall is relatively high, ranging from 1,431 to 2,265 mm per year or an average of 2,100 mm per year, with an average number of rainy days of 173-230 days per year. In drier areas, average annual rainfall of less than 1,500 mm was recorded in some parts of the Simalungun, South Tapanuli and North Tapanuli regions, while high rainfall ranging from 2,000 to 4,500 mm took place throughout the year in the Asahan Regency. Dairi, Deli Serdang, Karo, Labuhan Batu, Langkat, Nias, Central Tapanuli, and most of South Tapanuli Regency.

Land surface height in North Sumatra is very varied, some of the area is flat, only a few meters above sea level, the climate is hot enough to reach 35.80 ºC, some are hilly areas with gentle slopes, temperate and some are at high altitude temperatures the minimum can reach 13.40 ºC. The average humidity is 78% to 91%.

3.6 Land use

Forest Land

Based on the Decree of the Minister of Forestry No. 579/Menhut-II/2014 concerning Forest Areas in North Sumatra Province (replacing Minister of Forestry Decree No. 44/Menhut-II/2005 dated 16 February 2005 concerning the Reference to Forest Areas in the North Sumatra Province no longer valid in accordance with Supreme Court Decree No. 47/P/Hum/2011 on December 23, 2013) the total forest area in North Sumatra Province is 3,055,795 ha or 42.90% of the total area. Based on its function the Forest area consists of**:**

a) Nature Reserve Area (KSA)/Nature Conservation Area (KPA)/Taman Buru (TB), covering ± 427,008 ha.

b) Protected Forest Area (HL), covering ± 1,206,881 ha.

c) Limited Production Forest Zone (HPT), covering ± 641,769 ha.

d) Production Forest Zone (HP), covering ± 704,452 ha.

e) Convertable Production Forest Area (HPK), covering ± 75,684 ha.

Land for cultivation

Based on the 2014 Indonesian Earth Map which originated from the Geospatial Information Agency, land use in North Sumatra Province is dominated by plantation activities covering 2,946,512 Ha (41%) and forests totaling 2,381,013 Ha (33%). The largest land use for agricultural activities is in the East Coast region, which covers an area of 57% of the total agricultural area of North Sumatra. While the majority of forest land is in the West Coast region, which covers 69% of the forest area in the province. Based on this land use, agricultural activities dominate the East Coast region, while the West Coast region is dominated by agriculture and forestry activities. Utilization of space for activities other than agriculture, such as industrial areas, transportation and mining is not too large in changing the use of existing space.

3.7 Demography

North Sumatra is the fourth province with the largest population in Indonesia after West Java, East Java and Central Java. Based on the 2010 population census the total population of North Sumatra reached 12,982,204 with a population density of 188 people per km^2. The rate of population growth during the period 1990-2000 was 1.20 percent per year, and in the period 2000 - 2010 it became 1.22 percent per year. In 2017 the population of North Sumatra amounted to 14,262,147 people.

North Sumatra has a heterogeneous population consisting of various tribes, namely indigenous tribes consisting of 8 tribes namely the Malays, Karo Bataks, Toba Bataks, Coastal Bataks, Mandailing/Angkola Bataks, Simalungun, Pakpak and Nias. In addition there are residents coming later to this region, namely the Minangkabau, Aceh, Javanese and ethnic Chinese.

Based on data from North Sumatra in the 2018 figures, the population of North Sumatra women is relatively more than that of men, which amounted to 7,145,251 people (50.1%) while men were 7,116,896 people (49.9%) . The population according to sex can be seen in Table 4.

Table 4. Number of population by age group and gender 2017

Age Group	Male	Female	Total	Sex Ratio
0-4	780.652	753.292	1.553.944	104
5-9	787.706	756.797	1.544.503	104
10-14	729.726	694.428	1.424.154	105
15-19	683.277	655.554	1.338.831	104
20-24	622.950	606.967	1.229.917	103
25-29	550.164	545.949	1.096.113	101
30-34	517.846	523.859	1.041.705	99
35-39	485.113	496.126	981.239	98
40-44	446.939	456.345	903.284	98
45-49	399.810	415.678	815.488	96
50-54	346.337	366.379	712.716	95
55-59	287.999	306.144	594.143	94
60-64	212.047	224.166	436.213	95
65**+**	266.330	343.567	609.897	78
North Sumatra	7.116.896	7.145.251	14.262.147	100

Source: Sumatra Utara Dalam Angka 2018

3.8 Public Work

The road conditions in Sumatra Province are shown in Table 5. The percentage of district roads that are in good condition (> 40 km/hour) is not greater than half the total length of all district roads. The length of the road network in good condition experienced an increase in 2015 of 13,985.72 km and then successively decreased until 2017 of 12,186.05 km.

Table 5. Regency/City Road Network Length in 2013 - 2017

Year	Regency/City Road Condition (km)					
	Good	Moderate	Bad	Very Bad	No Data	Total
2013	12.310,98	7.033,90	7.832,39	6.158,62	47,77	33.383,66
2014	12.186,05	7.115,58	7.357,55	6.745,95	47,77	33.452,90
2015	13.985,72	9.426,21	7,889,89	7.401,45	47,77	30.861,15
2016	13.239,10	4.580,62	6.254,15	7.028,66	2.535,92	33.638,45
2017	12.186,05	7.115,58	7.357,55	6.745,95	47,55	33.452,90

Source: SUDA 2013 - 2016 dan Dinas Bina Marga dan Bina Konstruksi Provsu Tahun 2017

The development of road length and conditions based on authority in North Sumatra Provice based on the conditions in 2013 - 2017 as shown in Table 6.

Table 6. Length of provincial road network in 2013 - 2017

No.	Road Condition	Provine Road Length (km)				
		2013	2014	2015	2016	2017
1.	Very Good	69,60	74,42	76,11	80,83	84,31
2.	Good	803,69	1.190,19	1.236,23	1.397,83	1.346,28
3.	Moderate	1.276,01	1.078,56	1.083,97	1.066,37	1.223,84
4.	Bad	324,32	259,00	259,72	242,12	177,42
5.	Very Bad	643,50	520,75	468,58	342,18	300,97
Total		3.048,50	3.048,50	3.048,50	3.048,50	3.048,50

Source: Dinas Bina Marga dan Bina Konstruksi Provsu Tahun 2017

From Table 3.6 it can be seen that the length of the provincial road network with steady road conditions every year has seen improvement from 2013 with a road length of 69.60 km up to 2017 reaching 84.31 km.

The development of provincial road conditions per region based on steady conditions can be seen in Table 7.

Table 7. Recapitulation of Provincial Roads in 2013 - 2017

Area	Province Roads Condition per Area									
	2013		2014		2015		2016		2017	
	(km)	(%)	(km)	(%)	(km)	(%)	(km)	(%)	(km)	(%)
East Coast	783,45	70,70	831,97	74,29	755,17	78,58	768,72	83,66	811,83	88,03
West Coast	476,36	65,47	529,70	73,99	498,77	70,69	546,74	77,54	565,87	79,65
High Lands	480,50	61,76	546,09	70,19	696,70	74,46	820,32	82,68	837,35	85,50
Nias Islands	339,39	78,06	360,99	83,03	369,56	82,83	328,42	75,95	355,07	81,29

Source: BAPPEDASU, 2018

From the table above it can be seen that during the period of 2013 to 2017 the condition of provincial roads with the division of regions namely the East Coast Region, West Coast Region, the Highlands Region, and the Nias Islands Region has increased, with the largest steady road conditions in the East Coast Region namely around 88.03% and the lowest in the West Coast Region at 79.65%. Key Performance Indicators in Provision of roads to serve the needs of the community are the Fulfillment of Minimum Service Standards (SPM) in the Field of Public Works and Spatial Planning in the Roads Sub-Sector, namely by improving the quality of provincial road services by 60% in 2019. While for the development of bridge conditions in Good condition can be seen in the following Table 8.

From Table 8 above it can be seen that the number of bridges in good condition from year to year has decreased from 757 to 2013 with a bridge length of 12,500.80 m and decreased in 2017 by 681 pieces with a bridge length of 11,164.41 m.

Table 8. Number of provincial bridges in 2013 - 2017

No.	Condition	Total Province Bridge (pcs)				
		2013	2014	2015	2016	2017
1.	Good	757	770	663	655	681
2.	Moderate	138	124	162	166	160
3.	Bad	47	44	54	52	51
4.	On Progress Building	2	-	-	-	-
TOTAL		944	938	879	873	892
	Bridge Length (m)	12,500.80	13,505.50	11,723.70	11,623.50	11,164.41

3.9 Forestry

Forest and critical land rehabilitation

Literally, forest rehabilitation is an effort made both physically and vegetatively to restore the value and function of the forest and its environment due to various damages or disturbances. Whereas land rehabilitation is an effort to restore land conditions by planting trees and soil conservation techniques so that the land is productive again.

The area of critical land in the Province of North Sumatra reaches 1,338,810 ha (in accordance with Decree of the Minister of Environment No 306/2018) while the social forestry program only covers an area of 592,438 ha (according to Decree of the Minister of Environment No. 3511/2018). Based on the performance of forest and land rehabilitation, in 2015 the total area of rehabilitated land reached 7,187.00 ha originating from rehabilitation activities within the forest area of 6,840.35 ha and an area of 346.65 ha located outside the forest area. Furthermore, in 2016 reforestation activities were carried out covering an area of 2,964.56 ha. Rehabilitation activities outside the forest area carried out in 2016 included reforestation activities in the form of planting by the Women's Planting and Treating Tree Movement by a Women's Organization covering an area of 9 ha, Environmental Greening covering an area of 303.11 ha, and procurement of symbolic seeds totaling 527 stems.

Damage to forest areas

The Forest Register Area in North Sumatra is a state forest of ± 2,121,500.02 ha. Furthermore, based on TGHK (Forest Land Use Agreement) in accordance with the Decree of Minister of Agriculture No. 923/Kpts/Um/12/1982. In 1982 the forest area increased to ± 3,780,132.02 ha and increased to 3,867,761 ha based on the TGHK Paduseration and Provincial RTRW in 1997. However, the forest area decreased to ± 3,679,338.48 ha in the RTRW of North Sumatra Province in 2003 - 2018 in accordance with Regional Regulation No. 7 of 2003. Based on the appointment of the North Sumatra Province Forest Area in accordance with Decree of the Minister of Forestry No. SK.44/Menhut-II/2005 covers ± 3,742,120 ha; At present the North Sumatra Province Forest area according to the Minister of Forestry Decree No. 579/Menhut-II/2014 dated June 24, 2014 reaches an area of 3,055,795 ha.

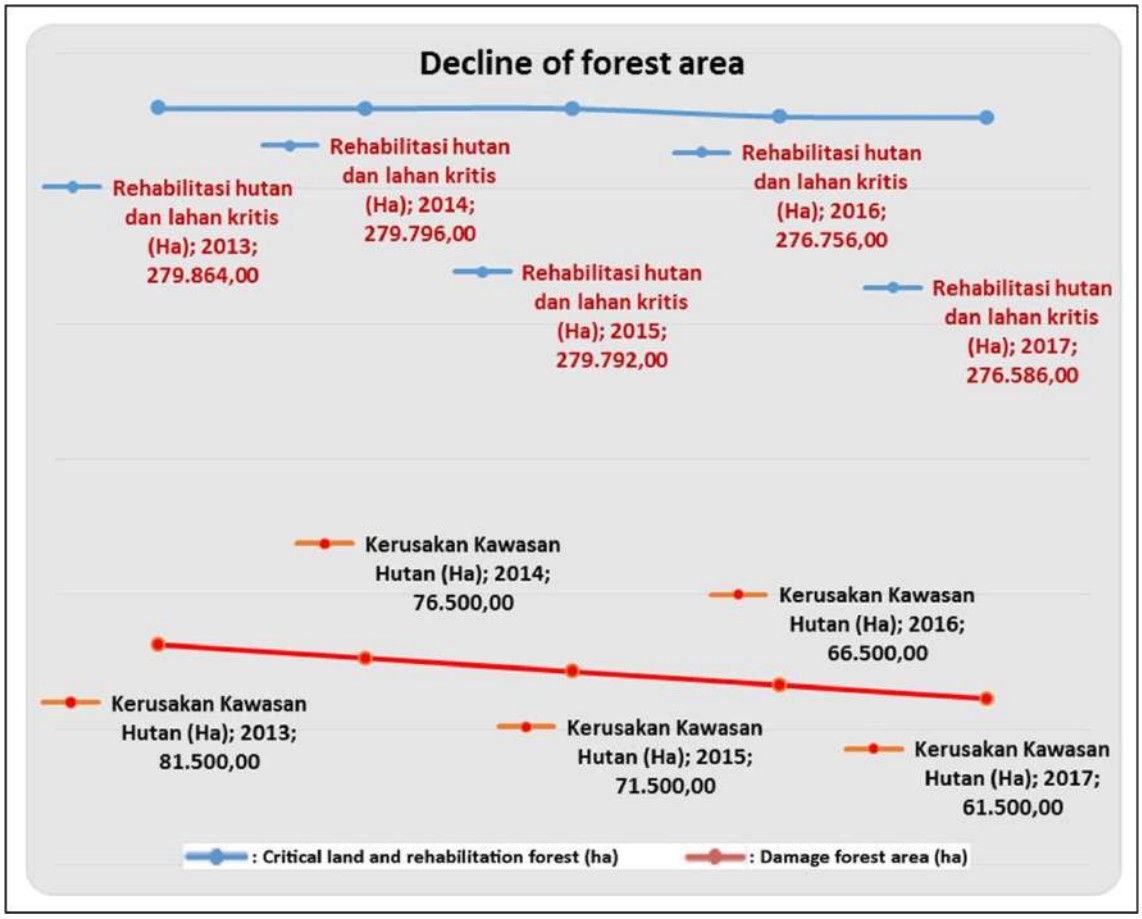


Figure 4. Decrease in damage to forest areas in North Sumatra Province in 2013 - 2017

During the 2013 - 2017 period, the rate of forest destruction in North Sumatra reached its highest point in 2013 which was 81,500 ha/year (Figure 4), a significant extent compared to the ability and performance of the area rehabilitation. Based on Figure 3.2 it can be seen that there are still many forest areas in North Sumatra in critical condition. In 2013 the rehabilitated critical forest area was 279,864 ha, but in 2017 it was only able to rehabilitate 3,728 ha or become 276,586 ha. In 2013 the forest area damage reached 81,500 ha and in 2017 it dropped to 61,500 ha. This shows that over the past 5 years it has only been able to reduce the damage to a forest area of 20,000 hectares. This has become a serious problem, with the high destruction of forest areas and critical land will have an impact on extreme climate change, natural disasters, which will ultimately result in stability of food security.

Forestry Sector Contribution to RGDP

The RGDP (current price) of North Sumatra Province is getting better despite slowing (Figure 5). One of the sectors that contributed to the RGDP was the Agriculture, Forestry and Fisheries category, which amounted to Rp 115.2 billion in 2013 and became Rp 146.4 billion in 2017, where the forestry and logging sectors contributed 0.97% in 2013 of the total RGDP value and 0.80 percent in 2017 of the total RGDP value, for more details, it can be seen in Figure 5.

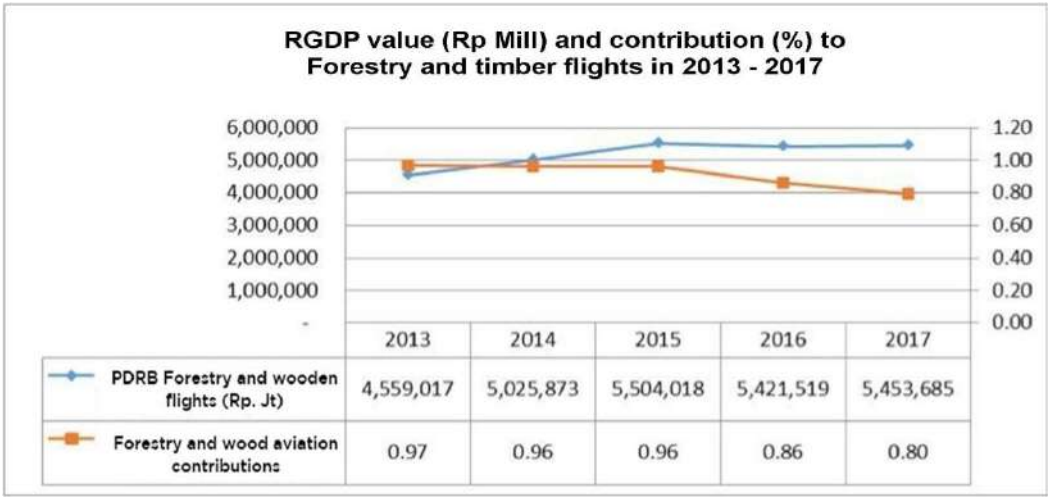


Figure 5. RGDP Value and Contribution of Forestry and Timber Cutting in 2013 – 2017

If seen in the graph above the contribution of the forestry and logging sub-category from 2013 - 2017 is declining, this is in line with the GDP value of the forestry and logging sub-category which continues to decline.

3.10 Strategic Area of North Sumatra Province

Designated national strategic areas in the North Sumatra Province are as follows in Table 9.

Table 9. National Strategic Areas in North Sumatra Province

No.	National Strategic Area
1.	National Border Area in North Sumatra Province (Pulau Berhala)
2.	Medan-Binjai-Deli Serdang-Karo Urban Area (Mebidangro)
3.	Kawasan Danau Toba Area and Vicinity

Source: PP Nomor 13 Tahun 2017 tentang revisi PP No 26 Tahun 2008 tentang RTRWN

Berhala Island is the outer small island in North Sumatra Province, one of 34 outer small islands in Sumatra Island. Based on Presidential Regulation of the Republic of Indonesia Number 13 of 2012 Regarding Sumatra Island Spatial Planning, Berhala Island is determined as part of the country's border area and becomes the front porch and gate of the country bordering India, Thailand, Malaysia, Singapore, and Vietnam. Besides Berhala Island, there are still 2 (two) small outer islands in North Sumatra Province, namely Simuk Island and Wunga Island.

Based on the Republic of Indonesia's Presidential Regulation No. 62 of 2011 concerning Spatial Planning for Urban Areas of Medan, Binjai, Deli Serdang, and Karo that the Mebidangro Urban Area is a unified urban area consisting of Medan City as the core urban area, Binjai Urban Area in Binjai City, Hamparan Perak Urban Area, Sunggal Urban Area, Tanjung Morawa Urban Area, Percut Sei Tuan Urban Area, Pancur Batu

Urban Area, Lubuk Pakam Urban Area, and Galang Urban Area in Deli Serdang Regency, and Berastagi Urban Area in Karo Regency, as an urban area around it, which forms the metropolitan area.

Furthermore, the Lake Toba Area has been designated as a National activity center in the National Spatial Plan with environmental functions and has its own spatial plan as outlined in Presidential Decree No.81 of 2014, Lake Toba Coverage Area based on Presidential Regulation Number 81 of 2014 consists of bodies lake, DTA and CAT, covering 25 sub-watersheds in 7 districts and 28 sub-districts namely North Tapanuli, Humbang Hasundutan, Dairi, Samosir, Karo, Simalungun, Toba Samosir and 4 CAT in 8 Regencies and 57 Districts namely North Tapanuli, Humbang Hasundutan, Dairi , Samosir, Karo, Simalungun, Toba Samosir and Pakpak Bharat.

In addition to the National Strategic Zone, to support the acceleration and expansion of national economic development, the Sei Mangkei Special Economic Zone (KEK) has been established, as stipulated through the Government Regulation of the Republic of Indonesia Number 29 of 2012 concerning Sei Mangkei Special Economic Zone, covering 2,002.77 ha (two thousand and two point seventy seven hectares) located in Bosar Maligas District, Simalungun Regency. The Sei Mangkei SEZ is planned to become one of the National Strategic Areas. The Sei Mangkei SEZ is expected to accelerate regional economic development that will have implications for the dynamics of development in the surrounding area, such as increased economic activity, land use changes, human resource / labor needs, as well as supporting facilities and infrastructure support needs that lead to the formation of new city concepts around KEK Sei Mangkei.

Provincial Strategic Areas contained in North Sumatra Province Regional Regulation Number 2 of 2017 concerning the Regional Spatial Planning (RTRW) of North Sumatra Province in 2017 - 2037, namely among others**:**

1. Bukit Barisan highlands agropolitan area;
2. Simalungun - Coal - Asahan Integrated Economic Development Zone;
3. Labuhanbatu Integrated Economic Development Zone and surroundings;
4. Integrated Economic Development Zone of the West Coast and its surroundings
5. Nias Islands Integrated Economic Development Zone;
6. Historic site sites and buildings in the urban area of Mebidangro,
7. Religious areas and temple/monastery sites in Padanglawas and North Padanglawas Regencies;
8. Bawomataluo Traditional Area, South Nias Regency and surrounding areas;
9. Religious areas and historic sites in Barus, Central Tapanuli Regency;
10. Religious areas and historic sites of the Batak tribe in Pusuk Buhit
11. Leuser and Bahorok Ecosystems;
12. Batang Toru Forest Conservation Area; and
13. Conservation Area of Batang Gadis National Park, Mandailing Natal Regency
14. Disaster Prone Areas of Sinabung and Sibayak Volcanoes.

The strategic areas with values or strategic aspects are described in Table 10.

Table 10. Strategic aspects for strategic areas

No	Strategic areas	Strategic values
1.	Marine Territory border of the Republic of Indonesia with the Indian / Thai / Malaysian States at Serdang Bedagai Regency	Defense and security
2.	Mebidangro Urban Area	Economic
3.	Historic site sites and buildings in the urban area of Mebidangro, including: • Chinese City sites and historical relics in Medan City and Rantang City in Deli Serdang Regency; • Historic buildings in Belawan Old City Corridor and Kesawan Old City in Medan City; • The cultural heritage building of the Sultanate of Deli in Medan City and Deli Serdang Regency.	Social Cultural
4.	Danau Toba Area and Vicinity	Environmental Social Cultural Economic
5.	Ecosistem Area Leuser dan Bohorok	Environmental
6.	Protected Area Tapanuli (Hutan Batang Toru)	Environmental
7.	National Park Area Gadis Mandailing Natal Regency;	Environmental
8.	Nias Islands Integrated Economic Development Area	Economic Socio Cultural
9.	Bawomataluo Traditional Area, South Nias Regency and surrounding areas	Socio Cultural
10.	West Coast and its surrounding Integrated Economic Development Zone • Labuan Angin - Sibolga area • Mandailing Natal Area - South Tapanuli • Padangsidimpuan Urban Area and surroundings	Economic
11.	Area of Economic Development Integrated Simalungun - Coal - Asahan • Cape Town Hall - Hope • Limestone Area - Coal • Special Economic Development Area Sei Mangke	Economic
12.	Agropolitan Area of the HighlandsMerek Karo; • Siborong borong, Tapanuli Utara; • Dolok Sanggul, Humbang Hasundutan; • Lumban Julu Toba Samosir; • Harian, Samosir; • Silimakuta Simalungun; • Sitinjo, Dairi, • Siempat Rube Pakpak Bharat • Siantar Martoba Kota Pematangsiantar	Economic
13.	Labuhan Batu Integrated Economic Development Zone and surroundings	Economic
14.	Religious area and Islamic historic site in Barus, Central Tapanuli Regency	Socio Cultural

Tabel 10. *Continued...*

No	Strategic areas	Strategic values
15.	Religious area and historic site of Batak tribe in Pusuk Buhit, Samosir Regency	Socio Cultural
16.	Religious Areas and Temple / Monastery Sites in Padanglawas and North Padanglawas Regencies	Socio Cultural
17.	Sinabung and Sibayak Volcano Prone Areas	Environmental

Source: PP No 13 of 2017 concerning revision of PP No 26 of 2008 concerning RTRWN and Perda No. 2 of 2017 concerning RTRW of 2017-2037 Province of Sumatra Utara.

POLICY REVIEW ON NEW RENEWABLE ENERGY

4.1 North Sumatra Electric Energy Supply

The electricity system of North Sumatra Province cannot be separated from the electricity system of Northern Sumatra (SUMBAGUT) of PT PLN (Persero). Electric power is channeled to the consumer community through integrated systems of generation, transmission and distribution. Considering that all regions of Indonesia, including North Sumatra, are PT PLN (Persero), the supply of integrated electricity is only done by this SOE. The SUMBAGUT electricity system covers the provinces of Aceh, North Sumatra and Riau. This regional system is supplied by several power plants which are generally located in North Sumatra. The primary energy source used to generate the electric energy of the SUMBAGUT system varies from petroleum, gas, coal, to water and geothermal.

The power supply of SUMBAGUT regional power plants reaches 2,683.12 MW or only about 70.98% of the total installed capacity. In this case there is a program to add 599 MW of electric power in North Sumatra, which will be produced through several new power plant developments as follows**:**

- PLTP Sarulla 3 (110 MW),
- PLTU Pangkalan Susu 2 (200 MW),
- PLTU Pangkalan Susu 4 (200 MW),
- PLTP Sorik Merapi (45 MW),
- PLTA Lae Kombih 3 (8 MW),
- PLTBg (Bio gas) Kwala Sawit (1 MW),
- PLTM (Micro Hydro) Sewampu (9 MW), dan
- PLTA Hasang (26 MW).

4.2 North Sumatra Electric Energy Needs

The electrification ratio of North Sumatra Province in 2016 reached 93.29%, while in 2017 it was 96.72%. In line with the rate of economic growth, electricity consumption has increased. The peak load of the SUMBAGUT system in 2016 and 2017 has reached around 2,000 MW and the supply capacity is approximately 2,600 MW, so it has electricity reserves of around 600 MW. This condition is better compared to the previous period with the power reserves owned only reached 50 MW. This is quite risky when there is damage to the generating unit so there will be a power outage.

Based on Bank Indonesia data in the second quarter of 2017, North Sumatra Province recorded economic growth of 5.09%. If the projected growth in electricity demand in the province refers to a figure above the average economic growth of around 7%, the projected electricity demand in 2018 will increase 140 MW so that the peak electricity load can reach around 2140 MW. If the growth of new power plant construction and the performance of existing power plants remain stable, economic growth will also run well.

The available electricity besides being used to drive the industrial sector is also used to illuminate villages in North Sumatra. But until 2017, of 6,107 villages, only 5,815 villages have been electrified or there are still 292 villages, which have not been illuminated (Ratio of Electrified Villages 95.22%). The villages are mainly located in remote areas that are difficult to reach by the PLN transmission network.

4.3 Potential for New and Renewable Energy

Some types of new and renewable energy potential in North Sumatra include water energy (3,098 MW), biomass (54 MW), solar and geothermal energy. The potential of water energy owned by North Sumatra reaches a total of 3,098,341 MW. The energy comes from large scale plants (3,005,300 MW), mini scale plants (89,698 MW) and micro scale (3,343 MW). Water energy is used for electricity generation (hydropower) which consists of**:**

- PLTA Asahan I = 180 MW in Kab. Tobasa
- PLTA Asahan II = 603 MW in Kab.Tobasa
- PLTA Renun = 82 MW in Kab. Dairi
- PLTA Sipansihaporas = 50 MW in Kab. Tapanuli Tengah

During the 2017-2026 period, it was expected that 1137 MW of electricity will be available from 11 hydroelectric power plants. Mini hydroelectric power plant (PLTM) is expected to be available 99 MW of electricity from 16 power plants.

Another renewable energy source is biomass. Biomass energy comes from rice husks, coconut shells, palm shells and bagasse. In North Sumatra there is the potential for 11 million tons of fresh fruit bunches (FFB) production. From the processing of crude palm oil (CPO) will produce waste in the form of empty bunches of 2.6 million tons, fiber 1.3 million tons and shells of 701 thousand tons. Furthermore, if this waste is treated there will be an energy potential of 3,599,078 Million K. Cal from bunches, and 3,599,078 and 2,769,420 million K. Cal from fiber and palm shells.

Palm oil waste (fiber and shell) is used as boiler fuel in more than 91 PKS (Palm Oil Mills) spread across several districts. Steam utilization from boilers for power plants (PLTU) with an installed capacity of around 54.4 MW.

4.4. National Energy Policy

Some government policies related to national energy are as follows**:**

- UU No. 30/2007 concerning Energy
- UU No. 30/2009 on Electricity.
- Government Regulation No. 79/2014 concerning National Energy Policy.
- Regulation of the Minister of ESDM No. 12/2015 concerning the 3rd Amendment to the Minister of Energy and Mineral Resources Regulation 32/2008 concerning Provision, Utilization and Business Administration of Biofuel as Other Fuels.
- Regulation of the Minister of ESDM No. 24/2017, Regarding the Mechanism of Determining the Cost of Generating PT State Electricity Company (Persero).
- Regulation of the Minister of ESDM No. 41/2018 concerning Provision and Utilization of Biodiesel-Type Biofuel in the Framework of Financing by the Palm Oil Plantation Fund Management Board
- Regulation of the Minister of ESDM No. 50/2017 concerning Utilization of Renewable Energy Sources for Electric Power Supply
- Presidential Regulation No. 22/2017 concerning the National Energy General Plan
- Presidential Regulation No. 35/2018 concerning the Pilot Project for the Acceleration of PLTSa Development in 12 Cities that experience a garbage emergency condition.
- Ministerial Decree (Kepmen) of ESDM No. 1772/2018, About the Amount of Cost of Provision of Power Plants PT PLN
- Regulation of the Minister of ESDM No. 53/2018, concerning Amendment to the Regulation of the Minister of Energy and Mineral Resources NO. 50/2017, on Utilization of Renewable Energy Sources for Electricity Supply
- Ministerial Decree of ESDM No. 55/2019, Regarding the Amount of Cost of Provision of Power Plants for PT PLN.

Specifically regarding New Renewable Energy, the Ministry of Energy and Mineral Resources (ESDM) issued regulations regarding the use of new renewable energy sources for the supply of electricity. Minister of Energy and Mineral Resources Regulation Number 50 of 2017 replaces Minister of Energy and Mineral Resources Regulation Number 12 of 2017. There are several points in the revised regulation. First, PT PLN (persero) as the buyer and private developer as the seller can negotiate the price of electricity from all new renewable energy sources. In the old rules, this only applies to geothermal and biomass based plants.

The electricity purchase mechanism in this Permen only uses direct appointment. Previously could use a direct appointment scheme or auction. In direct elections, the developer must submit a proposal to PLN. Then PLN will evaluate the proposal. Later PLN will choose the most competitive price. To support the direct election process, the

Ministry of Energy and Mineral Resources asks PLN to prepare and publish Procurement Document Standards, Electricity Purchase Agreement Standards (PPA), and technical instructions.

Another point in the regulation is about the transfer of power plant assets to PLN, after the contract expires at no cost. Specifically for geothermal power plants, PLN has the option to purchase projects other than through asset transfer. The reason is that the Geothermal Working Area cannot be transferred based on Law 21/2004. While the EBT electricity purchase contract that was signed before the regulation was published, the selling price cannot be changed. While new contracts must refer to these new rules.

Some of the schemes contained in Ministry of Energy and Mineral Resources Regulation number 50 of 2017, are thought to be burdensome to investors (private), namely the existence of a build, own, operate and transfer scheme (build, own, operate, and transfer/BOOT), where all assets are transferred to PLN after the contract ends. Another scheme is price negotiation, this scheme is considered to make the process longer because they have to find a meeting point between buyers and sellers.

Another issue burdening investment in the new renewable energy policies is the low purchase price of PLN. Article 8 (3) reads; "In the case of the Cost of Supply (BPP) for generation in the local electricity system above the national average BPP for generation, the purchase price of electricity from PLTBm as referred to in paragraph (2), is the highest at 85% (eighty-five percent) of the BPP Generation in the local electricity system". Based on Ministry of Energy and Mineral Resources No. 55/2019, North Sumatra BPP is Rp 1,451/kWh or 10.18 cents USD/kWh, then the purchase price of PLN is: Rp 1,451 x 85% = Rp 1,233.35/kWh. Referring to the price of domestic wood pellets, which ranges from Rp 1,500 - Rp 1,800 per kg, prices at factories, the PLTBm investment in North Sumatra is still not profitable. However, if a power plant is to be built on Nias Island, with a BPP of Rp. 3,041/kWh, a PLTBm investment is very feasible.

FEASIBILITY ANALYSIS

5.1 Analysis of Market Prospects for Wood Pellets

5.1.1 World wood pellet production and consumption

Wood pellets are a promising renewable energy source to replace coal in various developed regions in North America and Europe. This biomass energy market has a high attractiveness because of the resulting low emissions. Indeed, the use of wood pellets for fuel has been adopted for heating and electric boilers, especially in various countries in Europe. The easy availability of raw materials, such as wood and compacted sawdust, and low production costs are some of the key factors that support the expanding market for wood pellets.

Based on European bioenergy statistics, AEBIOM (2016), and Biomass Magazine (2017), the largest demand for wood pellets comes from Europe, which accounts for around 75% of world consumption, which is around 20.3 MT in 2015 and 19.0 MT in the year 2016. In 2017, EU wood pellet demand has increased to reach 22.5 MT. The two main sectors of the wood pellet market are the industrial sector, where quality pellets are being used for electricity generation, as well as use in small units, especially for heating needs which require higher product quality.

Based on geography, the wood pellet market is segmented to Europe, Asia Pacific, North America, Central America, South America and the Middle East, and Africa. Of these, European countries are the main markets for wood pellets and lead the market in 2015. Regional markets are driven by various government incentives, such as significant fiscal subsidies to encourage the generation of renewable energy sources.

Besides Europe, North America is a prospective area for the wood pellet market. This is driven by the issuance of several emission regulations that have triggered regional markets for new renewable energy sources. The formulation of federal policies that seek to establish carbon neutrality for biomass is another important factor for the improvement of the US wood pellet market. The main application of wood pellets is for heating and power generation. The heating application segment holds the main market share in 2016, and dominates the overall market with better revenue. The application of wood pellets on a broad scale for industry and housing is expected to drive economic growth in the coming

years. The growing popularity of pellet fuel in developed countries, such as the US and Canada, is expected to increase demand for wood pellets in other countries.

Table 11, displays the statistics of pellet production throughout the world. In this table it can be seen that production recovered after 2016 which was relatively stagnant, growing 11% in 2017 (± 3,133,023 Tons). Very strong growth in the markets of South America, Asia & Oceania and Europe.

Table 11. World Wood Pellet Production (Tons)

Country	Year						Growth 2016-2017
	2012	2013	2014	2015	2016	2017	
EU 28	10.978.087	12.011.594	13.558.541	14.263.427	14.421.208	15.310.461	6%
Others Europe	1.835.100	2.003.128	2.084.366	2.384.124	2.568.352	3.069.225	20%
North America	6.456.500	6.781.000	7.978.000	9.450.000	9.900.000	10.400.000	5%
South America	56.580	61.500	43.390	75.000	125.350	608.300	385%
Asia & Oceania	152.853	309.177	1.281.977	1.567.796	1.900.483	2.660.430	40%
Total	19.479.120	21.166.399	24.952.274	27.740.347	28.915.393	32.048.416	11%

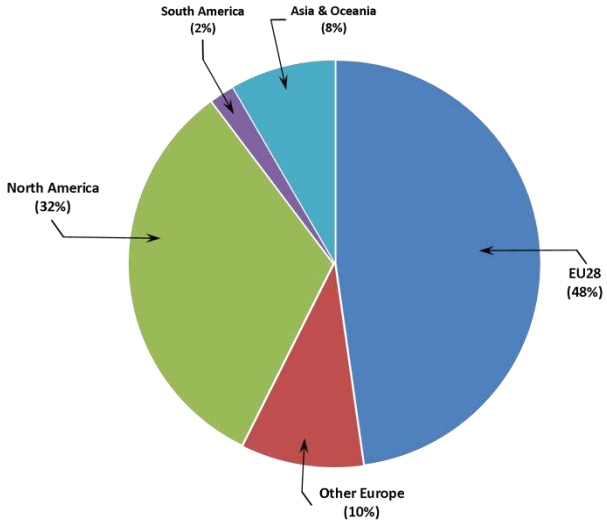
Source: Bioenergy Europe Statistical Report, 2018

Based on Table 11, wood pellet production from the South American region showed significant growth, especially from Brazil and Chile, with production growing + 385% in 2017. While throughout Asia and Oceania, the volume of wood pellet production increased to + 40% in 2017 , led by Vietnam and Malaysia. The increase in production volume in Asia and Oceania is also the second largest increase in production, representing + 24% of the increase in world production in 2017.

The European Union plays an important role in world pellet production. About 48% of world wood pellet production comes from countries in the region, followed by North America (32%). While other European countries have a contribution of 10% of world production. Asia and Oceania and South America have the smallest production distribution of 8% and 2%, as shown in Figure 6.

The level of consumption of wood pellets worldwide is shown in Table 12. The consumption of biomass energy in the European Union grew by almost 2.3 million tons in 2017. The UK is expected to continue to increase its national consumption of wood pellets because it has more biomass power plants. For example Drax, an energy company, has announced the fourth unit it operates has been converted using biomass energy in 2018 and other power plants that will soon be converted using renewable energy.

A significant increase in consumption was also shown in Scandinavian countries, including Denmark, because the Combined Heat and Power (CHP) plant was operating in the country, which consumed 2,300,000 Tons of pellets in 2017 (+ 46% in CHP consumption). Denmark also has the highest level of wood pellet consumption per population for the housing sector.



Source: Bioenergy Europe Statistical Report, 2018

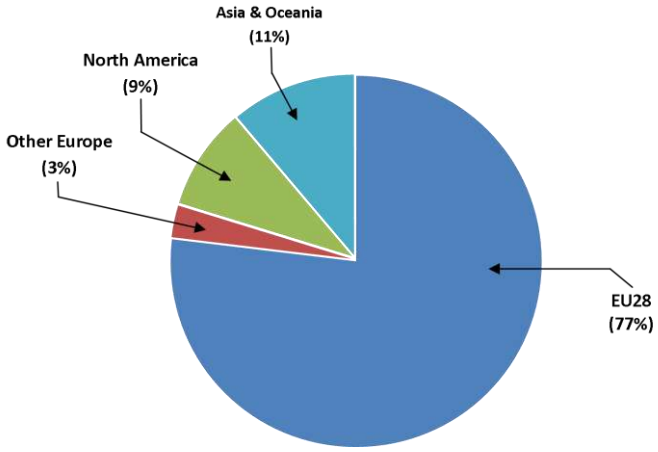
Figure 6. Distribution of wood pellet production in 2017 (%)

Table 12. World Wood Pellet Consumption (Tons)

Area	Year					Growth
	2013	2014	2015	2016	2017	2016-2017
EU 28	16.990.804	17.984.077	21.020.161	21.834.545	24.137.466	11%
Others Europe	325.079	569.134	598.730	704.194	892.236	27%
North America	2.506.000	2.875.000	2.902.000	2.760.000	2.850.000	3%
South America	0	58.000	90.000	n.a	n.a	n.a
Asia & Oceania	168.941	218.551	1.828.500	2.503.500	3.505.500	40%
TOTAL	19.990.824	21.704.762	26.439.391	27.802.239	31.385.202	13%

Source: Bioenergy Europe Statistical Report, 2018

The distribution of world wood pellet consumption is shown in Figure 7. European Union countries dominate up to 77% of world consumption, followed by Asian and Oceania countries (11%) and North America (9%). The Asian market is represented by Korea, Japan and China. European countries outside the European Union have a consumption of 3% of world wood pellet consumption.



Source: Bioenergy Europe Statistical Report, 2018

Figure 7. Distribution of wood pellet consumption in 2017 (%).

5.1.2 Wood pellet industry and European market

Bioenergy is the main source of the renewable energy mix in European countries, such as Denmark, Germany, Italy, Finland, France and Austria. At present, around 70% of renewable energy consumption in Denmark is based on bioenergy, mostly in the form of straw, wood and renewable waste. Whereas the use of wood pellets in Germany, especially in the housing sector, is supported by the Market Incentive Program (MIP) combined with the Renewable Energy Act (EEWärmeG), which provides financial support for the use of wood pellets on the small scale market. On the other hand, due to the sawmill industry crisis in Germany in 2014, MIP experienced a budget freeze, coupled with the stop and go phenomenon, which caused uncertainty for investors, leading to a decrease in demand for wood pellet heating systems, thereby affecting internal demand.

Furthermore, global market conditions in Italy have a different phenomenon. Pellet heating systems in this country utilize energy saving schemes in the building sector, through tax reduction. Individual or group taxpayers can reduce their personal or corporate income tax by 65% of expenses incurred for certain types of energy-enhancing jobs in existing buildings, including the installation of pellet heating systems. The maximum amount of tax reduction through this scheme is € 30,000.

Biomass from forests is the most important renewable energy source in Finland. Around 80% of the national energy needs are sourced from renewable energy. In this country, most forest-based bioenergy is produced from processing forestry by-products (waste).

As in other European countries, the current development of the wood pellet market in France has a promising future. Apart from the United Nations Climate Change Conference, which was successfully held in Paris in December 2015, the energy transition law was passed by the French National Assembly in July 2015. The law contains several objectives, such as the amount of renewable energy intended for final energy consumption in 2020 of 32%, or the fulfillment of 40% of electricity from renewable energy.

Another scheme encountered in other European countries, such as Austria, which is driving the wood pellet market, is financial support for the replacement of oil-based heating systems. Up to 30% of investment costs come from the "Klima und Energiefond" scheme for boilers and heating in the non-residential sector (<400 kW thermal), up to 35% for private installations (<50 kW), depending on location, even allowing more than that if funds are available from their respective regions. The funding level is based on guidelines for domestic environmental support that are confirmed in the Environmental Law, the Environmental Measures Support Act and in regional support schemes.

Production and consumption

In general, wood pellet production in European countries continues to increase, with prices fluctuating between € 150 - 300/Tons. Danish wood pellet production

continues to increase from year to year. Until 2015, production levels reached 375,000 Tons. The overall production capacity is around 400,000 Tons, or about 15% of the total national wood pellet demand. However, there was no further significant increase, due to limited raw material resources in Denmark.

The total consumption of wood pellets in Denmark during 2015 reached 2.6 MT. About 70% of wood pellets consumed are used by large-scale utilities for heat and electricity production. Most of the heat and power plants still use imported pellets. The wood pellet market for the private sector has increased over the past 15 years and private consumers have invested in producing more modern pellet stoves and boilers, thereby increasing the efficiency and comfort of using pellets. Meanwhile, up to 2015, the price of bag pellets for personal consumption in Denmark is around € 236/Ton, while prices for bulk pellets are much lower, which is around € 180/Ton.

Wood pellet production in Germany is one of the largest in Europe. About 70% of the raw materials used for pellet production are by-products by sawmills, namely sawdust and the remaining 30% comes from low-quality round wood. In 2015, wood pellet production in Germany decreased by 1.9 MT. Meanwhile, starting in 2006, German dependence on imports continued to decline, replaced by locally produced wood pellets. This decrease is due to the lack of imported pellet products that meet the standards. Wood pellet consumption in Germany was around 2 MT in 2013, with a stagnant growth rate in subsequent years.

5.1.3 Wood pellet industry and Asian market

Japan

Japan's most important national energy policy after the earthquake that was followed by the tsunami and the Fukushima nuclear power disaster in 2011 was the Feed-in Tariff Scheme (FIT) for Renewable Energy which has been implemented since July 2012. Under this scheme, electricity utilities are obliged to purchase electricity that is generated from renewable energy, such as solar power and biomass on a fixed period contract at a fixed price.

FAOSTAT data (2016) shows that Japan's domestic wood pellet production in the last 5 years has reached 90 kilo tons. However, higher imports of wood pellets indicate greater consumption of wood pellets in Japan. In 2015, imports of wood pellets from Canada (62.9%), China (24.9%), and Vietnam (11.8%), others (0.4%) reached 230 kilo tons.

In 2018, Japanese wood pellet imports exceeded 1 million tons for the first time, about double the amount compared to 2017. In the first three quarters of 2018, 63% of the imports of these industrial country wood chips came from Canada and 31% originated from Vietnam, as can be seen in Figure 8. This is because Japan supports fixed prices and long-term contracts for feed-in renewable energy tariffs. Japanese wood pellet imports will continue to grow rapidly in the coming years, and imports are expected to exceed 5 million tons in 2023.

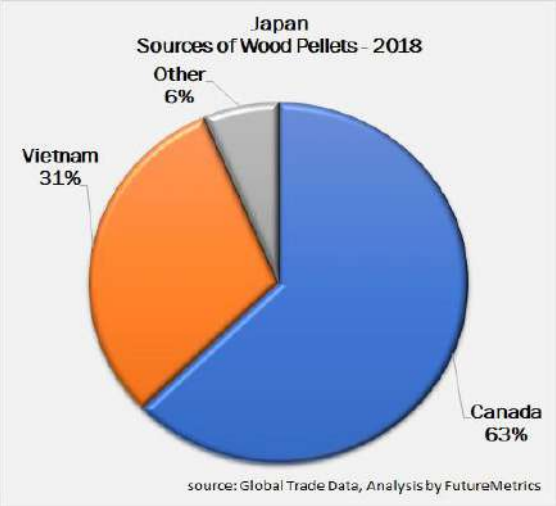


Figure 8. Imports of Wood Pellets by Japan in 2018

South Korea

The Renewable Portfolio Standard (RPS) scheme has played an important role in the wood pelleting market in South Korea, since it was implemented in 2012. Based on this national program, it requires the use of 2% electricity from renewable energy. The new renewable energy mix will increase to 10% by 2022.

Compared to other renewable energy sources such as wind, solar or hydropower, biomass is expected to produce greater clean energy capacity, estimated at 50-60%. Demand for wood pellets in South Korea began to increase after the adoption of RPS with more imports than other countries.

According to FAOSTAT (2016), the average annual production of wood pellets in South Korea has only been around 15 kilo tons in the last five years, which has not met domestic demand. Consumption of wood pellets is much higher than domestic production of wood pellets in South Korea. Imports of wood pellets increased from 122 kilo Tons in 2012 to 1,850 kilo Tons in 2014 and decreased slightly to 1,471 kilo Tons in 2015. Currently, the Korean wood pellet market is getting tougher. While the price of wood pellets from Vietnam ranges between $ 110-133/Ton.

5.1.4 Domestic market

Until now, the domestic wood pellet market is still not encouraging. This is caused by the low selling price, and has not been supported by government policies, especially those that are directly related to energy use. Indonesian wood pellet producers are generally export-oriented (to South Korea and Japan), and only a small portion is sold on the domestic market. Domestic wood pellet prices currently range between Rp 1,500 - Rp 1,700 per kg (factory prices).

Some domestic markets that have the opportunity to increase their capacity are as follows**:**

- Food and tea processing plants, including MSMEs of tofu and other small food factories. For demand in West Java, the need for wood pellets per month reaches around 5,000 Tons.
- Textile factories, on Java, need around 20,000 MT/month.
- Heaters on chicken farms, restaurants, and hospitality.
- PT PLN (Persero) for power plants

Electricity has become a basic need in our lives. General Plan for Electric Power Supply (RUPTL) of PT PLN (Persero) in 2010-2019 said that electricity demand was estimated at 55,000 MW. So the average increase in electricity demand per year is 5,500 MW. At present PLN is still using coal as the main fuel for Steam Power Plants (PLTU). The cost per kWh for coal-fired power plants is US $ 4.81 cents, while for gas around US $ 7 cents per kWh. The cost of biomass electricity with wood pellets is still higher compared to other energy sources, which is around US $ 9 cents.

One kilogram of wood pellets produces electricity of 1,355 kWh, or 1 kWh produced by 0.74 kg of pellets. If the price of wood pellets is Rp 1,700 / kg, the electricity production cost is Rp 1,700/kg x 0.74 kg = Rp 1,258/kWh, or around US $ 9 cents per Kwh. If the co-firing scheme is carried out with a combination of 10% wood pellets and 90% coal, as was done in Japan and South Korea, a combined price (9.0 cents x 0.1) + (4.81 cents x 0) will be obtained. 9) = 0.9 + 4.33 or valued at US $ 5.23 cents. Indonesia's current electricity selling price is US $ 11 cents, so there is still a profit margin of around US $ 5.77 cents.

5.2. Feasibility Analysis of Plant Location

Based on the distribution of raw materials and the availability of land for industrial development, which is close to the port and road transportation facilities, as well as other infrastructure support, wood pellet processing plants in North Sumatra should be built in two potential locations, namely (a) Special Economic Zones (KEK) Sei Mangke in Simalungun Regency, and in region (b) Gunung Tua city in North Padanglawas Regency. The choice of location is also based on community perceptions that support the construction of a wood pellet processing plant in their area and the distribution of raw materials, ie the first location will be supplied from forests in the northern region, while the second location is for receiving raw materials from the southern part of North Sumatra.

Sei Mangkei SEZ is a Special Economic Zone located in Bosar Maligas sub-district, Simalungun Regency, North Sumatra. This SEZ has an area of 2,002.77 ha, consisting of three zones, namely the industrial zone, the logistics zone and the export processing zone. This SEZ was established through Government Regulation Number 29 of 2012 on February 27, 2012. This area is the first SEZ in Indonesia that was inaugurated by President Joko Widodo on January 27, 2015. The Sei Mangkei Special Economic Zone is being integrated with the Port of Kuala Tanjung in the coastal District through the construction of a 30 kilometer railroad track.

5.2.1 First location: Sei Mangkei SEZ

The Sei Mangkei Special Economic Zone (Figure 9) was developed based on Government Regulation No. 29 of 2012, and the Decree of the Regent of Simalungun No. 188.45/193/BPPD in 2015. This integrated zone is the first SEZ in Indonesia that was officially opened by President Joko Widodo on 27 January 2015 and supports the development of industrial estates outside the city of Medan.

Figure 9. Sei Mangkei Special Economic Zone, North Sumatra

Sei Mangkei SEZ is located in North Sumatra Province, Simalungun Regency, Bosar Maligas District. Topographical conditions in this region are relatively flat and are in the lowlands, with a height of about 100 m above sea level. As an industrial estate located in an agro-based raw material center and close to the Malacca Strait, KEK Sei Mangkei also has supporting businesses from the logistics sector and the tourism industry. With a total land area of 2,002.7 ha, Sei Mangkei SEZ is open to other industrial potentials, especially in the downstream sector with high added value.

At first the Sei Mangke SEZ in Simalungun was built by PT Perkebunan Nusantara III as a pioneer. This strategic area is considered very potential because it has several advantages. Among them are the location advantages in the plantation area far from the settlement, not far from Kuala Tanjung Harbor (50 km). In addition, sources of raw materials are already available namely the area of energy forest plantations in Simalungun Regency and abundant water sources from the Bah Bolon River, one of the largest rivers in the region.

The central government and the North Sumatra Provincial Government strongly support the realization of the region in full. This is not only to improve the regional economy but also for the future of the national industry. Government support includes accelerating the adoption of regional regulations on the Provincial Spatial Plan (RTRWP) for special industrial clusters of Sei Mangke. Sei Mangke RTRWP is considered very important for the legal basis for foreign investors who want to invest in the region. If the RTRWP and other infrastructure are ready, then Sei Mangke will be one of the supporters of the Sumatra economic cluster planned by the government together with other clusters in other regions.

Sei Mangkei SEZ is supported by infrastructure within and outside the region. Access from the SEI Mangkei SEZ to the Sumatra highway is approximately 10 km. In addition, the SEZ distance to the Port of Kuala Tanjung, an international cargo port of approximately 40 km. While the distance to Kualanamu International Airport is approximately 110 km.

Until the end of 2016, business investment flow for industrial activities in the SEi Mangkei SEZ has reached Rp 3.52 trillion and became Rp 5.52 Trillion by the end of 2017. When fully operational in 2025, this KEK is projected to attract a total investment of Rp 129 Trillion and contribute to the GRDP of Rp 92.1 Trillion per year.

Some of the infrastructure within the Sei Mangkei SEZ Zone are as follows**:**

- A 60 MW capacity electricity supply is available from the substation at KEK, and is planned to operate a 250 MW Gas Power Plant in 2018.
- There is a 250 m^3/day water supply capacity sourced from the Bah Tungguran River, and planned to operate a phase II water treatment plant with a capacity of 500 m hour/day in March 2017.
- 75 mmscfd of gas supply is available sourced from the Arun Regasification Refinery.
- There are adequate telecommunications facilities and internet networks.
- Centralized waste treatment plant with a capacity of 250 m^3/hour.
- A dryport capacity of 5,300 TEUs/year is available
- Available 2 x 3,000 Ton (CPKO) and 1 x 5,000 Ton (CPO) storage area
- There are 104 rigid concrete road areas for the Phase I lots.
- Other facilities available are waste facilities, fire fighting fleets, oil palm innovation centers, and housing.

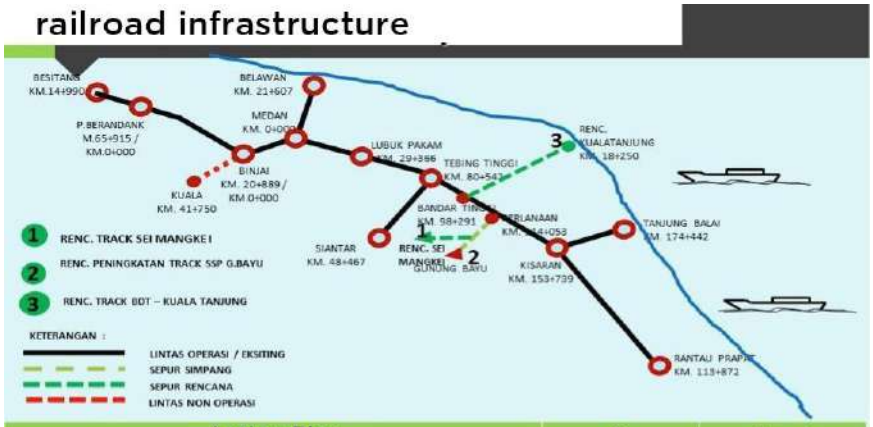
While some of the infrastructure outside the Sei Mangke SEZ Zone are:

- Sei Mangkei Railroad Development - Belawan Harbor/Kuala Tanjung (Figure 10).
- Kuala Tanjung Multipurpose Port Development (Figure 11).
- Handling of Sei Mangkei access - Kuala Tanjung/Belawan Harbor.

The construction of the Perlanaan-Sei Mangkei Railway line is part of the 39.5 km Sei Mangkei SEZ-Kuala Tanjung Harbor SEZ. Construction of the route from this area to Kuala Tanjung Harbor has been started since 2011 with the Bandar Tinggi-Kuala Tanjung segment of 21.5 km. The next development is the Perlanaan-Gunung Bayu segment with a length of 4 km and the Bandar Tinggi-Perlanaan segment along 15 km during 2013-2015. Then in 2015-2016 the construction of the Perlanaan-Sei Mangke segment along 2.95 km.

Kuala Tanjung Harbor (Figure 11) continues to be developed so that it becomes an international capacity port. Thus, the traffic and logistics system of the Sei Mangkei

industrial area will become more efficient and effective. At present, the depth of sea water in the port of Kuala Tanjung has only reached 14 m and can be expanded to 20 m. The capacity of the leaning ship is designed to be 60 thousand tons dead weight (DWT) from the current 30 thousand DWT.



Action Plan	PJ	Target
1. construction of the Sei Mangkei KEK railroad - Sepur Simpang (2,9 Km)	PTPN president director	Juli 2013
2. the upgrade of the Bandar Tinggi Pantilbalan railroad - kuala Tanjung (22,15km)	Minister of Transportation	Februari 2014
3. construction of the Bandar Tinggi pantibalan railway line - kuala tanjung (22.15km)	Minister of Transportation	Februari 2014

Figure 10. Sei Mangkei SEZ Railroad

The development of the port in Kuala Tanjung became an international port as the entrance to the western region of Indonesia. Based on the results of a study conducted by the Ministry of Transportation in 2015, the development of the port will increase the volume of container flows to 12.4 Million TEUs by 2039.

The increase in container flow volume originates from requests originating from the Sei Mangkei Special Economic Zone (SEZ) to Jambi Province and it is assumed that the port will receive additional demand from four competitor ports, namely the Port of Singapore, Port of Tanjung Pelepas, Port of Klang and Port of Penang.

Figure 11. Port of Kuala Tanjung, North Sumatra