Chapter 4

Cost Estimation of Biomass Supply Chain in the Southern Region of Thailand

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Chapter 4

Cost Estimation of Biomass Supply Chain in Southern Thailand

This chapter discusses the results of the study on supply chain of biomass for power generation in three southern border provinces of Thailand. The study surveyed biomass power plants, assessed the cost throughout the supply chain, and analysed problems and solutions of biomass power plants in southern Thailand.

1. Data from Field Survey of Biomass Power Plants in the Three Southern Border Provinces

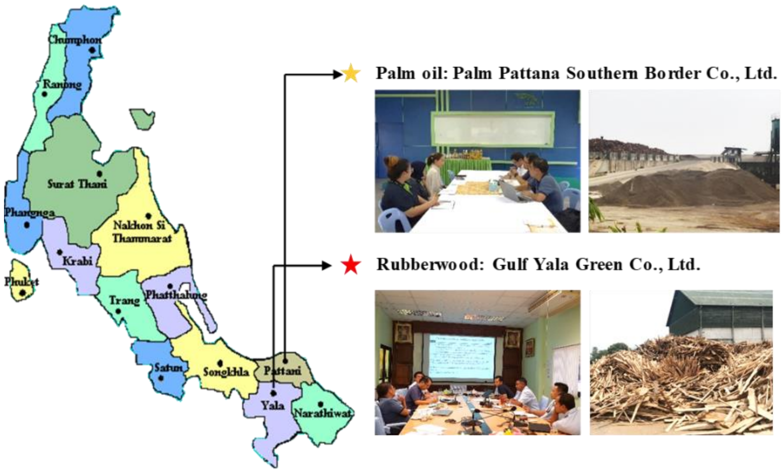
Data on the supply chain of biomass for power generation were collected by interviewing the representatives of two biomass power plants in the three southern provinces, Palm Pattana Southern Border Co., Ltd. in Pattani and Gulf Yala Green Co., Ltd. in Yala (Figure 4.1). The interview included detailed information on fuel sources, biomass potential to produce electricity and the opportunities to increase power generation in the future, etc. Table 4.1 summarises the data from the interview on 15 August 2018.

Table 4.1 Field Survey Results

Topics	Palm Pattana Southern Border Co., Ltd.	Gulf Yala Green Co., Ltd.
Address	No. 3/2 Moo 4 Petchkasem Road, Bang Khao Sub-district, Nong Jik District, Pattani	No. 80 Moo 1, Pron Sub-district, Muang District, Yala
Installed capacity	1.8 MW	23 MW (Consumption of power plant: 1.7 MW)
Commercial operating date (COD)	1 October 2014	28 November 2006 (25-year contract)
Type of biomass used	Shredded oil palm empty fruit bunch	Rubberwood slabs and rubberwood wastes (twigs, roots, sawdust)
Current fuel cost	B400–500/ton	B1.62 /ton (Current price of fuel is B973/ton)
Supporting measures from the government		Adder at B1.18/kWh (Biomass B0.18/kWh + Special adder for 3 southern border provinces amounting to B1/kWh)
Capacity expansion plan	Expand by 50% its existing capacity, planned to be completed by January 2019	Build a new power plant using all biomass from rubber root

Source: Author's data field survey, 2019.

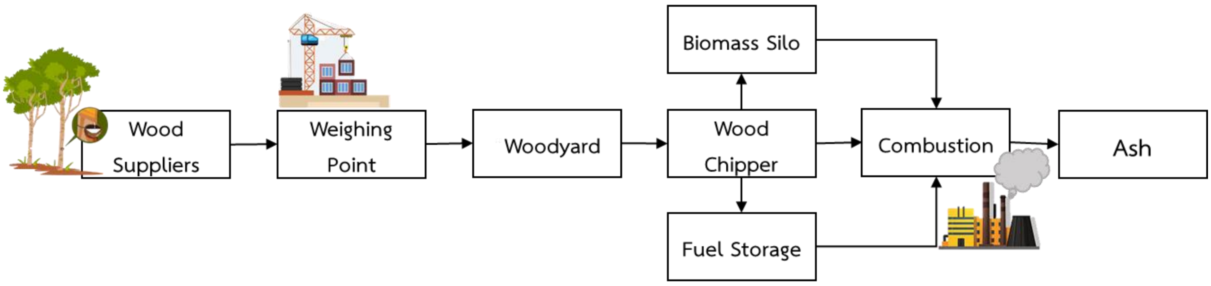
Figure 4.1:Palm Pattana Southern Border Co., Ltd. and Gulf Yala Green Co., Ltd.



Source: Author's field survey photo, 2019.

The consulting team conducted field surveys and interviewed representatives from two biomass-fired power plants – one power plant using biomass from oil palm and another using biomass from rubberwood – to collect data (as shown in the field survey process flow in Figure 4.2). Due to low production of palm oil in the three border provinces, the analysis focused mainly on power plants using biomass from rubberwood.

Figure 4.2: Supply Chain of Biomass for Power Generation (from Field Survey)



Source: Author's data field survey, 2019.

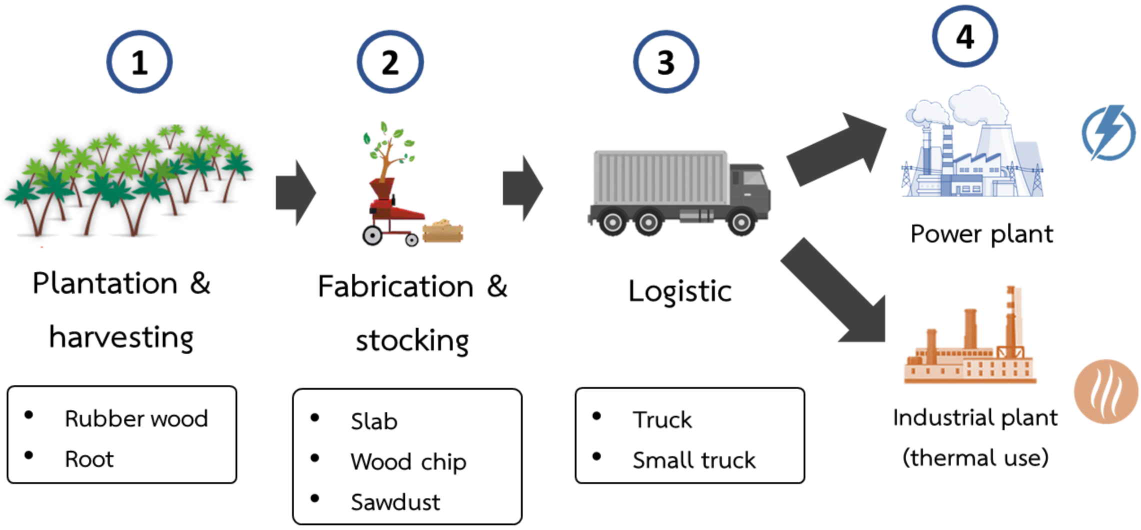
2. Supply Chain of Biomass

The supply chain of biomass for power generation is composed of four components: (i) plantation and harvesting, (ii) fabrication and stocking, (iii) logistic, (iv) power plant and industrial plant (Figure 4.3).

- The cost in the three border provinces is higher than other southern provinces for many reasons, such as higher insurance payment and no night-time construction.
- Rubberwood price frequently increases during the rainy season due to limited access to the rubberwood area.

- The particle board manufacturing business, located in Songkhla Province, is the cause of the rising selling price of rubberwood. These businessmen can pay more due to higher value added of their products.

Figure 4.3 Supply Chain of Biomass for Power Generation



Source: Author's data field survey, 2019.

2.1. Cost of raw materials (from field survey)

Tables 4.2 and 4.3 show that the price of rubberwood that the factory bought is based on the purchase price in Hat Yai, Songkhla. In the past when the number of manufacturing plants of the particle board in Songkhla was increasing, the price of rubberwood went up to B1,423/ton. This caused a loss to the power plant, rubberwood being the main raw material. In general, the highest acceptable price of rubberwood for the power plant to be operational is B1,500/ton, though at this price the factory must absorb a loss of as much as B1,200/ton.

Table 4.2 Buying Prices of Raw Materials of Gulf Yala Green Co., Ltd.

Type of biomass	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conclusion
Rubberwood slabs	Ton	13,000	18,000	20,000	13,000	17,000	17,000	23,700	24,000	20,000	17,000	16,000	16,000	220,000
	B/ton	769	833	650	538	647	765	759	625	650	588	625	750	538-833
Rubberwood wastes (Twigs, Roots, Sawdust)	Ton	7,000	8,000	6,000	3,000	5,000	6,000	8,000	4,000	1,400	1,700	800	5,000	55,000
	B/ton	1,000	1,050	883	633	800	950	875	625	714	706	750	900	625-1,050

Notes: (1) US$1 = B32.
(2) It is found from the interviews that the price of rubberwood increases due to the expansion of particle board production. The expansion results in a higher demand of rubberwood (resulting in a price war).
Source: Author's field survey data, 2019.

Table 4.3 Share of Rubberwood and Sources

Raw Materials	Share (%)	Sources
Rubberwood slabs	80	• Songkhla: Thepa, Sabayoy, Natawee • Pattani: Yarung, Koke Pho, Thung Yang Daeng • Yala: All districts • Narathiwat: All districts
Rubberwood wastes (twigs, roots, sawdust)	20	

Source: Author's field survey data, 2019.

2.2. Cost of wood processing (chopping)

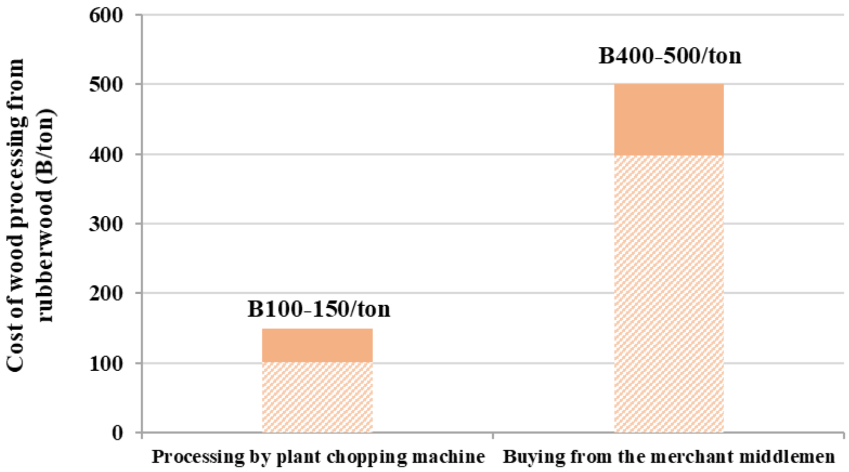
The field survey revealed that the main method for producing biomass from rubberwood is to chip residues from rubberwood, including wood slaps and rubberwood chips (branches, sawdust roots), into small pieces to make it easier for the power generation process (Figure 4.4). Wood pellets are not produced. The costs of processing rubberwood into woodchips include machinery and equipment (wood-chipping machine), labour, and electricity costs. The two practices in acquiring biomass from rubberwood are (i) processing rubberwood into woodchips and (ii) buying woodchips from middlemen (Figure 4.5).

Figure 4.4 Production of Biomass from Rubberwood

Source: Author's process diagram of the field survey, 2019.

- Buying processed rubberwood from merchant middlemen costs B300–350/ton higher than processing through the factory's own chopping machine.
- Power plants processing rubberwood using a chopping machine incur a 13% cost.
- Power plants processing rubberwood without a chopping machine (buying from middlemen) incur 34% cost.

Figure 4.5 Cost of Wood Processing (Chopping)



Source: Author's field survey data, 2019.

3. Logistic cost

The logistic cost is estimated from the rate of fuel consumption, capacity of vehicles, and distance. There are two types of vehicles in this assessment: small truck with 1.2-ton capacity and truck with 10-ton capacity. Also, the transportation distance ranges from 50 km to 200 km (Table 4.4). Key assumptions include:

- Fuel consumption rate from the Truck Data Service Center
  - Truck: 3.3 km/litre (capacity = 10 tons)
  - Small truck: 10.5 km/litre (capacity = 1.2 tons)
- Diesel retail prices in Yala on 31 October 2018 = B30.34/litre
- Adjusted factor for three provinces ≈ 1.1

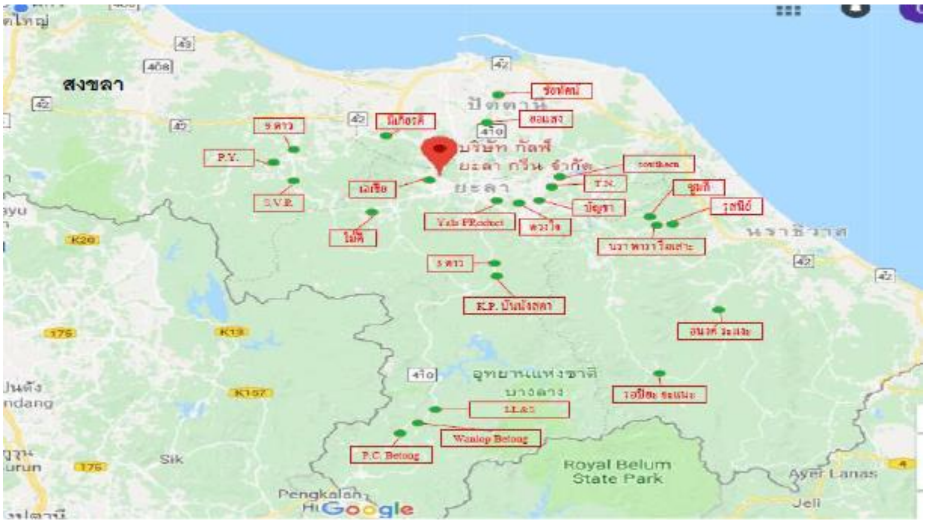
Figure 4.6 shows the location of selected large sawmill networking for supply biomass for one power plant (red pinned point). Some sawmills are located more than 200 km from the power plant, resulting in a higher logistic cost.

Table 4.4 Logistic Cost

Type	Distance	Fuel Consumption Rate (km/litre)	Capacity	Cost of Logistic (B/ton)
Truck	50	3.3	10	50
	100	3.3	10	100
	150	3.3	10	150
	200	3.3	10	200
Small truck	50	10.5	1.2	130
	100	10.5	1.2	260
	150	10.5	1.2	400
	200	10.5	1.2	530

Source: Truck Data Service Center (TDSC). http://www.thaitruckcenter.com/tdsc/GCS/index

Figure 4.6 Location of Large Sawmills Supplying Biomass to Power Plants



Source: Author's field survey data, 2019.

4. Assessment of labour through supply chain

This section assesses the jobs throughout the supply biomass chain. The supply chain starts from collecting biomass, processing, transporting, storing, and using (Table 4.5). The most labour-intensive process is collecting biomass, especially rubberwood roots, which requires a lot of labour and digging equipment.

The cost of biomass can be assessed by referring the buying–selling prices from the field survey, together with evaluating all expenditures incurred in the process (Table 4.6).

Table 4.5 Assessment of Labour through the Supply Chain

Biomass Production	Collection	Processing	Logistics	Storage	Usage
Slab	👤👤	👤👤	👤	👤	👤
Root	👤👤👤	👤👤	👤	👤	👤
Sawdust	👤👤	👤👤	👤	👤	👤
Wood tip	👤👤	👤👤👤	👤	👤	👤

👤 = amount of labour.
Source: Author's field survey data, 2019.

Table 4.6 Cost of Biomass through the Supply Chain

Biomass Production	Raw Material	Processing[a]	Logistic[b]		Storage	Consumption[c]
Slab	365	150	50–200	130–530	-	565–1,045
Root	450	150			-	650–1,130
Sawdust	600	-			-	650–1,130
Wood tip	450	150			-	650–1,130

[a] Processing cost for rubberwood B100–150/ton
[b] Cost of logistics
[c] Cost of biomass consumption from the survey of power plants

- Fuel consumption rate from Truck Data Service Centre
  - Truck: 3.3 km/litre (capacity = 10 tons)
  - Small truck: 10.5 km/litre (capacity = 1.2 tons)
- Diesel retail prices in Yala on 31 October 2018 = B30.34/litre
- Transportation distance: 50–200 km

Source: Author's field survey data, 2019.

5. Barrier analysis on the biomass supply chain

The field survey revealed that barriers and constraints of the biomass supply chain can be classified in four aspects, i.e. policies and regulations, biomass supply, biomass price, and cost and investment (Table 4.7).

Table 4.7 Barriers and Suggestions on the Biomass Supply Chain

Barriers	Suggestions
1) Policies and Regulations • Changes in policies cause different electricity tariff rates. With limited supply, the price of biomass increases when demand rises. This places a heavier burden on power plants with lower electricity tariff.	• Need for flexible tariff based on biomass price/type, if possible.
2) Biomass Supply • Less rubberwood supply in the rainy season may cause supply shortage.	• Due to excess supply of rubber roots, increased use of rubber root can lessen the shortage in the short run.
3) Biomass Price • Price increases due to the demand from particle board production and new biomass power plants • High processing cost from middlemen	• Import the biomass (rubberwood) from other provinces or enter into a long-term contract with suppliers. • Provide chopping machines to those with large consumers.
4) Cost and Investment Barriers • Higher construction cost as well as O&M cost since the plants are located in the southern border provinces. • Higher insurance cost due to the unrest in the areas	• Three border provinces should have feed-in tariff premium.

O&M = operation and maintenance.
Source: Author's field survey data, 2019.

6. Data from the Field Survey of Biomass Power Plants in the Three Southern Provinces

From the previous study on the levelized cost of energy (LCOE) and information on power plants from the Thailand Energy Awards, the cost of electricity production of biomass-fired power plants covers investment cost of the power plants, fuel cost, and O&M cost (Tables 4.8–4.10).

Table 4.8 Investment Cost of Biomass-fired Power Plant (Capex)

9.9-MW Biomass Power Plant Capex	US$[a]	Baht
Consulting services, licences, and permits	483,871	5,781,307
Civil works	1,152,685	16,088,399,517
Installation (labour, electricity, mechanical)	1,228,520	6,744,731,900
Equipment (boiler, turbine, generator, others)	16,326,847	2,655,968,158
Land development costs	30,334	2,763,772,151
Design, engineering, project management	1,036,052	3,641,029,251
Grid connection	645,161	282,898,058
Others	2,806,208	5,781,307
Total	**23,709,678**	**782,893,568**
Capex per 1 MW	**2,394,917**	**79,080,158**

Capex = capital expenditure.
Notes: Calculated from the actual data of the biomass power plant (wood), size 9.9 MW.
[a] US$1 as of 27 November 2018, equal to B33.02.

Table 4.9 Fuel Cost of Biomass-fired Power Plant

9.9-MW Biomass Power Plant Fuel Cost	US$[a]	Baht
Fuel cost per 1 MW	**208,211**	**6,875,131**

Notes: Calculated from the actual data of the biomass power plant (wood), size 9.9 MW.
[a] US$1 = B33.02 (as of 27 November 2018).

Table 4.10 O&M Cost of Biomass-fired Power Plant

9.9 MW Biomass Power Plant O&M Cost	US$[a]	Baht
O&M escalation rate	5% per year	
Employment cost	322,581	10,651,625
Total	**2,155,674**	**71,180,356**
O&M Cost per 1 MW	**217,744**	**7,189,935**

O&M = operation and maintenance.
Calculated from the actual data of the biomass power plant (wood), size 9.9 MW.
[a] US$1 = B33.02 (as of 27 November 2018).

Table 4.8 shows that the initial investment cost per 1 MW of biomass-fired power plant is US$2,394,917. The fuel cost is US$208,211 (Table 4.9) and the O&M cost is US$217,744 (Table 4.10). Therefore, the total cost per 1 MW of power plant is US$2,820,872.

7. Merit Order of Biomass-fired Power Plants

The country's power system is an enhanced single buyer, with the Electricity Generating Authority of Thailand (EGAT) acting as system operator. The National Control Center under EGAT is the nerve centre of Thailand's power grid system. This is where economic merit order in power production and dispatch from all major power plants of both EGAT and private power producers are commanded and controlled to reliably meet the country's demand. It decides which power stations will generate electricity and when. The economic merit order in power production and dispatch from all major power plants are described as follows:

- The first priority is for the must-run power plants to ensure the security of the power system. Non-operation of these power plants may lead to a power outage.
- The second priority is the must-take power plants. These power plants signed a power purchase agreement with EGAT and EGAT guaranteed to purchase a certain amount of their electricity production. These power plants include small private power producers, SPP firms, and SPP non-firms. Also, some power plants of EGAT itself have contracts on minimum fuel supply such as natural gas. Thus, these power plants need to run or face high loss.
- The third priority is the power plants with the least production cost to meet the electricity demand. These are the remaining power plants from the first two, must-run and must-take plants.

8. Recommendations to Overcome Barriers and Crucial Policies to Promote New Power Plants

To overcome the above-mentioned barriers and to promote new power plants, this chapter recommends the following:

(1) On policies and regulations – The policymakers should consider the impact of certain policies on existing power plants before it formulates or implements such policies and regulations. It should consider that biomass supply is enough to ensure that the demand is not so high, thus, making the price unacceptable. The new tariff should not be much higher such that the existing power plants could not compete.

(2) On biomass supply – In case the government plans to promote biomass-fired power plants in the three southern provinces, it should consider the cost of transport as the biomass may come from all provinces in the south.

(3) On biomass price – the promotion of new power plants should consider the supply of biomass to ensure that the price of biomass would not rise too much.

(4) On cost and investment barriers – investment subsidy or higher production subsidy is needed for the promotion of new power plants to compensate for higher investment and insurance costs due to a greater risk of insurgency.

9. Conclusions for Biomass Resources for Power Generation in Southern Thailand

The interviews of the representatives from the Pattani and Yala power plants revealed the following:

- 1) The existing biomass **is not** adequate for the promotion of new power plants with a total capacity of 100 MW.
- 2) Currently, the three biomass-fired power plants in Yala have a total capacity of 40 MW, but there is shortage of biomass supply from December to January.
- 3) Some sawmills decrease their operations due to less demand; as a result, the biomass from sawmills decreases.
- 4) The shortage of biomass can be alleviated by imports from nearby provinces in the central and the upper parts of the south.

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