Chapter 5

Cost Analysis of Biomass Power Generation

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Chapter 5

Cost Analysis of Biomass Power Generation in Southern Thailand

1. Introduction

Biomass is one kind of clean energy. The biomass power plant uses feedstock materials like agricultural straws, woodchips, rice husk, residues from palm oil such as empty fruit bunches, etc. which are smashed, briquetted, or gasified, then burned to produce high temperature and pressure steam. The heat energy in steam is transferred to electric energy and supplied to innumerable homes via highly efficient steam turbines. Biomass power normally uses condensing steam turbine for generation or cogeneration. The ash of biomass could be used as farmland fertiliser, providing green power for crops.

The southern provinces of Thailand have a huge biomass potential for power generation. Although some provinces may have a deficit of biomass for power generation due to the competing uses of biomass in other sectors, the region has a biomass surplus if the transport arrangement is well managed. The feedstock comes from oil palm and rubber plantation. For biomass power generation, the biomass supply chain should be secure in terms of supply and price, as these could affect the cost and stability of supplying the power.

For a better understanding of the situation of the biomass power plant in southern Thailand, this chapter explores the possibility of different price scenarios of biomass feedstock, and how these prices affect the levelized cost of energy (LCOE). This is important for policy if the introduction of more biomass power plants in the southern provinces will be economically viable or not. Currently, the government provides subsidies through the feed-in-tariff (FiT) scheme to different types of renewables, and some price premiums for the location in the southern provinces. For the biomass power plant of different installed capacity, the premium tariff is summarised in Table 5.1.

Table 5.1 Feed-in Tariff for Electricity Generated from Biomass Power Plant

Capacity (MW)	FiT (B/kWh)			Duration (Years)	FiT (Premium) (B/kWh)	
	FiT (Fix)	FiT (Variable)	FiT		Bioenergy project (first 8 years)	Adder for Southern Provinces
Installed capacity less than 1 MW	3.13	2.21	5.34	20	0.5	0.5
Installed capacity of 1–3 MW	2.61	2.21	4.82	20	0.4	0.5
Installed capacity of more than 3 MW	2.39	1.85	4.24	20	0.3	0.5

FiT = feed-in tariff.
Source: Klomgrich Tantravanich (2018)).

2. Local and International Cost of Biomass

In the supply chain analysis in Chapter 4, the price of biomass vary according to seasons (Tables 5.2.1 and 5.2.2).

Table 5.2.1 Price of Biomass (January to June, 2018), baht/ton

Type of Biomass	January	February	March	April	May	June
Rubber wood slabs	769	833	650	538	647	765
Rubber wood waste	1,000	1,050	883	633	800	950

Source: Authors' survey data, 2018.

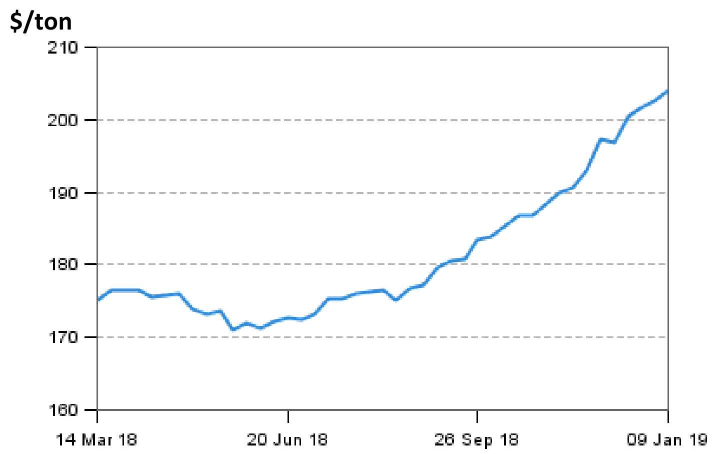
Table 5.2.2 Price of Biomass (July to December, 2018)

Type of Biomass	July	August	September	October	November	December
Rubber wood slabs	759	625	588	625	750	683
Rubber wood waste	875	625	714	706	750	900

Source: Authors' survey data, 2018.

Globally, wood pellets and woodchips are traded internationally at high prices (Figure 5.1) while local biomass, such as low-cost agricultural and forestry waste, is primarily traded locally. Therefore, prices of wood pellets and wood chips are generally higher than the local prices. Undoubtedly, Asia's demand for biomass is growing rapidly as many countries have accelerated the share of renewables into the energy supply mix.

Figure 5.1 Spot Market of Wood Pellets (90-day Index cif, US$/ton)



Source: Argus Media Ltd. (2017).

Wood pellet imports into South Korea and Japan have grown exponentially since 2015. In 2017, South Korea imported 2.4 metric tons (MT) of wood pellets, 20 times of imports in 2012. Japan is currently a smaller market, but its growth has also been impressive. Japan imported over 0.5 MT in 2017, a sevenfold increase from 2012.

The price of biomass in southern Thailand is very competitive and suitable for biomass power generation. The local biomass price is at least five times cheaper than the international biomass spot market, thus, making biomass price for power generation attractive.

3. Levelized Cost of Energy

The LCOE of renewable energy (RE) technologies varies by technology, country, and project, based on RE resources, capital and operating costs, and the efficiency/performance of the technology. The method of calculating the cost of RE technologies, adapted from the approach used by IRENA (2012), is based on discounting financial flows to a common basis, considering the time value of money. The weighted average cost of capital, often also referred to as the discount rate, is an important part of the information required to evaluate biomass power generation projects and has an important impact on the LCOE.

The formula used for calculating the LCOE of RE technologies is:

$$LCOE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

LCOE = the average lifetime levelized cost of electricity generation;

I_t = investment expenditures in the year t;

M_t = operations and maintenance expenditures in the year t;

F_t = fuel expenditures in the year t;

E_t = electricity generation in the year t;

r = discount rate; and

n = life of the system.

3.1. Key assumptions

A few key assumptions are used in calculating the LCOE. These assumptions are based on the information given by the research team that conducted the survey of the supply chain for biomass power generation in southern Thailand.

Table 5.3. Key Assumptions Adopted from a Biomass Power Plant in Southern Thailand

Installed Capacity	9.9 MW
Net Plant Capacity	80%
Thermal Efficiency	27%
Capex	US$2,561/kW
Construction Financing Cost	US$166/kW
Economic Lifetime	25 years
Discount Rate	5%
Rate of Return on Equity	9.50%

Source: Authors' survey data, 2018.

Although biomass-fired electricity plants can achieve availabilities in the range 85% to 90%, they will not always operate at these levels. Thus, this study assumes a net plant capacity of 80%, rather than 90%. The thermal efficiency of biomass power plant ranges from 20% to 30%. However, we assume it at 27% as this information is provided by the study team.

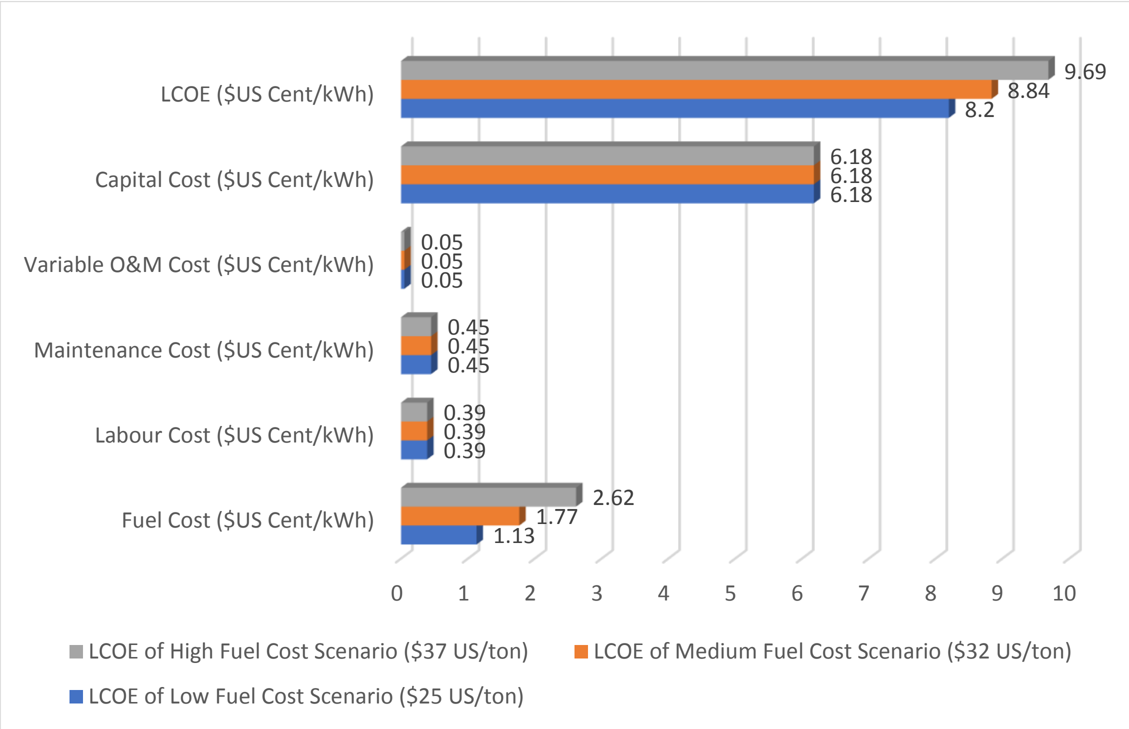
3.2. LCOE result estimates

The results of the LCOE are broken down into fuel cost, labour cost, fixed or capital cost, and variable operation and maintenance (O&M) costs. It is important to note that fuel cost contributes significantly to the overall cost. The study of IRENA (2012) on biomass for power generation concluded that the fuel cost could be the largest share in the overall cost; in some cases, its share could be as much as 30%–40% of the overall cost in terms of US dollars per kilowatt-hour. Luckily, the study of biomass for power generation in southern Thailand showed a favourable price for feedstocks. The study used three price scenarios: US$25/ton, US$32/ton, and US$37/ton. With certain assumptions, the three fuel price scenarios produced the following results (Figure 5.2).

- At the fuel price of US$25/ton, the LCOE is estimated at US$8.2 cents/kWh
- At the fuel price of US$32/ton, the LCOE is estimated at US$8.84 cents/kWh
- At the fuel price of US$37/ton, the LCOE is estimated at US$9.69 cents/kWh

The ASEAN Centre for Energy (ACE) conducted a study on the LCOE in selected renewable technologies in ASEAN member states in 2016 (ACE, 2016). The results showed that the LCOE of biomass ranges from US$5.70 cents/kWh to US$12.5 cents/kWh. The range is about US$9.2 cents/kWh. The 2012 study of IRENA on biomass for power generation also found that the LCOE ranges from US$6 cents/kWh to US$21 cents/kWh due to fuel cost and other factors (Figure 5.3).

Figure 5.2 LCOE Results of Fuel Cost Scenarios (25 Years of Plant Lifetime)

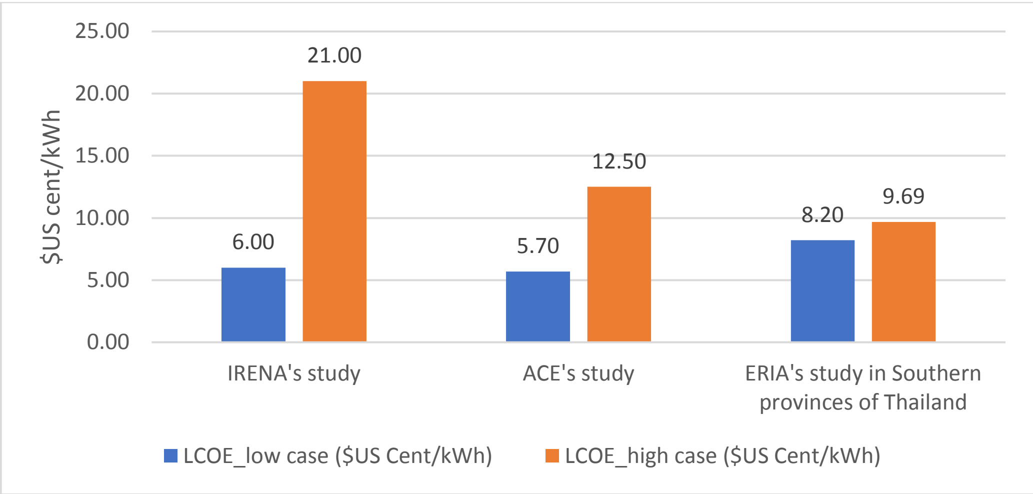


Source: Author's calculation.

Nonetheless, ERIA's study for biomass power generation in southern Thailand found that the LCOE ranges from US$8.2 cents/kWh to US$ 9.69 cents/kWh. This is a very competitive LCOE cost and is attractive for investment compared to the current FiT provided by the government to the biomass power generation in the southern provinces, which ranges from US$15.7 cents/kWh to US$19.8 cents/kWh. The FiTs of US$15.7 cents/kWh and US$19.8 cents/kWh are the tariff rates for electricity generated from the biomass power generation in southern Thailand for the installed capacity of more than 3 MW and of less than 1 MW, respectively (Figure 5.4).

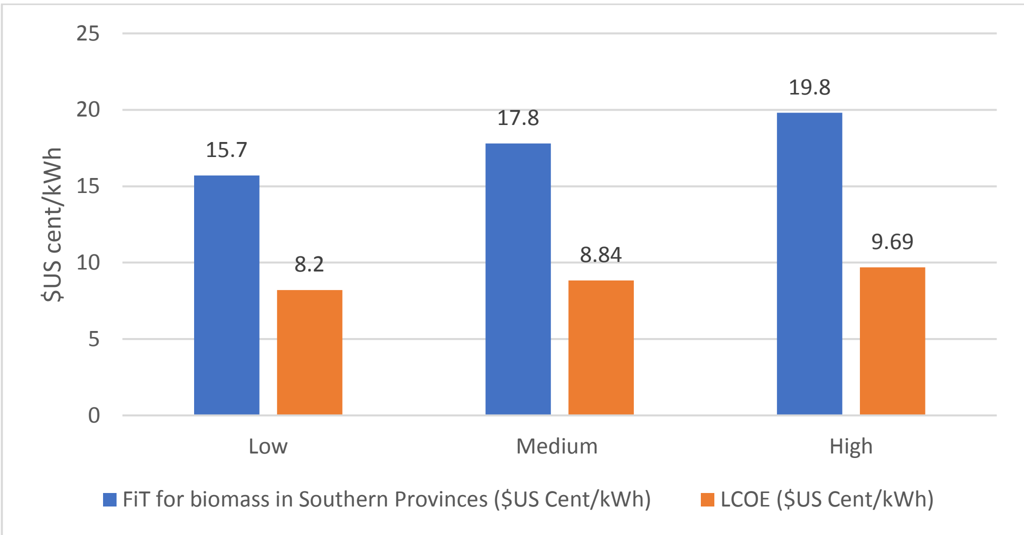
The study shows possibilities of increasing the biomass power generation in the southern provinces. The supply chain analysis in Chapter 3 illustrates that some provinces in southern Thailand may face a deficit in biomass supply. However, as a group, there is a surplus in the supply of biomass in the southern provinces. Thus, introducing additional capacity of biomass fired power generation will need to strengthen the supply chain through collection, transportation, and storing biomass feedstock.. The current scheme of FiT is generous, and it lasts for 20 years for the FiT (fix) and FiT (variable). However, the FiT (premium) lasts only 8 years. In addition, the FiT ladder (US$0.5 cents/kWh) is added to investment in biomass for power generation in southern provinces of Yala, Pattani and Narathiwat..

Figure 5.3 LCOE Results of Biomass Power Generation, Various Studies



ACE = ASEAN Centre for Energy, IRENA = International Renewable Energy Agency, LCOE = levelized cost of energy.
Source: Author's calculation.

Figure 5.4 Results of LCOE Study Compared with Current FiT



FiT = feed-in tariff.
Source: Author's calculation.

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