

Wongkot Wongsapai; Yaowateera Achawangkul; Waranya Thepsaskul; Sopit Daroon; Thongchai Fongsamootr

Article

Biomass supply chain for power generation in southern part of Thailand

Energy Reports

Provided in Cooperation with:

Elsevier

Suggested Citation: Wongkot Wongsapai; Yaowateera Achawangkul; Waranya Thepsaskul; Sopit Daroon; Thongchai Fongsamootr (2020) : Biomass supply chain for power generation in southern part of Thailand, Energy Reports, ISSN 2352-4847, Elsevier, Amsterdam, Vol. 6, Iss. 2, pp. 221-227,
<https://doi.org/10.1016/j.egy.2019.11.066>

This Version is available at:

<https://hdl.handle.net/10419/243882>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

The 6th International Conference on Power and Energy Systems Engineering (CPESE 2019),
20–23 September 2019, Okinawa, Japan

Biomass supply chain for power generation in southern part of Thailand

Wongkot Wongsapai^{a,c,*}, Yaowateera Achawangkul^b, Waranya Thepsaskul^a,
Sopit Daroon^a, Thongchai Fongsamootr^c

^a Energy Technology for Environment Research Center, Chaing Mai University, Suthep, Muang, Chiang Mai, 50200, Thailand

^b Department of Alternative Energy Development and Efficiency, 17 King Rama I Rd., Pathumwan, Bangkok, 10130, Thailand

^c Department of Mechanical Engineering, Faculty of Engineering, Chaing Mai University, Suthep, Muang, Chiang Mai, 50200, Thailand

Received 4 October 2019; accepted 22 November 2019

Abstract

The development of rubberwood into electricity generation for biomass power plant is one of the most interested renewable energy options in Southern part of Thailand. This research presents a biomass supply chain for power generation in Southern part of Thailand focusing on only rubberwood in Southern region including three border provinces and the survey on one rubberwood power plant. The results show that the remaining potential of biomass from rubberwood in three border provinces for electricity generation is approximately 40.2 MW and the amount of biomass in other provinces within the radius of 200-km, 187.62 MW is remaining. Therefore, only 40.2 MW remaining potential for NEW power plant in three border provinces from rubberwood, more rubberwood needs to be imported from other provinces. The policy recommendation from this research is import the rubberwood from other provinces or long-term contract with supplier.

© 2019 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the scientific committee of the 6th International Conference on Power and Energy Systems Engineering (CPESE 2019).

Keywords: Biomass; Rubberwood; Supply chain

1. Main text

Southern part of Thailand enriches with biomass, such as rubberwood thus, it is interesting for entrepreneur to invest biomass power plant project in southern part. Likewise, due to special privilege the government has provided in southern provinces. Both SPP and VSPP have been constructed and supplied electricity to national transmission line.

In November 2018, there were totally 237.11 MW of biomass power plant in which have already sold electricity to the grid (COD). Suratthani and Nakhon Sri Thammarat became the two highest existing capacity, which were 48.3 MW and 46.7 MW, respectively. Because these provinces consist of large number of rubberwood plantation area.

* Corresponding author at: Department of Mechanical Engineering, Faculty of Engineering, Chaing Mai University, Suthep, Muang, Chiang Mai, 50200, Thailand.

E-mail address: wongkot@eng.cmu.ac.th (W. Wongsapai).

<https://doi.org/10.1016/j.egy.2019.11.066>

2352-4847/© 2019 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the scientific committee of the 6th International Conference on Power and Energy Systems Engineering (CPESE 2019).

1.1. The SPP and the VSPP schemes in Thailand

The SPP, or Small Power Producer scheme, was established on 17 March 1992 through an endorsement by Thailand's cabinet. The scheme aims to promote power generation by using alternative fuel and waste including cogeneration to efficiently use domestic alternative resources and by-product energy. This concept also decreases the government's duty to invest in power infrastructure.

The electricity generation and supply under the Government of Thailand is originally managed by three power Utilities, i.e., The Electricity Generating Authority of Thailand (EGAT), the Metropolitan Electricity Authority (MEA), and Provincial Electricity Authority (PEA) have issued the small power purchasing announcement in 2007 [1]. Purchasing will cover existing capacity between 10 MW to 90 MW.

The VSPP or Very Small Power Producer scheme started on 14 May 2006 [2]. When the Thai cabinet agreed to regulate the VSPPs. Power Producers can enter into power purchasing contracts with the MEA or the PEA (depending on the power plant's location). This scheme aims to promote to use of domestic resources, increase the stability of national transmission by distributing power generation, power plant operation in peak-time. In 2007, Energy Policy Administrative Committee has endorsed to extend the capacity of VSPP from maximum 1 MW to be 10 MW.

1.2. Status of the SPP and the VSPP in Southern part of Thailand

Energy Regulatory Committee (ERC) has summarized for the overall status of RE SPP and VSPP [3]. In November 2018, it can be investigated that there were totally 13 SPP using renewable sources with 347.90 MW in existing capacity, while total purchasing capacity was 313.47 MW.

For VSPP, it can be found VSPP using renewable energy were 122 plants, whereas total existing capacity presented by 534.20 MW, and the total purchasing electricity shown by 476.61 MW.

2. Materials and method

2.1. Potential of biomass obtained from rubberwood

The collection of biomass plantation area was done in 14 provinces of Southern of Thailand, shown in Fig. 1(a) The data is based on the statistics from the Office of Agricultural Economics (OAE), Ministry of Agriculture and

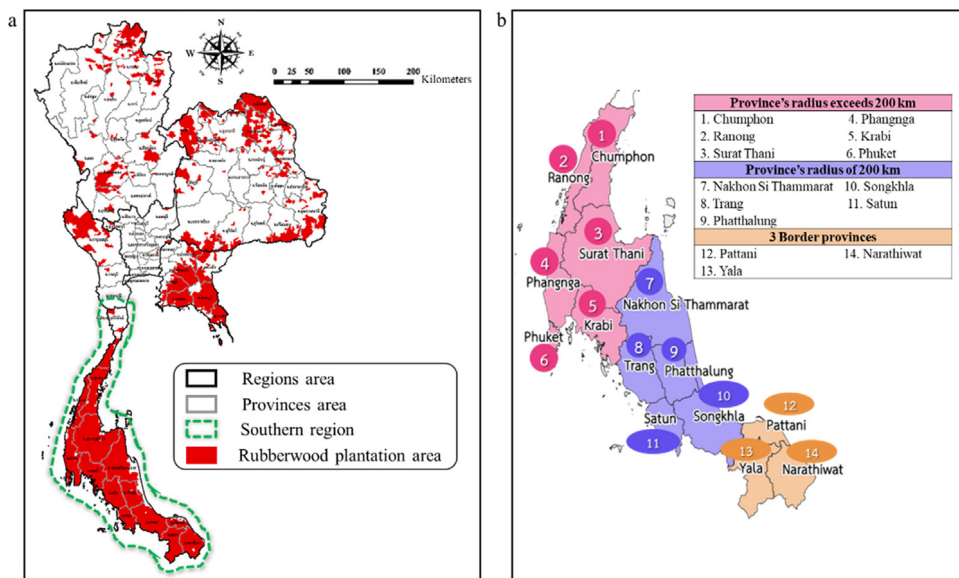


Fig. 1. (a) Map of rubberwood plantation in Thailand; (b) Provinces in South of Thailand (14 Provinces).

Cooperatives. The data is reported in terms of plantation area, harvesting area, production. In the South, there is 1 biomass crops with 4 types of rubberwood, i.e. (1) Stumps, roots and branches (2) Offcut (3) Slabs (4) Sawdust and wood residues. The biomass from rubberwood will be classified into 3 parts, i.e. (i) Logs (ii) Offcuts (iii) Stumps, roots and branches. In this study, the sources of rubberwood biomass are then focused on two sources: (i) Stumps, roots and branches at the felling area, (ii) Rubberwood slabs, sawdust and wood residues at rubberwood manufacturing factory.

By felling the rubber trees of 1 rai, it will give 30 tons of logs. Most of log are sent to sawmills or rubberwood processing plant. The logs are cut to obtain sawn timber. The wastes from cutting are “slab” and “sawdust”. In general, the slabs produced is about 40% of logs, thus give 12 tons of slabs. Sawdust produced is 10% of logs, thus gives 3 tons of sawdust. This production rate is inversely to the size of logs. Thirty percent of slab and sawdust are used in-house in the drying process of sawmill so 70% of slabs and sawdust will be available to sell.

Unlike the data of plantation area, harvesting area, the data of felling area of rubber trees is limited due to the fact that it is uncertain to plan the rubber tree felling. However, the Rubber Authority of Thailand (RAOT), established under RAOT Act 2015, has its missions to promote and support the farmers and all stakeholders to fulfill their needs. RAOT therefore has some information about the felling area. From the statistics of the past 10 years, the tendency of felling area increases. The target of felling area by RAOT is 400,000 rai/year.

2.2. Assumption in this study

- (1) Focus only rubberwood in Southern region including three border provinces.
- (2) Estimate the potential from the plantation data from Office of Agricultural Economics (OAE)
- (3) Consider the current rubberwood consumption in power plant, industry heat generation and other uses.
- (4) Field survey to current rubberwood power plant for recheck the data.
- (5) Investigate the “remaining potential” for power generation from rubberwood which located in three border provinces from (i) three border provinces plantation, (ii) three border provinces + 200 km. transportation.

2.3. Three border provinces: At a glance

To access biomass supply from rubberwood in the southern part of Thailand, the region can be divided into 3 group, i.e. (Group 1): Covering three border provinces — Pattani, Yala and Narathiwat, (Group 2): Covering other provinces within 200 km. radius of three border provinces. And (Group 3): Covering other provinces with over 200 km. radius of three border provinces. The provinces as identified in 3 cases are shown in Fig. 1(b).

3. Result and discussion

3.1. Data from field survey of biomass power plant

Data related to the Supply Chain of Biomass for Power Generation were collected by interviewing the representatives of one biomass power plants in three border provinces, which in this study will be called “Plant A”. The interview included detailed information on fuel sources, biomass potential to produce electricity and the opportunities to increase power generation in the future, etc. The data from the interview on August 15, 2018.

Biomass from rubberwood for power generation came from felling of about 25–35 years rubber trees which give less latex. The biomass derived from felling rubber trees are stumps, roots, slabs, wood tips, and branches while rubberwood trunks are sent to sawmills, producing sawdust as biomass. Normally, biomass traders collect biomass from felling areas and sawmills to sell to power plants.

3.2. Supply chain of biomass

Supply chain of biomass for Power Generation is comprised in general of four components: (1) Plantation & Harvesting (2) Fabrication & Stocking (3) Logistic (4) Power plant & Industrial plant. The price of rubberwood that the factory purchased is based on the purchase price in Hat Yai, Songkhla. In the past, during the period when there were increasing numbers of the manufacturing plants of Particle board in Songkhla, the price of rubberwood went up to 1423 THB/ton. As one of the main raw materials, this caused a loss to the power plant. In general, the

highest acceptable price of rubberwood that the power plant is still operational is 1500 THB/ton, though at this price the factory needs to absorb the loss as high as 1200 THB/ton.

From the field survey, the main method for production of biomass from rubberwood is to chip residues from rubberwood including wood slaps and rubber wood chips (branches, sawdust roots) into small pieces to make it easier for power generation process. From the survey, there is no production of wood pellets. The costs of processing rubberwood into woodchips include machinery and equipment (Wood chipping machine), labor cost, and electricity cost. There are currently two practices in acquiring biomass from rubberwood, i.e. (1) Processing rubberwoods into woodchips and (2) Buying woodchips from middlemen. Which cost of wood processing from rubberwood are 100–150 THB/ton and 400–500 THB/ton respectively.

The logistic cost is estimated from rate of fuel consumption, capacity of vehicles, and the distance. There are 2 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 50–200 km.

The supply chain starts from collecting biomass, processing, transporting, storing and using. The employment through the supply chain is as shown in Table 1. The most labor-intensive process is collecting biomass especially rubberwood roots, which require a lot of labor and digging equipment.

Table 1. Assessment of labor through supply chain. (Unit: Persons).

Biomass	Collection	Processing	Logistics	Storage	Usage
Slab	2	2	1	1	1
Root	3	2	1	1	1
Sawdust	2	2	1	1	1
Wood tips	2	3	1	1	1

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 as shown in Table 2.

Table 2. Cost of biomass through supply chain. (Unit: THB).

Biomass	Raw material	Processing ^a	Logistics ^b		Consumption ^c
			Truck	Small truck	
Slab	365	150			565–1045
Root	450	150			650–1130
Sawdust	600	–	50–200	130–530	650–1130
Wood tips	450	150			650–1130

^aProcessing cost, for rubberwood 100–150 THB/ton.

^bCost of logistics

- Fuel consumption rate from truck data service center; Truck 3.3 km/l (Capacity 10 ton); Small truck 10.5 km/l (Capacity 1.2 ton).
- Diesel retail prices in Yala in 31, October 2018 = 30.34 THB/l.
- Transportation distance 50–200 km.

^cCost of biomass consumption from survey of the power plant.

3.3. Electricity demand in three border provinces

There is an increasing trend of electricity demand in three border provinces [4]. It is estimated that the electricity demand in 2026 is about 331 MW. The existing capacity of power plants under the SPP and the VSPP scheme contracts in the three provinces are lower than the current demand therefore, it is needed to import electricity from other provinces. The largest power plant close to the three provinces is Jana Power Plant with the installed capacity of 700 MW in Jana District, Songkhla Province, shown in Fig. 2. Therefore, very critical for both government and private sectors to promote power generation to meet the demand.

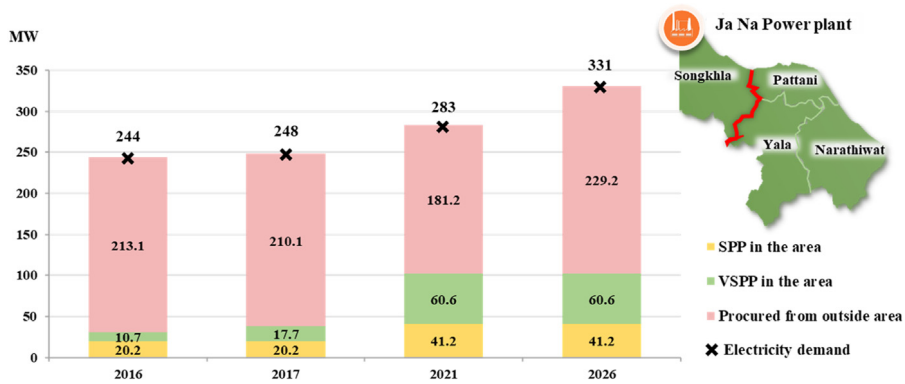


Fig. 2. Electricity demand in three border provinces. Remarks: (1) Demand forecasts are taken from Load Demand Forecast Committee (2) SPP and VSPP information from Energy Regulatory Committee Office website.

3.4. Electricity supply in three border provinces (current status)

The total power plants in three border provinces are 205.10 MW, in consist of, (1) EGAT power plant as 103.30 MW, (2) Private power plant as 101.80 MW and (3) New project (as planned) in 3 provinces as 50.05 MW.

The status of nine biomass-fired power plants in three border provinces is as shown in Table 3. There are three powerplants whose COD (Commercial Operation Date) are in 2006, 2013, and 2017 while six power plants whose SCOD (Scheduled Commercial Operation Date) are in 2017, 2018, and 2019.

Table 3. Currently there are 9 operational biomass power plant (COD and SCOD).

Plant in three border provinces	COD (MW)	Installed capacity (MW)	Status	COD year	Type
Narathiwat A	7.5	7.0	COD	2017	FiT
Narathiwat B	6.3	6.3	SCOD	2018	FiT bidding
Pattani A	23.0	21.0	SCOD	2019	Adder
Yala A	23.0	20.2	COD	2006	N/A
Yala B	9.9	8.7	COD	2013	FiT
Yala C	5.2	5.0	SCOD	2016	FiT
Yala D	7.5	7.0	SCOD	2017	FiT
Yala E	9.9	9.9	SCOD	2017	FiT bidding
Yala F	9.9	9.9	SCOD	2017	FiT bidding

3.5. Plantation and felling area of rubber tree

In 2017, the plantation area of rubber trees in three border provinces is more than 2.6 million Rai [5,6] (1 rai = 0.16 hectares). Assumed that 2% of plantation area is felling areas, biomass can be produced from 52,000-Rai felling areas. The felling area in Yala is largest, approximately 25,000 Rai, followed by Narathiwat and Pattani, respectively. The plantation areas and felling areas of rubberwood by province in the south of Thailand are shown in Fig. 3. and Table 4. shows the biomass supply from rubberwood by province and by group of provinces.

3.6. Estimation of 2017's demand of rubberwood

Several studies of the distribution of rubber tree growth have been conducted in Southeast Asia [7] such as in Yunnan, China [8–10], Indonesia [11] and Laos [12]. Most spatial analysis of rubber trees has been limited to suitability analyses in Thailand (e.g. [13]). From the data on rubber tree plantation areas and felling areas in 2017, it is estimated that about 1.68 million tons of biomass from rubberwood is produced annually in three border provinces. The biomass uses in industries and other uses are about 35,000 tons/year. The remaining amount of biomass for electricity generation is about 1.64 million tons/year; therefore, the electricity generation using biomass

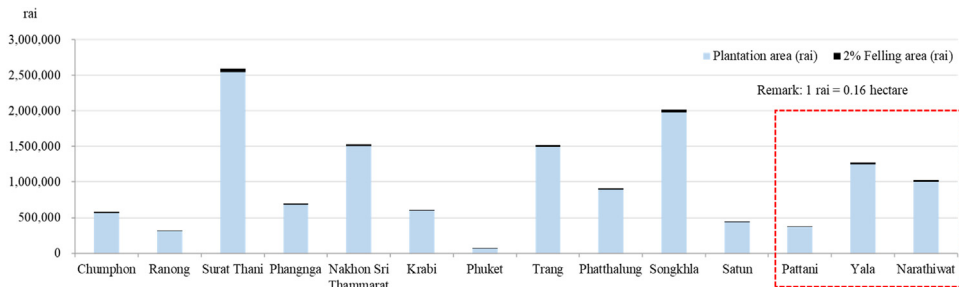


Fig. 3. Plantation and Felling area of rubber tree.

Table 4. Biomass from rubberwood supply potential.

Share types	Biomass potential of rubberwood (ton)			
	Root	Sawdust	Slab	Wood tips
Southern region	1,369,931	821,959	3,287,835	3,287,835
3 Provinces + Provinces within radius of 200 km	892,609	535,565	2,142,260	2,142,260
Provinces within radius of 200 km	630,076	378,045	1,512,181	1,512,181
Provinces with radius exceeding 200 km	477,323	286,394	1,145,575	1,145,575
Three border provinces	262,533	157,520	630,079	630,079

Gained for each rai of felling area, is 5 ton of root, 3 tons of sawdust, 12 tons of slab, and 12 tons of wood tips.

from rubberwood is about 142.4 MW. The existing capacity of nine operational Biomass Power Plant is about 102.2 MW (COD = 40.4 MW and SCOD = 61.8 MW). Therefore, the remaining potential of biomass from rubberwood in three border provinces for electricity generation is about 40.2 MW.

The total biomass, including the amount of biomass in other provinces within a 200 km is about 4 million tons/year. This can generate about 349.13 MW of electricity. The existing consumption is about 161.51 MW; therefore, 187.62 MW is remaining.

4. Conclusion

Due to low potential land is available for producing fast-growing feedstocks. Therefore, only 40.2 MW remaining potential for NEW power plant in three border provinces from rubberwood, more rubberwood needs to be imported from other provinces. Other biomass crops in the three border provinces are very few. The significant potential from rubberwood in the future, it is required to improve collection efficiency of root of rubberwood.

The rubberwood price frequently increase in rainy season due to limited access to rubberwood area. Likewise, cost in three border provinces is higher than other southern provinces from many reasons such as higher insurance payment, no night-time construction. The significant particle board manufacturing business, located in Songkhla provinces, is the case of rising of rubberwood market selling price. They can pay more due to higher value added of their products.

Acknowledgment

The authors would like to thank the Energy Technology for Environment Research Center (ETE) for information in term of Rubberwood potential in Southern part of Thailand. We remain culpable for any remaining errors.

References

- [1] Pipattanasomporn M, Ongsakul W, Pacudan R, Lefevre T. Electricity prices in a competitive market: a preliminary analysis of the deregulated Thai electricity industry. *Util Policy* 2000;171–9.
- [2] Gamonwet P, Dhakal S, Thammasiri K. The impact of renewable energy pricing incentive policies in Thailand. *GMSARN Int J* 2017;11:51–60.

- [3] Energy Regulatory Commission. Power consumption in power plant [internet]. 2017, Available from: <http://www.erc.or.th/ERCWeb2/>. [cited 2019 May 10].
- [4] Department of Industrial Works. Power consumption in factory (boiler) [internet]. 2017, Available from: <http://www.diw.go.th/>. [cited 2019 June 2].
- [5] Rubber Authority of Thailand. Plantation and felling area of rubber tree [internet]. 2017, Available from: <http://www.raot.co.th/>. [cited 2019 June 7].
- [6] Office of Agricultural Economics. Perennial area of rubber tree [internet]. 2017, Available from: <http://www.oae.go.th/>. [cited 2019 June 7].
- [7] Zhe L, Jefferon M Fox. Rubber tree distribution mapping in northeast Thailand. *Int J Geosci* 2011;573–84.
- [8] Li H, Ma Y, Aide TM, Wenjun L. Past, present and future land-use in Xishuangbanna, China and the implications for carbon dynamics. *Forest Ecol Manag* 2008;255(1):16–24.
- [9] Hu H, Liu W, Cao M. Impact of land use and land cover changes on ecosystem services in Menglun, Xishuangbanna, Southwest China. *Environ Monitor Assess* 2008;46(1–3):147–56.
- [10] Li H, Aide TM, Ma Y, Liu W, Cao M. Demand for rubber is causing the loss of high diversity rain forest in SW China. *Biodivers Cons* 2007;16(6):1731–45.
- [11] Ekandinata A, Widayati A, Vincent G. Rubber agroforest identification using object-based classification in Bungo district, Jambi, Indonesia. In: *The 25th Asian conference on remote sensing*; Chiang Mai, Thailand; 2004 Nov 22–26.
- [12] Hurni K. Rubber in laos: detection of actual and assessment of potential plantations in lao PDR using GIS and remote sensing technologies [Master thesis], Bern: Centre for Development and Environment: University of Bern; 2008.
- [13] Ranst EV, Tang H, Groenemans R, Sinthurath S. Application of fuzzy logic to land suitability for rubber production in Peninsular Thailand. *Geodema* 1996;70(1):1–19.