Digital Asia Discussion Paper Series

DP 08-003

An Introduction of Biodiesel to Thai Economy

– Community Biodiesel and Oil Palm-Biodiesel Complex –

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2008 年 3 月

Academic Frontier Project
"Digital Asia Building: Regional Strategy Design Platform
Digital Asia Regional Strategy Research Center

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Content

An Introduction of Biodiesel to Thai Economy

1. Introduction

Amidst a roaring price of crude oil over the world, Thailand, which relies on crude oil import more than 80 % of total crude oil demand in order to fulfill domestic petroleum production, has inevitably faced the problem of skyrocketing price of gasoline and diesel. Table 1 shows the retail price of petroleum products in Bangkok in which the retail price of both gasoline and diesel products have remarkably increased. During 2003 – 2007, the retail prices of gasoline and diesel products rose between 76% and 85%, from 16.60 to 29.18 baht/liter for ULG 95 (76% increase), from 15.65 to 28.32 for ULG 91 (81% increase), from 14.03 to 25.66 for HSD (high speed diesel) (83% increase), and from 13.73 to 25.45 for LSD (low speed diesel) (85% increase). In the beginning of this year, 2008, when crude oil price dramatically increased again, the retail prices have climbed up to the point that reached more than two times those of 2003, 33.05 baht/liter for ULG 95, 31.86 for ULG 91, 29.36 for HSD, and 29.13 for LSD.

Table 1 Retail Price of Gasoline and Diesel Products in Bangkok (yearly weighted average)

Unit: baht/liter

Year	Gasoline					Diesel		
	ULG 95	ULG 91	Gasohol 95 (E10)	Gasohol 95 (E20)	Gasohol 91	HSD	B5	LSD
2003	16.60	15.65	n.a.	-	n.a.	14.03	-	13.73
2004	19.05	18.26	n.a.	-	n.a.	14.59	-	14.37
2005	23.90	23.10	23.77	-	n.a.	20.03	-	18.18
2006	27.58	26.79	26.09	-	n.a.	25.59	25.09	25.37
2007	29.18	28.32	26.17	-	25.76	25.66	24.95	25.45
2008 (Jan-Feb)	33.05	31.86	29.06	27.21	28.26	29.36	28.62	29.13

Source: Energy Policy and Planning Office (EPPO)

In terms of vehicle fuel usage in Thailand, gasoline is mainly used in personal cars; whereas, diesel is greatly used in trucks and pick-ups[5], major land transportation modes. Table 2 depicts sales of gasoline and diesel over the nation in selected years.

[5] Pick-ups are both personal cars and transport-purpose cars. Many households use pick-ups for both purposes.

The demand for gasoline and diesel on average increased 220% between 1986 and 2007; nevertheless, when looking at the numbers in details, we found that the demand for LSD peaked in 1994 and has declined since then. Yet, the ratio of demand for diesel to that of gasoline has remained constant at 2.5:1.

Table 2 Sales of Gasoline and Diesel Products in Thailand

Unit: million liters

Year	Gasoline	Diesel		
		Total	HSD	LSD
1986	2,269.0	5,737.0	5,666.6	70.1
1990	3,686.9	9,928.0	9,811.1	117.0
1995	6,293.3	15,619.1	15,424.1	194.9
2000	6,761.6	14,973.8	14,868.2	105.6
2001	6,857.1	15,221.3	15,119.9	101.3
2002	7,326.0	16,076.9	15,963.6	113.2
2003	7,635.1	17,550.3	17,450.8	99.5
2004	7,660.7	19,639.9	19,535.4	104.6
2005	7,248.1	19,645.2	19,568.1	77.2
2006	7,215.1	18,371.0	18,311.8	59.2
2007	7,336.8	18,709.7	18,676.9	32.8

Source: Energy Policy and Planning Office (EPPO)

The roaring price of gasoline and diesel has resulted in a struggle of government and private sectors to find alternative energy to help relieve the problem. Bioethanol is the answer for gasoline; while, biodiesel is the one to substitute conventional diesel.

Bioethanol and biodiesel has been promoted at the same time in Thailand but bioethanol has successfully penetrated the market before biodiesel because of its feedstock supply readiness. The feedstock of bioethanol is currently molasses and cassava. Molasses are by-products of sugar mills in which they are easily supplied to an ethanol plant that is newly built in the same complex. A supply surplus of cassava that is a problem for the country for a long time partly has been supplied to cassava-based ethanol plants. Besides, a cultivation period for both sugarcane and cassava is only one year. Biodiesel, whose main feedstock is oil palm, however, has faced a feedstock supply problem since it was first promoted. Oil palm needs 3 – 4 years since planted until it bears fruits. Moreover, an expansion of oil palm plantation areas is not easy due to limited suitable areas in the South of Thailand. Therefore, its new cultivation area has been planned to expand in other areas such as the Northeastern Thailand.

The structure of this paper starts from describing biodiesel utilization in Thailand in which two types of biodiesel, vehicle use and agricultural machine use, are explained with theirs promotion policy. Then, the paper explores community biodiesel production sites and oil palm-biodiesel complex in Northeastern Thailand in which the research team visited in December 2007.

2. Biodiesel in Thailand

Biodiesel in Thailand can be categorized into two types, vehicle use and agricultural machine use. Vehicle use biodiesel is also divided into two sub-categories, a mixture of conventional diesel with biodiesel, and pure biodiesel. A blending ratio of biodiesel blend currently is at 2% and 5%; therefore, they are called B2 and B5, respectively. Pure biodiesel (B100) is also sold in the market but at very few gas stations. On the other hand, agricultural machine use biodiesel is called community biodiesel since it is basically produced and sold in the community for agricultural machine use only, not for vehicle use.

For vehicle use biodiesel blend, B2 (a mixture of 2% B100 with 98% normal diesel) was first introduced to the market in the end of 2004; it was sold to small local bus drivers in Chiang Mai with a price set 0.5 baht less than normal diesel or 3.43% cheaper. After that, B5 (5% B100, 95% normal diesel) has been sold in some gas stations, first in Bangkok then extended to other regions. Currently there are 5 fuel distribution companies such as Bangchak and PTT that sell B5 through their 1,289 gas stations nationwide as of February 2008. Another 4 companies, for instance, Shell, Esso and Chevron, sell B5 to the industrial sector. Since 1 February 2008, a mandate of B2 was carried out; as a result, diesel presently sold at gas stations, except for B5 or pure biodiesel, has 2% biodiesel content in the fuel and there are no more diesel products called B2.

B100 or biodiesel used to mix with conventional diesel for vehicle use above is made from palm oil and produced by the biodiesel plants with a proper license.

Biodiesel quality must meet the specifications[6] set by the government, the quality that has been proved no adverse effects on a vehicle engine. Currently, there are 9 biodiesel plants in Bangkok, Ayuthaya, Pathum Thani, Prachinburi, Chachengsao, Samutsakorn, Rayong and Chumporn with the total production capacity of 2,185,800 liters (DEDE, Jan 2008).

Table 3 List of Biodiesel (B100) Plants in Thailand

	Name of Biodiesel Plant	Location	Feedstock	Production Capacity (liter/day)
1.	Bangchak Petroleum Public Co., Ltd.	Bangkok	Used vegetable oil, CPO, RBD PO	50,000
2.	Bio Energy Plus Co., Ltd.	Ayutthaya	Stearin, RBD PO	100,000
3.	Sun Tech Palm Oil Co., Ltd.	Prachin Buri	CPO, Stearin	200,000
4.	Patum Vegetable Oil Co., Ltd.	Pathum Thani	CPO	300,000
5.	Bangkok Renewable Energy Co., Ltd.	Chachoengsao	CPO	200,000
6.	Green Power Corporation Co., Ltd.	Chumporn	Stearin	200,000
7.	A I Energy Co., Ltd.	Samut Sakhon	CPO	250,000
8.	Weera Suwan Co., Ltd.	Samut Sakhon	Stearin, RBD PO	200,000
9.	Thai Oleochemical Co., Ltd.	Rayong	n.a.	685,800

Source: Department of Alternative Energy Development and Efficiency (DEDE), Thailand

Apart from diesel-use trucks or some personal cars, agricultural machines such as water pumps, tractors and bulldozers are also other major diesel consumers. Called "Community Biodiesel", biodiesel made from used cooking oil or vegetable oil such as Jatropha oil has been promoted and introduced to communities around the nation to produce and use it for agricultural machines in one's own community. Anyone can produce and sell community biodiesel by applying for a community biodiesel distribution license. Presently there are 27 persons or groups who have a community biodiesel distribution license (DEDE, Aug 2007).

[6] Refer to the characteristics and specifications of biodiesel in the appendix.

Nonetheless, the community biodiesel produced must meet the specifications separately set for the community biodiesel only, and must be added purple color in order to be able to distinguish between community biodiesel and other types of diesel. According the specifications[7] specified by the law, community biodiesel is exclusively used with simple agricultural machines that have a water-cooled 4-stroke single horizontal cylinder engine such as a water pumping machine and a walk-behind tractor. Therefore, community biodiesel produced according to the specifications required by law is not yet appropriate for agricultural machines that have a multi-cylinder engine e.g. tractors and bulldozers.

2.1 Feedstock

In general, feedstock for biodiesel production is animal oils or vegetable oils. Among the six oil yielding plants grown in Thailand, i.e., oil palm, coconut, soybean, peanut, sesame and castor, oil palm has the highest annual yield of 4 million tons, followed by coconut and soybean in 2003. Other plants have far less production. Table 4 summarizes the production of those oil yielding plants in Thailand during 1996 – 2003.

Table 4 Production of Oil Yielding Plants in Thailand, 1996 – 2003

Unit: thousand tons

Year	Oil Palm	Coconut	Soybean	Peanut	Sesame	Castor
1996	2,255	1,413	386	147	34	6
1997	2,688	1,419	359	147	34	6
1998	2,681	1,386	338	126	35	6
1999	2,465	1,372	321	135	36	7
2000	3,514	1,381	319	138	37	7
2001	3,256	1,400	312	132	39	9
2002	4,089	1,396	261	107	39	9
2003	4,001	1,418	260	112	40	10

Source: Office of Agricultural Economics, Thailand

In the world market, Thailand contributes only 3.76% of the world's oil palm production in 2006 but ranks as the third largest producer. Malaysia and Indonesia rank as the first and the second producing oil palm much further, more than 10 times, than Thailand because of their high and regular rainfall all the year. Table 5 depicts the harvested area, production and yield of major world oil palm producers during 2004 – 2006.

[7] Refer to the characteristics and specifications of community biodiesel in the appendix.

Table 5 Oil palm: harvested area, production and yield of major countries, 2004 - 2006

	Harvested area (1,000 rai)			Production (1,000 ton)			Yield per rai (kg)		
	2004	2005	2006	2004	2005	2006	2004	2005	2006
World Total	77,132	60,106	63,841	163,669	165,453	165,923	2,122	2,753	2,599
Malaysia	21,313	22,625	22,625	69,881	75,650	75,650	3,279	3,344	3,344
Indonesia	20,750	22,500	25,750	60,426	64,255	64,255	2,912	2,856	2,495
Thailand	1,932	2,026	2,374	5,182	5,003	6,241	2,682	2,469	2,629
Colombia	983	1,060	1,060	3,107	3,273	3,273	3,161	3,088	3,088
Others	32,154	11,895	12,032	25,073	17,272	16,504	n.a.	n.a.	n.a.

Source: Food and Agriculture Organization of the United Nations, data of Thailand from Office of Agricultural Economics

In terms of net energy gain[8], according to the 2006 study on "Appropriateness and net energy ratio of Thailand's oil yielding plants for biodiesel production" by the National Metal and Materials Technology Center, Oil palm is most appropriate because of its highest production, as mentioned above, and the highest net energy ratio of 3.92. Coconut has the second highest production and the second best net energy ratio of 3.85. Soybean, peanut and sunflower seed have the net energy ratios in the same range between 3.2 and 3.6. Castor and sesame have the lowest net energy ratios of 1.99 and 1.51. As a result, the feedstock that the government has planned to promote for biodiesel production is oil palm.

Another potential energy crop for biodiesel production is Jatropha. Jatropha has long been planted mostly in the Northern and Northeastern Thailand. But it is not planted for consumption but planted around the field in order to protect the field from cattle's invasion since Jatropha, especially its fruits and seeds, has poison (Suppapitnarm, 2006). Jatropha is easy-growing and drought-resistant. Besides, according to the study of MTEC, its net energy ratio is 3.74 (Suppapitnarm, 2006). Jatropha is therefore a potential energy crop. However, it is so far a local plant that has not been commercialized; as a result, its yield is still low. Many government units have been conducting researches to increase its yield. Meanwhile, the government is encouraging farmers to plant it around the field as supplementary crops and sell its seeds to the community biodiesel production sites nearby.

[8] Net energy ratio is a ratio of energy output or heating value of that energy crop to energy input or all energy needed in the production processes of that energy crop.

2.2 Biodiesel Promotion Policy

According to biodiesel promotion measures announced on 17 May 2005, use of biodiesel of 8.5 M liter per day is targeted by 2012 in which crude palm oil (CPO) of 2.47 million ton per year is needed. Ministry of Agriculture and Cooperative declared to support feedstock procurement by promoting domestic oil palm cultivation of 4 million rai and 1 million rai for that of neighboring countries.

Then, various policies and measures have been launched to encourage the use of biodiesel and the production of feedstock, roughly summarized as follows.

<u>Demand Encouraging Measures</u>

- Biodiesel for vehicle use
  - Successfully set in 2007, quality standard of B100 for blending in normal diesel partly helping boost consumers' confidence.
  - Setting B2 and B5 prices lower than that of normal diesel by lowering excise tax levied on B5 from 4 baht/liter to 2.1898 baht/liter and lowering money collected for oil fund[9] with a varied rate.
  - Advertisement of biodiesel via various public mediums such TV and radios sponsored by the government agencies
- Community biodiesel for agricultural machine use
  - Quality setting for community biodiesel also successfully carried out in 2006.
  - Disseminating information on community biodiesel to the local people and nearby community via a community biodiesel production sites that are already established in various places.

<u>Supply Supporting Measures</u>

- Biodiesel for vehicle use
  - No direct subsidy to the biodiesel producers but exemption from import duty on machinery and corporate income tax for 8 years (BOI, 2005)
  - Conducting and sponsoring biodiesel R&D activities through various government agencies, for example, a study on possibility in establishing an oil palm-based biodiesel plant in Krabi, and researches on making best use of by-products from biodiesel production.

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[9] Money collected for oil fund always varies depending on the world oil price to help stabilize the domestic price and also varies from fuel to fuel as one of the measures to increase demand for the fuel being promoted.

- Community biodiesel for agricultural machine use
  - DEDE providing a biodiesel conversion machine to 60 communities on the occasion of the 60th Anniversary Celebrations of His Majesty the King Bhumibold Adulyadej's Accession to the Throne in 2006.
  - Conducting and sponsoring community biodiesel R&D activities through a variety of government agencies, for instance, a study on using Jatropha oil to run agricultural engines and a study on improvement in the waste management system of community biodiesel production.

In 2007 the biodiesel action plan was nevertheless revised to meet the slow expansion of oil palm plantation during the past years. Biodiesel utilization target by 2012 has thus been reduced to 3.14 million liter/day, which will need CPO of 0.87 million ton/year. Oil palm plantation is planned to expand 0.5 million rai/year or 2.5 million rai during 2008-2012. In terms of productivity, the government has planned to raise oil palm productivity from 2.7 to 3.3 ton/rai/year, and that of Jatropha from 0.4 to 1.2 ton/rai/year.

As for distribution aspect, starting from a mandate of B2 nationwide use since 1 February 2008, the government has planned to mandate the use of B5 nationwide in 2011. Table 6 summaries the revised biodiesel action plan.

Table 6 Biodiesel Action Plan, as of 2007

<table>
<tr><td rowspan="2"></td><td colspan="2">National standard for vehicle biodiesel and agricultural machine biodiesel</td><td>B5 distribution in some areas</td><td>Nation-wide B2 mandate starting Feb 2008</td><td></td><td></td><td>Nation-wide B5 mandate</td><td></td></tr>
<tr><td>2005</td><td>2006</td><td>2007</td><td>2008*</td><td>2009*</td><td>2010*</td><td>2011*</td><td>2012*</td></tr>
<tr><td rowspan="2">Oil palm plantation expansion (million rai/year)</td><td>–</td><td>–</td><td>–</td><td>0.5</td><td>0.5</td><td>0.5</td><td>0.5</td><td>0.5</td></tr>
<tr><td colspan="3">productivity improvement
Oil palm: 2.7 ->3.3 ton/rai/year
Jatropha: 0.4 ->1.2 ton/rai/year</td><td colspan="5">Oil palm plantation expansion of 2.5 million rai</td></tr>
<tr><td>B100 demand (M liter/day)</td><td>0.0007</td><td>0.0006</td><td>0.13</td><td>1.2</td><td>1.33</td><td>1.38</td><td>3.02</td><td>3.14</td></tr>
<tr><td rowspan="2">B2 & B5 distribution (million liter/day)</td><td>0.015</td><td>0.12</td><td>8.2</td><td>52.0</td><td>57.3</td><td>58.7</td><td>60.3</td><td>62.7</td></tr>
<tr><td colspan="8">← B2 →
← B5 →</td></tr>
<tr><td>CPO demand for B100 production (million ton/year)</td><td>0.0002</td><td>0.002</td><td>0.045</td><td>0.26</td><td>0.29</td><td>0.3</td><td>0.84</td><td>0.87</td></tr>
</table>

Source: Department of Alternative Energy Development and Efficiency (DEDE)

Note: 1. Data with the symbol * is estimated data.

2. Data on oil palm planting area and domestic use during 2008 – 2012 is from the oil palm and palm oil industry development plan of 2008 – 2012.

3. Data on CPO demand for B100 production has been deducted by demand for stearin used for B100 production.

4. B2 & B5 distribution data is collected by Department of Energy Business.

3. Community-based biodiesel production

As mentioned above, "community biodiesel" is biodiesel that is produced and used in the community and only used for simple agricultural machines. Most used feedstock is used cooking oil and Jatropha oil.

We visited the first community biodiesel production site of Thailand, Wat Phayakkharam Temple, or commonly known as Wat Sua Temple, in Suphanburi. The center was first built in 2004 with the idea that Jatropha planted scattered in the neighboring area can be used to produce biodiesel in which it can be used instead of diesel in cars especially pick-ups, the main transport mode of the temple. This will help the temple reduce expenses on fuel, and at the same time it also increases income of people in the community, who sells Jatropha seeds to the temple. As for waste management, Jatropha's shells and the rest after oil extraction are used to make charcoal.

Picture 1 Jatropha's fruits

Picture 2 Jatropha's seeds

Picture 3 Jatropha seed crushing machine **Picture 4 Jatropha oil**

Currently (December 2007) the center buys Jatropha seeds at 14 baht/kg from people in the community. Since there is also Jatropha planted inside the temple area, the center pays for collecting its seeds 1 baht/kg. Jatropha's harvest period is March-April and November-December. Nonetheless, if it is watered enough, it fruits all the year.

Wat Sua Temple also plays role as a biodiesel learning center that people not only from the nearby community but also from over the country come and learn how to produce biodiesel. As a learning center, Wat Sua Temple has also researched on biodiesel made from used cooking oil and other seed oil such as Sunflower, Roselle and Canton.

Picture 5 Roselle **Picture 6 Roselle's seeds**

We visited another place that has a biodiesel conversion machine provided by the Department of Alternative Energy Development and Efficiency (DEDE). In 2006 on the occasion of the 60th Anniversary Celebrations of His Majesty the King Bhumibold Adulyadej's Accession to the Throne, DEDE provided 60 biodiesel conversion machines to government units and the communities around the country. Puphan Royal

Development Study Center[10] in Sakon Nakhon is one of those places. To produce biodiesel for agricultural machines in the center, it asks for used cooking oil for free from people in the community nearby. Otherwise, it buys used cooking oil at 14 baht/liter. With the conversion cost of 4-5 baht/liter, the cost of biodiesel becomes 18 – 19 baht/liter.

Picture 7 Jatropha seed crushing machine

Picture 8 Biodiesel conversion machine

The center also distributes Jatropha seeds to farmers to plant them at the corner of the field. Without much care, it grows easily and the farmers can sell the seeds back to the center at 5 baht/kg. Nonetheless, the use of Jatropha seeds to produce biodiesel causes a high cost; only raw material cost, 5 baht/kg with the need of 4 kg to produce 1 liter of biodiesel, reaches 20 baht/liter excluding a conversion cost.

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10 Among 3,083 royal development projects over the country, there are 6 royal development study centers located in Chiang Mai, Sakon Nakhon, Chachoengsao, Chanthaburi, Phetchaburi, and Narathiwat. These study centers conduct researches and disseminate knowledge on agriculture to people in the nearby area.

Picture 9 Survey areas: community biodiesel production sites in Suphan Buri and Sakon Nakhon, and oil palm-biodiesel complex project areas in Ubon Ratchathani and Nong Khai

Map No. 3853 Rev. 1 UNITED NATIONS
January 2004

Department of Peacekeeping Operations
Cartographic Section

4. Oil Palm – Biodiesel Complex

Dr.ir.Somjate Pratummintra, Senior Expert, Department of Agriculture and Director of Nong Khai Palm Oil Research Office, Nong Khai, Thailand, has been thinking to set up an oil palm planting project that incorporates a biodiesel plant in the same community. This project can serve the community in both job creating and energy supplying at the same time. Besides, he also expects that the project can become the prototype of biofuel production or utilization in the community level; the country has still lacked such a prototype, which is needed as a study model for investors.

Dr.Somjate planned to launch this project in the Northeastern Thailand (NE) where oil palm is not a generally planted crop in the area. This is because he considers that the NE has potential for oil palm plantation in some areas that have enough water resources and the government has also been thinking to expand oil palm planting area in the NE by assigning Nong Khai Palm Oil Research Office under the Department of Agriculture to prepare 1 million seedlings of oil palm to distribute to farmers in the NE. However, farmers hesitated to take part in the project; as a result, almost 900,000 seedlings have still been left. He now as a director of the office would like to continue the seedling growing project. Besides, the NE is the poorest region in Thailand so he thinks the project can partly contribute to the improvement of the NE people's quality of life by creating jobs and supplying cheaper energy to the region.

Until recently oil palm had been planted only in the South, East and West of Thailand. There was no plantation in the Central, Northern and Northeastern regions. This is because oil palm needs lots of water and moist in every growing step. Drought or water stress and water deficit in the soil will directly affect its physical growth and in turn results in low production. Due to proper climate of the Southern region, most plantations have been practiced in Krabi, Surat Thani, Chumporn, Satul and Trang.

Nevertheless, recently some farmers in the NE are interested in and have tried to plant palm oil since they have seen some other farmers planting Para rubber, which is not originally a typical plant in the NE either, for years and recently planting oil palm. Also, some farmers have started planting oil palm because they previously worked in the oil palm fields in the South. When they came back home in the NE, they came up with the idea to plant oil palm at home since the experience telling them that planting oil palm might need more investment in both seedlings and water expenses but use less labor, one of the main cost of agriculture in Thailand lately.

According to a survey by Dr.Somjate and his team, he found some areas, for example, Huai Mong irrigation area having already had infrastructure for both irrigation and transport systems. But agricultural production in the area does not pay off because most farmers choose to produce rice in which low production is a main problem due to sandy loam with low water retention. After a field study was conducted, it is found that this land has a potential to plant oil palm.

It is a research project being conducted with the budget of Department of Agriculture. Its designated areas, basic principles, project scale and project period are as follows.

Project's Designated Area

Nong Khai: 1. Huai Mong Irrigation Area, Tha Boa, Pho Tak, and Sri Chiang Mai Districts.
2. Seka, Sophisai, Phonphisai and Pak Khat Districts

Ubon Ratchathani 1. Sirinthorn Dam-surrounded land reform project
2. Nam Khun, Nam Yun, Boontharik, Najaruai, Phiboonmangsaharn Districts (southern area in Ubon Ratchathani)

Basic principles of the project

(1) Lending seedling and letting farmers pay back in form of fresh palm, 10% of production per time, totally not more than 500 kg/rai with the insured price of 2.5 baht/kg[11], starting from the beginning of the 4th year after starting plantation and must finish paying back in 4 years.
(2) Encouraging farmers to establish a biodiesel factory themselves by using the number of rai farmers possess as the number of share.
(3) Reducing energy used in the whole system
    - No tillage is needed because oil palm has big roots, which do not snatch breath from grass. Just grass cutting is enough. This also helps reduce soil erosion, one of severe problems in the NE.
    - Use of palm planted nearby the factory reduces energy for transport.
    - Palm cluster stem left can be used to generate electricity.
    - Sewage from biodiesel production can be used to produce biogas. Waste

[11] The insured price of 2.5 baht/kg was set when he submitted the project proposal in 2006. But the price of fresh oil palm has risen since 2007 up to 5.6 baht/kg (in case of more than 15 kg a bunch) in January-February 2008 (Office of Agricultural Economics). The writer believes he must adjust the insured price to chase the recent roaring price of oil palm.

still left from biogas production can be used as fertilizer in palm fields.

(4) Encouraging self production and consumption in the same community

The project does not encourage only palm plantation in one field. For example, if a farmer has 15 rai, he can use 13 rai for palm plantation and use the left 2 rai for fish or chicken rising, according to Majesty the King's integrated agriculture or alternative agriculture.

In the same community, everyone does not have to plant palm. Rice farmers sell rice to palm farmers and buy biodiesel from the plant that palm farmers owns shares.

Project Scale

The biodiesel (B100) plant capacity of 100,000 liter/day needs crude palm oil (CPO) of 100 ton/day. This calculation is based on the 24-hour operating plant that can process CPO at 4 ton/hr. CPO of 100 ton/day requires palm of 480 tons/day (20% of palm is extracted as CPO.), accounting for palm plantation of 160 rai/day with the productivity of 3 tons/rai/year, or 60,000 rai/year.

Fresh palm is normally bought at 3 baht/kg when it contains oil 18% on average. Thus, if farmers can increase oil percentage in fresh palm to 20%, they can receive an increment of not less than 0.20 baht/kg.

More than 10,000 rai has been planted in Nong Khai and Ubon. Targets were set at 3 planting units, each unit containing 60,000 rai, totally 180,000 rai. One unit has an area within a 50 km radius from the biodiesel factory so that it does not need long-distance transport.

Project Period

5 years and 4 months (from June 2007 to September 2012)

Project's Current Situation

When the research team visited the project's designated sites with Dr.Somjate, it was just 6 months after the project started. Of course, a biodiesel plant had not been built. What we could do was to visit potential oil palm planting areas in Ubon Ratchathani and Nong Khai; as well as, a seedling raising place at Nong Khai Palm Oil Research Office, Nong Khai.

For potential oil palm planting areas, we visited farmers who have started planting oil palm on their own interest and are therefore the targets for Dr.Somjate's project. One farmer started to plant Para rubber in 1992-1993 and now has started planting oil palm. He said at the first place he heard many people said that planting palm in the Northeast would not yield any fruits. But he finally planted it. He now has 30 rais of Para rubber and 67 rais of oil palm; while reserving a small area for planting rice for self consumption. He used to plant rice and cassava. But since a continued drop in rice and cassava prices, he decided to change to plant Para rubber. Plus, he said recently he had heard about oil palm and biodiesel by His Majesty the King's speech. He became interested in it and started planting it.

Picture 10 Oil palm planted by a farmer in Ubon Ratchathani

Picture 11 and Picture 12 Oil palm planted by another farmer in Ubon Ratchathani

Another farmer previously worked in the South of Thailand and saw oil palm plantation. He had had an idea to plant oil palm for a long time but had not started because there were no processing plants such as a palm oil mill or a palm oil refinery. Five or six years ago he asked his friends to plant oil palm and harvest palm fruits at the same time so that they can transport the fruits together to a processing plant in Chon Buri in the Eastern region of Thailand. So far there were no diseases affecting oil palm. One major enemy is a rat that will bit the trunk of oil palm when it is still small. Once it grows, cows can be left to freely walk in the field. Cows' droppings are good fertilizer for oil palm.

Furthermore, we also visited Ubon Ratchathani Field Crop Research Center, where many oil palm strains have been researched if they are proper to the NE's soil and weather. Among Surat Thai from 1 to 6 strains, Surat Thani 2 is most recommended because of best drought-resistant. Oil palm planted in the center's area in 2004-2005 does not really grow well because of lacking underground water. Best soil condition for oil palm is sandy loam that has 1-meter deep underground water. Staff there found that many areas in Ubon Ratchathani when they were first seen did not seem appropriate to oil palm plantation. But after they checked underground water, they found that those areas had enough underground water for oil palm's growth.

Picture 13 Surat Thani 2 hybrid planted at 23 June 2004, Ubon Ratchathani Field Crop Research Center

On the way we moved to Nong Khai, we dropped at Sakon Nakhon, not only to visit Puphan Royal Development Study Center where is one of the community biodiesel production sites as mentioned earlier but also to visit a large-scale farmer, who raises oil palm seedlings and lend them to other interested farmers. She lends seedlings with the cost of 80 baht/seedling and asks borrowers to return the fruits, not money, to her after the oil palm tree bears fruits (usually the forth year). The borrowers can choose freely to return between 10% and 20% of the output each year. She has planned to establish a palm oil refinery, not a biodiesel plant. She said the government's policy on biodiesel had not been stable; therefore, she chose to build an oil refinery in which palm oil had already had a firm market. She said she was interested in the biodiesel plant, though.

At Nong Khai Palm Oil Research Office, oil palm seedling raising and researches are conducted. The strain that Dr.Somjate considers appropriate to Northeastern areas is Surat Thani 2 hybrid (*Deli Dura x La Me*). Its average production is 3.62 ton/rai/year with oil percentage of 23 percent. It has long cluster stem, average cluster weight of 17.4 kg., black unripe fruit, black-orange-red ripe fruit, thick shell and thick meat. Its limitations are small cluster and low cluster weight.

The temperature conducive to oil palm's growth is 24-30°c. The average annual lowest temperature should not lower than 20°c and that of highest temperature should not higher than 33°c. An average temperature of the Southern region of Thailand is between 23°c and 29°c. Nevertheless, for oil palm plantation in the NE such as Nong Khai, which has an average annual temperature of 21.7-29.2°c but has lower temperature in some months, this might slightly affect oil palm production. Furthermore, oil palm is usually not salt-resistant and needs a lot of water for growth.

Nevertheless, Dr.Somjate has thought that a plant usually adapts itself to a new environment. Thus, an oil palm strain originally from the Southern area may adapt itself to the Northeastern area more than we think.

Picture 14 Oil palm seedling raising

A good seedling is 8 -12 months old (planting from seeds) and has 7 stems with the trunk's circumference of 4 -5 cm. The seedling cost in the South is 35 baht/seedling but when it is raised in North East it becomes 37 baht/seedling. The market price of a seedling is 50 baht when buying from a government unit and 40 - 300 baht when buying from a private enterprise.

As for gathering people who are interested in the project, Dr.Somjate's team has those interested people fill in the application form that requiring information such as their own field's size and conditions, number of household labor or wage labor, water source, financial source, for instance. The problem of his project in this first step is that farmers do not easily join the project with a reason that a biodiesel plant has not been built. For farmers, basically if there are no processing plants or no market for the crops in question yet, they hesitate to invest in planting those crops.

After talking to Dr.Somjate, even though building a biodiesel plant has not concretely planned, potential areas to establish a biodiesel plant would probably be Phonphisai district in Nong Khai and another place in Ubon Ratchathani.

5. Conclusion

This paper explored an only part of the current biodiesel development in Thailand in which feedstock procurement is facing the problem of limited supply; therefore, oil palm cultivation has been planned to expand in the Northeastern Thailand. Furthermore, community biodiesel, which is based on the concept of self production and self consumption of energy in one's own community, has just started and still needs a long way to go.

Nevertheless, in some aspects biofuels such as biodiesel might cause environment problems, which arise in the cultivation and transport processes. Furthermore, a remarkable phenomenon of skyrocketing cereal prices around the world in recent years in which biofuels are alleged to be the main cause has also happened in Thailand. In case of biodiesel, oil palm's producer price (more than 15 kg a bunch) increased from 2.39 baht/kg in 2006 to 4.07 in 2007, accounting for 70% increase. Likewise, only during the first two months of 2008 the price has risen to 5.60 baht/kg (OAE, 2008).

Biodiesel and its feedstock development in Thailand need some more time and efforts from both public and private sectors not only to penetrate the market but also to find the way that energy, environment and economy can develop together under the concept of sustainability.

6. Appendix

Notification of Department of Energy Business

Characteristics and Specifications of Fatty Acid Methyl Ester

(FAME)-Typed Biodiesel of 2007

	Item	Unit	Low or High Value		Testing Method*
1.	Methyl Ester	%wt.	No less than	96.5	EN 14103
2.	Density at 15°c	kg/m^3	No less than and no more than	860 900	ASTM D 1298
3.	Viscosity at 40°c	cSt	No less than and no more than	3.5 5	ASTM D 445
4.	Flash Point	°c	No less than	120	ASTM D 93
5.	Sulphur	%wt.	No more than	0.0010	ASTM D 2622
6.	Carbon Residue, on 10% distillation residue	%wt.	No more than	0.30	ASTM D 4530
7.	Cetane Number		No less than	51	ASTM D 613
8.	Sulphated Ash	%wt.	No more than	0.02	ASTM D 874
9.	Water	%wt.	No more than	0.050	EN ISO 12937
10.	Total Contaminate	%wt.	No more than	0.0024	EN 12662
11.	Copper Strip Corrosion	%wt.	No more than	No.1	ASTM D 130
12.	Oxidation Stability at 100°c	hours	No less than	6	EN 14112
13.	Acid Value	mg KOH/g	No more than	0.50	ASTM D 664
14.	Iodine Value	g Iodine/100g	No more than	120	EN 14111
15.	Linolenic Acid Methyl Ester	%wt.	No more than	12.0	EN 14103
16.	Methanol	%wt.	No more than	0.20	EN 14110
17.	Monoglyceride	%wt.	No more than	0.80	EN 14105
18.	Diglyceride	%wt.	No more than	0.20	EN 14105
19.	Triglyceride	%wt.	No more than	0.20	EN 14105
20.	Free glycerin	%wt.	No more than	0.02	EN 14105
21.	Total glycerin	%wt.	No more than	0.25	EN 14105
22.	Group I metals (Na+K)	mg/kg	No more than	5.0	EN 14108 and EN 14109
	Group II metals (Ca+Mg)	mg/kg	No more than	5.0	pr En 14538
23.	Phosphorus	%wt.	No more than	0.0010	ASTM D 4951
24.	Additive (if any)		To follow the permission of Director-General of the Department of Energy Business		

Note: * The testing method can be other equivalent methods. In case an argument occurs the specified methods are therefore used.

Notification of Department of Energy Business
Characteristics and Specifications of Biodiesel for Agricultural Engines
(Commodity Biodiesel) of 2006

	Item	Unit	Low or High Value		Testing Method*
1.	Density at 15°c	kg/m^3	No less than and no more than	860 900	ASTM D 1298
2.	Viscosity at 40°c	cSt	No less than and no more than	1.9 8	ASTM D 445
3.	Flash Point	°c	No less than	120	ASTM D 93
4.	Sulphur	%wt.	No more than	0.0015	ASTM D 2622
5.	Cetane Number		No less than	47	ASTM D 613
6.	Sulphated Ash	%wt.	No more than	0.02	ASTM D 874
7.	Water and Sediment	%vol.	No more than	0.2	ASTM D 2709
8.	Copper Strip Corrosion		No more than	No.3	ASTM D 130
9.	Acid Value	mg KOH/g	No more than	0.80	ASTM D 664
10.	Free glycerin	%wt.	No more than	0.02	ASTM D 6584
11.	Total glycerin	%wt.	No more than	1.5	ASTM D 6584
12.	Colour			purple**	Test by eyes
13.	Additive (if any)		To follow the permission of Director-General of the Department of Energy Business		

Note: * The testing method can be other equivalent methods. In case an argument occurs the specified methods are therefore used.

** Using compounds such as 1,4-dialkylamino anthraquinone and alkyl derivatives of azobenzene-4-azo-2-naphthol

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