Feasibility Study on CDM/JI Project in 2003

Research of Biodiesel production project based on Sunflower as a resource crop in Thailand

-Summary-

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Abstract

1. General objectives

This project aims to produce biodiesel (BDF) from sunflower oil. Sunflower as a resource crop will be cultivated by contracted farmhouse in Loei province, the northeast of Thailand. The produced biodiesel will be sold to contracted gas station and transportation company as an alternative to petroleum diesel fuel. This will eventually lead to lower petroleum diesel fuel consumption and reduced greenhouse gases (GHG) emission.

This report summarizes the feasibility study of the project stated above as an alternative strategy in accordance to CDM.

2. Background

Planning and evaluation of the project was started with preliminary assessment of the site considering the agriculture, energy consumption and climatic changes of Thailand.

Agriculture

Agriculture is one of major industry supporting Thailand's economy. Half of the work force is engage in agriculture. Rice is Thailand's major produce and its export alone amounts to 30% of the world's rice production.

The central field region in Thailand is a grain belt of advanced irrigation. In southern region, primarily natural rubber and palm have been cultivated. On the other hand, in northern and northeastern region, agriculture is not favorable due to poor water resource and soil erosion. Hence, the productivity and income from agricultural sector have been relatively poor in these regions. In spite of this, agriculture remains to be the leading industry.

The agricultural policy is very important for national economic growth. In the Ninth National Economic and Social Plan (2002 ~ 2006), Prime Minister Thakshin Shinawatra of Thailand instituted the "One Village, One Product" policy encouraging the local sectors to improve the quality and productivity of their own agricultural produce to create new job opportunities. With this mandate from the Prime Minister, our strategy is not only in accordance with the CDM policy but also with the present trust of Thailand's agricultural sector.

Energy

Because of the rapid industrial development in Thailand, the country's energy consumption has been increasing. Thailand has to rely the 90% of the country's petroleum supply and more than 60% total energy consumption overseas. On the other hand, more than 75% of the country's natural gas supply is produced locally.

Diesel fuel used in transportation constitutes the 45% of the total refined crude oil in Thailand. This amount contributes 80% of the transportation fuel of the country because of the significantly higher popularity of diesel fuel running vehicles compared to gasoline. Moreover, 90% of energy used in agricultural sector is petroleum diesel.

Natural gas is a major domestic energy in Thailand. To decrease the dependence on energy import, the government recommends enhancement of natural gas consumption. This has been used mainly for generation of electricity, and more than 60% of fuels for electricity generation are dependent on natural gas.

The renewable energy has been used for commercial and industry. In 2002, energy from renewable resources attained almost 20% of the final energy consumption, which mainly come from wood, bagasse and rice husks.

For sustainable development, it is essential that energy is available in reasonable and competitive price without sacrificing the environment. In the Ninth National Economic and Social Plan (2002 ~ 2006), utilization of renewable resources for a more efficient, economical and stable energy supply was mandated. The policy aims to increase the share from renewable energy from 0.5% to 8% by the year 2011.

Climate changes

Thailand ratified the United Nations Framework Convention on Climate Change (UNFCCC) in December 1994, and the Convention became effective to Thailand in March 1995. Initial National Communication was submitted to UNFCCC in November 2000. The initial communication covers the 1994 inventory of GHG. Thailand also signed the Kyoto Protocol (KP) in February 1999, and ratified it in August 2002. Thailand is under the non Annex-I countries and is entitled to host the Clean Development Mechanism (CDM). Thailand has completed its national strategy study on CDM and is now in the process of CDM institutional development.

The total GHG emissions of Thailand during 1990 and 1998 had increased. The energy supply sector especially accounted for more than half of the country's GHG emissions. On the other hand, GHG emissions from forestry and land use changes declined, and they accounted for only 20% in 1998.

In the energy sector, one-third each of CO_2 emissions is from energy supply (mainly power plants) and transportation. About 20% of total emission was generated by industry, mining and construction sectors. The remaining small proportions were from other sectors (commercial, residential and agriculture).

Thailand is a developing country in the tropical region, and is highly vulnerable to the impacts of climate change. Since more than half of its populations rely mainly on agriculture, climate change will likely to have serious impacts on the livelihood of the majority of the people. The act on climate changes addressed the following: improvement of energy efficiency, development of alternative and

renewable energy, improvement of transportation, and the expansion of forest areas.

CDM policy in Thailand

Thai government adopted the principles of CDM in January 2003. Several points that were given careful consideration in accordance to CDM are as follows:

- Sustainable development.
- Real and genuine transfer of technology.
- The strategy should offer a competitive and reasonable commodity.

Furthermore, there are areas that need more attention to ensure sustainable development:

- Identify specific areas where sustainable renewable energy development can be utilized.
- Jointly develop the activities of projects to accommodate such needs.
- Develop a monitoring system, among those required by KP, to ensure such objectives are met.

CDM option analysis highlights the types of mitigation options that are likely to be successful CDM project, based on a number of indicators, including sustainable development priorities, institutional difficulties, unit costs, international demand and attractiveness to investors. CDM option in Thailand suggests that energy sector is the most feasible sector in terms of economic and other sustainable development conditions especially now that the national energy policy has recognized the importance of renewable energy and has emphasized its development over the next decade. CDM could contribute to renewable energy development in Thailand.

The sunflower cultivation

Sunflower is one of the crops incorporated by Thai government for diversification of agriculture in 8 provinces of the central and northern region. The cultivation of sunflower is done from September to January, and in another season beans and corn are cultivated as double- or triple-cropping.

The sunflower cultivated in Thailand is hybrid species. The harvested seeds are normally used for food and oils. At present, Thailand is importing huge amount of sunflower oil from the US and Argentina, which is mainly used in canned seafood industry.

In 1975, PACIFIC SEEDS (THAI) LTD. initiated the test cultivation of sunflower oil in Lopburi and Saraburi provinces. They were able to expand the cultivation area under the collaboration with Ministry of Agriculture and Cooperative, Thailand. To promote the cultivation of sunflower, PACIFIC SEEDS used the strategy that they make a contract with every farmer and agriculture research centers, buy all harvested seeds, and guarantee farmers' income. This strategy made sunflower fields 100,000 ha around Lopburi and Saraburi provinces. Sunflower became a big tourist attraction in both provinces with peak season from November to December when tourists enjoy hectares of full bloom sunflower. This tourist attraction earns about 1 billion baths and alleviates farmers' of life.

The price of seeds and income of farmers are shown in table below:

Selling price of seed to farmer	220 ~ 260 Baht/kg
minimum price of seed from farmer	8.5 Baht/kg
average yield of seed after cultivation of 1 kg seed	200 kg
yield of seed per 1 ha	0.65 ~ 1.5 t/ha
average field area per one farmhouse	4 ha
average yield per one farmhouse from sunflower cultivation	30,000 Baht/ha/year

The biodiesel research

Biodiesel research started as a royal project in November 2000 and since then biodiesel started to gain more attention. In Thailand, methyl- and ethyl esters of long chain fatty acids are referred to as "biofuel" (this term is synonymous to BDF in this project) while the term "biodiesel" is used to refer mixtures of vegetable oil or ethanol and petroleum diesel.

In 2001, King Bhumibol submitted a patent about palm diesel, a mixture of petroleum diesel and palm oil. Its fuel properties and production technology have been investigated. This marks the beginning of palm oil-based biodiesel in Thailand. However, major problems encountered in filter and engine performance prevented public acceptance of the technology. In May 2003, the Ministry of Energy in cooperation with Thailand Navy, allotted 400 million Baht for feasibility study of biodiesel for possible utilization in naval base. The Ministry of Agriculture and Cooperative also issued their plan of increasing palm oil production to more than 2 times by 2007, and expect to increase the production of alternative fuel. Thai government expresses their continuous study of biodiesel.

Biofuel has been thought of being more effective than biodiesel because of its better fuel properties. However, high production cost prevents its marketing. Public acceptance therefore still lies on improved production method and lower selling price.

3. Project plan

Outline

Sunflower was chosen because of other venture opportunities it offers. According to **"Bio Refinery"** strategy, not only BDF but also honey (biologically active substance), pulp, feeds and fertilizer will be produced from sunflower. Such a lot of commercial products can make each selling price lower by multiplier effect.

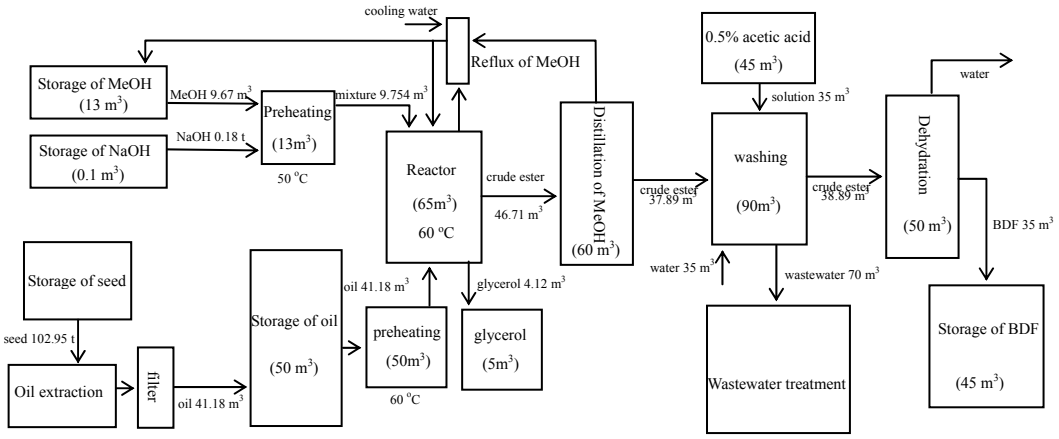
Drafting of the project

The production of biodiesel

The BDF production in this project is based on transesterification process in EU and USA. The production process is shown below:

seed → oil extraction → transesterification → separation of glycerol → washing → dehydration → BDF

The plant is planed to have 35 m^3/day of production capacity. The operation days are 22 days/month, 264 days/year, with annual production of 9,240 m^3 of BDF. The production plant is outlined below:

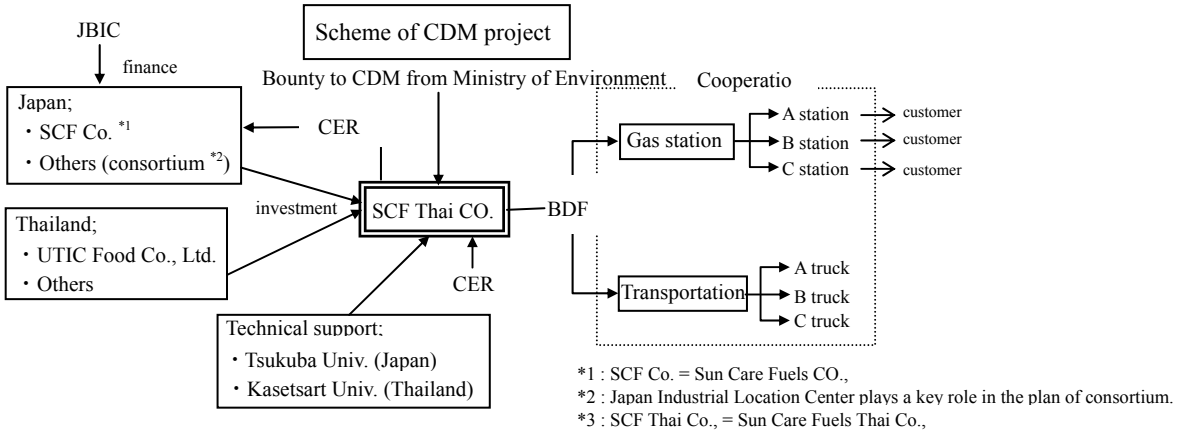


The flow of BDF production plant

This production process is relatively simple that technology transfer could be realized in such a short time with low production cost. With this viewpoint, the technology therefore appears to be very suitable in Thailand.

The system of project enforcement

"Sun Care Fuels, Thailand Co.", a corporation invested by Japan and Thailand, will be established. The company will benefit from recent development in biodiesel research conducted in Japan. The produced BDF will be supplied to contracted gas stations and transportation companies.



Economics

The first year of this project shall focus on the establishment of company, design and

construction of plant, continuous study and preparation of PDD. The Japanese group shall provide the plant design while the Thai group, under the Japanese group guidance, shall be in-charge of the plant construction. The plant operation is planned to commence on the following year (2006).

The test calculation of income and expenditure is summarized below. The cost of plant construction is estimated to be ¥101.15 M. The proceeds include the income not only from BDF production but also from glycerol and fertilizer.

(thousands yen)

	2005	2006	2007	2008	2009
Sales	0	927,135	1,001,306	1,081,410	1,167,923
sales margin	0	893,775	965,277	1,042,499	1,125,899
sales gross profit	0	33,360	36,029	38,911	42,024
cost of selling • general adominstrative expenses	20,000	20,000	21,400	22,898	24,501
operating income	-20,000	13,360	14,629	16,013	17,523
non-operating proceeds		0	0	0	0
non-operating expense		100,000	0	0	0
ordinary profit	-20,000	-88,640	14,629	16,013	17,523
extraordinary profit					
extraordinary loss					
current income before taxes	-20,000	-88,640	14,629	16,013	17,523
Corporation tax • residence tax					
current income after taxes	-20,000	-88,640	14,629	16,013	17,523

Sun Care Fuels Co., a venture company of the University of Tsukuba, Japan established in May 2004, shall provide the necessary investment for SCF Thai Co. Japan Industrial Location Center is preparing the establishment of consortium with companies interested in CER, and this consortium will also invest to SCF Thai Co. The investment from Thailand will be done by UTIC Food Co., Ltd., our counterpart in Thailand, and others. The expenses incurred by plant construction will be deducted from the initial capital and partly financed by the Japan Bank for International Cooperation (JBIC) under its overseas and investment and enterprise program.

The test calculation of income and expenditure of capital for the first 5 years are shown below:

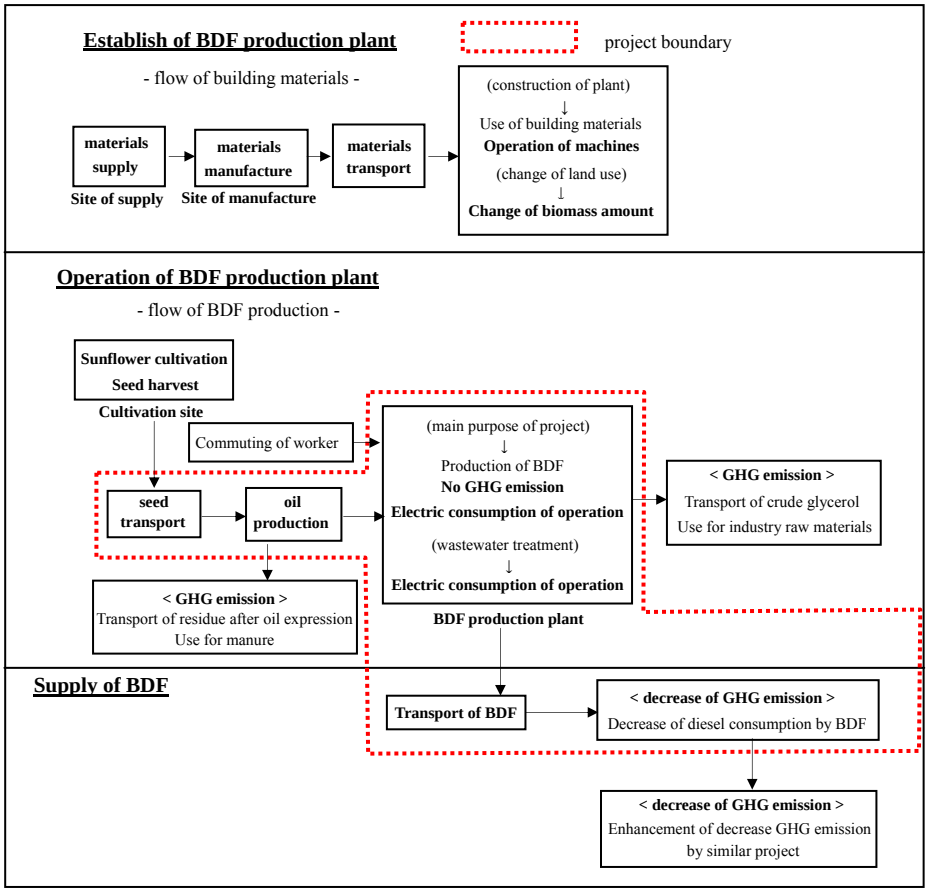
	2005	2006	2007	2008	2009
Depreciation expenses					
cash flow	9,000	9,000	9,000	9,000	9,000
long- • short-term loan	-11,000	-77,640	23,629	25,013	26.523
payment of principal loan		13,000	12,700	12,400	12,100
dividend to stockholders	0	0	0	0	0
net cash flow	119,000	-90,640	10,929	12,613	14,423

4. The evaluation of project

The project was introduced to Dr. Asadaporn Krairapanond and Dr. Vute Wangwacharakul, both CDM experts in Thailand. The experts welcomed the project and both agreed that this would contribute to sustainable development. The evaluation of this project is further explained below:

The project boundary

The following project boundary was set up.



Baseline scenario

BDF can be utilized as an alternative to petroleum diesel and could contribute in reducing the GHG emission. Therefore the baseline is the amount of petroleum diesel that would be substituted by BDF produced by this project in Thailand.

The baseline could be estimated by considering the differences in fuel consumption and combustion efficiency between BDF and petroleum diesel. In this project, the following assumptions were adopted; fuel consumption is proportional to calorific values of BDF and petroleum diesel, and combustion efficiency is almost equal.

At first, the amount of petroleum diesel equivalent to 1 m^3 of BDF was determined. Calculation using calorific values and densities of BDF and petroleum diesel showed that the energy content of 1 m^3 BDF is equal to that of 0.889 m^3 (0.776 t) petroleum diesel.

Carbon credit shall be acquired for 8 years starting from the first year BDF is produced. From the sunflower cultivation areas and BDF production volume during these 8 years, the baseline CO_2 emission from substituted petroleum diesel volume was estimated. The CO_2 emission from diesel was calculated according to IPCC guideline.

	BDF production [t/year]	substituted diesel [t/year]	baseline CO_2 emission [t-CO_2/year]
2006	8,811	7,832	24,884
2007	9,516	8,459	26,875
2008	10,277	9,135	29,025
2009	11,099	9,866	31,347
2010	11,987	10,655	33,854
2011	12,946	11,508	36,563
2012	13,982	12,428	39,488
2013	15,101	13,423	42,647
Total			264,681

Monitoring

BDF consumption

The produced BDF will be sold to contracted gas stations and transportation company.
The total BDF consumption will be monitored based on the BDF volume to be sold from the production plant and BDF volume to be purchased or utilized by contracted business partner.
We believe however that different engine types exhibit different consumption and combustion efficiency and therefore also emit CO_2 at varying levels. Nevertheless, estimation of CO_2 emission from the use of BDF is very important but beyond the scope of the present study. In the future, a CDM expert, who will be in-charge in this aspect, will be invited to join our group.

The quantity consumed methanol and electricity in BDF production plant

Monitoring of the electricity used to power the BDF plant will be done. Methanol material balance will be determined. The unreacted methanol will be recovered and reuse. The CO_2 emission contributed by burning the methanol incorporated in BDF during production will be calculated based on the amount of reacted methanol and will be deducted from the total GHG reductions.

The calculation of GHG reductions

The amount of CO_2 reduction contributed by the present project permits for carbon credit and will be estimated considering the CO_2 baseline calculations.

The raw materials for BDF production are sunflower oil and methanol. According to IPCC guidelines, combustion of material from plant origin has a zero net CO_2 emission. On the other hand, the burning of methanol incorporated in the BDF molecules contributes to CO_2 emission. In the whole operation, other factors that would contribute to CO_2 emission include the electricity to be consumed during plant operation, the transportation of sunflower seeds and BDF and inside project boundary. All these factors will be deducted from the total GHG reductions.

The amount of C from methanol is about 2.963 mol in 1 m^3 of BDF and CO_2 emission from its combustion was calculated to be 0.130 [t-CO_2]. The electricity used for the production of 1 m^3 BDF

is 400 kWh and would account to 0.178 [t-CO_2]. The average distance to transport the seed to BDF production plant is about 20 km using a truck with carrying capacity of 15t. At present, the distance for BDF transportation is not yet determined.

The CO_2 emission inside boundary was calculated from the target seed yield and BDF production volume and is shown in the following table.

Factors considered in the case of CO_2 emission outside boundary include the change of biomass amount by cultivation of sunflower, the fuel consumption by tractor, harvest of seed, and transportation of residue after oil extraction and crude glycerol. Since an idle farmland will be utilized to cultivate sunflower oil, the effect of change in biomass generated is not investigated. The harvest of seed will be done manually and therefore does not require any fuel. On the other hand, the use of tractor in cultivation and transportation of residue after oil extraction is estimated to contribute 30 – 150 [t/year] each, which is still much lower compared to the GHG reduction in this project. This imparts insignificant effect and is considered outside boundary. The transportation of crude glycerol is remained a subject of future investigation. We believe that all activities that would be generated by this project offer no possibility of leakage.

The CO_2 emission from this project, which is equal to one inside boundary and the contribution in GHG reduction, would be tantamount to the deduction values of CO_2 emission estimated from baseline CO_2 emission calculations.

	baseline CO_2 emission [t- CO_2/year]	CO_2 emission from methanol combustion [t- CO_2/year]	CO_2 emission from electricity [t- CO_2/year]	CO_2 emission from seed transportation [t- CO_2/year]	GHG reduction [t- CO_2/year]
2006	24,884	1,312	1,797	53	21,722
2007	26,875	1,417	1,940	57	23,460
2008	29,025	1,530	2,095	62	25,337
2009	31,347	1,653	2,263	67	27,364
2010	33,854	1,785	2,444	72	29,553
2011	36,563	1,928	2,640	78	31,917
2012	39,488	2,082	2,851	84	34,370
2013	42,647	2,249	3,079	91	37,228

Comments from experts

In a personal interview, experts have expressed their strong interest in this project.

From Dr. Manoom Pumklom, director of Nahkon Sawan Field Crops Research Center:

"BDF production from sunflower oil will make demand of sunflower higher. The plan of producing many by-products as resource crops will make the income of farmers higher, and farmers can learn cultivation techniques for higher yield. So this project will be welcome."

From Petroleum Authority of Thailand (PTT) staff:

"The establishment of BDF production is welcome. Especially, this project has

new technique and possibility of new fuel, and is very interesting."

PTT has produced palm diesel, and offered technical collaboration with us.

The environmental effect and indirect effect

The environmental impact

Air pollution by exhaust gas has become a serious problem in Thailand as a result of significant increase in number of vehicles throughout the country. The use of BDF as an alternative to petroleum diesel would contribute in mitigating this problem since studies have proven that the use BDF decreases the amount of suspended particulate material, polycyclic aromatic hydrocarbon, CO and SOx in exhaust gas.

The indirect effect

The cultivation of sunflower and the BDF production is expected to generate new industries that would alleviate farmers' economy.

5. Conclusion

Sunflower will be cultivated in northeastern part of Thailand for biodiesel production based on transesterification process. The project is expected to create new job opportunities especially for Laos refugees who expressed strong interest in the project.

The use of virgin oil may impart high production cost. However, low cost of land lease and labor are expected to minimize such problem to some extent. Furthermore, our concept of "Bio Refinery", producing many by-products from sunflower such as honey, pulp, herb medicine, feed, and raw material of biodegradable plastic, would enable us to commercialize biodiesel at reasonable and competitive price.

BDF production could be an alternative CDM strategy that would contribute to GHG reduction and in solving the current air pollution problem in Thailand.

This feasibility study still requires a number of further investigation and evaluation. Next year, Dr. Matsuo Naoki of Climate Experts and another expert in PDD drafting will join our group. Moreover, collaboration with partner company in Thailand has been started and test cultivation of sunflower will be initiated. Finally, with our strong cooperation with Thai government, we believe that they will endorse this project as another CDM strategy in Thailand.