Chapter 7

Current Status of Biodiesel Fuel in East-Asia and ASEAN countries

Benchmarking of Biodiesel Fuel Standardization in East Asia Working Group

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7. CURRENT STATUS OF BIODIESEL FUEL IN EAST-ASIA AND ASEAN COUNTRIES

7.1 Australia

7.1.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

Alternative fuels are expected to play a small but important role in supplementing Australia's fuel supply. Currently, biofuels (ethanol and biodiesel) rank as the second most widely available alternative fuel in Australia after Liquefied Petroleum Gas (LPG). In developing the Government's policy for biofuels the Prime Minister requested that the Ministers for Resources, Energy and Tourism and Agriculture, Fisheries and Forestry conduct a review of existing Australian biofuels policies. The review, will assess the current state of play in the Australian and global biofuels industry, examine the existing support mechanisms and outlook for the Australian biofuels industry and will be used to inform future policy decisions. The Government is currently considering the outcomes of this review.

(2) Targets/strategies/regulations/incentives for BDF

The Australian Government does not support the mandating of the use of particular levels of biofuels in the fuel mix. Instead it believes in allowing individual consumers to make a choice regarding the fuel mix which best meets their individual preferences and needs.

The key component of the Government's support for non-fossil fuels is the concessionary excise regime. To encourage their wider uptake alternative fuels, including biodiesel, are effectively excise free until 1 July 2011. From 1 July 2011, effective excise will be phased in progressively until 2015 after which time these alternative fuels will have an ongoing 50 per cent excise discount compared to fuels with the same energy content. This will equate to 19.1 cents per litre for biodiesel (based on current excise of 38.143 cents per litre on diesel).

Energy Grants (Cleaner Fuels) Scheme

The Energy Grants (Cleaner Fuels) Scheme (EGCFS) provides a 38.143cpl subsidy for the production or importation of biodiesel until 30 June 2011. The grant offsets the excise or customs duty payable on biodiesel meaning the net effective excise for biodiesel is zero. From 1 July 2011, the fuel tax rate on biodiesel will progressively increase to 50 per cent of the initial subsidy in 2015.

Biofuels Capital Grants Program

The Biofuels Capital Grants program offered competitive grants from $800,000

to $10 million to fund one-off capital projects that provided new or expanded biofuels production capacity. The grants provided assistance for the construction of new or additional plants at a rate of 16 cents per litre of installed capacity. Four biodiesel plants were initially offered funding under the program. While the program closed in 2004, the Government still has contractual commitments with recipients.

Energy Grants Credit Scheme

Non-fossil fuels used on road in heavy vehicles are eligible for grants under the Energy Grants Credit Scheme (EGCS), subject to certain restrictions. These grants are being phased out between 1 July 2006 and 30 June 2010.

Biofuels mandates

The Australian Government does not support the mandating of the use of particular levels of biofuels in the fuel mix. Instead it believes in allowing individual consumers to make a choice regarding the fuel mix which best meets their individual preferences and needs.

On 6 December 2008, the New South Wales (NSW) Government announced that it would introduce a 2 per cent (B2) biodiesel mandate. It is expected that this mandate will come into effect in January 2010. Based on the current consumption of diesel transport fuel in NSW (4,000ML p.a.) a B2 mandate would equate to 80ML of biodiesel. This is approximately the current amount of biodiesel produced nationally. The NSW Government has indicated an increase to 5 per cent (B5) as supply is available. This would equate to 200ML of biodiesel based on 2009 consumption data. Sustainability criteria are also being included as a requirement and, at this stage, it is expected that they will align with the criteria of the Roundtable on Sustainable Biofuels (RSB).

The Australian biofuels industry

The Australian biofuels (ethanol and biodiesel) industry is, by international standards, a relatively small and immature sector, accounting for just 0.5 per cent of combined petrol and diesel use in Australia. The industry currently uses existing and proven technologies to produce first generation biodiesel. Australia's biodiesel is mainly produced from processed waste (primarily used cooking oil) and tallow.

Biodiesel and diesel/biodiesel blended fuels can be purchased at only a small percentage of Australia's retail fuel distribution network outlets and installed supply capacity is not fully used. The production of biodiesel in 2007/08 reached 50ML of biodiesel with predictions for 08/09 to be approximately 80ML. Current capacity is approximately 245ML per annum with 300ML of additional capacity expected in the next couple of years.

(3) Main crops for BDF and its production planning

Australia's biodiesel is mainly produced from processed waste (primarily used cooking oil) and tallow. Some soy based product has recently been imported.

Table 20 Current status of biodiesel fuel in Australia

Country	Mixing rate	Main Feedstocks	Strategy / Goal	Standard
Australia	Up to 5% in automotive diesel.	Tallow Waste cooking oil Soy (imported)	No Federal mandate. Up to 5% allowed in automotive diesel.	Fuel Standard (Biodiesel) Determination 2003. Fuel Standard (Automotive Diesel) Determination 2001.
	NSW B2 mandate (January 2010)		NSW mandate - B2 in January 2010 and B5 in 2012 – as supply is available.	Biofuels Act 2007 (NSW Government).

7.1.2 Standardization of BDF

Table 21 B100 specifications for blending with diesel (for retail sale)

Items	Units	U.S.	EU	Australia	EAS-ERIA BDF Standard
		ASTM D6751-07b	EN14214:2003		(EEBS):2008
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900
Viscosity	mm2/s	1.9-6.0	3.50-5.00	3.5 - 5.0	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	120.0 min.	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.0010 max.	0.0010 max.
Distillation, T90	deg. C	360 max.	-	360 max.	-
Carbon residue (100%) or	mass%	0.05 max. -	- 0.30 max.	- 0.30 max.	0.05 max. 0.3 max.
Cetane number		47 min.	51.0 min.	51.0 min.	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.02 max.	0.02 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	.050 [vol%] max.(1	500 max.
Total contamination	mg/kg	-	24 max.	24 max.	24 max.
Copper corrosion		No.3	Class-1	Class-1	Class-1
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.80 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	6 min.	10.0 min. (****)
Iodine value		-	120 max.	-	Reported (***)
Methyl Linolenate	mass%	-	12.0 max.	-	12.0 max.
Polyunsaturated FAME (more than 4 double bonds)	mass%	-	1 max.	-	N.D. (***)
Methanol content	mass%	0.2 max. (*)	0.20 max.	0.20 max.	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	-	0.80 max.
Diglyceride content	mass%	-	0.20 max.	-	0.20 max.
Triglyceride content	mass%	-	0.20 max.	-	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.020 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.250 max.	0.25 max.
Na+K	mg/kg	5 max.	5.0 max.	5 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	5 max.	5.0 max.
Phosphorous content	mg/kg	10 max.	10.0 max.	10 max.	10.0 max.

(*) Equivalent to diesel fuel
(**) Meet diesel fuel specification
(1) Water and sediment

7.1.3 R&D Trends of Second Generation Biofuels in Australia

The Australian Government has established the $15 million Second Generation Biofuels Research and Development Program (Gen 2). Gen 2 is a competitive grants

program that supports the research, development and demonstration of new biofuel technologies which address the sustainable development of the biofuels industry in Australia. Gen 2 will provide matching grants, ranging from $1 million to $5 million, for eligible projects. Applications under the Program closed on 30 January 2009 and are currently being assessed. Successful projects are likely to be announced mid year (2009). Guidelines for the program are available on the Australian Government's Department of Resources, Energy and Tourism website (www.ret.gov.au).

Another Commonwealth initiative, the CSIRO Energy Transformed National Research Flagship, includes a broad research program to address Australia's biofuels knowledge gaps and moves towards achieving a low emission transport sector are in place. The program is assessing a range of new technologies for producing biofuels and other bio-based products, including the economic and environmental impacts.

Significant government and privately-funded biofuels research is also being conducted in the states and territories. The Western Australian Government is conducting trials on alternative oilseeds for biodiesel production, including Moringa oleifera and Pongamia pinnata and on early maturing canola varieties.

Research in the Northern Territory (NT) includes the identification of bio-fuel crops that are agronomically suitable for the NT and experimentation with a wide variety of crops such as mustard, sesame, sunflower, safflower, Pongamia and African oil palm. The University of Queensland has begun research into the use of the Pongamia in biodiesel production and the Queensland Premier recently announced funding for a project to convert sea algae into biodiesel.

In late 2007, the NSW Government established a biofuels research 'pipeline' for the production of alternative vehicle fuel from plant and crop waste at the universities of NSW, Sydney and Macquarie. Research in NSW focuses on sustainable non-food crop feedstocks, such as agricultural and forestry waste and dedicated energy crops. Research is being conducted into the potential for production of biofuels, particularly ethanol, via lignocellulose, from woody plants and applying overseas research to local feedstocks such as eucalypts. In Victoria, research is focusing on alternative feedstocks including algae and grasses. Some research is also underway on plant genetics for improve production.

Research in South Australia centres on the South Australia Research and Development Institute (SARDI) which has two streams of activity: sustainable production of biodiesel from microalgae which includes bio-prospecting native algae strains and evaluation and development of new crops as feedstocks for biodiesel which involves the selection and breeding of varieties tailored to biodiesel production.

7.2 China

7.2.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

At the end of 2008, the population of vehicle in China is about 64.67 million, and the private vehicle is about 41.73 million, commercial vehicle is about 11.25 million. In the recent years, the vehicle increase in China is more than 15%.

As a result, the vehicle fuel is becoming more and more relying on abroad market although more than 94% of the Chinese energy consumption is from domestic. In 2008, the petroleum import in China is about 200 million tons, which is nearly 52% of the petroleum consumption in China. This status gives both the Chinese economic and energy safety a huge challenge.

On the other hand, the air environment in the middle and large cities is facing more and more heavy burden, especially the emission given by vehicle. Although the vehicle emission standards are becoming more and more strictly, majority of the air pollutions in big city, such as CO, HC, NOx, are still from vehicle emission.

According DOE of China, the Strategy of New Energy Development has begun to plan since April 2009, which will focus in two directions: the first is mainly on accelerating the development of wind energy, solar energy and bio energy, the other is clean using the traditional fossil energy such as coal based energy, new fuel for vehicle and intelligent power system.

According "Development Strategy of Renewable Energy in China" of NDRC, the new capacity of renewable power and the related investment in China are:

(1) the hydro power will be 190 million kW, investment is about 1.3 trillion RMB;
(2) the wind power will be 100 million kW, investment is about 0.9 billion RMB;
(3) the solar energy will be 1.73million kW, investment is 130 billion RMB;
(4) the solar water heater 200 million m2, investment is about 400 billion RMB;
(5) the bio energy power is 28 million kW, investment is about 200 billion RMB.

As a result, the evaluated total investment is about 3 trillion RMB.

For the influence of the economic crisis since 2008, the new energy strategy and investigation will be adjusted, which means both total adding new capacity of power output and investment will be increased, for example, the wind energy may be adjusted to 1 billion kW, the solar power may be adjusted to 10 million kW, and the total investigation before 2020 may be very huge.

(2) Concrete target and strategy for BDF

China has determined its principles of developing non-food biomass liquid fuels,

that is, it should not deprive people of food, should not deprive food of land, and should not deprive cattle of feed.

As a result, the target of BDF is keeping adjusted. According "Development Strategy of Renewable Energy in China" (Issued on Sep.05, 2007), the target of bio fuel is 10 million tons, in which BDF is 2 million tons till 2020.

At the end of 2007, the total BDF production in China is about 300 thousand tons, but at the end of 2008, the total BDF production is even less than 300 thousand tons for the price increase of stock, that means the BDF market is suffering from atrophy.

Waste oil is a very important source in China. It is statistics that the total waste oil in China is 5 million tons, but it faces the problems of collection cost and hard to mass production.

(3) Main crops for BDF and its production planning

Many provinces have their own ambitious plan of plant cultivation for BDF several years before (especially 2005~2007). But two factors affect seriously the enthusiasm of the investors: one is the too high oil price, which influences the stock cost and results in almost no profit for BDF companies; the other is the global economic crisis, which influences the investment. Since the second half year of 2008, the BDF encountered harsh situation in China.

It is statistics that there will have about 25 million Mus (1Chinese Mu equals 0.0667 hectare) Jatropha plant potential in the three provinces including Yunnan, Sichuan and Guizhou within the next 10 years, and the total potential BDF cultivation area will be more than 0.1 billion Mus in China before 2020. But how to turn the potential to reality is still a huge challenge.

In China, many crops are trying to be planted recently years including:

Jatropha

Jatropha is the most important potential oil-bearing crop planted in south part of China. Thousands hectares of Jatropha has been planned to cultivate in Sichuan, Hainan, Guizhou and Yunnan province during the past few years, and millions hectares area are planned to planted within the next decade years.

The most important domestic energy companies and food & edible oil company have already involved in Jatropha cultivation, including the three biggest petroleum companies CNPC, PetroChina and CNOOC, as well as the biggest edible oil & food company COFCO.

Many foreign companies also have great interesting in investment in Jatropha

cultivation in China, but till now, the mass production of Jatropha based biodiesel in China is still a dream.

Chinese pistache

Chinese pistache is another important woody oil plant in China besides Jatropha, which is mostly planted in Central and North China, such as in Hebei province, Henan province, Shanxi province and Shannxi province.

In Handan city Hebei province, the resource of Chinese pistache ranked No.1 in China. There is about 200 thousand Mu wild Chinese pistache and 100 thousand Mu artificial Chinese pistache, some BDF factories have been set up.

In Hebei province, about 110 thousand Mu Chinese pistache has been planted by Hainan Zhenghe Company in order to obtain BDF stock..

The largest area distribution of wild Chinese pistache is in Shannxi province, which is statistic to be more than 4 million Mu.

Acidification oil

The ordinary vegetable oil in china includes rapeseed, soybean, peanut, cotton seed and others, which composes the edible oil in China.

For a shortage of edible oil, no such oil is permitted to produce BDF by the government. As a result, the residual material named soapstock, is first changed to acidification oil and then to BDF, which is widely used in the small scale BDF companies in China

Oil alga

Oil algal is the largest potential resource for BDF, and the technology of gene breeding of oil alga is now being focused in China

7.2.2 Standardization of BDF

The non-compulsory standard for FAME blended diesel fuel, GB/T20828-2007, was issued in May 2007. This standard is for the quality control of Diesel fuel BD-100. The Chinese biodiesel standard is based on ASTM D6751-03a “Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels”. GB/T20828-2007 has specified 17 items on biodiesel fuel (B100) blend stock for distillate fuels, as shown in Table 22.

Table 22 B100 specifications in China

Biodiesel properites	GB/T 20828-2007	Test-method
Density at 20 ^{O}C., kg/m^{3}	820-900	GB/T2540
Cetane Number, min	49	GB/T386
Flash point, deg C., min	130	GB/T261
CFPP, deg C., max	Report	SH/T0246
Sulfur, % , max	0.05 0.005	SH/T0689
10%, wt%, max	0.3	GB/T17144
Ash, wt %, max	0.020	GB/T2433
Water, vol%, max	0.05	SH/T0246
sediment	None	GB/T511
Copper corrosion (3hr at 50deg C.), max	1	GB/T5096
Oxidation stability at 110deg C., hr, min	6	EN14112
Acid value, mg KOH/g, max	0.8	GB/T 264
Viscosity at 40deg C., cSt, min-max	1.9-6.0	GB/T 265
Free glycerides, wt%, max	0.02	ASTM D 6584
Total glycerin, wt%, max	0.24	ASTM D 6584
Distillation T90, deg C., max	360	GB/T6536

The draft standard of B5 standard has been in state for examination in April 2009, the formal standard will be issued this year.

7.3 Indonesia

7.3.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

Energy consumption in Indonesia increases rapidly in line with economic and population growth. Currently, Indonesia is still very much dependent on fossil fuel for its energy source and the non fossil alternative renewable energy has not been utilized optimally. Data of fossil energy reserves from Department of Energy and Mineral Resources shows that the proven reserve of oil is about 9 billion barrels and with an average production rate of 500 million barrels per year, the reserve will be exhausted in 18 years. The data also shows that around 63% of the Indonesian's final energy demand is still depend on oil. On the other hand, the national oil production facilities are limited and the capacity decreasing gradually. Therefore, to satisfy domestic energy consumption, Indonesia has to import crude oil and finished petroleum products, such as gasoline and diesel fuel. Indonesia becomes very dependent on overseas oil supply to fulfill the increasing demand. This situation may worsen the security of fuel supply.

The increase of the international crude oil and fuel price has become a burden to the state budget, due to the subsidizing policy of fuel products. When the crude oil price stays at around US$125 per barrel, Indonesia has to provide around 240 trillion Rupiah just for fuel subsidy. This will result in reduced government capacity to finance

development programs in needed sectors such as health, education, basic human services, and infrastructures either in rural or in urban areas. It means that the government has very limited resources to stimulate and maintain productivity and economic growth.

In addition, air quality of major cities in Indonesia has been deteriorating especially in the city of Jakarta. Ambient air quality monitoring results suggest that NOx, CO and THC are a serious problem in almost all areas of Jakarta. PM10 may be considered as a problem in certain areas and motor vehicles are a major contributor of NOx, PM10, CO and THC emission (more than 70% of each parameter). To reduce the high dependency on oil and to meet the global environment requirement, there is no choice that the maximum utilization of environmental friendly alternative fuel should be developed. One alternative is converting plant oil to methyl esters or famously called biodiesel.

(2) Targets/strategies/regulations/incentives for BDF

The business of biodiesel in Indonesia is expected to grow as the government intends to boost the biofuel program since the new issuance of National Energy Policy in 2006 [37], [38]. The policy has stated that biofuels are parts of renewable energy sources besides other types of sources such as geothermal, biomass, biogas, wind, river flow, etc. The targets in this policy include the role of each renewable energy source in the energy consumption for optimum primary energy mix. In the latter, the role of biofuels is set for more than 5% in the national energy consumption by the year 2025. This policy has been reinforced by the issuance of President Instruction No. 1/2006 concerning the regulation of biodiesel utilization, National Biodiesel Standard SNI 04-7182-2006 and Decree of the Oil and Gas Directorate General on Biodiesel Blending regulation that allows maximum blending of 10%.

Decree of the Minister of Energy and Mineral Resources No. 32/2008 on mandatory utilization of biofuel has just been issued on September 2008. This policy regulates, among others, the targets schedule of biofuel mandatory utilization, as shown in Table 23.

Table 23 Biodiesel (B100) mandatory utilization mandatory phases in Indonesia

Sector	Oct.-Dec. 2008	January 2009	January 2010	January 2015	January 2020	January 2025	Remark
Household	-	-	-	-	-	-	Non mandatory
Transportation PSO	1% (existing)	1%	2.5%	5%	10%	20%	From total demand
Transportation Non PSO	-	1%	3%	7%	10%	20%	
Industry and commercial	2.5%	2.5%	5%	10%	15%	20%	From total demand
Power Plant	0.1%	0.25%	1%	10%	15%	20%	From total demand

Although the biodiesel development in Indonesia has been started since ten years ago, but it has just gained significant milestone in 2006, when PERTAMINA as a state-owned company dealing with business in oil & gas, LNG, energy and petrochemical industries, started to sell a blend of 95% diesel fuel and 5% SNI standard biodiesel (B5) with the trade name of BIOSOLAR on 20 May 2006. To date, PERTAMINA has been selling a BIOSOLAR at several hundred fuel outlets in Java and Bali Island. In line with the policy of biofuel mandatory utilization and the continuously growing domestic biodiesel producer, PERTAMINA plans to open the BIOSOLAR's fuel outlets in all parts of Indonesia and increase the biodiesel blending content at least up to B20 in 2025.

The most significant hurdle for broader commercialization of biodiesel in Indonesia is its cost. Thus acceptance of biodiesel in Indonesia is more influenced by pricing factor. The advantages of biodiesel such as a renewable energy, lower exhaust gas emission and favorable effect on engine life time are often ignored. As a resolution to this pricing problem, the government has issued Presidential Regulation No. 45/2009 on the alteration of President Regulation No. 71/2005 concerning the supply and distribution of "certain fuels". Through this new regulation, the status of biodiesel, which is previously classified as "other fuel" and thus receive no subsidy from the government, is now classified as "certain fuel" that could be subsidized by the government.

(3) Main crops for BDF and its production planning

The option of using biodiesel as alternative fuel is based on the availability of raw material. If rapeseed oil is the raw material for biodiesel in Germany and soybean for the United States, crude palm oil (CPO) is the logical option for Indonesia, due to its large production volume and thus ready availability in the country. Concerns on food

versus fuel competition have driven researchers to seek and identify alternative, and preferably non-edible, fatty oil resources. Table 24 shows some potential vegetable oil plants found in Indonesia. As also the case in many other countries, Jatropha curcas is the non edible oil plant that has received most attention of government as well as other stakeholders.

Table 24 Potential vegetable oil plants in Indonesia

Name	Latin name	Oil Source	Oil, %-w dry	E / NE
Jarak pagar	*Jatropha curcas*	Kernel	40 – 60	NE
Sawit	*Elais guineensis*	Pulp + kernel	45-70 + 46-54	E
Kapok/randu	*Ceiba pentandra*	Kernel	24 – 40	NE
Kelapa	*Cocos nucifera*	Kernel	60 – 70	E
Kecipir	*Psophocarpus tetrag.*	Seed	15 – 20	E
Kelor	*Moringa oleifera*	Seed	30 – 49	E
Kusambi	*Sleichera trijuga*	Kernel	55 – 70	NE
Nimba	*Azadirachta indica*	Kernel	40 – 50	NE
Saga utan	*Adenanthera pavonina*	Kernel	14 – 28	E
Akar kepayang	*Hodgsonia macrocarpa*	Seed	≈ 65	E
Gatep pait	*Samadera indica*	Seed	≈ 35	NE
Kepoh	*Sterculia foetida*	Kernel	45 – 55	NE
Ketiau	*Madhuca mottleyana*	Kernel	50 – 57	E
Nyamplung	*Callophyllum inophyllum*	Kernel	40 – 73	NE
Randu alas	*Bombax malabaricum*	Seed	18 – 26	NE
Seminai	*Madhuca utilis*	Kernel	50 – 57	E
Siur (-siur)	*Xanthophyllum lanceatum*	Seed	35 – 40	E
Tengkawang. Terindak	*Isoptera borneensis*	Kernel	45 – 70	E
Bidaro	*Ximenia Americana*	Kernel	49 – 61	NE
Bintaro	*Cerbera manghas/odollam*	Seed	43 – 64	NE
Bulangan	*Gmelina asiatica*	Seed	?	NE
Cerakin/Kroton	*Croton tiglium*	Kernel	50 – 60	NE
Kampis	*Hernandia peltata*	Seed	?	NE
Kemiri cina	*Aleurites trisperma*	Kernel	?	NE
Nagasari (gede)	*Mesua ferrea*	Seed	35 – 50	NE
Sirsak	*Annona muricata*	Kernel	20 – 30	NE
Srikaya	*Annona squamosa*	Seed	15 – 20	NE

Note :
E ≡ Edible fat/oil, NE ≡ Non-Edible fat/oil

(Source: Soerawidjaja, T. H. 2003)

Commercialization of biodiesel in this country has gained significant milestone in 2006, when the Indonesian government issued blending permit regulation of up to 10% biodiesel with mineral diesel fuel. Following the issuance of this regulation, Pertamina started selling B5 at several fuel dispensing stations on 20 May 2006. Since then, the number of fuel dispensing stations selling B5 is continually increasing.

As shown on Table 25, the installed capacity of biodiesel plant in Indonesia has reached considerable size of around 3.07 million ton in 2009 [39]. The plant with capacity less than 5.000 tons/year has been fully designed and constructed by local institution and industries, whereas large scale commercial plants apply technologies of international licensors.

Table 25 Existing installed capacity (status up to Dec 2009)

No	Company/Institution Name	Location	Capacity (Ton/Year)
		Total	**3,069,440**
1.	PT. Energi Alternatif Indonesia	North Jakarta	7,000
2.	PT. Indo biofuels Energi	Merak, Banten	60,000
3.	PT. Anugrah Inti Gemanusa	Gresik, East Java	40,000
4.	PT. Eterindo Nusa Graha	Gresik, East Java	40,000
5.	PT. Eternal Buana Chemical Industries	Cikupa, Tangerang, Banten	40,000
6.	PT. Wilmar Bio Energi Indonesia	Dumai, Riau	1,050,000
7.	PT. Sumi Asih Oleo-Chemical	Bekasi, West Java	100,000
8.	PT. Darmex Biofuels	Bekasi, West Java	150,000
9.	PT. Pelita Agung Agri Industri	Bengkalis, Riau	200,000
10.	PT. Primanusa Palma Energi	North Jakarta	24,000
11.	PT. Sintong Abadi	Asahan, Sumut	35,000
12.	PT. Musim Mas	Batam	350,000
		Deli Serdang, North Sumatera	70,000
13.	PT. Multi Kimia Intipelangi	Bekasi, West Java	14,000
14.	PT. Cemerlang Energi Perkasa	Dumai, Riau	400,000
15.	PT. Petro Andalan Nusantara	Dumai, Riau	150,000
16.	PT. Bioenergi Pratama Jaya	Kutai Timur, East Kalimantan	6,000
		Berau, East Kalimantan	60,000
17.	PT. Wahana Abadi Tritatehnika Sejati	Cileungsi, West Java	132,200
18.	PT. Damai Sejahtera Sentosa Cooking	Surabaya, East Java	120,000
19.	PT. Alia Mada Perkasa	Tangerang, Banten	11,000
20.	PT. Pasadena Biofuels Mandiri	Cikarang, West Java	10,240

Source: Indonesian Biofuel Producers Association (APROBI).

7.3.2 Standardization of BDF

Commercial utilization of biodiesel especially as one alternative of automotive diesel fuels requires certain quality standard. To protect both biodiesel consumers and producers as well as to support the development of biodiesel industries, the biodiesel standard – so called SNI 04-7182-2006 has been approved by the National Standardization Agency (BSN) through a decree No. 73/KEP/BSN/2006 on 22 February 2006. The biodiesel standard has been formulated by technical committee of new and renewable energy in order to assure that the norm is accommodative to the interest of all parties involved in biodiesel issues. The member of committee consist of all related biodiesel stakeholder include of the government institution, private institutions and academicians. The committee has performed a series of discussion, procedural processes and finalized in the Consensus Forum XXIV on 6-7 December 2005 in Jakarta.

The content of SNI 04-7182-2006 has partially adopted the existing European and US standard (ASTM D6751 and EN 14214:2002) and other values were set based on several considerations including:

- The plant oil resources in Indonesia have wider range of carbon components compared to the plant oils from European and US. For example, coconut oil has a range of fatty carbon chains of C8 to C18.
- Some of Indonesian plant oil resources have unique fatty acids that their existence in a biodiesel fuel may have negative effect in the diesel engine.
- As biodiesel plants may be located dispersedly and operated by medium and large enterprises, all level of enterprises should be able to afford the testing methods. Hence such methods should be designed for the local condition without disregarding the quality assurance. The detail SNI 04-7182-2006 is shown in Table 26.

On 17 March 2006, the Oil and Gas Directorate General of Department on Energy and Mineral Resources has been issued the decree No. 3675K/24/DJM/2006 regarding the quality and specification of diesel oil type Solar 48 and Solar 51. This decree regulates the use of FAME (fatty acid methyl ester) up to the maximum of 10 percent of the volume of automotive diesel fuel with which it is to be blended. The biodiesel to be mixed has to meet the biodiesel standard SNI 04-7182-2006.

Table 26 Characteristic comparisons of Fossil Diesel Fuel (FDF) and Biodiesel

No	Parameter	Unit	FDF[1]	Biodiesel[2]
1	Density	kg/m^3	820 - 870 (15°C)	850 – 890 (40°C)
2	Kinematic viscosity (40 °C)	Mm^2/s (cSt)	1.6 – 5.8	2.3 – 6.0
3	Cetane number		min. 45	min. 51
4	Flash point	°C	min. 60	min. 100
5	Cloud point	°C		max. 18
6	Pour point	°C	Max. 18	
7	Copper strip corrosion	Rating (3 hours at 50°C)	max. no 1	max. no 3
8	Carbon residue - in undistilled sample, or - in 10 % distillation residue	 % (m/m) % (m/m)	 - max. 0.1	 max 0.05 max 0.30
9	Water and sediment	%-vol.	max. 0.05*	max 0.05*
10	90% (v/v) recovered at distillation temperature	°C	-	max. 360
11	95% (v/v) recovered at distillation temperature	°C	max. 370	-
12	Ash content (sulfated ash)	% (m/m)	max.0.01	max.0.02
13	Sulfur content	ppm-m (mg/kg)	max. 5000	max. 100
14	Phosphorous content	ppm-m (mg/kg)	-	max. 10
15	Acid number	mg-KOH/g	max.0.6	max.0.8
16	Free glycerol	% (m/m)	-	max. 0.02
17	Total glycerol	% (m/m)	-	max. 0.24
18	Ester content	% (m/m)	-	min. 96.5
19	Iodine number	% (m/m) (g-I2/100g)	-	max. 115
20	Halphen test		-	Negative

Note : can be separately tested as long as sediment content maximum 0.01 %-vol

1. Automotive Diesel Oil, www.pertamina.com (accessed 19 June 2006)
2. SNI Biodiesel No. 04-7182-2006, based on ASTM D 6751 & EN 14214.

7.4 Japan

7.4.1 BDF Policy and Measures

(1) Target and strategy from energy and environment point of view

The Japanese government has committed to the ***Kyoto Protocol***, meaning that in 2010 the amount of green house gas emissions shall be reduced by six percent from the 1990 level. To comply with its own plan to meet the Kyoto Protocol, it has a target to introduce 500,000 kl-crude oil equivalent of biofuels (including bio-ethanol) by 2010. The ***Ministry of the Environment (MOE)*** planed the introduction target of biofuels for the transport sector, based the Kyoto protocol, as shown in Table 27.

Table 27 Biofuel introduction targets for the transport sector

Targets	2010	2020	2030
Quantity of biofuels	500,000 kL (Crude oil equivalent)	about 2,000,000 kL (Crude oil equivalent)	about 4,000,000 kL (Crude oil equivalent)
Ratio of biofuels to total fuels	about 0.6 %	about 3%	About 10 %
Consumption restraint	The status quo (about 86,000,000 kL)	Reduction of about 20%	Reduction of about 50%

The introduction of 500,000 kl-crude oil equivalent of biofuels in 2010 is crucial to meet the commitment, as this measure alone could contribute to a one percent reduction in greenhouse gases, out of a total target of six percent.

In the ***New National Energy Strategy*** issued by ***Ministry of Economy, Trade and Industry (METI)*** in May 2006, the ministry raised the target for the reduction of crude oil dependence in the country's transportation sector to about 80% in 2030, compared to 100% at present, with the aim to reduce both carbon dioxide emissions and its huge dependence on fossil fuels.

Electric vehicles and hydrogen-fuel cell vehicles and intelligent transportation system could be promising mid- and long-term measures to reduce carbon dioxide emissions and the dependence on fossil fuels.

Those next generation vehicles are, however, still in their research and development stage. On the other hand, biofuels are liquid, can be used in existing vehicles and have an immediate effect on carbon dioxide emission reduction and fossil fuel dependence. Hence biofuels are useful.

Ethanol, ETBE (ethyl tertiary butyl ether) and fatty acid methyl esters (FAME) are under consideration as biofuels. The ***Petroleum Association of Japan (PAJ),*** a Japanese oil industry body has committed to introduce 210,000 kl-crude oil equivalent of ETBE into gasoline. Regarding the remaining 290,000 kl-crude oil equivalent, discussions are still ongoing.

To promote biomass energy and materials, "***Nippon Biomass Comprehensive Strategy***" was established in 2002 by the Prime Minister's cabinet, which was composed of several ministries, including major stakeholders ***MOE***, ***METI***, the ***Ministry of Agriculture, Fishery and Forest (MAFF)***.

The ***MAFF*** promotes the "***Biomass Town Concept***" with cities, towns and villages playing a central role in an overall plan for using regional biomass, as shown in Figure 56. As of March 31, 2007, 90 cities, town and villages have announced this concept. In these biomass towns, resources from cattle excrement or food waste, etc. are converted into energy at biomass conversion facilities such as power generation

facilities or composting facilities to ensure that biomass is effectively used inside and outside the regions.

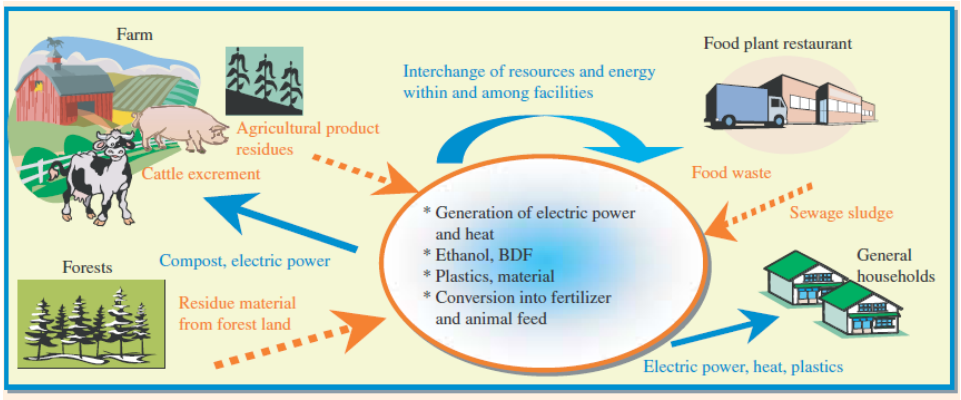

Figure 56 Biomass Town Concept in Japan

METI has established the ***Law on the Quality Control of Gasoline and Other Fuels*** (known also as the Quality Assurance Law). The Quality Assurance Law has been amended to allow up to 5 % by mass of FAME in diesel fuels, and to prevent the use of unprocessed vegetable oils. The requirements took effect in March of 2007. The diesel fuel properties specified in this law control sulfur, cetane index, T90 distillation temperature and upper limits of FAME and triglyceride content. For biodiesel fuel, additional requirements include limits for methanol, total acid number (TAN), low molecular weight acids and oxidation stability as acid growth measures. Both diesel fuel and biodiesel/diesel blends have limits on FAME and triglycerides to clearly distinguish between the two and to prevent the use of unprocessed triglycerides.

In this concept, biodiesel fuel is used in public vehicles, such as garbage trucks and city buses, as the fuel of choice for the concept of locally sourced – locally consumed.

In May 2007, the minister of ***METI***, the president of the ***Japan Automobile Manufacturers Association, Inc. (JAMA)*** and the president of ***PAJ*** published a plan for the future entitled "***Next-Generation Automobiles Initiative***", with reference to biofuels in "Worry-Free, Safe and Fair Expansion" and "Second-Generation Biofuels", as shown in Figure 57.

Figure 57 Outline of Next-Generation Automobiles and Fuels

(2) Main Crops for Biodiesel Fuels: Production Planning

Japanese biodiesel is mainly produced from waste cooking oil, in current community usage. In some cases rapeseed (canola) is also used. However, there is no mandate to blend biodiesel into diesel fuel.

Table 28 Current status of biodiesel fuel in Japan

Country	Mixing rate	Main Feedstocks	Strategy / Goal	Standard
Japan	Up to 5% in diesel fuel (no mandate)	Waste cooking oil	No national mandate. Up to 5% allowed in automotive diesel. The reduction of crude oil dependence in the country's transportation sector to ca. 80% in 2030	Compulsory Diesel Fuel Standard (FAME Blended Diesel Fuel) JIS K2390:2008 (Blend-stock for B5)

7.4.2 Standardization of BDF

(1) Outline of Fuel Regulations in Japan

Fuel quality has a significant impact on vehicle lifetime and performance, thus it is very important to control the quality of fuels at the pump from the viewpoint of safety, environment and customer protection. If substandard fuels are distributed and used in

vehicles, serious trouble may happen. Figure 58 shows an example of an actual incident cased by inadequate fuel. High alcohol content fuel corrodes metals in fuel system components. In the case at hand, fuel leakage occurred, leading to a fire.

Figure 58 Example of Consumer Incident caused by Fuel Quality

In Japan, the Ministry of Economy Trade and Industry (METI) is responsible for fuel quality in the consumer market. In accordance with the Japan fuel standards law, METI is obligated to:

- Monitor registration of gas stations: Gas stations are required to register with METI
- Develop fuel quality standards (mandatory and voluntary)
- Requiring gas stations to report quality check of gasoline once every 10 days, or annually if its supply chain is approved by METI
- Fuel quality monitoring at pump, which can be outsourced to four registered testing organizations

Table 29 shows current fuel quality standards in Japan. An asterisk (*) in the table indicates mandatory items, because these properties directly relate to issues of safety and the environment. There are about 50,000 filling stations in Japan. METI gathers about 200,000 fuel samples/year and investigates their quality. If METI finds any off-spec fuels, METI instructs fuel suppliers to follow fuel regulations. If they do not follow through, METI orders suspension of business up to 6 months and in some case, fuel distributors will be assessed criminal penalties. If FAME bended diesel fuel is made commercially available in Japan, the raw fuel has to be modified so that it is fully

compatible with the FAME components in the blend.

Table 29 Quality standard items for Gasoline and Diesel Fuel

Items	Level	
Lead	No detection	*
Sulfur	< 10 ppm	*
MTBE	< 7 vol%	*
Oxygen Content	< 1.3 wt%	*
Benzene	< 1 vol%	*
Kerosene	< 4 vol%	*
Methanol	No detection	*
Ethanol	< 3 vol%	*
Existent Gum	< 5 mg/100mL	*
Color	Orange	*
Octane	Regular > 89	
	Premium > 96	
Density	< 0.786 g/cm3	
Distillation Temp.	(specified)	
Copper Corrosion	< 1 max	
RVP	44 - 65 kPa (Summer)	
Oxidation Stability	> 240 min	

Items	Level	
Sulfur	< 10 ppm	*
Cetane Index	> 45	*
90% distillation temp.	< 360 deg.C	*
Flash Point	> 45 deg.C	
Pour Point	Depend on region and month	
CFPP		
10% Carbon Residue	< 0.1%	
Kinematic Viscosity	> 1.7 mm2/s	

Note: * = mandatory

(2) Developing Biodiesel Fuel Standards in Japan

Currently biodiesel fuel has not been introduced commercially in Japan. However bio fuels like bioethanol and biodiesel fuel have been under discussion for reducing CO_2 from the transportation sector. In order to use biofuels for vehicles, developing adequate specifications is essential. METI organized its Fuel Policy Sub-committee which is a type of advisory committee, to discuss biodiesel fuel specifications. There are many kinds of biodiesel fuels in existence, such as crude vegetable oil, refined vegetable oil, FAME (Fatty Acid Methyl Ester), hydrogenated vegetable oil and BTL (biomass to liquid). First, it was agreed to select FAME as a biodiesel fuel to develop standards for because it was used as a fuel for fleet use in some local governments, and was expected to be used more widely in Japan.

The characteristics of FAME are quite different from fossil based diesel fuels. As shown in Figure 59, the characteristics of FAME depend on raw material feedstock. For example, SME (Soy Methyl Ester) has a tendency to easily oxidize. FAME from fish oils easily produces sludge. PME (Palm Methyl Ester) and TME (Tallow Methyl Ester) easily form wax. The specific refining process also influences the quality of FAME. If the washing process is insufficient, some impurities like methanol, glycerin and so on remain in the FAME.

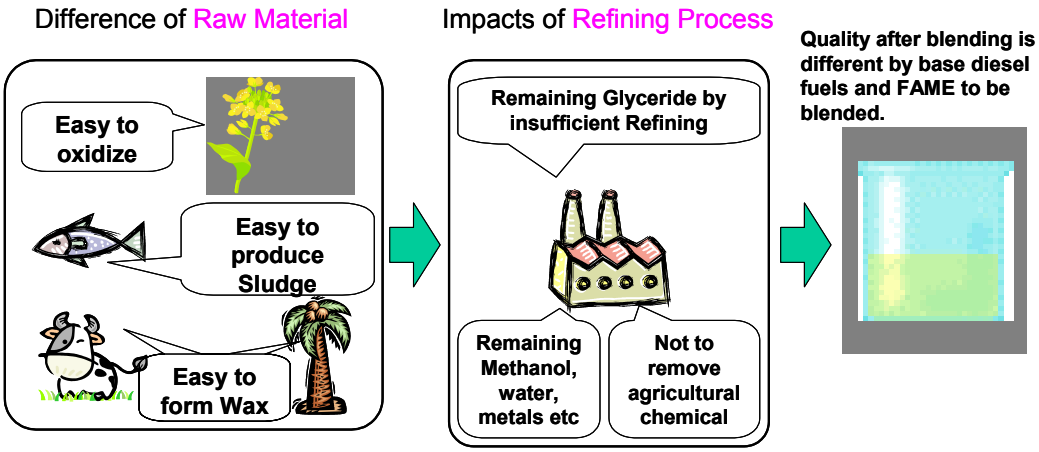

Figure 59 Influence of Raw Materials and Refining Process on FAME Characteristics

The preceding characteristics all closely relate to vehicle performance, as shown in Figure 60. If the quality of FAME is not controlled properly, serious trouble and/or fatal damage to vehicles may be expected.

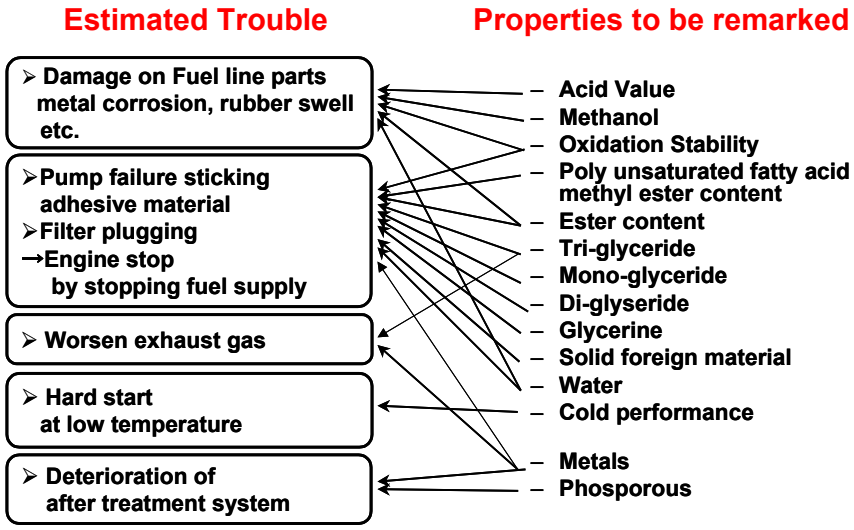

Figure 60 Important FAME Properties and their Expected impact on Vehicle Condition and Operation

For developing biodiesel fuel specifications, METI has conducted a series of FAME conformity tests to build out a technical knowledge base about FAME. In order to shorten the specification development period, the European FAME specification EN14214 was selected as a starting point. Even though starting from EN14214, more than two years and about four hundred million yen were spent refining the

specifications.

Table 30 presents a summary of conformity tests in which FAME that completely meets EN14214 was prepared and blended into Japanese JIS No. 2 diesel fuel at a rate of 5 % by volume, and was then used for each test. One problem related to FAME properties is corrosion, which was observed in the fuel tank tests and metal dip tests, even though the test FAME used in the conformity tests met European requirements.

Table 30 Summary of METI Conformity Test Results

Test Items	Results	Summary
Material Compatibility		
Metals	**Fail**	**Corrosion in Tern Sheet**
Rubber & Plastics	Pass	No effects of Ester as far as less than 5v%
Cold Performance	—	Poor Startability
Long Storage Test	Pass	Slight Degradation
Fuel Line Parts Test		
Fuel Filter Test	Pass	Same as diesel fuel with B5
Fuel Tank Test	**Fail**	**Corrosion and melting plating in lead-tin alloy coated and electrolytic zinc-coated steel sheets**
Fuel Pipe Test	Pass	Same as diesel fuel with B5
Fuel Hose Test	Pass	Same as diesel fuel with B5
FIE Durability Test	Fail	Wear in Injectors with B5
Engine Durability Test		
LD, ID&DI	Pass	Observation of no trouble with B5
HD, DI	Fail	Flow loss and Wear in Injectors with B5
Vehicle Durability Test (LDV, IDI)	Pass	Observation of no trouble with B5
Emission Test	Pass	Little Impact with up to 10v%

Note) Test FAME consists of PME:RME:SME=60:38:2 and is blended in commercial diesel fuel by 5%. Test FAME completely met EN14214.

Furthermore, Figure 16(top) shows an example of corrosion observed in the fuel tank tests. The cause of corrosion was a lack of oxidation stability. The FAME blended diesel fuel oxidized during the test period and produced corrosive acids. No other problems related to FAME were observed. These results suggested that using only the oxidation stability requirement in EN14214 would not ensure long-term performance in vehicles. Next, effects of improving FAME blended diesel fuel oxidation stability were investigated. Oxidation stability is easily improved with anti-oxidant agents, as shown in Figure 61. The test FAME oxidation stability was improved to 10 Hrs (Rancimat method) using additive technology and then blended into JIS No. 2 diesel fuel at the same 5% rate. Figure 16(bottom) shows a photograph of the inner fuel tank after

concluding the test. No corrosion was observed and the effectiveness of improving oxidation stability was confirmed. Based on conformity tests such as these, Japanese biodiesel fuel specifications were developed.

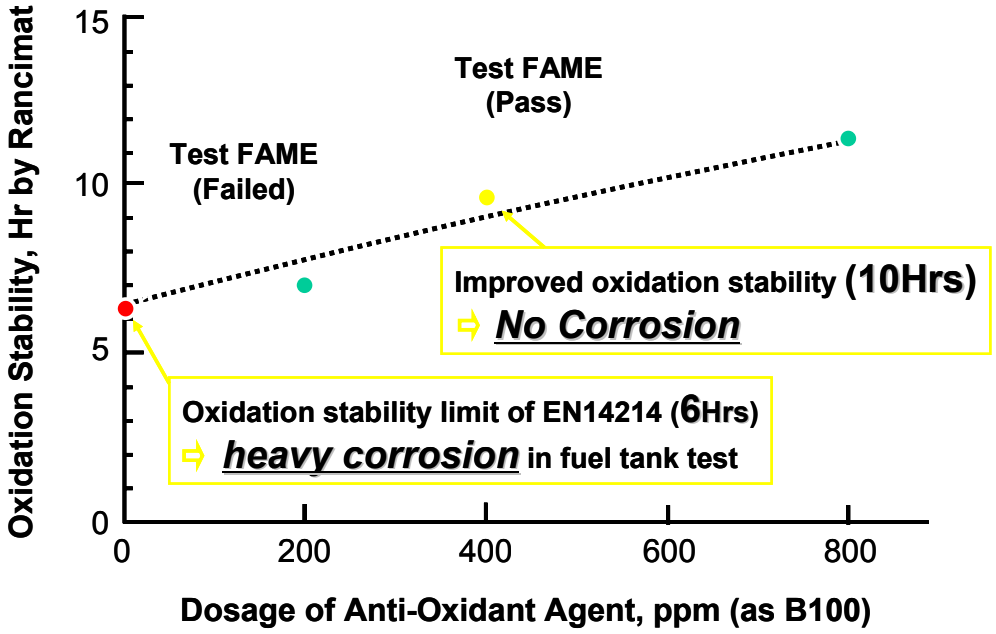

Figure 61 Effect of Anti-Oxidant Agent on Oxidation Stability

(3) Japanese B5 diesel fuel specification

In Japan, the quality of FAME blended diesel fuel is regulated by compulsory standards under the fuel quality control laws. The standard of neat FAME (B100) for use as blending stock is not included the compulsory standards, but rather as a voluntary specification.

Figure 62 shows the difference in fuel regulations between Europe and Japan. In Europe, there are two specifications for the quality of FAME blended diesel fuels. That is, one is the diesel fuel specification, EN590. The other is the FAME (B100) specification, EN14214. EN590 refers to only ester content in terms of FAME related properties.

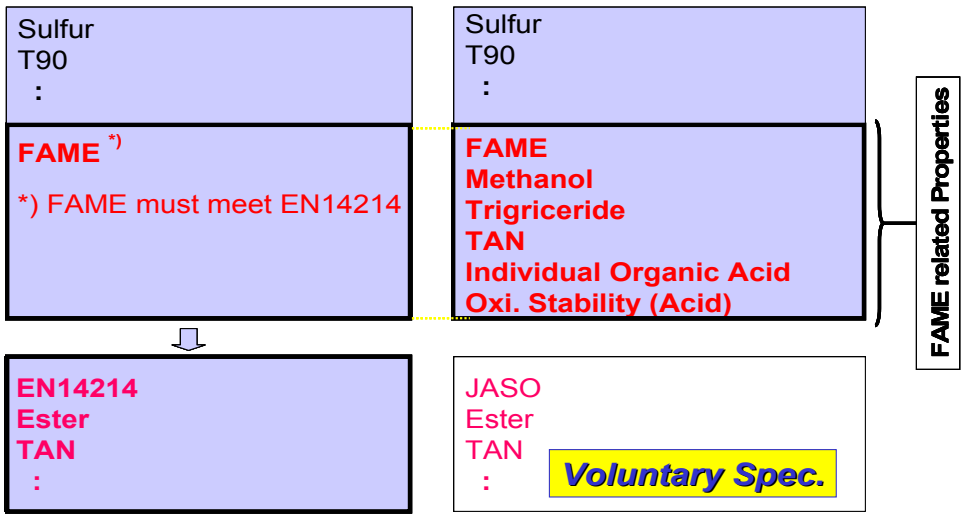

Figure 62 Difference in Fuel Regulations between Europe and Japan

The split specifications mean that both EN590 and EN14214 are necessary to specify the quality of FAME blended diesel fuels. European governments regulated both sets of specifications and monitor the quality of both diesel fuel and FAME before blending. There is no way to check the quality of the fuel after blending, because there are no specifications related to FAME except for the ester content in EN590. In case of Japan, the fuel quality is controlled at the dispensing pump. This principle is also applied to FAME blended diesel fuels. Then, the quality of FAME blended diesel fuel is regulated by the Japan "Fuel Law" as a set of compulsory standards, which do not include specifications of the neat FAME (B100) blending stock. Actually, the B100 specifications were developed as a "Guideline for FAME Producers" under JIS K2390:2008. These two standards will next be explained in more detail.

(i) Compulsory Diesel Fuel Standards (Specification of the Japan "Fuel Law")

METI developed the specifications of FAME blended diesel fuel based on the conformity test results shown in Table 31. Existing items in the present diesel fuel standards consist of the following three items.

- Sulfur Content of 0.005% by mass, or less.
- Cetane index of 45 or higher.
- 90% distillation point of 360 C, or lower.

New additional items are classified into two groups. Either of the following must be satisfied, namely item (a) or (b).

⇒ Standard to be satisfied by diesel fuel not containing FAME

(a) FAME content of 0.1% by mass, or less

Triglyceride content of 0.01% by mass, or less

⇒ Standard to be satisfied by diesel fuel containing FAME

(b) FAME content of 5.0% by mass, or less

Triglyceride content of 0.01% by mass, or less

Methanol content of 0.01% by mass, or less

Acid value of 0.13 mg KOH/g or less

Total formic acid, acetic acid and propionic acid of 0.003% by mass, or less

Oxidative stability of 0.12 mg KOH/g or less, for acid value growth

Regulatory items need to be added to the diesel fuel standards in order to specify the upper limit of FAME content in diesel fuel (up to 5% is allowed), and the fuel properties satisfying points 1, 2 and 3 for the use of FAME conforming to the neat standards.

1. FAME sufficiently refined (high purity) may be blended. This covers triglyceride and methanol content.
2. FAME in fresh condition, not degraded with time, may be blended. This covers acid value and specific acid content.
3. Properties should be such that generation of acid and sludge from heat and oxidative degradation is controlled during storage. This establishes a baseline for oxidative stability.

Table 31 Compulsory Diesel Fuel Standards

Regulated Item		**FAME Blended Diesel Fuel**	**Diesel Fuel**
Existing Items	Sulfur	Max 0.001% by mass	
	Cetane Index	45 min	
	T90	Maximum of 360 C	
Additional Items	FAME Content	Max 5.0% by mass	Max 0.1% by mass
	Triglyceride Content	Max 0.01% by mass	Max 0.01% by mass
	Methanol Content	Max 0.01% by mass	-
	TAN	Max 0.13 mgKOH/g	-
	Individual Organic Acid*	Max 0.003% by mass	-
	Oxidation Stability (Acid Value Growth)	Max 0.12 mgKOH/g	-

* Total Formic, Acetic and Propionic acids

Differences from the regulated of European EN standard values are the limits for specific organic acids, and the oxidative stability (acid value growth) limit. Items to study based on the regulated value of EN Standard consist of FAME to diesel fuel blending ratio, Acid Value, Methanol content, Triglyceride content.

FAME Content

When the FAME to diesel fuel blend ratio (ester content) is increased, blotting of fuel from the fuel hose will take place. In the EN Standard (EN590), the blending ratio in diesel fuel is limited to 5% or less. The FAME to diesel fuel blend ratio can be used as an upper limit for the effect on safety, and also in identifying diesel fuel containing FAME or not containing FAME.

When the compulsory standard for diesel fuel is simply increased, items investigated regarding fuel quality by producers and distributors will also increase, whether or not FAME is contained in the diesel fuel. In order to avoid increasing the burden unnecessarily when diesel fuel not containing FAME is handled, the FAME blend ratio should be the main criteria.

Our conformity study was based on the fact that the FAME blending ratio is limited to 5% in Europe. A variety of tests were conducted within the sub 5% FAME blend ratio. No phenomena related to problems considered due to ester were confirmed. As to the soak test for plastics and rubber in which a significant effect was anticipated, no significant effect was observed for the FAME blend cases.

In fuel filter durability tests using the conventional test method, pressure-tightness decreased after the plastic filter case test. It was considered an effect of FAME on rubber (NBR) and plastics (Nylon 6). Effects of acid in addition to ester were also considered. In the fuel filter tests under the revised test conditions adjusted for actual in-use conditions, it was confirmed that no problems existed.

Triglyceride Content

Triglycerides are purely vegetable oils and animal fats. When blended with diesel fuel even at a concentration typical of impurities, they easily form sludge from oxidative degradation, which in turn causes clogging of the fuel filter or improper sliding of parts within the fuel system. As to the measuring method of neat FAME before blending with diesel fuel, a maximum of 0.2% by mass is specified by EN14214. Provisions are necessary because triglycerides (the actual fat) will blend with diesel fuel without forming methyl ether.

The triglyceride content is used as an index to measure the refinement level of FAME before blending with diesel fuel, similar to methanol. A value of 5%, equivalent to the EN standard, should be used as the standard value. Conformity test results showed that combustion residuals are easily formed from triglycerides (increase of carbon residue). No problems caused by triglycerides occurred in the conformity tests, including in durability tests using the triglyceride content equivalent to the EN Standard.

Methanol Content

Methanol aggressively corrodes certain metals. The present quality law specifies that 'no methanol shall be detected' in the compulsory standard item for gasoline. Currently, blending methanol in diesel fuel is not considered, but for FAME blended diesel fuel, methanol is used in the production of FAME, and residual methanol may be contained in the fuel. It is appropriate that the standard value should be 'not detected,' the same as for gasoline.

The level presently prescribed for 'not detected' in gasoline is a maximum of 0.5% by mass. In the case of FAME, methanol is not added intentionally but will be included as an impurity accompanying the synthesis process. In this compulsory standard, only the critical items to be prescribed for FAME should be applied after it is blended with diesel fuel, and it is necessary to decide whether the FAME quality before blending was appropriate. Among the items proposed as a compulsory standard, residual methanol and triglycerides (both are raw materials in FAME synthesis) constitute a measure of the refinement level of FAME before blending. Accordingly, it is considered appropriate to use the 5 % equivalent to the European Standard.

Acid Value and Specific Acid Content

When the acid value or the specific acid content is increased, metals used in motor vehicle fuel systems, begin to corrode. According to the European standard EN 14214, the limiting acid value for 100% FAME is 0.5 mgKOH/g or less.

The cause of corrosion is the acid originating in the FAME itself, and it is necessary to specify the combination of the acid value of FAME blended diesel fuel and the concentration of specific acids. When the acid value specified by EN 14214 (0.50 mgKOH/g) is applied to the 5% FAME blended diesel fuel, the acid value should not exceed 0.03 mgKOH/g.

There have been cases where fatty acids were added to diesel fuel to improve lubricity, but it was confirmed that this level would not cause corrosion with the present

dosage, and the maximum available acid value in the existing diesel fuel is 0.10 mgKOH/g. Accordingly, 0.13mgKOH/g is taken as the upper limit for the standard.

Specifying the acid value only is not sufficient to limit corrosion, and it is necessary to specify a limit for short chain fatty acids, which demonstrate strong corrosiveness. From the study of acids generated by FAME and from the results of corrosion tests for each acid, the specifications for formic acid, acetic acid and propionic (propanoic) acid should be provided.

Formic acid, acetic acid and propionic acid are important according to the results of the study of corrosive acids generated by FAME that has exhibited oxidative degradation. The evaluation results of corrosiveness from these acids confirmed that no corrosion occurred when formic acid, acetic acid and propionic acid did not exceed 0.003 %, and when caproic acid was under 0.01 % by mass in a moisture-free system (tens of parts per million level).

A study of the acid content analysis method indicated that formic acid, acetic acid and propionic acid can be analyzed by relatively simple methods, but caproic acid cannot be analyzed with the same test method. Because it is known that caproic acid is generated by oxidative degradation of methyl linolenate (which also generates acetic acid), it is possible to restrict the caproic acid content to a certain maximum level by controlling the acetic acid content. It was confirmed that no problems such as a decrease in durability would occur in fuel filter durability tests using FAME blended diesel fuel with a maximum mass-based acetic acid content of 0.003 % or less, and acid value of 0.13 mgKOH/g.

Oxidative Stability

Organic acids, fatty acids and moisture are generated when FAME undergoes oxidative degradation, and these can corrode metals. Furthermore, when oxidative stability is decreased, polymers (sludge) are generated which can cause failure in sliding parts of the fuel pump and injectors. Regarding the pre-blend measurement method of the neat FAME, an organic acid oxidative stability of at least six hours is required by the European standard EN14214.

No measurement method or standard value for neat FAME are provided with respect to sludge; however, in the European Diesel Fuel Standard EN590, 25 g/m3 is specified in accordance with ISO 12205 (ASTM D2274). This remained the same when it was amended in 2004 to allow a 5% FAME blend.

A study of the oxidative stability was conducted based on the concept that it is necessary to specify both the acid value (yield of organic acid) and yield of sludge in

FAME blended diesel fuel. Because it is considered appropriate to evaluate the oxidative stability after some degree of thermal (oxidative) degradation, testing was conducted to determine the method by which the yield of sludge and acid value can be simultaneously measured by reviewing test conditions and referencing the existing oxidation test methods. Other examples of such oxidation stability tests are for gasoline, lubricants, etc.

Although corrosion occurred in the fuel tank circulation tests conducted with the fuel used for the fuel system rig durability test, corrosion did not occur with fuel with established oxidative stability (with antioxidant added) in the fuel tank circulation test performed with the test method under development. While the difference in results is significant, according to the testing laboratory, in both yield of sludge and acid value growth, even if the same sample was used, the difference was remarkably reduced for fuel with antioxidant added. There was some correlation between the yield of sludge and acid value growth on the whole, and it was decided that the restriction of yield in sludge can be controlled by specifying a standard limiting value of acid growth.

Because the average acid value growth for fuel assumed to be border in the fuel tank circulation test was 0.06 mgKOH/g, the standard value was decided to be 0.12 mgKOH/g, considering the 95% confidence level.

Results of fuel simulation tests at high temperatures and in a common rail injection system confirmed that the degradation of fuel was accelerated and problems like corrosion and deposit build-up also occurred. Build-up of deposits was observed in the suction control valve (a valve to regulate the volume and pressure of fuel) of the supply pump (a pump to boost fuel pressure and to supply fuel to injection nozzles) in fuel system durability test rig and in the fuel system piping. These results were obtained by significant on-road vehicle operating tests. While it may not be as significant a problem in practical use for all customers, it was considered necessary to maintain a certain minimum level of deposit and corrosion resistance for the fuel.

Although corrosion occurred in the fuel tank circulation test using the conventional test method, it was confirmed that no problems existed by conducting the fuel tank durability test again using fuel with antioxidant added.

Polyunsaturated Fatty Acid Methyl Ester Content

Since polyunsaturated acid methyl esters, such as methyl linolenate, are molecules having multiple unsaturated bonds, a large amount of sludge is easily generated by oxidative degradation, and blockage of the fuel system is likely to occur, even if the content of this contaminant is small. As to the specific make-up of methyl

esters with unsaturated bonds, some are provided with the analysis method and the standard value for neat FAME according to the European standard EN14214. Specifically, the analysis method and standard value exist for the content of methyl linolenate, having three unsaturated bonds. As for polyunsaturated fatty acid methyl esters with four or more unsaturated bonds, the standard value exists while the analysis method does not exist. In EN14214, the content of methyl linolenate cannot exceed 12% by mass, and the content of polyunsaturated fatty acid methyl esters with four or more unsaturated bonds cannot exceed 1% mass.

While it was confirmed that the yield of sludge increases when the content of methyl linolenate was substantial, it was determined that the yield of sludge can be controlled by maintaining a standard value of oxidation stability (acid value growth). Polyunsaturated fatty acid methyl esters with four or more unsaturated bonds were more difficult to deal with. Analysis was extremely difficult after blending with diesel fuel, and it was considered appropriate to specify the limiting value according to the neat FAME standard instead.

The volume of sludge generated in the simulation tests increased when the content of methyl linolenate in FAME blended diesel fuel increased. It was found that the methyl linolenate decreased the oxidative stability significantly. It was considered necessary to maintain a certain minimum level of fuel robustness.

Build-up of deposits was observed in the suction control valve, which regulates the fuel pressure and volume of the fuel supply pump. This was observed in fuel system rig durability tests and in the fuel system tubing of the endurance test vehicle. While it may not be a problem in practical use, it was considered necessary to maintain the level of fuel used for the durability test as the minimum.

Regarding polyunsaturated fatty acid methyl esters with four or more unsaturated bonds, no confirmation was made through simulation tests or durability tests, and no results were obtained, sufficient to make firm conclusions. However, the fuel blend's oxidative stability may decrease significantly even due to a small quantity of this contaminant.

Cetane Index

The cetane number and cetane index are indicators of the ignitability of diesel fuel, and the engine cannot be operated unless they are above a certain value. In Japan a compulsory standard cetane index of at least 45 is required. The cetane index is an indicator estimating the cetane value from the density and distillation characteristics. It is not always applicable when a substance with different composition is blended,

because it is based on petroleum sourced components. While the variation is large to some extent when compared with conventional diesel fuels, the cetane index of biodiesel blends can be applied when the blend ratio is 5% or less.

When FAME is blended, the cetane index tends to be large compared with the cetane value. This tendency is more significant with the increase in the blending ratio of FAME. Variation in correlation between cetane value and cetane index is significant compared with diesel fuel without added FAME. Within the 5% FAME blending range, the cetane index is higher than cetane value by an average of 1.3.

Test Methods

The FAME and triglyceride content of diesel fuel are determined using high performance liquid chromatography (HPLC). The methanol content in FAME blended diesel fuel is determined using gas chromatography with an oxygen detector (GC-AED), with head space, or with water extraction. Since one of the initial intentions of this work was to add the intermediary contaminant methyl linolenate as a standard test item, measurement using the GC-AED method was evaluated to analyze methanol and methyl linolenate simultaneously. However, a more general test method can be considered if one were to analyze only methanol. Water extraction – gas chromatography and head space – gas chromatography were considered, after which the preferred method was established.

Acid values are determined by potentiometric titration. Formic acid, acetic acid and propionic acid in FAME blended diesel fuel are determined using water extraction ion chromatography. The oxidation stability of FAME blended diesel fuel is estimated by the total acid number (TAN) growth after thermal degradation. The rise of TAN is measured after 16 hours of heating to 115 C, while bubbling oxygen at 3.0 L/h through the sample. The test apparatus used in this method is defined in ISO-12205-1995 ‘Petroleum Products – Determination of the Oxidation Stability of Middle – Distillate Fuels.’

Other Regulatory Information

The test method and oxidation stability limit were newly developed by METI because the current oxidation stability test method and limitations were not suitable for application to FAME blended diesel fuel. This diesel fuel regulation went into effect starting March 2006. For reducing the workload of fuel distributors who do not actually blend FAME, two properties, ester content and triglyceride content are initially measured. If neither is detected, distributors do not need to sample and measure the

other four properties.

(ii) Neat FAME for Blending Stock (JIS K2390:2008 Specifications for B100)

Along with standards for FAME blends described above, standards were also developed for the pure substance. Basically, the standard items and values were modeled after the FAME standards in Europe at the time, with EN 14214 as the starting point. The characteristics especially focused upon include oxidative stability, acid value, specific acid content, and cold temperature properties.

Oxidative Stability

A standard value was not established for oxidative stability of B100, but quality requirements are 'In accordance with the mutual agreement between parties concerned'. While a new evaluation method was established as the standard for FAME blended diesel fuel, based on a series of careful studies it was found that the oxidative stability could be different for the same FAME, because it actually depends on the diesel fuel component. However, the diesel fuel properties that affect the oxidation stability after it is blended with FAME have not been identified. If an oxidative stability standard of FAME is established that is applicable for blending with any kind of diesel fuel, it will be an excessively strict standard. Accordingly, this item was defined as 'Based on mutual agreement between the manufacturer and the user'. However, a 10 hr minimum oxidative stability is needed to meet the Japanese Compulsory Diesel Fuel Standards.

Acid Value and Content of Specific Acid

The standard value of acid content for B100 is a maximum of 0.5 mgKOH/g. This value is equal to the European Standard. Regarding the maximum acid value after blending with diesel fuel, a value was computed by taking 5% of the European Standard and adding this contribution of the FAME-originating acid to the acid value of the conventional diesel fuel.

When it is assumed that formic acid, acetic acid and propionic acid, which are specific acids, are contained FAME in the quantity equaling 0.5mgKOH/g, the concentration becomes 20 ppm, 27 ppm and 33 ppm, respectively. Because the total is 30ppm or less and the acid value of the FAME 0.5 mgKOH/g is almost equivalent, the standard for the content of a specific acid is not added to the neat standard.

Table 32 Japanese FAME Specification (JIS K2390:2008)

JIS K2390:2008 Neat FAME for use as Automotive Fuel Blend Stock

Item	Unit	Specification	
		Limit	Test Method
Ester content	mass %	96.5 min	EN 14103
Density (@15 deg.C)	g/cm^3	0.860-0.900	JIS K 2249
Kinematic viscosity (@40 deg.C)	mm^2/s	3.50-5.00	JIS K 2283
Flash point	Deg.C	120 min	JIS K 2265
Sulfur content	mg/kg	10 max	JIS K 2541-1, -2, -6 or -7
10% carbon residue	mass %	0.3 max	JIS K 2270
Cetane number		51.0 min	JIS K 2280
Sulfated ash content	mass %	0.02 max	JIS K 2272
Water content	mg/kg	500 max	JIS K 2275
Total contamination	mg/kg	24 max	EN 12662
Copper corrosion	rating	1 max	JIS K 2513
Oxidation stability	hours	Agreement between producer and distributor	
Acid value	mgKOH/g	0.50 max	JIS K 2501or JIS K 0070
Iodine value	gl/100g	120 max	JIS K 0070
Methyl linolenate	mass %	12.0 max	EN 14103
Methanol content	mass %	0.20 max	EN14110
Monoglyceride content	mass %	0.80 max	EN 14105
Diglyceride content	mass %	0.20 max	EN 14105
Triglyderide content	mass %	0.20 max	EN 14105
Free glycerol content	mass %	0.02 max	EN 14105 or EN 14106
Total glycerol content	mass %	0.25 max	EN 14105
Metals (Na+K)	mg/kg	5.0 max	EN 14108 and EN 14109
Metals (Ca+Mg)	mg/kg	5.0 max	EN 14538
Phosporous	mg/kg	10.0 max	EN 14107
Pour point	Deg. C	Agreement between producer and distributor	
CFPP	Deg. C		

Cold Temperature Properties

Standard values are not established for cold temperature performance characteristics, but the specified quality requirements are 'Based on the mutual agreement between parties concerned.' Because the low temperature performance of FAME blended diesel fuel depends significantly on the properties of both the FAME and the diesel fuel, it is difficult to specify the low-temperature performance of FAME in a useful manner. Although low-temperature performance specifications are provided in the European Standards, similar to the diesel fuel standards, this is intended for use with neat FAME, and it is difficult for use as an indicator when it is blended with diesel fuel.

7.5 Malaysia

7.5.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

Under the National Energy Policy, three principal energy objectives are instrumental in guiding the future energy sector development; the supply, utilization and environmental. They are

(a) The Supply Objective: To ensure the provision of adequate, secure, and cost-effective energy supplies through developing indigenous energy resources both non-renewable and renewable energy resources using the least cost options and diversification of supply sources both from within and outside the country;

(b) The Utilization Objective: To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and

(c) The Environmental Objective: To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

In the Eighth Malaysian Plan, Renewable Energy was announced as the fifth fuel in the new Five Fuel Strategy in the energy supply mix. It is targeted that RE will contribute 5% of the country's total electricity demand by the year 2005, that is by the end of the Eighth Malaysia Plan period. With this objective in mind, greater effort is being undertaken to encourage the utilization of renewable resources, such as biomass, biogas, solar and mini-hydro, for energy generation. The Ministry has identified palm oil wastes as the biggest renewable resources that can be developed into bio-energy. Solar is another important option, particularly for rural electrification and water heating. The government is currently working on 'hands-on' applications of RE and EE with a number of on-going projects.

On the 9th pril 2009, the Ministry of Energy, Water and Communication has been named Ministry of Energy, Green Technology and Water. The strong commitment of Malaysian Government to address long term sustainability of our environment has resulted in the launching of National Green Technology Policy, which pathed the way forward on Malaysia’s commitment towards the path of green development. The National Green Technology Policy is built on Four Pillars:

- Energy – Seek to attain energy independence and promote efficient utilization;
- Environment – Conserve and minimize the impact on the environment;
- Economy – Enhance the national economic development through the use of technology;
- Social – Improve the quality of life for all.

Government has committed RM 1.5 billion fund for the promotion of Green Technology related activities.

One of the short-term national goals of the Green Technology Policy is to make significant progress and major improvements in the transportation sector by incorporating of Green technology in the infrastructure and vehicles, in particular, biofuels and public road transport. A study identified the renewable energy resource potential in the country, in ringgit (MYR) value, as shown in Table 33.

Table 33 Energy value for potential renewable energy resource in Malaysia, in ringgit

Renewable Energy Resources	Energy Value in RM million (Annual)
Forest residue	11,984
Palm oil biomass	6,379
Solar thermal	3,023
Mill residues	836
Hydro	506
Solar PV	378
Municipal waste	190
Rice husk	77
Landfill gas	4

To achieve the national objectives, the Government is pursuing the following strategies:

- **Secure supply**
  Diversification of fuel type and sources, technology, maximize use of indigenous energy resources, adequate reserve capacity to cater for contingencies, adequate reserve margin for generation, upgrading transmission and distribution networks and distributed generation (islanding);
- **Sufficient supply**
  Forecast demand, right energy pricing and formulate plans to meet demand.
- **Efficient supply**
  Promote competition in the electricity supply industry.
- **Cost-effective supply**
  Promote competition and provide indicative supply plan to meet demand based on least cost approach using power computer software such as WASP;
- **Sustainable supply**
  Promote the development of renewable and co-generation as much as possible.
- **Quality supply (low harmonics, no surges and spikes, minimal variation in**

voltage)

Match quality with customer demand with variable tariffs;

- **Efficient utilization of energy**

  Bench marking, auditing, financial and fiscal incentives, technology development, promotion of ESCOs, Labeling, Ratings, correct pricing, energy managers; and
- **Minimizing Negative Environmental Impacts**

  Monitor the impacts, improve efficiency of utilization and conversion and promote renewable.

(2) Concrete target and strategy for Biofuel

Under the leadership of the Ministry of Plantation Industries and Commodities, the National Biofuel Policy was announced by the Honorable Prime Minister of Malaysia in March 2006. In May 2006, the Biofuel Bill 2006 has passed the Parliament of Malaysia. The National Biofuel Policy encourages the use of biofuels in line with the nation's Five-Fuel Diversification Policy. It spells out a comprehensive framework with concrete initiatives in line with the objectives of the United Nations Framework Convention on Climate Change (UNFCC) to which Malaysia is a party. The National Biofuel Policy was formulated after extensive consultation with all the stakeholders and as a result of research findings by PORIM/MPOB since 1982. The policy focuses on blending processed palm oil with petroleum diesel and also converting palm oil into biodiesel (methyl ester), mainly for export. The implementation of the National Biofuel Policy is spearheaded by the Ministry of Plantation Industries and Commodities.

The National Biofuel Policy envisions (a) the use of environmentally friendly, sustainable and viable sources of energy to reduce the dependency on depleting fossil fuels and (b) the enhancement of prosperity and well-being of all stakeholders in the agriculture and commodity based industries through stable and remunerative prices. The policy is underpinned by five strategic thrusts:

Thrust 1: Biofuel for transportation
Thrust 2: Biofuel for Industry
Thrust 3: Biofuel technologies
Thrust 4: Biofuel for export
Thrust 5: Biofuel for cleaner environment

Announcement of mandatory use of biodiesel was made in October 2008 by the Prime Minister of Malaysia. The Malaysia Biofuel Industry Act was gazetted on 1st

November 2008 to regulate and ensure orderly development of the Malaysian biofuel industry. The Act provide for the mandatory use of biofuel, prescribing the type of biofuel, percentage of blending, licensing of activities related to biofuel and other related matters.

The Government noted that a policy has been put in place to ensure a balance in the supply of sustainable palm oil to the food sector while meeting the demand in the biofuel sector. As a rule, palm oil supply for the biodiesel production of biodiesel will not exceed more than six (6) million tonnes per year in order to ensure the supply of sustainable palm oil to the food sector would not be jeopardized.

The local implementation of B5 programme by the Government Departments took place started on 3rd February 2009. The splash blending of B5 was done at Klang Valley Distribution Terminal (KVDT) by Petronas. The Government Departments involved in the B5 implementation are the Armed Forces (ATM) and Kuala Lumpur City Hall (DBKL). For duration 3rd February – 30th September 2009, the supply of B5 to ATM and DBKL reached to 4.05 million litres (equivalent to 3,439 tonnes). It involved the utilization of biodiesel amounted to 202,293 litres (equivalent to 178 tonnes).

Currently, there is no biodiesel limit set in diesel fuel. The Malaysian Standard on Palm Methyl Esters (MS 2008:2008) which similar to EN 14214 / ASTM D6751 was published in November 2008 and also ready to be enforced.

The biodiesel industry is considered a new emerging growth area for Malaysia. As of December 2009, a total of 70 licenses applications were received by the Ministry of Plantation industries and Commodities, 43 licenses have been approved and 27 applications in various review stages. A total of 28 biodiesel plants with annual biodiesel production capacity of 2.7 million tonnes per year have been established. Fifteen (15) plants are under construction with production capacity of 1.9 million tonnes per year (Table 34).

Table 34 Biodiesel Approved Licencees in Malaysia (as at December 2009)

Implementation Phase	No.	Biodiesel Capacity (Tonnes/Year)
Commercial Production	17	2,340,700
Production Trial	11	405,000
Under Construction	15	1,940,200
Total	43	4,685,900

(3) Main crops for BDF and its production planning

At present, the major crop for BDF production in the country is palm oil. Malaysian and Indonesian Governments pact agrees to use 40% (~6 million tonnes) of palm oil production (15.8 million tonnes in 2006) for the production of biodiesel. This 6 million tonnes of palm oil is a moral pledge between the two Governments and no legal implications on either country should biodiesel usage fall below or shoot above this level. Jatropha curcas is another crop of interest of the Malaysian Government. The government has planned on a demonstration project on cultivation of Jatropha curcas to establish the economic feasibility study of the crop for biodiesel production. Biofuel from algae is also under extensive R&D programme.

(4) Regulations and incentives to promote BDF utilization

Under the Promotion of Investment Act 1986, numerous incentives have been given to promote the private sector involvement to capitalize on this new development. These incentives are provided for producers and generally available for all the manufacturing industries including biodiesel industry.

The major tax incentive is Pioneer Status. A company granted Pioneer Status enjoys a 5-year partial exemption from paying income tax. It pays tax on 30% of its statutory income. To encourage investment in the states of Sabah and Sarawak and the designated Eastern Corridor of Peninsular Malaysia, companies located in these areas will enjoy a 100% tax exemption on their statutory income during their 5-year exemption period.

The incentives for strategic and high technology projects, and commercialization of R&D findings of the public sector in resource based industries also have been given to the relevant companies. A company which invests in its subsidiary company engaged in the commercialization of R&D findings will be given tax exemption equivalent to the amount of investment made in the subsidiary company. At the same time, the subsidiary company that undertakes the commercialization of R&D findings will be given pioneer status with 100% tax exemption on statutory income for 10 years.

7.5.2 Standardization of BDF

(1) Concept of BDF standards and regulations

The Malaysian specification/standard of palm biodiesel was formulated based on European biodiesel specifications, EN 14214 as a basis. The test methods are based on ASTM, ISO, EN and Malaysian test methods which are identical to ASTM or ISO methods. The standard drafting for biodiesel was undertaken by the Technical

Committee (TC) on Petroleum Fuels which it membership includes oils and gas companies (e.g. Shell, Petronas, Caltex, Exon Mobile etc.), government agencies (e.g. MPOB, Department of Environment, Department of Transportation, etc.) and representatives from Malaysian Automotive Association (MAA). The provisional voluntary Malaysian standard on B5 palm olein biofuel blend (MS 2007:2007) was published in March 2007. The Malaysian standard on palm biodiesel was published in November 2008.

(2) Standards of BDF

(i) Current status of BDF standardization

The Malaysian standard on palm methyl ester MS 2008:2008 has been published. Drafting of B5 standard is underway.

(ii) Reference standards

Reference standards for Malaysian biodiesel standard is ASTM D6751 and EN 14214.

(iii) Remarkable items

The parameter on CFPP for Malaysian biodiesel is +15°C. We acknowledged the important of polyunsaturated methyl esters in biodiesel and maintained it as 1 %wt. maximum. The iodine value was 110°C as certain oil palm species is highly unsaturated.

(3) Specification values

The specification of palm methyl ester is shown in Table 35.

Table 35 Malaysian FAME Specification MS 2008:2008 – Automotive Fuels – Palm Methyl Esters (PME) for Diesel Engines – Requirements and Test Methods

Property	Unit	Limits		Test methods
		Min	Max	
Ester content	% (m/m)	96.5	-	EN 14103
Density at 15 °Cc	kg/m3	860	900	ISO 3675 ISO 12185 ASTM D 4052
Viscosity at 40 °C	mm2/s	3.50	5.00	ISO 3104 MS 1831
Flash point	°C	120	-	ISO 3679e MS 686
Sulfur content	mg/kg	-	10.0	ISO 20846 ISO 20884 ASTM D 5453
Carbon residue (on 10% distillation residue – ISO 10370)f (on 100% distillation sample – ASTM D 4530)	% (m/m)	-	 0.30 0.05	 ISO 10370 ASTM D 4530
Cetane number		51.0	-	ISO 5165 MS 1895
Sulfated ash content	% (m/m)	-	0.02	ISO 3987 ASTM D 874
Water content	mg/kg	-	500	ISO 12937 ASTM E 203 ASTM D 1160
Total contamination	mg/kg	-	24	EN 12662 ASTM D 5452
Copper strip corrosion (3 h at 50 °C)	rating	Class 1		ISO 2160 MS 787
Oxidation stability, 110 °C	hours	6.0	-	EN 14112
Acid value	mg KOH/g	-	0.50	EN 14104 MS 2011
Iodine value	g iodine/100 g	-	110	EN 14111
Linolenic acid methyl ester	% (m/m)	-	12.0	EN 14103
Polyunsaturated (>=4 double bonds) methyl esters	% (m/m)	-	1	-
Methanol content	% (m/m)	-	0.20	EN 14110
Monoglyceride content	% (m/m)	-	0.80	EN 14105 ASTM D 6584
Diglyceride content	% (m/m)	-	0.20	EN 14105 ASTM D 6584
Triglyceride contenth	% (m/m)	-	0.20	EN 14105 ASTM D 6584
Free glycerolh	% (m/m)	-	0.02	EN 14105 EN 14106 ASTM D 6584
Total glycerol	% (m/m)	-	0.25	EN 14105 ASTM D 6584
Group I metal (Na+K) Group II metals (Ca+Mg)	mg/kg mg/kg	-	5.0 5.0	EN 14108 EN 14109 EN 14538
Phosphorus content	mg/kg	-	10.0	EN 14107 ASTM D 4951
CFPP	°C	-	15	EN 116

7.6 New Zealand

7.6.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

The New Zealand Government released the final New Zealand Energy Strategy (NZES) in October 2007. The NZES also notes an in-principle goal to halve domestic transport emissions per capita by 2040 relative to 2007 emissions. It includes an emphasis on reducing transport emissions and reducing our dependence on imported oil, which will require a combination of energy sources for vehicles, including biofuels and electricity. The NZES is currently being updated.

(2) Targets/strategies/regulations/incentives for BDF

The biodiesel grants scheme commenced on 1 July 2009 and will continue for three years. A grant of up to 42.5 cents per litre for biodiesel or the biodiesel content of a diesel/biodiesel blend will be available to biodiesel producers. The grant is for domestic production of biodiesel for a range of end uses.

(3) Main crops for BDF and its production planning

There is currently around 15 million litres of biodiesel production capacity in New Zealand, and the biodiesel being produced is predominately sold via the contractual market, rather than being incorporated in the retail fuel mix.

For the most part, the feedstocks being utilised are tallow, rapeseed and waste-cooking oil. Algae is being investigated as a feedstock for second generation biofuels. Table 36 shows the current status of biodiesel in New Zealand.

Table 36 Current status of biodiesel in New Zealand

Country	Mixing rate	Main Feedstocks	Strategy / Goal	Standard
New Zealand	Up to 5% for retail sales	Tallow, Rapeseed, Waste cooking oil	Up to 5% biodiesel permitted in diesel for retail sale.	Engine Fuel Specifications Regulations 2008 (B100 and biodiesel blend quality requirements)

7.6.2 Standardization of BDF

The quality of petrol and diesel in New Zealand is regulated by the Engine Fuel Specifications Regulations 2008 [40]. Up to 5% biodiesel content is permitted in diesel for retail sale. Table 37 shows the B100 specifications for blending with diesel (for retail sale).

Table 37 New Zealand FAME Specification

Property	Units	New Zealand Engine Fuel Specifications Regulations 2008
Ester content	Mass%	96.5 min
Density	Kg/m³	860 – 900
Viscosity	Mm²/s	2.0 – 6.0
Flash Point	Deg C	100 min
Sulfur Content	Mass%	10 max
Distillation, T90	Deg. C	-
Carbon residue 100% or 10%	Mass%	 0.05 max 0.30 max
Cetane Number		47 min
Sulfated ash	Mass%	0.020 max
Water content	Mg/kg	500 max
Total contamination	Mg/kg	24 max
Copper corrosion		Class 1
Acid value	mgKOH/g	0.50 max
Oxidation Stability	Hours	10.0 min
Iodine Value		140 max
Methyl Linolenate	Mass%	12.0 max
Polyunsaturated FAME (more than 4 double bonds)	Mass%	1 max
Methanol content	Mass%	0.20 max
Monoglyceride content	Mass%	0.80 max
Diglyceride content	Mass%	0.20 max
Triglyceride content	Mass%	0.20 max
Free glycerol content	Mass%	0.020 max
Total glycerol	Mass%	0.25 max
Na + K	Mg/kg	5.0 max
Ca + Mg	Mg/kg	5.0 max
Phosphorous content	Mg/kg	10.0 max

7.7 Philippines

Oil, which is practically 100% imported as raw material crude oil and as finished products, dominates the energy sources in the Philippines. In 2008, oil constituted 33% of the energy mix. The thrust towards diversification and development of indigenous and renewable energy sources resulted in the present 7% oil share in the power sector demand mix. Therefore, diversification of fuel sources in the transport sector is a major program of the Philippines.

The high and volatile price of this finite resource (oil), and its being a major contributor to the deteriorating air quality further drives the thrust towards energy independence of the Philippine Government thru the Department of Energy (DOE). With the Philippines having vast agricultural and underutilized lands, the promotion and use of biofuels as an alternative fuel for transport have become a national strategy.

7.7.1 Policy and Measure of BDF

(1) Biodiesel Policy

It is the policy of the State "to achieve energy independence and fuel diversification while meeting environmental challenges through the utilization of agricultural-based feedstocks". The Biofuels Act of 2006 (Republic Act No. 9367), mandating the use of biofuels, including biodiesel, was signed into law on January 12, 2007 and became effective on February 6, 2007 after its publication in 2 newspapers of general circulation. This landmark legislation is one of, if not the quickest-passed legislation, as it was pursuant to the government's thrust to reduce dependence on oil, increase self-sufficiency, improve air quality, as well as improve the economic condition in the countryside and promote rural development, thereby encouraging "balik probinsiya" and at the same time decongesting the urban centers.

Specifically for biodiesel, Section 5.3 of the law provides that: "Within three (3) months from the effective date of this Act, a minimum of one percent (1%) biodiesel by volume shall be blended into all diesel engine fuels sold in the country: *Provided,* that biodiesel blend conforms to PNS for biodiesel." The law further states that "Within two (2) years from the effective date of this Act, the National Biofuels Board (NBB) created under this Act is empowered to determine the feasibility and thereafter recommend to DOE to mandate a minimum of two percent (2%) blend of biodiesel by volume which may be increased taking into account considerations including but not limited to domestic supply and availability of locally-sourced biodiesel component." Effective May 7, 2007, a 1% biodiesel blend (B1) was required for all diesels sold in the country.

On February 6, 2009, the mandated 2% biodiesel blend (B2) in all diesels became effective by virtue of DC 2009-02-0002. This was after the supply and availability of locally-sourced biodiesel, as well as its compatibility with the in-use vehicle fleet, especially for those vehicles under warranty, was ascertained with the concerned stakeholders. Discussions for a higher blend are underway, with due consideration for its impact on the local diesel (B2) pump prices. It may be noted that because of its use in the public transport, the price of diesel is one of the most critical and sensitive factors in the prices of goods and commodities, and transport fares. Qualified transports, both local and international, as well as qualified product tankage are concerns especially as they add to the cost of doing business.

The policy towards use of biofuels is further enhanced by the passage of the Renewable Energy Law on December 10, 2008, with biofuels classified under biomass which is among the renewable energy sources.

(2) Policy Background

The use of biodiesel is actually the result of several initiatives of the government over the years. During the early 1980's, the Philippine National Oil Company and the Ministry of Energy, now with DOE, embarked on a Cocodiesel Program using pure coconut oil as a diesel blend. However, technical problems (e.g., gumming resulting in filter clogging), the improvement of vegetable oil prices in the world market, and the relatively lower prices of diesel caused the program to be discontinued. Nonetheless, researches continued.

To promote the utilization of coco-biodiesel, President Gloria Macapagal-Arroyo launched the coco-biodiesel program on April 21, 2004 in San Pablo City, Laguna, one of the biggest coconut-producing areas.

Earlier, in February 2004, the President issued Memorandum Circular (MC) No. 55 mandating all government offices, including all government-owned and controlled corporations, to use 1% coco-biodiesel blend in all their diesel fuel requirements. MC 55 was meant to serve as a pilot test to determine the techno-economic viability of coco-methyl ester (CME) as an alternative transport fuel. To implement MC 55, Department Circular (DC) No. 2004-04-003 was issued in March 2004.

A year later, DC No. 2005-04-003 was issued to promote the wider utilization of coco-biodiesel in the transport sector as a blending component of petroleum diesel. Under the said Circular, oil companies in the Philippines were enjoined to support the alternative energy program of the DOE by making available coco-biodiesel (in bottles) as a retail shelf item in all their gas stations nationwide. Local Government Units (LGUs) were likewise enjoined to issue the proper ordinances to ensure compliance with the said circular.

The program gained another boost in August 2005 with the intensified implementation of the energy efficiency and conservation. Through the issuance of Administrative Order (A.O.) No. 126, all government agencies were subjected to energy audit. Their compliance to MC 55 (use of B1) formed part of their efficiency rating.

(3) Strategy for Biodiesel

Learning from experiences of other countries that have embarked on a program on biofuels, the Biofuels Law made sure that every aspect of the biofuels program has lead agency to take care of. A National Biofuels Board (NBB) was created, composed of heads of concerned Departments and Authorities, and chaired by the Secretary of the Department of Energy (DOE), namely: the Department of Trade and Industry (DTI); Department of Science and Technology (DOST); Department of Agriculture (DA),

Department of Finance (DOF); Department of Labor and Employment (DOLE); Philippine Coconut Authority (PCA); and the Sugar Regulatory Administration (SRA). The Board also agreed to include as non-voting members the heads of the Department of Agrarian Reform (DAR), the Department of Environment and Natural Resources (DENR), Department of Transportation and Communication (DOTC), and National Commission on Indigenous People (NCIP).

Research and Development / Promotions

AS shown in Figure 63, there are numerous on-going research and development studies for each level in the supply chain, i.e., from the agri-based feedstocks to the extracted oil, biodiesel and the blended petroleum fuel. In all of these levels, considerations are made on the following.

(1) process/infrastructure/logistics for land use, viable basestocks, agro-industrial development, quality products, etc.;

(2) marketing and distribution to ensure supply security – availability and accessibility, supply competition, export market, etc;

(3) implementation / enforcement of regulations/guidelines, standards, as well as monitoring compliance; and

(4) incentives to encourage investments and sustainability of the program.

Research, development and extension (RD&E) and promotions are underway at the various levels. The NBB, DOE and the oil companies are working together for extensive information, education and communication (IEC) campaign on biofuels and blends, even as the oil and car companies are having their respective IEC campaigns on their customers.

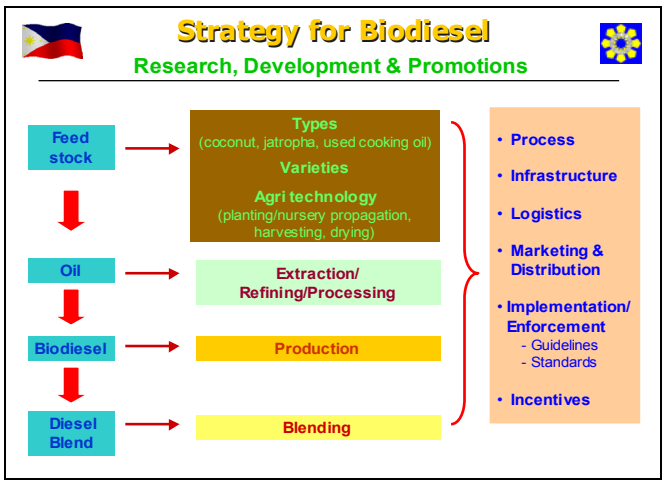

Figure 63 Strategy for biodiesel research, development and promotions in The Philippines

Supply Management

The NBB has to ensure adequate and continuous agricultural supply for the fuel program, without sacrificing food and other traditional uses of the feedstocks. Thus, one of the key functions of the NBB is to recommend to the DOE the level of the mandatory blend of biodiesel to petroleum diesel considering availability of biodiesel from local supply.

The DA is in-charge for the biodiesel feedstocks, and assisted by the PCA, with coconut as the feedstock of accredited biodiesel producers. To handle jatropha, which is a potential feedstock, the Philippine Forest Corporation is actively involved in the plantation/propagation. The Alternative Fuels Corporation (PAFC), a subsidiary of the Philippine National Oil Company, was recently created to cover RD&E and investment promotions for jatropha and other alternative fuels. Of course, the DOE is lead for the products – biodiesel and the diesel fuel blends.

On October 8, 2008, the NBB issued Joint Administrative Order (JAO) No. 2008-1 Series of 2008 "Guidelines Governing the Biofuel Feedstocks Production, and Biofuels and Biofuel Blends Production, Distribution and Sale Under Republic Act No. 9367". Among the objectives are to ensure the availability of alternative and renewable clean energy without detriment to the natural ecosystem, biodiversity and food reserves of the country; to ensure that lands devoted to food crops shall not be utilized for biofuel feedstocks; to ensure compliance to the PNS; and to ensure compliance with the mandated biofuel blends, among others.

(4) Feedstocks

There are many possible feedstocks for biodiesel. At the moment, the following are the present and high potential feedstocks.

Coconut

Coconut, known in the Philippines as the tree of life, is at present the only feedstock that can meet the Philippine National Standard for biodiesel and the diesel blend B2 (Diesel with 2% biodiesel), having consistently passed all the necessary tests. The National Research and Energy Laboratory of the US-DOE was among the laboratories that conducted tests on coconut methyl ester samples, confirming its high oxidation stability, among other properties.

Coconut is a favored biodiesel feedstock because its composition closely resembles diesel, and it is grown in large areas all over the country. Coconut methyl ester (CME) adds value to coconut, and there is more than sufficient CME capacity in the country.

Coconut and its products are major exports of the Philippines. CME started as a by-product of oleo-chemical plants. Researches led to its "refinement", making it suitable for use as a blending component of diesel. Over time, it was established that CME not only substitutes part of our diesel requirements, as a blend, but also enhances its quality, in terms of detergency and solvency, thus contributing to cleaner air. Not all CME, though, are of fuel grade.

With surplus coconut for its traditional uses in the food and oleo-chemicals sector, CME as fuel was encouraged. As of December 2009, 11 commercial plants and one (1) LGU-based plant , with a combined annual capacity of close to 400 million liters, that have been accredited by the DOE for biodiesel production. Local requirement (potential diesel displacement) is about 130 million liters per year at 2% blend.

The NBB, particularly the Department of Agriculture, has adopted a feedstock program. These include ensuring that its use as a biofuel feedstock will not conflict with existing agro initiatives, guaranteeing local market for biofuels pursuant to the Biofuels Act; meeting domestic demand first before exports; continuing support to feedstock development as such also supports development in the countryside through employment/income generation for the farmers; intercropping other high-value crops in coconut plantations; and provision of social amelioration for coconut farm workers, among others. Coconut is a beneficiary of the FIELDS Program 2008, which covers Fertilizer, Irrigation and other infrastructure, Education and extension, Loans, Dryers and other post harvest facilities, and Seeds and other genetic materials.

Jatropha

Jatropha, known locally as *tuba-tuba* or *tubang bakod,* has been identified as a potential feedstock for biodiesel, being a non-food crop, and supposed to grow well anywhere. Speciation studies are on-going, to determine appropriate varieties/species for commercialization, considering climate, rainfall, soil, geography, etc. While jatropha does not compete with food, it must not also be allowed to compete with land use. The afore-mentioned JAO provides the guidelines.

Others

The DOE is also in receipt of proposals for registration and accreditation of biodiesel from used cooking oil. Consistency of the biodiesel product quality is seriously being looked into, as well as its indigenous component which is a requirement of the Biofuels Law.

(5) Incentives

There is no direct government subsidy for biodiesel production, blending and marketing. Moreover, with the liberalized environment in the oil downstream sector investments have been expected to come from the private sector. To encourage the investments, various incentives applicable to the biodiesel sector are contained in at least three laws.

(i) Omnibus Investments Code of 1987

Investment Priority Projects (IPP) identified and updated annually may be registered with the Board of Investments and would thus be entitled to incentives. Production facilities, vehicles, etc. for the biofuels program have been part of the IPP.

(ii) Biofuels Act

Incentives to jumpstart the program are explicitly provided. These are on top of those applicable under the Omnibus Investments Code.

- ***Specific Tax*** Biofuels are zero (0)-rated, regardless of source – local or imported.
- ***Value Added Tax (VAT)***. The sale of raw materials used in the production of biofuels is exempted from the 12% VAT.
- ***Philippine Clean Water Act Fees and Charges.*** Water effluents from biofuels production used as liquid fertilizer and other agricultural purposes which are considered "reuse" are exempted under by RA 9275.
- ***Government Financial Institutions' Loans***. High priority will be accorded to Filipino entities that shall engage in production, storage, handling and transport of biofuels and biofuel feedstocks, including the blending of biofuels with petroleum, as certified by the DOE.

(iii) Renewable Energy (RE) Act

With biomass, including biofuels categorized as renewable energy sources, the expanded incentives also apply to biodiesel and projects related to its commercialization and use. Further, there are also incentives for RE commercialization (for all manufacturers, fabricators and suppliers of locally-produced RE equipment and components duly recognized and accredited by the DOE) as well as for farmers engaged in the plantation of biomass resources.

- ***Income Tax Holiday (ITH)***. For the first 7 years of the commercial operation, biofuels manufacturers shall be exempt from income taxes.
- ***Duty-free importation of RE Machinery, Equipment and Materials.*** Within the first 10 years upon the issuance of an RE developer, the importation of the above, including parts thereof, and control and communication equipment, shall not be subject to tariff duties.

- ***Special Realty Tax Rates on Equipment and Machinery.*** Applicable to those actually and exclusively used for RE facilities not exceeding 1.5% of of their original cost less accumulated depreciation or net book value.
- ***Net Operating Loss Carry-Over.*** Applicable during the first 3 years from the start of commercial operation.
- ***Corporate Tax Rate.*** After 7 years of ITH, all RE Developers shall pay a corporate tax of 10% on its net taxable income.
- ***Accelerated Depreciation.*** If and only if an RE project fails to receive an ITH before full operation, it may apply for Accelerated Depreciation in its tax books and be taxed based on such.
- ***Value Added Tax (VAT)***. The sale of fuel or power generated from renewable sources shall be subject to zero percent (0%) VAT
- ***Tax Exemption of Carbon Credits.*** All proceeds from the sale of carbon emission credits shall be exempt from any and all taxes.
- ***Tax Credit on Domestic Capital Equipment and Services.*** A tax credit equivalent to 100% of the value of the VAT and customs duties that would have been paid had the items been imported, within the validity period of the RE operating contract.

(6) Regulations / Prohibited Acts for Biodiesel.

Laws, rules and regulations, standards, etc. guide entities dealing with biofuels. Compliance is enforced by various units in the DOE, as follows.

(i) The Oil Deregulation Law (Republic Act (RA) 8479)

This law is the mother law for the fuel sector. This includes provisions to cover fuel security, quality and quantity, and environmental protection. As such it requires the registration by fuel marketers of all fuel additives, and the compliance to the Philippine National Standards (PNS) of all petroleum products, biofuels and petroleum-biofuel blends that are put into commerce in the country. DC 2007-05-006 required a 1% blend of biodiesel in all diesel fuels (B1) effectively on May 6, 2007, and DC 2009-02-0002 required increasing the blend to 2% (B2) effectively on February 5, 2009.

(ii) The Clean Air Act (RA 8749)

This Act explicitly provided specifications on fuel quality and the technical committee that will review and formulate standards. It also required the registration of all fuel additives by the manufacturers, processors and traders. Even prior to any government mandate for biodiesel, coconut derivatives have been considered as an additive. A Certificate of Fuel Additive Registration (CFAR) is issued to manufacturers, processors and marketers, including repackers who comply with the requirements of

DOE Department Circular DC2007-02-0001. Biodiesel producers are required to have a quality control laboratory.

(iii) The DOE Memorandum Circular (MC) No. 55

This Ciruclar mandates diesel-fed government vehicles to use biodiesel blend, requires biodiesel manufacturers to secure a Certificate of Accreditation before they can sell their biodiesel.

(iv) The Biofuels Act (RA 9367)

This Act implementing rules and regulations DC 2007-05-006 reiterate the requirements for CFAR and the Certificate of Accreditation. The DC also clarifies on the Prohibited Acts, which include among others, the sale of biodiesel blends not conforming to the PNS. Penalties include fine and imprisonment of the persons or officials of the oil company responsible for the violation.

(v) The Joint Administrative Order (JAO) No. 2008-1, series of 2008

This order was issued by the NBB detailing the roles of the various stakeholders, both government and private. The order recognizes community biodiesel to promote the development of the biofuel industry in the country and encourage private sector participation.

(vi) The Renewable Energy Law (RA 9513)

This Law, with implementing rules and regulations DC 2009-05-0008, required certification from the DOE through the Renewables Energy Management Bureau (REMB) to qualify RE developers to avail of the incentives provided in the Law.

(7) Roles of the Various DOE Units on Biodiesel

The Oil Industry Management Bureau (OIMB) processes the CFAR, as it oversees the downstream oil industry sector and monitors quality, quantity, price, supply and demand, and production and marketing processes of fuels, as well as developments in the sector.

The Energy Utilization Management Bureau (EUMB) processes applications for Certificate of Accreditation, for which the CFAR is a prerequisite. The EUMB presently handles the monitoring of biodiesel producers and marketers. However, this function will eventually be moved to the Renewable Energy Management Bureau that is currently being organized pursuant to the new law. For manufacturers, the CFAR and Accreditation are both signed simultaneously by the DOE Secretary.

To ensure consumer safety and welfare, especially as far as quality of biodiesel and blends are concerned, the OIMB and EUMB inspects and gathers samples from various supply points of their respective areas of jurisdiction. The product samples are

then submitted to the Energy Research and Testing Laboratory Service (ERTLS) which conducts tests pursuant to the PNS. The ERTLS is also undertaking correlation between laboratories and testing equipment among the government, industry players and third party testing facilities to minimize, if not totally avoid inconsistent and contestable test results.

Cases of non-compliance are forwarded by the OIMB and EUMB, as the case may be, to the Legal Service (LS) which prosecutes such cases and impose the corresponding penalties.

7.7.2 Standardization of BDF

(1) Mandate

Consumers, particularly the motorists have to be assured of the appropriate quality of fuels sold in the country, especially the new fuels. Thus, diesel blended with biodiesel must conform with the diesel standard.

The standard setting mandate is provided in the Clean Air Act, while its enforcement is provided in the Oil Deregulation Law. The Biofuels Law mandates compliance to the Philippine National Standards (PNS) and imposes severe penalties for violations, which include fine and imprisonment. Various authorities are as follows.

Technical Committee for Standards

The Technical Committee on Petroleum Products and Additives (TCPPA) created by virtue of the Clean Air Act undertakes the mandate. The TCPPA took over the role of the Technical Committee on Petroleum Products & Lubricants (TC 12) of the Bureau of Product Standards (BPS). The TCPPA is co-chaired by the DOE and the DENR, with members coming from concerned government agencies, fuel sector, engine/vehicle suppliers, consumers, non-government organizations, and the academe. The TCPPA follows the standards development and review procedure of the product standards body where its representative sits as a regular member of the TCPPA.

For the biodiesel standards, the TCPPA membership is expanded to include chemists from the oleochemical industry. The country's leaders in the oleochemical industry are now members of the biodiesel industry, forming themselves into the Philippine Biodiesel Manufacturers' Association.

Bureau of Product Standards (BPS)

As the main standards body, the BPS promulgates the draft prepared by the TCPPA into a Philippine National Standard (PNS), pursuant to the Clean Air Act.

Department of Energy (DOE)

The PNS, while providing specifications, can only be enforced with a regulation issued

by the pertinent authority. For fuels, a DOE regulation, usually in the form of a Department Circular DC, is issued to require compliance to the PNS. In the case of biodiesel, the IRR of the Biofuels Law DC 2007-05-006 required such compliance. This requirement is reiterated in the earlier-mentioned JAO. Thus any update on the PNS is circulated thru publication in newspapers of general circulation, and a notice to the concerned entities through a DOE DC, after stakeholders' consultations.

(2) Product Standards

Standards are prepared and/or reviewed for updating as necessary. Recognizing that biodiesel feedstocks have varied properties owing to their composition, the government deemed it appropriate to also set standards for pure biodiesel (B100), which will eventually be a critical blending component of diesel. Thus, there are standards for the pure biodiesel (B100) and the allowable biodiesel blends (initially B1, and now B2), and which are updated pursuant to the Biofuels Law and the biodiesel program. For example, the PNS for B1 was effective May 2007 up to Jan 2009. At present the PNS is for B2.

Biodiesel - PNS/ DOE QS 002:2007- Coconut Methyl Ester (B100) specification

This is the current standard, in effect at the start of this ERIA biodiesel standardization project and is shown in Table 38.

Table 38 PNS/DOE QS 002:2007 - Coconut Methyl Ester (B100) Specification

PROPERTY	Limits	Test Method
Appearance	clear	Visual
Acid number, mg KOH/g, max.	0.50	PNS ASTM D 664 / PNS ASTM D 974 / PNS EN 14104
Carbon residue on 100% sample, % mass, max.	0.050	PNS ASTM D 4530 or PNS ISO 10370
Cetane number, min.	55	PNS ASTM D 613 or PNS ASTM D 6890 or PNS ISO 5165 or PNS IP 498/03
Cloud point, ^{O}C, max.	5	PNS ASTM D 2500
Copper strip corrosion 3 hrs @ 50^{O}C, max.	No. 1	PNS ASTM D 130 or PNS ISO 2160
Density @ 15^{O}C, kg/L	0.86-0.90	PNS ASTM D 1298 or PNS ASTM D 4052 or PNS ISO 3675
Distillation AET 90% recovered, ^{O}C, max	360	PNS ASTM D 1160 or PNS ASTM D 86
FAME content, % m/m, min.	96.5	PNS EN 14103 modified *
Flash point, Pensky-martens ^{O}C min.	100	PNS ASTM D 93
Glycerin, % mass, max. Free glycerin, % mass, max.	0.02	PNS AOCS Ea 6-94 (1997) / PNS ASTM D 6584 modified [a] or PNS EN 14105 modified [a]
Total glycerin, % mass, max.	0.24	PNS AOCS Ca 14-56 (1997) or PNS ASTM D 6584 modified [a] or PNS EN 14105 modified [a]
Glyceride content, % m/m, max. Monoglyceride content Diglyceride content Triglyceride content	 0.80 0.20 0.20	PNS EN 14105 modified * or PNS ASTM D 6584
Group Metals, mg/kg, max. Group I metals (Na + K) Group II metals (Ca + Mg)	 5 5	 PNS EN 14108 / PNS EN 14109 PNS EN 14538
Methanol content, % m/m, max.	0.20	PNS EN 14110
Methyl Laurate, % mass, min.	45	PNS EN 14331 modified [a] or PNS EN 14103 modified [a]
Oxidation Stability, 110 ^{0}C, hours, min*.	6	PNS EN 14112
Phosphorus, % mass, max.	0.001	PNS ASTM D 4951
Sulfated ash, % mass, max.	0.020	PNS ASTM D 874
Sulfur, % mass, max.	0.050	PNS ASTM D 2622 / PNS ASTM D 5453 / PNS ASTM D 4294
Viscosity, kinematic @ 40 ^{O}C, mm^{2}/s	2.0 – 4.5	PNS ASTM D 445
Water, % vol. max.	0.05	PNS ASTM D 6304 or PNS ISO 12937 or PNS ASTM E 203
Water & sediments, % vol. max.	0.05	PNS ASTM D 2709

Notes: [a] interim ; [b] to be reported quarterly

*This standard is in the process of updating to harmonize with the ERIA Benchmark Standard of 2008, especially on the 10 hours minimum limit for oxidation stability.

As early as 2003, a standard for coconut-based biodiesel or coco-methyl ester (CME) was promulgated (PNS 2020:2003, renamed PNS/DOE QS 002:2003 as the DOE got the mandate for standards of petroleum fuels. Coconut was the only available feedstock then. While patterned after ASTM D6751 (2002) for B100, the PNS took cognizance of the fact that ASTM considered a set of biodiesel from feedstocks which have composition and properties different from coconut oil. A technical working group was created, led by oleo-chemical sector representatives. Thus for the properties of free glycerin and total glycerin, for which the ASTM standard noted their non-applicability

to B100 using coconut oil feedstock, the test methods of the American Organization of Chemical Scientists (AOCS) were adopted, modified accordingly, and interim limits set, pending further studies.

In 2005, the review of the standard started, this time considering EN 14214 and studies, findings and suggestions from JAMA. Moreover, the advent of other potential feedstocks in the country caused the TCPPA to initiate standards for Jatropha, as well as for a generic B100 standard. However, due to the shortage of sustainable jatropha samples, as well as the undertaking of this ERIA BDF standardization project for the East Asia Region, the TCPPA agreed to just update the CME standard.

The updated standard was officially promulgated by BPS in 2007. Other than the modified AOCS methods already adopted in the previous version, applicable ASTM and EN methods for fatty acid methyl esters (FAME), methyl laurate, glycerins and glycerides were also incorporated, modified accordingly, and interim limits set, pending further studies. Highlights of this update include: provisions on 96.5% mass, min. FAME Content, 45 % mass, min. Methyl Laurate (C12 ME) content, and JAMA / EN 14214 specs on oxidation stability, glycerides, group metals, density, methanol content & water. ASTM D6751 (2007a) was the available standard at the time of finalization of the standard.

In 2008, the TCPPA initiated the drafting of a standard test method for esters and lauric acid content in diesel and biodiesel blends by gas chromatography. This is the result of tests and correlations conducted by chemists from the oil and biodiesel companies and deliberations by the TCPPA since existing methods cover esters whose carbon chain range from C14-C20. CME has carbon chain range of C8- C18. The resulting test method, a modification of EN14103 has been submitted for promulgation into a PNS.

Biodiesel Blends - PNS/DOE QS 004:2009- Fatty Acid Methyl Ester (FAME)-Blended Diesel Oils specification.

This year, pursuant to the mandatory requirement for 2% biodiesel in all diesel fuels sold in the country, the standard for FAME-blended diesel B1 was updated, and PNS for B2 was promulgated. The requirement for compliance to this standard is contained in the rules and regulations implementing the Biofuels Law. The standard covers both automotive and industrial diesel fuel and became mandatory effective February 6, 2009, by virtue of DC 2009-02-0002. Table 39 presents the summary of properties and limits for B2.

Table 39 PNS/ DOE QS 004:2007 - FAME -Blended Diesel Oils (B2) Specification

PROPERTY	ADO	IDO	TEST METHODS
Calculated cetane index, min or Centane number min. Or Derived cetane number, min	50		PNS ASTM D 976 or PNS ASTM D 4737 PNS ASTM D 613 PNS ASTM D 6890 or PNS ASTM D 7170
Carbon Residue on 10% distillation residue, %mass, max	0.15	0.35	PNS ASTM D 189 or PNS ASTM D 524 or PNS ASTM D 4530
Color	2.5 max.	5.0 min.	PNS ASTM D 1500
Copper strip corrosion 3 h at 50 ^{0}C, max.	No. 1	No. 1	PNS ASTM D 130 or PNS ISO 2160
Density at 15^{0}C, kg/L	0.820-0.860	0.880 max.	PNS ASTM D 1298 or PNS ASTM D 4052
Distillation, 90% recovered, ^{0}C, max.	370	Report	PNS ASTMD D 86
FAME content, % volume	1.7 - 2.2	1.7 - 2.2	PNS EN 14078 modified or PNS EN 14103 modified or PNS EN 14331 modified
Flash Point, Pensky Martens, ^{0}C, min.	55	55	PNS ASTMD D 93
Kinematic viscosity, mm^2/s at 40^{0}C	2.0 - 4.5	1.7 - 5.5	PNS ASTMD D 445
Lubricity, (HFRR), wear scar dia. @60oC, micron, max	460		PNS ASTM D 6079
Methyl laurate (C12 ME), % mass, min.	0.80	0.80	PNS EN 14103 modified or PNS EN 14331 modified
Sulfur, % mass, max.	0.05	0.30	PNS ASTM D 129 or PNS ASTM D 4294 or PNS ASTM D 2622
Water, %volume, max.	0.05		PNS ASTM D 6304 or PNS ISO 12937 or PNS ASTM E 203
Water and Sediment, %volume, max.	0.10	0.10	PNS ASTMD D 2709

Note: ADO – automotive diesel oil; IDO – industrial diesel oil

Euro 4 Fuels.

The TCPPA has started discussion on what should be the equivalent fuel for vehicles to meet Euro 4 emission requirements. The Department of Environment is about to formalize the Euro 4 mandate for new vehicles that may be allowed to enter and be registered in the country.

(3) Implementation and Enforcement

The DOE conducts spot checks at the different supply points in the distribution chain of both biodiesel and biodiesel-diesel blends, and collect samples for laboratory tests to determine compliance to the PNS. Supply points include manufacturing/ production facilities, bulk storage depots/terminals, gasoline stations.

To minimize conflicts of test results, the DOE is coordinating with the oil and biodiesel industry participants on the type of equipment, especially on portable diesel analyzers that also detect FAME content, among others. The DOE is also conducting laboratory reconciliation with the industry players.

Moreover, since not all the biodiesel manufacturers have complete laboratory facilities to test their product pursuant to the PNS, quality assurance of B100 is still a concern. One possible option being considered by the producers is for DOE to accredit laboratories that can conduct complete test for B100 and to provide the list of the accredited laboratories to the biodiesel manufacturers to help the industry comply with the PNS requirement.

7.7.3 Thrust Towards Harmonization

In the Philippines, no less than our President Gloria Macapagal Arroyo has been advocating for harmonization. The country has thus been involved in projects towards harmonization. It is worth-noting that the thrust towards harmonization is actually not only limited to fuel quality, but also on facilities (including vehicles, engines and parts) giving due consideration on the issue of compatibility. The harmonization thrust also covers codes of practice.

This ERIA Biodiesel Fuel (BDF) Standardization Project is a very welcome development, it being a positive reaction to the call of President Arroyo during the January 2007 East Asian Summit in Cebu City, Philippines for the harmonization of standards for biodiesel.

While there are ASTM and EN standards, there are contentions of them being international since they have been based on select feedstocks, besides being in a different climate and other local conditions. It has been established that properties and behaviors of different biodiesel feedstocks vary, thus supposed standards and test methods cannot just be adopted for different feedstocks. This situation became more obvious as the Working Group Meetings progressed.

Theoretical and empirical data show excellent results for coconut as a feedstock for the blending component (CME) of diesel, with its carbon chain composition closely resembling petroleum diesel. However, since only the Philippines is basically using

CME, studies outside the country hardly, if at all, take CME into consideration.

The ERIA BDF Benchmark Standard has been very instrumental in having coconut recognized as a major biodiesel feedstock not only among East Asian countries, but globally. The March 2009 Biodiesel Guidelines of the Worldwide Fuel Charter providing for values and methods has eliminated earlier concerns on CME vis-a-vis EN 14214, particularly for iodine number, viscosity and flash point. With coconut as a major agricultural product of the country, and the establishment and accreditation of CME manufacturers, the high export potential of the country cannot be argued. A harmonized standard would thus facilitate trade across boarders, ensuring supply availability and better economics, not only for the fuel, but also for the vehicles. A harmonized fuel standard would also provide better access to improvements in technology, leading to improved air quality, mitigating, if not arresting, global warming and climate change.

Trade facilitation is expected to eventually reduce cost of biodiesel. The price of biodiesel is crucial in the Philippines as 70% of the diesel fuel demand is by the public transport sector. Local price of biodiesel feedstock (e.g., coconut oil) is linked to Rotterdam (export) price. Local biodiesel producers hope to create a bigger local market demand rather than struggle with export prices. Thus biodiesel producers propose to increase the mandated blend from B2 to B5.

Finally, higher demand for biodiesel is deemed to encourage and facilitate capacity additions, including expansion of feedstock sources such as jatropha, thus enhancing supply security and sustainability, improvement in the environment with cleaner air as a result of reduction in CO_2 and other emissions, as well as enhancing economic activity in the countryside.

7.7.4 Status of Biodiesel Implementation

The biodiesel implementation in the Philippines is summarized in Table 40. Specifically, biodiesel development in the Philippines is anchored on the Biofuels Act of 2006, and the biodiesel program is administered by the DOE along with other agencies lead by the NBB.

Table 40 Current status of biodiesel fuel in The Philippines

Country	Mixing rate	Main Feedstocks	Strategy / Goal	Standard
Philippines	- B1 (2004) for government -owned and controlled vehicles	Coconut	Memorandum Circular #55	- PNS/DOE QS 002:2003 (B100) (Biodiesel: Cocomethyl ester)
	- B1 (2007) for all diesels	Coconut	Biofuel Law 2006 ➢ National Biofuels Board	- PNS/DOE QS 002:2007 (B100) - PNS/DOE QS 004:2007 (B1)
	- B2 (2009) for all diesels	Coconut		- PNS/DOE QS 004:2009 (B2)
		(Research on-going for Jatropha and other feedstocks)	Renewable Energy Law 2009	

The Philippine government is promoting the utilization of biodiesel from coconut and continuously conducting extensive research and development on other biomass feedstock for biodiesel production. In the implementation of the biodiesel mandate, commercially available crops and the most advantageous use of land are carefully being considered to promote sustainable development, and most especially, not sacrificing food for fuel.

Various concerns are being worked out with all the stakeholders. These would include quality assurance capabilities of the biodiesel producers, qualified storage and transport facilities, compatibility of the higher biodiesel blends on the existing (in-use) vehicle fleet as well as those under warranty, etc. Other than technical issues, the higher price of biodiesel compared with pure diesel is a major consideration in the thrust for higher blends to maximize the utilization of the present production capabilities. Finally, in order to gain greater support from different sectors, an intensified information, education and communication campaign is being worked out.

7.8 Singapore

7.8.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

Singapore is a small island state at a size of 25 × 15 miles and area of 710.02 km^2 [41]. It has a population of 5.0 millions [42]. Singapore's GDP was S$257 billion in 2008 and with a GDP per-capita of S$59,192 [41]. There are more than 7,000 multinational corporations in Singapore, attributing to its high rate in competitiveness and globalization indices. Singapore is also a major oil & gas hub in the world, with

activities covering exploration and production support services, refining (>1.3 billion bpd of oil), petrochemical and chemical industries, storage, trading, etc.

The energy situation in Singapore is summarized as follows: the energy needs are almost entirely (>95% [43]) imported as oil and gas for electricity and also feedstocks for refining, petrochemical and chemical industries. The power generation capacity of Singapore is about 10 GW with peak demand at 6.07 GW as at 31 Dec 08. The electricity market was liberalized with the key restructuring involving the separation of the contestable and non-contestable parts of the electricity market, establishment of an independent system operator and the liberalization of the retail market.

Competition in the electricity market has lead to the introduction of more cost-effective, energy efficient and cleaner natural gas into the market. Natural gas is imported via pipelines from Malaysia and Indonesia and contributes to >80% of power generation output. To diversify its energy sources, Singapore will import LNG and the building of a LNG terminal of capacity 3 mtpa is expected to be completed by around 2013.

As a small city-state with limited indigenous resources, a strong and growing economy is the only means to provide Singapore with the resources to meet the challenges of rising energy prices and climate change. Singapore accounts for ~ 0.15% of the world's CO2 emissions and the government announced to do its fair share as part of the global effort to mitigate greenhouse gas emissions. Singapore acceded to the Kyoto Protocol in 2006 and has been actively looking at "climate change strategy" through improving energy efficiency, setting up carbon trading market, offering CDM projects etc. under the National Climate Change Committee (NCCC) and Climate Change Working Group (CCWG). In 2006, the Energy Policy Group (EPG) was set up to formulate and coordinate Singapore's energy policies and strategies in a more holistic way.

Singapore's energy strategies: The national energy policy framework outlines six key strategies to bring together the Government, industries, business and households to adopt practical and effective measures to strength Singapore's competitiveness, enhance energy security, and protect the environment. They are elaborated as below:

- First, to **promote competitive markets**. The Energy Market Authority (EMA) is now piloting the Intelligent Energy System, to review the option of full contestability in the electricity retail market.
- Second, to **diversify the energy sources**. Singapore is building a liquefied natural gas terminal to diversify the source of NG. The government is promoting further

energy diversification by supporting R&D, test bedding and demonstration of promising new energy technologies.

- The third strategy is to **improve energy efficiency**. The government has developed a comprehensive national energy efficiency plan to promote the adoption of energy efficiency measures, raise public awareness, and build capability in energy efficiency.
- Fourth, is to **develop the energy industry**. Besides growing its oil refining and energy trading sector, Singapore is also pursuing growth opportunities in clean energy, including solar energy, biofuels and fuel cells. The government has committed more than S$300 million to build up its energy R&D capabilities. The goal is to increase the value-added of the energy industry from S$20 billion to S$34 billion by 2015, and to triple the employment in the industry from 5,700 to 15,300. There are some early successes in the clean energy sector in Singapore. In Oct. 2007, Norway's Renewable Energy Corporation announced that they will build a $6.3 billion solar manufacturing complex in Singapore. When completed, it will be the world's largest solar manufacturing facility. In November 2007, Neste Oil also announced their plans to build a biorefinery that will produce NExBTL renewable fuel. With a capacity of 800,000 metric tonnes per annum, the plant will be the largest renewable fuel refinery in the world. In addition, Singapore has attracted investments in biofuels production from Nexsol (joint venture between Peter Cremer and Kulim Group), Continental Bioenergy and Natural Fuels. Singapore will have a biodiesel production capacity of 1,650,000 metric tonnes per annum when these projects are completed.
- The fifth strategy is to **set up international cooperation**. Singapore is developing closer relations with key energy producers, and participating actively in energy and energy-related discussions in major fora such as ASEAN, the East Asia Summit, the Asia-Pacific Economic Cooperation, and the United Nations Framework Convention on Climate Change.
- Strategy Six is to **take a whole-of-Government approach**. Apart from the Energy Policy Group, several government agencies have formed new units to manage the energy challenges. The Ministry of Trade and Industry now has an Energy Division. The Economic Development Board and the National Environment Agency have set up inter-agency programme offices for clean energy and energy efficiency respectively.

The Energy Market Authority (EMA) has also set up an Energy Planning and Development Division to plan and review Singapore's energy policies; and develop

scenarios for formulation of strategic plans to secure Singapore's energy needs.

(2) Concrete target and strategy for BDF

However, blending will not be mandated in Singapore, nor are there currently any plans to do so. Nevertheless, Singapore does not rule out any energy options for the future.

Singapore's biodiesel production output is expected to exceed one million tons per annum by 2010, Most of these plants will use palm oil as feedstocks, and increasingly diversifying into non-food feedstocks such as jatropha oil, algal oils and waste cooking oil.

(3) Main crops for BDF and its production planning

Singapore has a solid foundation in the petrochemical industry, and our strong R&D base will facilitate the development of next generation biofuels. However, we face constraints in terms of feedstock for biofuels. Furthermore, biofuels are generally more expensive than their fossil fuel equivalents.

Biodiesel plants built/building in Singapore:

- Small domestic plants are in operation (e.g. Alpha Biofuels has a production capacity of 120,000 mt/year. The feedstock for biodiesel are waste cooking oil, grease trap oil and waste palm oil.
- Neste Oil also announced their plans to build a biorefinery that will produce patented NExBTL renewable fuel (the cleanest diesel fuel in the world). With a capacity of 800,000 metric tonnes per annum, the plant will be the largest renewable fuel refinery in the world. The plant (at an investment of US$776 million) will be operational in June 2010 and initially cater to Europe's growing biofuel requirement. Neste has partnered with French company Technip to provide engineering, procurement and project construction management services for the Singapore project. Separately, Singapore Oxygen Air Liquide Pte Ltd (SOXAL), a unit of French company Air Liquide, is investing 250 million Singapore dollars in setting up a new hydrogen facility and expanding its pipeline network on Jurong Island that will allow it to deliver hydrogen to Neste Oil. Neste Oil and Air Liquide have signed a long-term hydrogen supply deal. Hydrogen is used to reduce the impurities in gasoline and diesel.

(4) Regulations and incentives to promote BDF utilization

There is no government mandate to regulate the use of biofuel in Singapore and

therefore the adoption of bio-diesel is highly dependent on free market forces. Presently, biodiesel produced for domestic market is at ~120,000 liter per month to supply ~500-600 vehicles in Singapore running at B100. The National Environment Agency (NEA) of Singapore is in charge of promoting clean air and setting vehicular emissions standards. NEA allows the use of bio-diesel for vehicles so long as the vehicle operators can demonstrate via certification by reputable independent testing bodies that vehicles using such fuel will be able to meet the prevailing vehicle emission standards.

7.8.2 Standardization of BDF

(1) Concept of BDF standards and regulations

In Singapore, bio-diesel can be used for vehicles so long as the vehicle operators can demonstrate via certification by reputable independent testing bodies that vehicles using such fuel will be able to meet the prevailing vehicle emission standards Singapore for new and existing motor vehicles, as shown in Table 41.

Table 41 Current emission regulation for vehicles in Singapore

Vehicle Type	Emission Standard	Implementation Date
Petrol vehicles	EURO II	1 Jan 2001
Diesel vehicles	EURO IV	1 Oct 2006
Motorcycles/scooters	97/24/EC	1 Jul 2003

All existing vehicles are subject to mandatory inspections periodically to ensure that they comply with the prescribed standards as follows:

(a) Petrol-driven vehicles:

Carbon Monoxide (CO)

- 6% by vol (registered before Oct 1986)
- 4.5% by vol (registered between Oct 1986 and Jul 1992)
- 3.5% by vol (registered on or after Jul 1992)

(b) Diesel-driven vehicles:

Smoke Opacity Limit: 50 HSU

(c) Motorcycles/scooters:

CO - 6% by vol (registered before Oct 1986)

- 4.5% by vol (registered on or after Oct 1986)

(2) Standards of BDF

(i) Current status of BDF standardization

Singapore does not have any National Standards for biodiesel. There is currently

negligible biodiesel market in Singapore. There only three biodiesel producers - Continental Bioenergy, Peter Cremer and Natural Fuel, and their products are for export. International standards are followed for biodiesel producers: European EN14214 and/or ASTM 6751 specifications, depending on the buyer.

(ii) Reference standards

European EN14214 and ASTM 6751 specifications are followed.

(iii) Remarkable items

Nil.

(3) Specification values

Details of values can be seen in European EN14214 and ASTM 6751 specifications. Singapore has the Intertek Testing Services (S) Pte Ltd, Singapore Technical Centre set up on Jurong Island. The methods used for testing biodiesel fuels are provided by Intertek, in the separated sheets.

7.9 Republic of Korea

7.9.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

The energy consumption in road transportation sector is around 17% of total energy consumption in Korea, and gasoline, diesel oil and LPG were consumed respectively 60,896, 101,623 and 47,641 thousand barrels in 2008.

In Korea, BDF has been introduced to reduce the petroleum dependency, to expend renewable energy, to reduce green house gas, and to improve air quality. In May 2002, Korean government MOCIE (Ministry of Commerce, Industry and Energy) launched BD20 demonstration program in Seoul metropolitan area and Jeonbuk provincial area. This biodiesel program has been shifted into two ways from July 2006. One is the change of diesel oil specification, in which diesel oil for road transportation can include maximum 5% of biodiesel, and this fuel is distributed and sold at gas station by petroleum companies in nationwide. Another case is BD20, which is distributed and sold by biodiesel company for the restricted fleet user, who has own oil storage capability and auto repair capability.

Biodiesel is mixed in diesel oil by voluntary agreement between government and petroleum companies. This agreement started from BD0.5 in July 2006 and changed to annul 0.5% increase from 2008, and up to 3% in 2012, resulting in an increase in biodiesel sale shown in Figure 64. Taxes for automotive fuel are composed of traffic tax, education tax, driving tax, and 10 % of VAT (Value Added Tax) for final price, but

biodiesel mixed in diesel oil has been taxed only VAT. However, blending ratio and tax policy will be discussed in 2010.

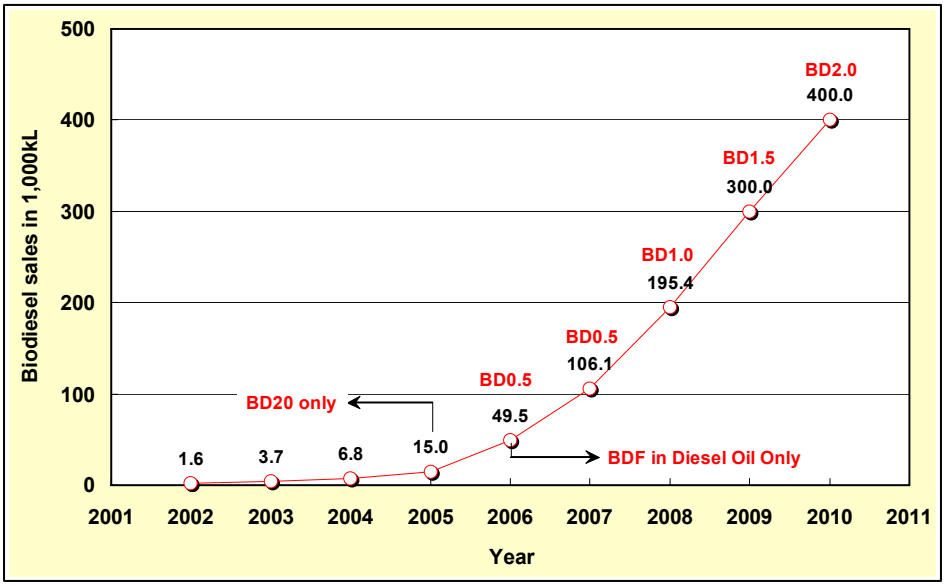

Figure 64 Biodiesel sales in Korea

(2) Main crops for BDF and its production planning

Main feedstock for BDF is imported soybean oil and domestic waste cooking oil, and some imported palm oil recently. To increase domestic feedstock, MOF (Ministry of Agriculture and Forestry) has been conducting demo-plantation program of rapeseed which covers 49.5 million m^2 in three provincial areas from 2007 to 2009. Overseas plantation such as Jatropha Curcas in East Asian countries has been conducting also by some Korean energy companies.

There are 21 biodiesel production companies in Korea and current production capacity is around 1 million tons per year. Total sales amount of biodiesel was around 200 thousand kilo liters, which is equivalent to BD1.0, in 2008 and will be expected around 300 thousand kilo liters in 2009.

7.9.2 Standardization of BDF

The quality of automotive fuels in Korea is regulated by the Petroleum and Petroleum Alternative Fuel Business Act. Specifications of BD100 for blending use and specification of BD20 specifications for fleet users are in Table 42 and Table 43, respectively.

Table 42 B100 specifications for blending with diesel (for retail sale) in South Korea

Items	Units	U.S.	EU	Rep. of Korea	EAS-ERIA BDF Standard
		ASTM D6751-07b	EN14214:2003	PPAFB Act	(EEBS):2008
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900
Viscosity	mm2/s	1.9-6.0	3.50-5.00	1.9-5.0	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	120 min.	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.0010 max.	0.0010 max.
Distillation, T90	deg. C	360 max.	-	-	-
Carbon residue (100%) or	mass%	0.05 max. -	- 0.30 max.	- 0.10 max.	0.05 max. 0.3 max.
Cetane number		47 min.	51.0 min.	-	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.01 max.	0.02 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	500 max.	500 max.
Total contamination	mg/kg	-	24 max.	24 max.	24 max.
Copper corrosion		No.3	Class-1	Class-1	Class-1
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.50 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	6.0 min.	10.0 min. (****)
Iodine value		-	120 max.	-	Reported (***)
Methyl Linolenate	mass%	-	12.0 max.	-	12.0 max.
Polyunsaturated FAME (more than 4 double bonds)	mass%	-	1 max.	-	N.D. (***)
Methanol content	mass%	0.2 max. (*)	0.20 max.	0.20 max.	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	0.80 max.	0.80 max.
Diglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Triglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.02 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.24 max.	0.25 max.
Na+K	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.

Table 43 B20 specifications for the fleet user

Item	Unit	Specifications	
		Limit	Test Method
Ester content	mass %	20 +/- 3 Winter (10 +/- 3)	EN 14078
Density (@15°C)	g/cm^3	0.815-0.845	ISO 3675 (KS M 2002)
Kinematic viscosity (@40 °C)	mm^2/s	1.9-5.5	ISO 3104 (KS M 2014)
Flash point	deg.C	40 min	ISO 3679 (KS M 2010)
Sulfur content	mg/kg	30 max	ISO 20846, ISO 20884 (KS M 2027)
10% carbon residue	mass %	0.15 max	ISO 10370 (KS M ISO 10370)
Cetane number (Cetane Index)		45 min	KS M ISO 5165, 4264
Ash content	mass %	0.02 max	KS M ISO 6245
Water & contamination	vol.%	0.02 max	(KS M 2115)
Copper corrosion (100 °C, 3h)	rating	1 max	(KS M 2018)
Acid value	mgKOH/g	0.1 max	EN 14104 (KS M ISO 6618)
T90	deg.C	360 max	KS M ISO 3045
Pour point	deg.C	0.0 max (winter -17.5 max)	KS M 2016
CFPP	deg.C	-16 max (winter)	KS M 2411
HFRR(@60 °C)	micron	460 max	KS M ISO 12156-1

7.10 Thailand

7.10.1 Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

The fossil fuel resources in Thailand are limited and inadequate to meet the national energy demand, which relies about 49 % on imported energy. In 2008, Thailand final energy consumption accounted about 1.0455 ton of oil equivalent (toe) per Capita, which had been increasing gradually from the average of 0.9885 toe per capita in 2004. The domestic production of primary energy amounted to 61,930 thousand tons of oil equivalent (ktoe) with the import of 59,386 ktoe. The final energy consumption was 66,284 ktoe of which 72% consumed in the transportation and manufacturing sectors.

Energy in transportation sector consumes about 35.1% of the total energy consumption in 2008. Of this amount, the energy consumed were mainly petroleum products including diesel oil 47.4%, gasoline 22.4%, jet fuel 16.5%, fuel oil 6.8% and liquid petroleum gas 3.9%. In addition, natural gas and electricity were consumed as energy source for transportation sector as well, about 2.9% and 0.1%, respectively as shown in Figure 65.

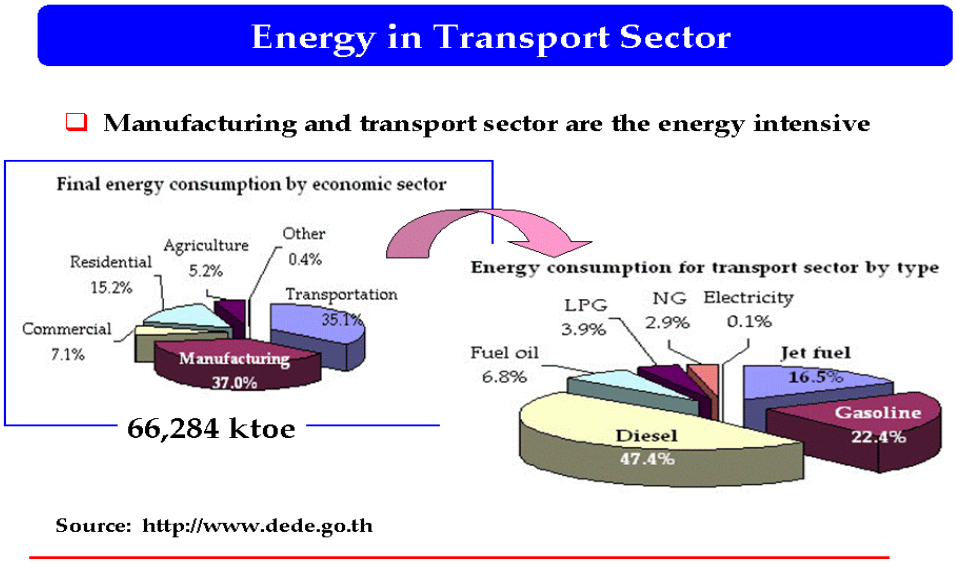

Figure 65 Energy consumption in transport sector

To strengthen the national energy security and competitiveness, Thailand has set up the policy on fifteen-year plan to promote the alternative energies for fossil fuel substitution. It is targeted to increase the proportion of the use of alternative energy to

be 20% of the final energy consumption by 2022. The objectives of the fifteen-year National Alternative Energy Plan (2008-2022) are the following:

1. To use mainly alternative energy instead of importing energy
2. To enhance the energy security in supply energy for the country
3. To promote the implementation of green community energy
4. To support the local manufacturing of alternative energy technology
5. To promote the R&D on the high efficient technology for alternative energy production

The alternative energy includes solar, wind, mini-hydropower, liquid biofuels, biomass and natural gas. The portions of 20% are categorized into 2.4%, 7.6%, 4.1% and 6.2% for electricity generation, heat generation, liquid biofuels, and natural gas vehicle respectively. According to the plan, the ethanol and biodiesel have been targeted to 9.0 and 4.5 million litres per day in 2022. In addition, it is emphasized to promote the new and renewable energy technology for bio-energy production.

(2) Targets/strategies/regulations/incentives for BDF

In 2005, Thailand developed the strategic plan for biodiesel promotion and development. Under the national biodiesel policy, biodiesel is promoted to be produced domestically and targeted to replace diesel consumption by 10% in 2012. The national strategic plan for development and promotion on the use of biodiesel fuel classifies biodiesel production into 2 categories, which are community-based biodiesel production and commercial-based biodiesel production. The community-based biodiesel is used for agricultural machines in the communities, while commercial biodiesel is used to be blended with normal diesel for selling at fuel service stations.

The action plan on biodiesel promotion and development was set in May 2005 and revised in the fifteen-year Alternative Energy Plan in January 2009 as the following:

- Promotion of community-based biodiesel production and use since 2006.
- Announcement of the specification of fatty acid methyl ester in 2007.
- Announcement of the specification of the regular high speed diesel oil (or B2) and the B5 high speed diesel oil in 2007.
- Mandate of B2 in February 2008, while B5 is optionally used.
- Target the amount of biodiesel use of 4.5 million litters per day in 2022.

The National Energy Policy Council (NEPC) has established measures to promote biodiesel utilization in Thailand. The measure includes regulations and incentives for biodiesel production and blends. Prior to getting the permission to sell

B100 from the facility, it is necessary for the biodiesel producer to register or get approval from the Department of Energy Business (DOEB). The incentives provided to the oil blender are the tax exemption and payment exemption to the Oil Fund for B100. In addition, oil blender or oil trader get compensation for the price of biodiesel B100 from the Oil Fund. The Department of Energy Business (DOEB) also sets the retail price for 5% FAME blended diesel oil or so-called B5 high speed diesel oil cheaper than regular high speed diesel oil (B2) by at least 0.70 baht/Litre.

(3) Main crops for BDF and its production planning

Oil crops in Thailand are oil palm, soybean, coconut, castor, and sunflower. Recently, the Office of Agricultural Economics reported the harvesting area and production volume of oil crops in Thailand during 2004-2007 as shown in Table 44. Oil palm shows its potential to be the feedstock for commercial biodiesel production for Thailand. In 2007, oil palm presented as the main oil crop in which its harvesting area and production were 426,080 hectares and 6,390,000 tons.

Table 44 Harvesting area and production volume of oil crops during 2004-2007

Oil crops	2004		2005		2006		2007	
	Harvested area (Hectares)	Production (Tons)	Harvested area (Hectares)	Production (Tons)	Harvested area (Hectares)	Production (Tons)	Harvested area (Hectares)	Production (Tons)
Oil Palm	309,120	5,182,000	324,160	5,003,000	379,840	6,715,000	426,080	6,390,000
Soybean	145,920	218,000	144,160	226,000	137,600	215,000	128,800	204,000
Coconut	270,400	2,126,000	265,440	1,940,000	258,240	1,815,000	255,680	1,722,000
Castor	13,280	10,000	13,440	10,000	12,960	10,000	12,960	10,000
Sunflower	28,640	22,000	42,080	38,000	33,280	24,000	30,560	23,000

(Source: Office of Agricultural Economics 2007, http://www.oae.go.th)

Oil palm is the main feedstock for biodiesel production for Thailand. To meet the target of the national strategic plan for biodiesel development and promotion on the use of biodiesel fuel, the feedstock supplied for the biodiesel production is promoted accordingly. It is planned to promote the additional oil palm plantation area to 2.5 million rais or 400,000 hectares by 2012. According to the plan, its productivity will be improved to be 2.7-3.3 ton/rai-yr or 16.87-20.62 ton/hectare-yr.

Beside oil palm, jatropha and waste cooking oil also show its potential to be the feedstocks for community-based biodiesel production. At present, several R&D studies report the production of biodiesel from jatropha or physic nut oil (*Jatropha curcas* Linn) in Thailand. However, there are no report on harvesting area and production of

jatropha. It is only planted in the experimental stations.

7.10.2 Standardization of BDF

(1) Concept of BDF standards and regulations

The Department of Energy Business under the Ministry of Energy set up the standard specifications for commercial-based and community-based biodiesel. The standard of commercial biodiesel, Fatty Acid Methyl Ester or so-called B100 was established by using EN 14214:2003 as a guideline. The FAME standard has been enforced since October 1, 2006. The B100 is used to be a FAME blend stock in regular high speed and B5 high speed diesel oils. In April 2009, the selling amount of regular high speed diesel oil was 9,980 million litres in every oil service stations, while the selling amount of B5 high speed was 8,155 million litres in 3,676 oil service stations.

The community-based biodiesel is used for agricultural engines in the communities and not allowed to be sold at any fuel service stations. Its standard specifications were notified on July 21, 2006.

(2) Specification values

Thailand has set the specifications for FAME or commercial biodiesel for blend stock, regular high speed diesel oil (or B2) and B5 high speed diesel oil. The standard specifications of FAME or biodiesel known as commercial-based biodiesel and their test methods are shown in the Table 45. The regular high speed diesel oil (B2), B5 high speed diesel oil and low speed diesel oil are shown in Table 46.

The introduction status of biodiesel fuel and B100 specifications for blending with diesel for retail sale are shown in Table 47 and Table 48, respectively.

Table 45 Thailand standard specification of biodiesel B100-FAME

Items	Fuel properties	Unit	Specification		
			Limit		Test method
1.	Methyl ester	% wt	min	96.5	EN 14103
2.	Density at 15° C	kg/m^3	min max	860 900	ASTM D 1298
3.	Viscosity at 40°C	CSt	min max	3.5 5.0	ASTM D 445
4.	Flash Point	°C	min	120	ASTM D 93
5.	Sulphur	% wt.	max	0.0010	ASTM D 2622
6.	Carbon Residue on 100% distillation residue	% wt	max	0.30	ASTM D 4530
7.	Cetane Number		min	51	ASTM D 613
8.	Sulfated Ash	% wt.	max	0.02	ASTM D 874
9.	Water	% wt.	max	0.050	EN ISO 12937
10.	Total Contamination	% wt.	max	0.0024	EN 12662
11.	Copper Strip Corrosion		max	No. 1	ASTM D 130
12.	Oxidation Stability at 110°C	Hours	min	10	EN 14112
13.	Acid Number	mg KOH/g	max	0.50	ASTM D 664
14.	Iodine Value	g Iodine/100 g	max	120	EN 14111
15.	Linolenic Acid Methyl Ester	% wt.	max	12.0	EN 14103
16.	Methanol	% wt.	max	0.20	EN 14110
17.	Monoglyceride	% wt.	max	0.80	EN 14105
18.	Diglyceride	% wt.	max	0.20	EN 14105
19.	Triglyceride	% wt.	max	0.20	EN 14105
20.	Free glycerin	% wt.	max	0.02	EN 14105
21.	Total glycerin	% wt.	max	0.25	EN 14105
22.	Group I metals (Na+K) Group II metals (Ca+Mg)	mg/kg mg/kg	max max	5.0 5.0	EN 14108 and EN 14109 prEN 14538
23.	Phosphorus	% wt.	max	0.0010	ASTM D 4951
24.	Additives	Approved by DG of Department of Energy Business			

(Source: Government Gazette, Volume 124, Special Section 62, 23 May 2007, p 7.)

Table 46 Thailand standard specification of diesel oil

Items	Fuel Properties	Limit	Diesel oil			Test method
			High speed		Low speed	
			Regular	B5		
1.	Specific Gravity at 15.6/15.6 ^oC	min	0.81	0.81	-	ASTM D 1298
		max	0.87	0.87	0.920	
2.	Cetane Number or					ASTM D 613
	Calculated Cetane Index					ASTM D 976
	Before 1 January 2012	min	47	47	45	
	From 1 January 2012	min	50	50	45	
3.	Viscosity, (*cSt*)					ASTM D 445
	3.1 at 40 ^{o}C	min	1.8	1.8	-	
		max	4.1	4.1	8.0	
	or 3.2 at 50 ^{o}C	max	-	-	6.0	
4.	Pour Point, (^oC)	max	10	10	16	ASTM D 97
5.	Sulphur, (*%wt.*)					
	Before 1 January 2012	max	0.035	0.035	1.5	ASTM D 4294
	From 1 January 2012	max	0.005	0.005	1.5	ASTM D 2622
6.	Copper Strip Corrosion	max	No. 1	No. 1	-	ASTM D 130
7.	Oxidation Stability, (g/m^3)	max	-	25	-	ASTM D 2274
8.	Carbon Residue, (*%wt.*)	max	0.05	0.05	-	ASTM D 189
9.	Water and Sediment, *(%vol.*)	max	0.05	0.05	0.3	ASTM D 2709
10.	Ash, (*%wt.*)	max	0.01	0.01	0.02	ASTM D 482
11.	Flash Point, (^oC)	min	52	52	52	ASTM D 93
12.	Distillation, (^oC)					ASTM D 86
	(90% recovered)	max	357	357	-	
13.	Polycyclic Aromatic Hydrocarbon,					ASTM D 2425
	Before 1 January 2012	-	-	-	-	
	From 1 January 2012	max	11	11		
14.	Colour					
	14.1 Hue		-	green	-	
	14.2 Dye, *(mg/L)*	min	-	4.0	-	
	14.3 Intensity	min	-	-	4.5	ASTM D 1500
		max	4.0	-	7.5	
15.	Methyl Ester of Fatty Acid, *(%vol.*)	min	1.5	4	-	EN 14078
		max	2	5	-	
16.	Lubricity, (μm)	max	460	460	-	CEC F-06-A-96
17.	Additives (if any)	Approved by DG of Department of Energy Business				

(Source: Government Gazette, Volume 125, Special Section 10, 16 January 2008, p 1
and Government Gazette, Volume 125, Special Section 124, 29 July 2008, p 1)

Table 47 Current status of biodiesel fuel in Thailand

Country	Mixing rate	Main Feedstocks	Strategy / Goal	Standard
Thailand	B2 (2008) B5 (optional)	Palm	Biodiesel Development and Promotion Strategy nationwide / Mandate B2 in Feb. 2008, Optional B5 (4.5 ML/D in 2022 target)	Have DOEB-2006 (B100 Community level) DOEB-2007 (B100 Industrial level) DOEB-2008 (B2 and B5)

Table 48 B100 specifications for blending with diesel for retail sale in Thailand

Items	Units	U.S.	EU	Thailand	EAS-ERIA BDF Standard
		ASTM D6751-07b	EN14214:2003	DOEB: 2009	(EEBS):2008
Ester content	mass%	-	96.5 min.	96.5	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900
Viscosity	mm2/s	1.9-6.0	3.50-5.00	3.5-5.0	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	120 min	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.0010 max	0.0010 max.
Distillation, T90	deg. C	360 max.	-	-	-
Carbon residue (100%) or Carbon residue (10%)	mass%	0.05 max. -	- 0.30 max.	- 0.30 max.	0.05 max. 0.3 max.
Cetane number		47 min.	51.0 min.	51.0 min	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.02 max	0.02 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	0.05[Wt%] max	500 max.
Total contamination	mg/kg	-	24 max.	24 max.	24 max.
Copper corrosion		No.3	Class-1	Class-1	Class-1
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.50 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	10.0 min.	10.0 min. (****)
Iodine value	g Iodine/100 g	-	120 max.	120 max.	Reported (***)
Methyl Linolenate	mass%	-	12.0 max.	12.0 max.	12.0 max.
Polyunsaturated FAME (more than 4 double	mass%	-	1 max.	-	N.D. (***)
Methanol content	mass%	0.2 max. (*)	0.20 max.	0.20 max.	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	0.80 max.	0.80 max.
Diglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Triglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.02 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.25 max.	0.25 max.
Na+K	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Phosphorous content	mg/kg	10 max.	10.0 max.	10.0 max.	10.0 max.

7.11.1 Vietnam

7.11.1. Policy and Measure of BDF

(1) Target and strategy from energy and environment point of view

On 20 November 2007, Vietnam Government released the Decision 177/QD-TTg signed by Prime Minister, this Decision 177/QD-TTg approving the "Project for development of bio-fuel by 2015, with prospect to 2025". The Decision 177/QD-TTg states: Developing bio-fuel, a new source of renewable energy is to partially substitute conventional fossil fuels and ensure energy security and environment protection, its main content is as follows:

The objective by 2010

- Establish and develop a test model for pilot production and use of bio-fuel in the scale of 100,000 tons of E5 and 50,000 tons of B5 per annum, meeting 0.4 % of the country's total demand for petroleum.
- By 2010 Vietnam plans to complete 5 biofuel plants to meet a small part of domestic demand for petrol and diesel.
- The 5 plants will churn out a combined 100,000 tons of ethanol 5 percent gasoline (E5) and 50,000 tons of biodiesel 5 percent (B5) per year to meet 0.4 % of national demand.
- The plants will use cassava and sugarcane as feedstock.

The objective for the period 2011-2015

- Develop establishments producing and using biofuels nationwide.

The objective for the period by 2015

- Ethanol and vegetable oil outputs are projected to reach 250,000 tons, meeting 1 % of the country's total demand for petroleum.

(2) Targets/strategies/regulations/incentives for BDF

Vietnam National Standards (TCVN)

In the year 2007, Ministry of Science and Technology of Vietnam declared voluntary Vietnam National Standard for biodiesel. TCVN 7717: 2007 Biodiesel fuel blend stock (B100) – Specification. This TCVN 7717: 2007 is prepared on the base of ASTM D 6751–06e1 and EN 14214:2003

In June 2009, Vietnam National Standards on B5 was declared and published by the Ministry of Science and Technology of Vietnam: TCVN 8064:2009, 5 % fatty acid methyl esters blended diesel fuel oils – Specification.

Vietnam National Regulation (QCVN)

In September 2009, the Minister of Ministry of Science and Technology of Vietnam approved the first National Technical Regulation (regulations are mandatory): QCVN 01:2009/BKHCN National Technical Regulation on gasoline, diesel fuel oils and biofuels. Among other requirements, the regulation specified the mandatory properties for: (1) Diesel fuel oils and biodiesel B5 and (2) Biodiesel fuel blend stock (B100).

(3) Main crops for BDF and its production for planning

Biodiesel produced from catfish fat as Basa fish: From Mekong River Delta with estimated production capacity of catfish of 10 million litres a year (Agrifish Company)

7.11.2 Standardization of BDF

The quality of diesel in Vietnam is regulated by Vietnam National Technical Regulation QCVN 01: 2009/BKHCN and Vietnam national Standards TCVN 5689: 2005 Diesel – Specifications. For biodiesel fuel blend stock (B100), Table 49 shows the specification regulated by TCVN 7717: 2007, prepared on the base of ASTM D 6751–06e1 and EN 14214:2003. Table 50 shows the comparison with other biodiesel standard.

Table 49 Biodiesel fuel blend stock (B100) specifications in Vietnam

Property		limit	Test methods*
1.Ester, % m/m	min	96,5	TCVN (EN 14103)
2.Density,15 oC, kg/m3		860-900	TCVN (ASTM D 1298)
3.Flash point, oC	min	130.0	TCVN (ASTM D 93)
4.Water and sediment, % v/v	max	0,05	TCVN (ASTM D 2709)
5. Viscosity, 40 oC, mm2/s		1.9-6.0	TCVN (ASTM D 445)
6.Sulphated ash, % m/m	max	0.020	TCVN (ASTM D 874)
7.Sulfur, % m/m	max	0.05	TCVN (ASTM D 5453)
8.Copper strip corrosion	No.	No.1	TCVN (ASTM D 130)
9.Cetane number	min	47	TCVN (ASTM D 613)
10.Cloud point, oC	max	Report	TCVN (ASTM D 2500)
11. Carbon residue, % m/m	max	0.050	TCVN (ASTM D 4530)
12.Acid number, mgKOH/g	max	0.05	TCVN (ASTM D 664)
13.Iod value, g iod/100g	max	120	TCVN (EN 14111)
14.Oxydation stability, h	min	6	TCVN (EN 14112)
15.Free Glycerin, %m/m	max	0.020	TCVN (ASTM D 6584)
16.Total Glycerin, % m/m	max	0.240	TCVN (ASTM D 6584)
17.Phosphous, % m/m	max	0.001	TCVN (ASTM D 4951)
18.Distillation, 90 %, oC	max	360	TCVN (ASTM D 1160)
19. Na and K	max	5.0	TCVN (EN 14108 and EN 14109)

*TCVN test method is equivalent to ASTM/EN test method.

Table 50 EAS-ERIA Biodiesel Fuel Standard 2008 compared to Vietnam existing standard TCVN 7717: 2007 (B100).

Items	Units	U.S.	EU	Vietnam	EAS-ERIA Biodiesel Fuel
		ASTM D6751-07b	EN14214:2003	TCVN 7717:2007	Standard:2008
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900
Viscosity	mm2/s	1.9-6.0	3.50-5.00	1.90-6.00	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	130 min.	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.05 max.	0.0010 max.
Distillation, T90	deg. C	360 max.	-	360 max.	-
Carbon residue (100%) or Carbon residue (10%)	mass%	0.05 max. -	- 0.30 max.	0.050 max. -	0.05 max. 0.3 max.
Cetane number		47 min.	51.0 min.	47.0 min.	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.020 max.	0.02 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	0.05[vol%] max	500 max.
Total contamination	mg/kg	-	24 max.	-	24 max.
Copper corrosion		No.3	Class-1	No.1	Class-1
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.50 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	6.0 min.	10.0 min. (****)
Iodine value		-	120 max.	120 max.	Reported (***)
Methyl Linolenate	mass%	-	12.0 max.	-	12.0 max.
Polyunsaturated FAME (more than 4 double bonds)	mass%	-	1 max.	-	N.D. (***)
Methanol content	mass%	0.2 max. (*)	0.20 max.	-	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	-	0.80 max.
Diglyceride content	mass%	-	0.20 max.	-	0.20 max.
Triglyceride content	mass%	-	0.20 max.	-	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.020 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.240 max.	0.25 max.
Na+K	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	-	5.0 max.
Phosphorous content	mg/kg	10 max.	10.0 max.	10.0 max.	10.0 max.