BIOFUELS - AT WHAT COST ?

Government support for ethanol and biodiesel in Indonesia

One of a series of reports addressing subsidies for biofuels in developing countries

December 2008

Prepared by:
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Prepared for:
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The Global Subsidies Initiative (GSI)
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Acronyms and abbreviations

APROBI	Association for Production of Biofuels in Indonesia
BPS	Bureau Central of Statistics Indonesia
BPKM	Investment Coordination Board
CAPS	Centre for Agricultural Policy Studies
CMoE	Coordinating Minister of Economic Affairs
CEO	Chief Executive Officer
CPO	Crude Palm Oil
DESDM	*Departemen Energi dan Sumber Daya Mineral* (Department of Mineral and Energy Resources)
DJLPE	Directorate General of Energy Research
EAI	PT Energi Alternatif Indonesia
EFB	Empty Fruit Bunches (oil-palm)
EU	European Union
FAME	Fatty Acid Methyl Ester
FAO	United Nations Food and Agriculture Organization
FFV	Flexible Fuel Vehicles
GAPKI	*Gabungan Pengusaha Kelapa Sawit Indonesia* (Indonesian Palm Oil Producers Association)
GHGs	Greenhouse gases
Government	Government of Indonesia
GNP	Gross National Product
GSI	Global Subsidies Initiative
IISD	International Institute for Sustainable Development
jatropha	*Jatropha curcus*
Lemigas	Oil and Gas Institute
LNG	Liquefied Natural Gas
MoA	Ministry of Agriculture
MoF	Ministry of Finance
MoFt	Ministry of Forestry
MoT	Ministry of Transportation
MoEnv	Ministry of Environmental Affairs
MOPS	Mean Oil Platt Singapore
MoRT	Ministry of Research and Technology

MoSOE	Ministry of State-owned Enterprises
NBDC	National Biofuels Development Committee
NTFBD	National Team For Biofuel Development
PLN	*Perusahaan Listrik Negara* (State Owned Power Company)
Pertamina	*Perusahaan Tambang Minyak Negara* (State-owned Oil Company)
PME	Palm methyl ester
PPKS-Medan	Indonesian Oil Palm Research Institute
PPO	Pure Plant Oil
PTPN	*PT Perkebunan Nusantara* (State-owned Plantation Company)
R&D	Research and development
RNI	*Rajawali Nusantara Indonesia* (State-owned company involved in the agro-food industry, health-product sectors and general trading)
Rekin	*Rekayasa Industri Rekin* (State-owned Manufacturing-Processing Company)
RES	Rural Energy Self-sufficiency
SOE	State-owned Enterprise
URDI	Urban and Regional Development Institute
U.S.	United States
VAT	Value-added tax

Conversion notes

Currency

In each year between 2006 and 2008, the average annual exchange rate was US$ 1 to IDR 0.00011.[1] This exchange rate has been used throughout this report.

Tonnes-to-litres

One tonne of ethanol equals 1 270 litres, based on a density of 0.789 tonnes per cubic metre. One tonne of biodiesel equals approximately 1 136 litres, based on an average biodiesel density of 0.88 tonnes per cubic metre. (Density, and therefore volume, varies with temperature.)

[1] Source: www.oanda.com average historic rates 2006, 2007 and 2008.

Executive Summary

In recent years, the governments of a growing number of countries have promoted industrial-scale production and use of liquid biofuels—fuel-grade ethanol and biodiesel[2]—and backed that commitment with financial support. This report, one of a series of country studies undertaken by or for the Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD), examines the types and magnitude of support to biofuels in Indonesia.

Previously blessed with abundant oil reserves, Indonesia has not had a long history of encouraging the use of alternative and renewable fuels. Indonesia's oil production started to go into decline in 2003, just at a time that oil prices began to soar, prompting a re-thinking of the country's energy policies. In 2006, the Government of Indonesia (the government) established its first national policy on biofuels as part of the National Security Act. Among the top reasons it gave for promoting the development of biofuels were energy security, job creation (particularly in rural areas), building on existing strengths in the agricultural sector and developing new export opportunities. Early government plans envisaged that biofuels would meet 10 per cent of transport fuel consumption by 2010, create thousands of new jobs and lead to energy self-sufficiency for rural villages.

The government's enthusiasm for biofuels has not been matched, so far, with equally vigorous programmes to ensure development of the industry in the planned timeframe. Volatile prices for biofuel feedstock and petroleum since 2006 have lead to dramatic shifts in the cost of biofuel production, relative to petroleum fuels, and the government's appetite for providing support has waxed and waned with the profitability of the industry.

In 2006, many agricultural commodity prices were relatively low and energy prices high, making biofuel production an attractive proposition. The government instructed the national oil company, Pertamina, to start selling blends of five per cent biofuel mixed with petroleum fuels (primarily biodiesel produced from palm oil).[3] Export prospects appeared highly lucrative and investors initiated major new projects in the plantation and biofuel sectors. The atmosphere resembled a modern gold-rush. At the peak of optimism about the industry, in early 2007, the government hosted an event in Jakarta at which 67 agreements for biofuel developments were signed, worth almost US$ 10 billion. The government was reported to have committed IDR 10 trillion (US$ 1.1 billion) in the 2007 budget for biofuel infrastructure subsidies, in addition to subsidies for plantation improvement, training, and research and development.

However, soaring agricultural commodity prices later in 2007 and during the first half of 2008 made biofuel production increasingly unprofitable. Pertamina suffered mounting losses from its biofuel blends, as the government required it to sell biofuels at the same

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2 "Biofuel" refers to liquid renewable fuels such as ethanol (an alcohol fermented from plant materials) and biodiesel (fuels made from vegetable oils and animal fats) that can substitute for petroleum-based fuels.

3 Pertamina sells biodiesel blended with fossil diesel under the brand name "Bio Solar" at service stations throughout Indonesia; a blend of ethanol with gasoline ("Bio Premium") is being trialled at several service stations, as is "Bio Pertamax," a high-performance gasoline-ethanol blend that is sold unsubsidized.

price as subsidized petroleum fuels but did not provide additional subsidies to cover the higher cost of biofuels. As a result, Pertamina unilaterally dropped the biofuel content of its blended fuels. By May 2008, the biodiesel content of Pertamina's biodiesel blend had fallen to one per cent, and the ethanol content of its trial blend with gasoline was three per cent. The government did not enforce the original biofuel blending ratio and it appears that other biofuel-related subsidies were not disbursed, such as the IDR 10 trillion in infrastructure subsidies.

High feedstock prices and limited government assistance left the industry foundering. Investors halted plans for new developments and many existing refineries suspended their operations. Others reduced their production levels to as low as 10 per cent of their production capacity and supplied limited amounts of biofuel to Pertamina or exported their product to OECD countries where subsidies help finance biofuel consumption.

Even with record-high oil prices in 2008, biofuels were more expensive to procure than petroleum fuels and only added to the government's fuel-subsidy burden. Pertamina's losses due to biofuel blending totalled IDR 360 billion (US$ 40 million) in the period from 2006 to June 2008 (see table below). These losses are effectively a government subsidy, given the company is a state-owned enterprise.

Including Pertamina's losses, total government allocations for biofuel development between 2006 and June 2008 reached up to IDR 1 500 trillion (US$ 1.6 billion). However, it is unlikely that all of these funds were disbursed. Low budget transparency in Indonesia makes it difficult to assess amounts committed in the budget and progress with implementation. Actual subsidy levels are likely to have been in the neighbourhood of IDR 1 793 billion (US$ 197 million), comprising Pertamina's losses and interest rate subsidies for plantation renewal, as well as training, research and development relating to biofuel feedstock cultivation.

Losses on sales of biofuel blends by Indonesia's national oil company, Pertamina (2006 to June 2008)

	Volume of blended biofuel sold at subsidized prices	Pertamina's loss due to biofuel blending	
	million litres	billion IDR	million US$
Biodiesel	1 057	359	40
Ethanol	7.2	2.25	0.25
Total	**1 065**	**361.25**	**40.25**

The biofuel subsidies were additional to the government's consumer subsidies for petroleum fuels. Approximately 60 per cent of petroleum fuels (gasoline, diesel and kerosene) are subsidized in Indonesia. The fuel subsidy cost for 2008 exceeded IDR 130 trillion (US$ 14.5 billion) by October 2008—almost three times higher than the IDR 45 trillion (US$ 5 billion) originally budgeted for that year.

In the second half of 2008, prices for both petroleum and biofuels began to ease. Biofuel producers increased production levels once again. As of October 2008, there were 11 commercial-scale biodiesel facilities in operation, producing 725 000 tonnes (824 million litres) per year—50 per cent of potential production (see table below). Existing plants are expected to increase production and expand in 2009. By 2010, several new plants are expected to come into production, taking total production capacity to over 2.3 million tonnes (2.7 billion litres) per year. Palm oil will be the main feedstock for these facilities.

There were four fuel-ethanol plants operating in 2008, with a total production capacity of 145 million litres (114 000 tonnes) per year. Actual production levels have not been reported for ethanol, although it is likely to be well below capacity. The Department of Energy and Mineral Resources reported that, by 2010, all four existing ethanol refineries plan to expand, 10 new major producers will commence operations and almost 20 small community-scale producers will begin production. Sugarcane and cassava will be the main feedstocks.

Biodiesel and ethanol production capacity (millions of tonnes per year)

	2008		2009		2010
	Capacity	Production[1]	Capacity	Production[1]	Capacity [e]
Biodiesel	1.59	0.72	2.52	1.12	4.12
Ethanol	0.12	n.a.	0.17	n.a.	3.12

Notes: [1] company production commitments; e = estimate; numbers rounded.

Optimism may be further boosted by the government's new biofuel mandate. The mandate requires that, by 2010, biodiesel will comprise 2.5 per cent of transport petroleum diesel consumption, and ethanol three per cent of gasoline for transport (these are lower than the original 2006 plan for biofuels to comprise 10 per cent of all transport fuels by 2010). Industry and power generation sectors face similar mandatory consumption requirements. Longer-term targets were also set out in the legislation. By 2025, biodiesel is expected to replace 20 per cent of all diesel use, and ethanol 15 per cent of gasoline use. These targets may be adjusted to align with global and domestic market conditions. Investors are likely to be cautious of the ambitious long-term targets, given the government's poor record in implementing its plans for development of the sector.

The flexibility demonstrated to date by the Indonesian Government in implementing its biofuel policies has not been welcomed by biofuel producers, who seek the certainty of sales and income offered by subsidies. However, the flexibility has been very positive for Indonesian taxpayers who must ultimately pay the subsidy bill. Had the government enforced the five per cent blending levels from 2006 to 2008, the cost to taxpayers would have been at least double, not including the trillions intended for biofuel support that were not disbursed.

The new mandates, if enforced, will lock in a predetermined share of biofuels in transport fuel consumption regardless of the cost. It is unclear why the government would want to do this. Indonesia's experience with petroleum pricing has clearly demonstrated that fuel subsidies can become a major drain on the economy, and politically difficult to reduce once in place. Steps to liberalize fuel prices have been a major advance for the Indonesian economy. Letting fuel prices rise to levels prevailing in international markets would reduce consumption and improve efficiency, resulting in improved energy security. The World Bank has estimated that fuel price reforms in 2005 freed-up US$ 10 billion in fiscal funding.

Fuel subsidies are unlikely to be the most effective way of helping the poor. A government report issued in 2006 concluded that the 60 per cent of Indonesians in the highest income bracket received 83 per cent of the fuel subsidies, while the 40 per cent

of people in the lowest income bracket received only 17 per cent of the subsidies. The funding liberated by subsidy reform could be directed to helping those in most need, through social protection measures targeting the poor, including a payment mechanism that allows recipients to spend on other choices such as food, health care or education. Adding an additional layer of subsidies for biofuels to an already distorted system makes little economic sense.

Social and environmental impacts

If biofuel subsidies do not make economic sense, an investigation is necessary into the social or environmental justifications for government support. The effect of biofuel production on social and environmental outcomes was not the key focus of this study. However, some discussion of these issues is highly relevant in the context of subsidy analysis. Government incentives that promote biofuels—either by Indonesia or other governments—have a direct influence on biofuel production and hence will exacerbate any positive or negative impacts.

Annual production by the nascent Indonesian biofuels industry is still small enough that it is unlikely to be having a significant social or environmental impact yet. But the government has big plans for the industry. Initial policies envisaged tens of thousands of new jobs in plantations and biofuel processing, and a large number of village-scale projects. The plans are not on-track, but with falling feedstock prices and a biofuel mandate to come into force from 2009, the implications of these policies could be significant. Biofuel production has been found to have a major influence on agriculture commodity prices by increasing demand. Higher prices benefit plantation owners and exporters but disadvantage other downstream users, such as food consumers and processors. Foreign biofuel production contributed to high food prices in 2007 and early 2008, adding to the pressure on supplies, prices and downstream users. Increased domestic biofuel production, except where it does not compete with current crops, has the potential to push up food prices and reduce food security (by increasing imports).

The government hopes that *Jatropha curcus* will be suitable for cultivation on marginal land that is unsuitable for food production.[4] The jatropha oil could be processed into a kerosene replacement in villages or for electricity generation. The government considers that the approach could reduce the fuel-subsidy burden given that a large proportion of total subsidies are spent on kerosene and transporting it to remote villages in the archipelago. However, jatropha oil is currently more expensive than kerosene. The cost of jatropha biofuel production would need to be reduced significantly for this policy to result in subsidy savings.

Biofuels and deforestation

Studies have shown that the use of biofuels can lead to lower emissions of harmful pollutants and greenhouse gases when compared with petroleum fuels. However, once the full lifecycle impacts are taken into account, the benefits become marginal for many

[4] *Jatropha curcas* is a hardy perennial plant native to South America. Its nuts have a high oil content, which has potential as a biofuel feedstock. Jatropha can be grown in dry, poor soils and is therefore less likely to compete with food production for arable land. Although the *Jatropha* genus contains many species, this report will use the conventional name of jatropha to refer to the species *J. curcas*.

types of biofuels. If native grassland or forest is cleared due to produce feedstock for biofuel production, the net environmental impacts are likely to be negative.

There is significant evidence that forests in Indonesia have been, and continue to be, converted to palm oil plantations, and that some of the oil may be used in biodiesel production or to supply global shortages of vegetable oil arising in part from biodiesel production in other countries. It is difficult to estimate the incremental impact of biofuel production on deforestation. There are many non-biofuel factors involved such as the market price for timber (legal and illegal), land clearance for non-biofuel crops, and population pressures.

A total of 22 million hectares of forest was allocated for conversion to oil-palm plantations up to 2007 but only two million hectares were actually planted with oil-palm. The remainder had been logged and abandoned. Palm oil therefore does not appear to have been the primary driver behind the land clearing. As a result of such practices, Indonesia has an estimated eight million hectares of land within the forest estate that are considered by the Indonesian Ministry of Forestry to be degraded, with another 15 million classified as degraded outside of the forest estate, with seven million hectares of such land suitable for oil-palm plantations. Some of this "degraded" land will have re-generated as "secondary" forest, with important ecological values.

Forests are still being converted to oil-palm plantations because the timber sales help fund plantation establishment and fertilizer requirements can initially be lower on recently-cleared land than on degraded land. The Department of Energy and Mineral Resources estimates that the area of plantations needed for biofuel feedstocks will increase 10 times by 2010, to over six million hectares. If this production is sited on non-forested degraded land, then environmental impacts could be minimized. However, the environmental impact would be significant if even half of the area involved the conversion of forest (whether pristine or secondary).

Sustainability certification will be a major hurdle for Indonesian producers but could reduce many of the negative environmental impacts associated with non-sustainable feedstock production practices. However, no certifications yet in operation can address land conversion induced indirectly as a result of diverting food crops into biofuel production.

Conclusions and recommendations

The government is continuing with its ambitious plans to develop a large, subsidized domestic biofuels industry, despite its recent experience of prohibitively high costs for biofuels, and the difficulties experienced socially and politically in reforming petroleum fuel subsidies.

The unintended consequences of biofuel production have the potential to undermine their hoped-for social and environmental benefits. There may be scope, however, for biofuels to play a useful role in supplying energy in rural communities, where the higher costs of biofuels might be warranted due to difficulties of supplying fossil fuels to these areas.

The study concludes with several basic recommendations for the Government of Indonesia. In our opinion, it should consider the following:

Eliminate subsidies on petroleum-derived transport fuels. To reduce dependence on petroleum fuels—the government's primary declared aim in promoting biofuels—it should start by allowing market pricing of fossil fuels. Removing subsidies for petroleum-derived fuels would decrease consumption and free-up government resources.

Replacing fossil fuels by subsidizing biofuels, a more expensive alternative than their fossil-equivalents, makes no economic sense.

Re-evaluate the government biofuel plan. The government needs to undertake an integrated evaluation of its blueprint for biofuel development. This initial investigation shows that policy in this area has been poorly coordinated and policy aims, as well as beneficiary targeting, have not been clearly articulated. Significant scope exists for improving transparency in the conduct of the current biofuels initiative.

The government should consider revising its energy-security strategies. Energy efficiency programmes might deliver greater reductions in energy use at a cheaper cost than subsidizing expensive alternative fuels, and have less of an impact on food resources for the poor and the environment.

Advocacy and environmental monitoring needed. Leaving aside the question of whether the capacity and resources exist for implementing the current national plan for developing biofuels, considerable risks have been identified relating to the deficits in capacity for good governance. This study highlights the need for increased capacity-building for good governance as a means to address the potential for illegal land appropriations and environmental degradation that the current biofuels programme is likely to exacerbate.

1 Introduction

This report examines government support for biofuels in Indonesia, which began with the announcement of a new biofuels plan in 2006. Current policies supporting biofuels came bundled together with the Energy Security Act under which liquid biofuels are intended to provide at least five per cent of total domestic energy needs by 2025.

Although biofuels are relatively new within the domestic policy discourse, their feedstocks include crude palm oil (CPO) and sugarcane, both of which have historically enjoyed government support in Indonesia.

The seriousness of the government's commitment to biofuel initiatives is evident in the statement by the President of Indonesia before the Indonesian House of Representatives on 16 August 2006 (Yudohono, 2006):

> …For the purpose of developing biofuel energy, the government will utilize asset expenditure allocations [in the 2007 Fiscal Budget] from various ministries and related institutions to support this programme. In addition, credit interest subsidies will be made available [in the 2007 Fiscal Budget] for the biofuel industry in the amount of IDR 1 trillion [US$ 110 million]…

The government expects that the development of biofuel production could bring multiple benefits to Indonesia. In addition to reducing oil imports and subsidies for petroleum, the most attractive benefit of biofuels is job creation, particularly in the agricultural sector. The government expects that growth in the agricultural sector and the rural economy resulting from increasing biofuel production could substantially improve the livelihoods of the rural poor. In contrast with many other countries, improvement of air quality or reduction in greenhouse gases (GHGs) has been a lesser motivation.

The National Team for Biofuel Development (NTFBD) was established by presidential decree to develop a roadmap for the biofuels industry as a means to reduce poverty and unemployment.[5] Biofuels were seen as a strong sector in which to invest because the plantation sector had remained robust, even after 1997 East Asian Financial Crisis. Indonesia's Gross National Product dropped 13 per cent after the crisis, while the plantation sector registered two per cent growth in 1997, and higher growth every year since then. The government intended to continue the trend by creating new markets for existing commodities such as palm oil and cassava, and developing new crops.

1.1 Framework of the analysis

Subsidies are payments made by the government for which it receives no direct goods or services in return. Often government subsidies are designed to help kick-start emerging industries. In other cases, subsidies are considered a means for correcting market failures (e.g., excessive imbalances in income distribution). As subsidies can affect the cost structure of an entire industry, examining a subsidy entails assessing the various cost components of that industry in relation to that subsidy regime.

Figure 1 illustrates the framework used in the report to assess the scale of subsidies provided at different points of the supply chain for biofuels in Indonesia, from the

[5] Presidential Decree 10/2006, issued June 2006, which reports to the President through the Coordinating Minister for Economic Affairs (CMoE).

production of feedstock crops through to the final consumption of the product. The framework of analysis is that developed by the Global Subsidies Initiative (first published in Koplow, 2006) and adapted to suit the conditions in Indonesia.

Theoretically, production costs are mirrored by value-added at various stages of the production process. Value added takes the form of labour costs (wages), capital costs (interest), land costs (rent) and entrepreneurial returns (profit). On a larger canvas, one must take into account all post-production processes occurring before the goods reach the final consumer. These subsidies can take the form of storage and infrastructure provision, the establishment of by-product consuming industries, or government procurement programmes (such as preferences for using biofuel in government vehicles).

In this study, production and consumption processes are treated separately from the point when biofuels leave the manufacturing plant. Under this assumption, distribution is regarded as part of the consumption process.

Quantifying subsidies for a specific industry is not always straightforward. Some types of subsidies, such as those to general infrastructure, are difficult to quantify because roads, harbours and power lines are not provided to a specific industry. Indonesia does not subsidize the price of energy to its industrial sectors; therefore such energy subsidies are not relevant to this analysis.

As indicated above, the biofuels industry in Indonesia is nascent. Consumption-related subsidies are, as a result, not quantifiable at this point. This study focuses on subsidies granted to the production and development processes. To develop estimates for aggregate subsidies, it examines each component of the industry to develop figures that will then feed into the final calculation of overall subsidy levels. In reality, an array of subsidies exists that affect both the production and consumption processes.

Intermediate inputs are defined in this study as goods and services used in the production process. The government has focused on using palm oil, cassava, jatropha and sugarcane as the main feedstocks for developing the biofuel sector. Palm oil is regarded as the most viable feedstock for biofuels as it is already a well-established industry and can be easily converted into biodiesel. The government is also promoting jatropha.

Subsidies are also granted to value-adding factors. These take the form of subsidies provided to capital goods; to labour employed directly within the production process; and to land. In Indonesia, capital subsidies normally take the form of loans provided at below market interest rates, credits and direct transfers. Subsidies to capital are larger than those provided to land or labour and support to labour usually takes the form of training programmes.

Output-related support is provided through government policy on the pricing of petroleum fuels and, in the case of ethanol, import tariffs. Import tariffs have the economic effect of subsidizing domestic producers by increasing the price of comparable imported products on the domestic market. Government procurement programmes are being applied as a means of indirectly boosting the potential size of the biofuels market. State Owned Enterprises (SOEs) in the energy sector—notably, Pertamina (National Oil Company) and PLN (National Power Company)—have been instructed to procure biofuels. The Ministry of Transportation, the Ministry of Research and Technology, and the Ministry of Environmental Affairs have all promoted the use of biofuels via a public campaign, such as through organizing biofuel technology exhibitions and sponsoring seminars and lectures.

Box 1.1 Biodiesel and ethanol production processes

Liquid transport biofuels are most commonly produced as either biodiesel or ethanol.

Biodiesel is produced from vegetable oil or animal fat. In a process known as transesterification, the fat or oil is reacted with an alcohol (usually methanol synthesized from natural gas) in the presence of a catalyst to yield mono-alkyl esters (biodiesel) and glycerine. Other by-products can include fatty acids, fertilizer and oilseed meal. Many of these by-products have a value, particularly the glycerine an oilseed meal (e.g., soybean meal used for both human and animal food).

The energy content of biodiesel varies between 88 per cent and 99 per cent of the energy content of diesel, depending on the feedstock and esterification process used (Love and Cuevas-Cubria, 2007).

Biodiesel is used to replace fossil diesel. It can be used pure or in a blend (commonly B5 or B20, which contains five per cent or 20 per cent, respectively, of biodiesel mixed with fossil diesel).

Over 50 plant species produce extractable oils. All have potential for use as fuel, but most are prohibitively expensive. The main oils used for fuel are derived from soybeans, oil-palm fruit, rapeseed (canola), sunflower seed, and physic nut (*Jatropha curcas*). Another possible source of lipids is oil-rich microalgal feedstocks. Producing biodiesel from algae is still at the research and demonstration phase.

For **palm biodiesel** production, palm oil is heated in the presence of excess methanol and an alkaline catalyst; it then passes through a set of multi-stage continuous reactors to maximise the amount of transesterification. Glycerol is removed after each reaction. The removal of glycerol is important to achieve a higher conversion to methyl esters as part of the reaction. After the reaction is completed, excess methanol is recovered and can be reused. The crude biodiesel is washed using hot water and separated by centrifugal action. It is then dried in a vacuum to ensure the final product has a low moisture content prior to it being sent to storage tanks. The glycerol is treated to recover the methanol and then sent to storage tanks as crude glycerol. A hectare of oil-palm yields approximately 3,600 litres of biodiesel.

Several alternative technologies are vying to replace transesterification. The costs of these technologies are highly sensitive to rises in the prices of oils and fats. One new process using existing equipment normally found in oil refineries creates a diesel substitute (called “renewable diesel”) from animal fats or vegetable oils. In the longer term, diesel substitutes may be synthesized from almost any type of low-moisture biomass using the Fischer-Tropsch (F-T) process. Although the F-T process is well developed, and has been used to make liquid fuels from fossil-fuel feedstocks (e.g., coal and natural gas), production from biomass is still at the research and demonstration stage.

One technology that shows promise is the use of thermo-chemical processes to produce petroleum substitutes from syngas (a mix of carbon monoxide and hydrogen). Syngas generated from waste-to-energy gasification facilities can be converted to dimethyl ether (DME), a diesel substitute. Diesel engines need virtually no modification to run on DME.

Ethanol is a clear alcohol that can be used as a fuel in spark-ignition engines, either neat or blended with gasoline. The energy content of fuel ethanol is around two-thirds that of gasoline (regardless of the feedstock used), but it has a significantly higher octane rating.

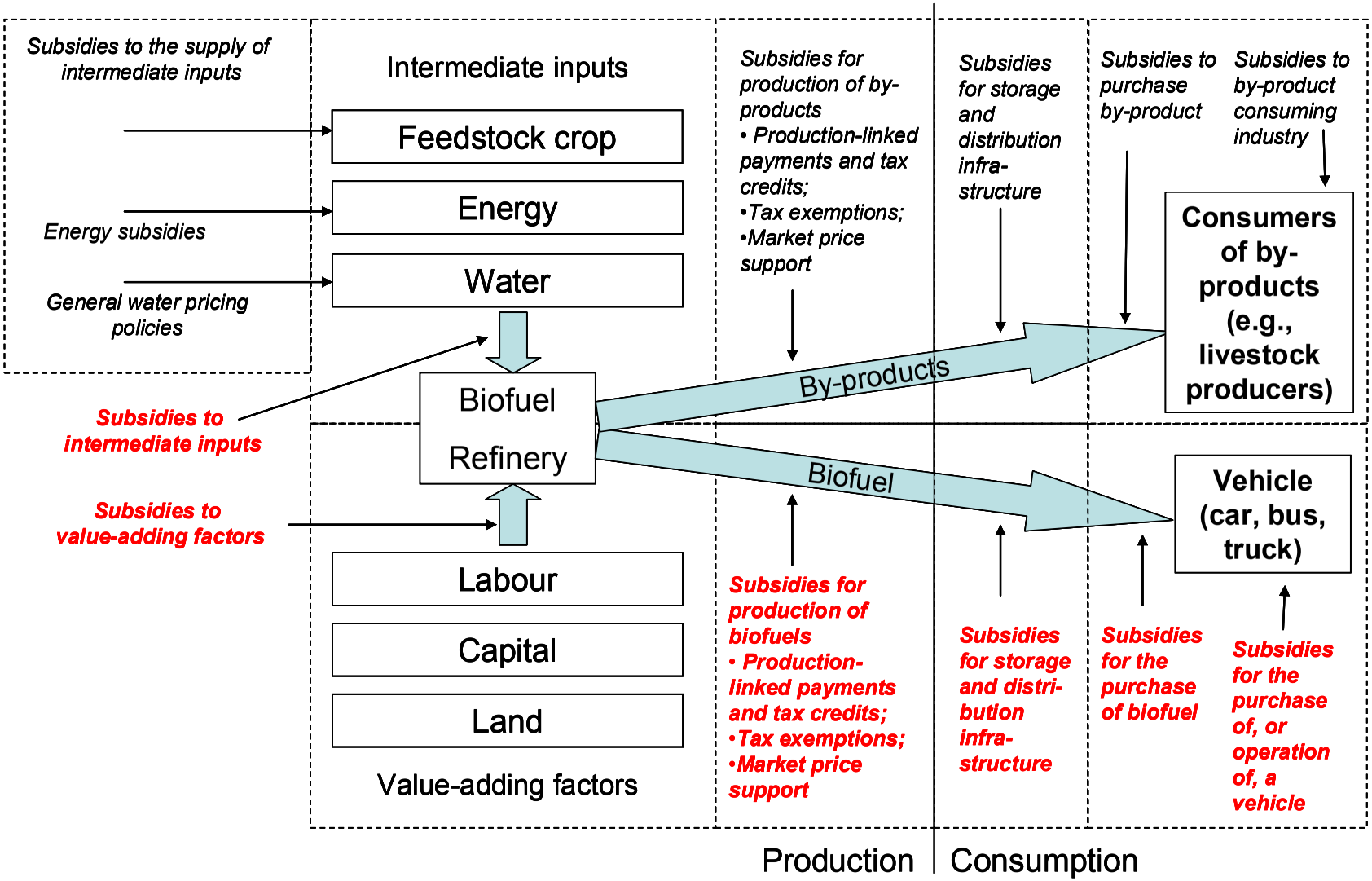
Fuel ethanol can be either hydrous (also called “hydrated”) or anhydrous. Hydrous ethanol typically has a purity of about 95 per cent and has been used in Brazil since the late 1970s as a fuel in motor vehicles with modified engines. Further processing to remove any residual water produces a high-purity anhydrous ethanol that is typically blended with petrol for use in unmodified engines.

Globally, more than 95 per cent of the world’s ethanol is produced by fermented plant-derived matter, mainly sugars and starches. The rest is produced synthetically, from petroleum or coal. In the early part of the decade, less than 25 per cent of total ethanol produced was being used for beverage or non-fuel industrial purposes (Berg, 2003); that fraction has probably dropped below 20 per cent.

Production from sugar and starch is referred to as a *first-generation* technology. *Second-generation* technologies are under development to commercialise production of ethanol from cellulosic material, such as crop waste, wood and grasses. In second-generation ethanol manufacturing plants, the cellulose and hemi-cellulose constituents of the biomass are converted into simple sugars either biologically, using enzymes, or chemically, using acids and high temperatures, prior to fermentation.

Sources: Love and Cuevas-Cubria (2007), Steenblik (2007).

Figure 1.1 Subsidies provided at different levels of production, distribution and consumption



2 The evolution of Indonesia's biofuel policy

The Indonesian Government's interest, and involvement, in the biofuels industry was until recently confined to supporting small amounts of research and development. Testing of E10 gasohol (a mixture of 90 per cent gasoline and 10 per cent ethanol) was conducted on 100 cars and 32 motorcycles in Indonesia during the 1980s, but no further work was undertaken over the following decade, as oil remained abundant and cheap.

However, the transformation of Indonesia from a net exporter to a net importer of petroleum, starting in 2006, provoked new exploratory investigations into alternatives to fossil fuels. During that period various government, university and industry research institutions, including the Oil and Gas Institute, Lemigas, and the state oil company, Pertamina, began to undertake research and development into biodiesel. Following trials, a mixture of biodiesel and petroleum diesel was developed that was determined to be safe for use in ordinary diesel engines. By 2001, the Ministry for Research and Technology (MoRT) had built a laboratory-scale factory capable of producing 1.5 tonnes of biodiesel a day (620 000 litres per year).[6]

2.1 The rising cost of subsidizing fuel

The Indonesian Governments concerns about energy security had a financial dimension as well. Since 1967, Indonesia has been subsidizing the retail price of transport and cooking fuels. During the 1980s, when Indonesia had an exploitable oil surplus, these energy subsidies were manageable, though they were criticized from abroad as causing economic distortions. Indonesian policy-makers maintained that, as a national product, transport and cooking fuels must be priced low enough for the poor to be able to afford them. Indiscriminate administrative pricing, however, meant that the not-so-poor tended to benefit disproportionately.[7] Rapid urbanization and increasing automobile ownership during the early 1990s led to increased demand for subsidized fuel, thus escalating government expenditures. One effect of the growth in government fuel-subsidy outlays was that resources for other government services, such as social spending, were reduced.

Escalating oil prices in 2005 forced the government to reduce price subsidies. This led to an approximate doubling of prices for transport fuels, and a near trebling of the price of kerosene (Table 2.1). The latter price hike disproportionately affected people living in remote rural areas, who depend on kerosene for cooking.

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6 This facility is used mainly for R&D and actual production averages less than capacity.

7 As reported by Guerin (8 February 2007), a government report issued in 2006 concluded that the 60 per cent of Indonesians in the highest income group received 83 per cent of the fuel subsidies, while the 40 per cent of people in the lowest income group received only 17 per cent.

Table 2.1 Prices of petroleum fuels, 2005 to 2008 (IDR per litre)

	January 2005	March 2005	October 2005	June 2008	December 2008
Gasoline	1 810	2 400	4 500	6 000	5 500
Diesel	1 650	2 100	4 300	5 500	5 500
Kerosene	700	700	2 000	2 500	2 500

Sources: 2005: U.S. Embassy in Jakarta (2005); 2008: Thai News Service (2008)

The World Bank found that the reduction in fuel subsidies in 2005 freed up US$ 10 billion of government expenditure, which became available for other programmes (World Bank, n.d.). Despite the reduction in fuel subsidies, total subsidies (not only fuel) still accounted for US$ 12 billion of the 2006 budget (15 per cent of total expenditures in 2006).

Fuel prices and demand continued to rise, increasing pressure on the budget (Table 2.2). By early 2008, fixed domestic prices for gasoline, motor diesel and kerosene accounted for over two-thirds of fuel sales and were absorbing about one third of all federal government spending, equalling total central government spending on capital and social programmes (World Bank, 2008a).

Table 2.2 Indonesian Government expenditure on petroleum fuel subsidies, 1999–2009

Year	Volume of fuel[1]	Subsidies	
	(billion litres)	(trillion IDR)	(billion US$)
1999	n.a.	39.5	4.3
2000	n.a.	55.6	6.1
2001	48.7	61.8	6.8
2002	49.6	31.6	3.5
2003	50.5	31.7	3.5
2004	50.2	72.9	8
2005	49.5	39.8	4.4
2006	37.5	67	7.4
2007	38.6	87.6	9.6
2008 (estimate)	35.8	160[2]	17.6
2009 (projection)	n.a.	57.6[3]	6.3

Notes: [1] Gasoline, diesel and kerosene.

[2] Actual January to until October 2008 expenditure was IDR 130 trillion. In estimating total subsidies for 2008, the GSI assumed that IDR 10 trillion would be required for each of the remaining three months of that year (this assumption was based on reported monthly subsidies for September 2008 of IDR 11 trillion) (*Platts Commodity News*, 2008).

[3] Government forecast based on an average price of US$ 80 per barrel of crude oil (Thai News Service, 2008).

Sources: *Subsidies*—**1999–2005:** Coordinating Minister for Economic Affairs (2007); **2006:** Department of Energy and Mineral Resources. (2007, 29 March); **2008:** Platts Commodity News (2008). **2009:** Thai News Service (2008). *Volumes*—2001 to 2006: www.bphmigas.go.id; 2007–08: Pertamina (2008, 14 January).

Crude oil prices hit a record high of almost US$ 140 a barrel in July 2008 (Table 2.3), much higher than the Indonesian budget assumption of US$ 95, raising the projected subsidy cost for 2008 from IDR 45 trillion (US$ 5 billion) to IDR 126 trillion (US$ 14 billion). Even this higher allocation was exceeded (IDR 130 trillion) by October, despite increases to fuel prices in June.

By December 2008, falling oil prices led the government to reduce the price of subsidized gasoline from IDR 6 000 to IDR 5 500 (Table 2.1). Prices for diesel and kerosene, however, were kept constant, with the government stating that it could not reduce prices for these fuels without exceeding its fuel-subsidy budget for 2009 (*Thai News Service*, 2008).

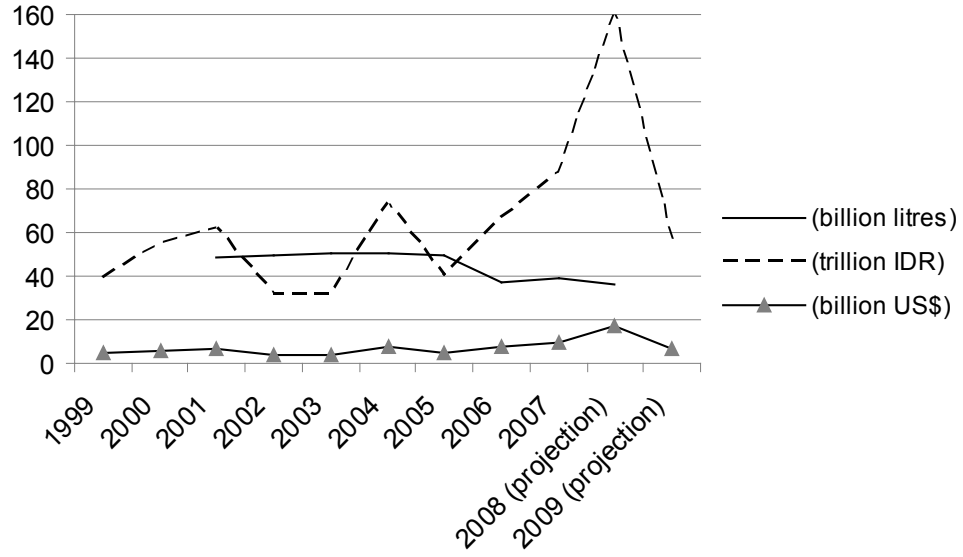
Table 2.3 Crude oil (Indonesia Minas-34) spot prices, 2008

Date (2008)	Crude oil price (US$ per barrel)
January	95
February	96
March	105
April	109
May	126
June	137
July	140
August	119
September	103
October	77

Source: Energy Information Administration, www.eia.doe.gov/

Figure 2.1 shows that, up to 2008, the total subsidy cost rose, while the volume of subsidized fuel fell. The government initially intended to reduce the fuel subsidy burden by replacing a proportion of fossil fuel use with biofuels. However, escalating feedstock prices in 2007 and the first half of 2008 made biofuels even more expensive than petroleum fuels.

Figure 2.1 Indonesian Government expenditure on petroleum fuel subsidies, 1999–2009



Notes and sources: See Table 2.2.

2.2 The National Energy Policy

In response to the political repercussions of the 2005 fuel-price increases, the government developed a strategic plan for energy security, announced in 2006 as the National Energy Policy (Presidential Regulation No. 5/2006). The over-arching aim of the National Energy Policy is to safeguard the national economic interest by improving domestic energy security. In general, the government seeks to reduce the economy's income elasticity of demand for energy,[8] from a level of 1.84 in 2006 to less than 1.0 in 2025. The government also aims to reduce Indonesia's dependency on fossil fuels.

Among other policy objectives, the National Energy Policy declared that bio-energy should meet 3.7 per cent of total household and commercial energy needs by 2010. Longer term, the National Energy Policy envisages liquid biofuels meeting at least five per cent of domestic energy needs by 2025 (Table 2.4).

[8] Energy elasticity roughly estimates energy consumption efficiency within a country. The lower the elasticity value, the better. Advanced countries usually have an energy elasticity value of less than one.

Table 2.4 Government targets for sources of domestic energy by 2025

Source of energy	2004 (per cent)[1]	2025 (per cent)[2]
Oil	53	≤ 20
Coal	22	≥ 33
Gas	19	≥ 30
Liquid biofuels	0	≥ 5
Geothermal energy	3	≥ 5
Other renewable energy (biomass, solar, wind, nuclear, hydro)	4	≥ 5
Liquid coal	0	≥ 2

Note: Numbers may not add due to rounding.

Source: [1] Government-Energy Statistics, [2] National Energy Security Act (Energy mix).

2.3 The Losari Concept

In July 2006, the government developed a policy regime to increase biofuel production in support of its energy-security plans. The President convened a special cabinet meeting to draw up a conceptual approach and obtain commitments from stakeholders. This approach has come to be known as the Losari Concept (named after the meeting venue). The aims of the plan were to improve energy security, boost economic growth, create employment and reduce poverty in rural areas (Wirawan, 2006). These aims would be achieved through substitution of petroleum fuels by domestically produced biofuels: gasoline by ethanol; petroleum diesel by biodiesel; and kerosene and petroleum diesel for electricity generation with pure plant oil. The plan envisaged bringing millions of "non-productive" hectares into production for biofuel feedstock cultivation.

The target was to create 3.6 million new jobs, reduce the poverty rate by 16 per cent and lower oil imports by US$ 5 billion a year. The government estimated that substituting biofuels for fossil fuels would also reduce fuel subsidies.

As part of this plan, the Minister of Energy and Mineral Resources, Mr. Purnomo Yusgiantoro, announced that Indonesia intended to meet 10 per cent of transport fuel usage with biofuels by 2010. The Minister said that the biofuel would be made from cassava, sugarcane, palm oil and castor oil (*People's Daily Online*, 2006). In relation to biodiesel, the Department of Mineral and Energy Resources (DESDM) estimated that Indonesia would consume around 15 billion litres of diesel in the domestic (non-industry) transport sector by 2010 (Table 2.5). If 10 per cent of this comprised biodiesel, around 1.5 billion litres of the biodiesel would be needed.

Table 2.5 Losari Concept Plan for biodiesel substitution in the domestic (non-industry) transportation sector (millions of litres)

Year	Total	Petroleum diesel	Biodiesel
2005	11 791	11 791	0
2006	14 498	14 411	87
2007	12 836	12 669	167
2008	13 478	13 101	377
2009	14 152	12 949	1 203
2010	14 859	13 522	1 337

Sources: Presentation of Department of DESDM in Losari Concept (2006).

To meet the 10 per cent target, the Losari Plan intended that Indonesia would need to establish over 100 new biodiesel plants with varying capacities (Table 2.6). Initially, the concept envisaged producing biodiesel predominantly from jatropha oil.

Table 2.6 Additional resources required to meet Losari Concept's milestones for biodiesel

	2006	2007	2008	2009	2010	Total
CPO (thousand tonnes)				440	320	760
jatropha oil (thousand tonnes)	40	200	400	456	504	1,600
Land for palm (thousand ha)		110	80			190
Land for jatropha (thousand ha)	25	125	250	285	315	1 000
Biodiesel plants (3 000 tonnes/yr capacity)		12	15	15	9	51
Biodiesel plants (30 000 tonnes/yr capacity)		6	10	13	15	44
Biodiesel plants /100 000 tonnes/yr capacity)				2	2	4

Source: Based on a presentation of Department of DESDM in Losari, in Wirawan (2006).

2.4 The creation of a National Team for Biofuel Development

To implement the objectives of the National Energy Policy and the Losari Concept, President Yudhoyono tasked selected cabinet members with duties to promote biofuels as alternatives to petroleum fuels (Presidential Decree No.10/2006 on Establishment of National Team for Biofuel Development, July 2006). The President also instructed sub-national governments to facilitate land procurement for biofuel-crops and to promote the use of biofuels. Key government bodies and agencies involved in this process included the Coordinating Minister for Economic Affairs (CMoE), the Ministry of Finance (MoF), the Ministry of Energy and the Mineral Resources (MoEMR), the Ministry of State-owned Enterprises (MoSOE), the Ministry of Transport (MoT) and the Ministry of Environmental Affairs (MoEnv).

To ensure coordination among this wide array of institutions, the government formed a national team for biofuels development (NTFBD) and gave it a mandate to formulate a

blueprint for biofuel development programmes. The team includes former cabinet members as well as CEOs of state-owned enterprises (SOEs). The mandate of the NTFBD is to ensure that biofuel development benefits the general population by increasing employment and reducing poverty. The NTFBD also serves as a clearinghouse for biofuel investment.

Along with creating the NTFBD, the government announced it would provide special incentives under the biofuels programme for investors (Government of Indonesia, 2008), including:

- a reduction in stamp duties;
- agreements with 50 countries to avoid double taxation;
- relief from import duties for goods used in the production of biofuels;
- an investment tax allowance in the form of a reduction in taxable income by a value equal to up to 30 per cent of the realized investment spread over six years;
- accelerated depreciation and amortization;
- a loss-carried-forward facility for a period of no more than 10 years;
- a 10 per cent income tax on dividends, possibly lower if stipulated in the provisions of an existing applicable tax treaty; and
- an exemption from the Value Added Tax for selected strategic goods.

2.5 Emergence of a rural energy self-sufficiency policy

The National Energy Policy envisages an increase in the use of vegetable oil in place of, or blended with, kerosene (a mix that it calls "bio-kerosene"). Kerosene is widely used in stoves for cooking, especially in rural areas of the archipelago. To this end, the government launched a "village-level energy self-sufficiency program" to help villages meet their own energy needs. This was also intended to save the government money, as kerosene subsidies were accounting for almost half of the expenditure on fuel subsidies.

Fuel-price hikes hit remote villages the hardest, as they also have to bear the high costs of transporting kerosene. The aim of the policy is to reduce the vulnerability of the rural poor to fuel-price volatility at the village level. The plan envisages creating 1 000 energy-self-sufficient villages, utilizing one million kilolitres of oil, mainly from jatropha, by 2010 (U.S. Department of Agriculture, 2007a).

The Rural Energy Self-Sufficiency (RES) model is being developed using a "nucleus-plasma planting scheme." Each village would cultivate around 50 hectares of biofuel feedstock crops (the "plasma" planting unit). Villages would grow jatropha, palm oil, coconut, cassava or sugarcane depending on its agro-climatic and social-economic conditions. Non-traditional crops, such as sorghum and corn, could also be encouraged.

A "nucleus" processing facility would purify the oil to produce a fuel-grade product that could be blended with petroleum fuels and used locally. The national electricity company would act as a standby buyer for any excess blended biodiesel.

According to government sources, 123 villages in several provinces were implementing the plasma credit scheme June 2008 (Legowo, 2008).

2.6 The roles of state-owned enterprises (SOEs)

State-owned enterprises remain dominant players in most sectors of Indonesia's economy, despite recent reforms that have corporatized many SOEs and allowed some private investment in these companies (Figure 2.1). Through two SOEs, PLN (*Perusahaan Listrik Negara*, Bahasa for "state electricity company") and Pertamina (*Perusahaan Tambang Minyak Negara*, "state oil company"), the government maintains monopoly control over electric power generation and, until recently, fuel. Until 2001, Pertamina was both regulator and service provider in the petroleum sector.

Pertamina and PLN have been assigned roles in implementing the government's biofuels policies. Among other functions, both have been designated as "standby" consumers of any excess biofuel production.[9] Pertamina is under a mandate from the government to provide transport fuel and kerosene at subsidized prices. It is also required to provide blended biofuels at the same price as subsidized petroleum fuels.

Another SOE, the PTPN (the National Plantation Company), stands to benefit from this captive market as it is a leading domestic producer of CPO and sugarcane. Several other SOEs, such as PT Rajawali Nusantara Indonesia (PT RNI, involved in the agro-food industry, health-product sectors and general trading) and PT Rekayasa Industri Rekin (involved in construction and engineering) are forging partnerships with foreign investors to establish biofuel processing plants. The state-owned Bank Mandiri has pledged to provide credit for biofuel industries.

[9] This role was issued as a joint decree by the Ministry of Mineral and Energy and the Ministry of State Owned Enterprises. Specifically, Pertamina would be the standby buyer of biodiesel and ethanol, while PLN will purchase any surplus fuel-grade straight vegetable oil, at market price.

Figure 2.2 The multiple roles of government in biofuel development

Generic biofuel supply chain	Farming/plantation (intermediate input) • Land • Seed • Fertilizer • Irrigation • Labour	Processing (input) • Technology • Machinery • Skilled labour	Distribution & consumption • Infrastructure - Road - Seaport • Marketing	Export • EU Domestic • Transportation • Power generation
Government as regulators	• Land use policy (MoFt) • Land ownership policy • Labour laws • Taxation	• Taxation • Incentives	• Infrastructure policies • Public private partnership policies	• Export tax • Energy security
Government as suppliers	• SOE – Plantations (PTPN)	• SOE – PT Rekin, RNI	• Road and port construction • Maintenance	• SOE – Pertamina • SOE – PLN
Government as facilitators	• SOE – Bank loans	• SOE – Bank loans • R&D	• Trade negotiations	• Energy policy • Environmental policy

Source: Authors.

2.7 The Joint Initiative for Biofuel Development

On 9 January 2007, the Ministry of Energy and Mineral Resources co-hosted an event in Jakarta, known as the Joint Initiative for Biofuel Development, at which 67 agreements for biofuel development were signed. Among the 52 foreign, local, and state-owned enterprises indicating they were either planning to invest, or had an interest in investing, in biofuel development in Indonesia, 12 were financial institutions and 11 foreign-Indonesian joint ventures. The total value of the investments covered by these agreements has been estimated at US$ 12.4 billion (U.S. Department of Agriculture, 2007a). Additional financing of US$ 2.8 billion in loans at interest rates subsidized by the Indonesian Government was to be provided by the national banks Bank Mandiri and Bank Negara Indonesia.

Few of these projects were implemented, as escalating feedstock prices in 2007 and early 2008 made biofuel production increasingly unprofitable. The largest of these projects, with projected total investment over US$ 5.2 billion, between China National Offshore Oil Corp, Hong Kong Energy (Holdings) Ltd and the Sinar Mas Agro Resources and Technology (SMART) Group, was halted in March 2008 due to high feedstock prices that made the project unviable (Soeriaatmadja, 2008).

2.8 Mandatory consumption

In October 2008, the Indonesian Government passed legislation that makes biofuel consumption mandatory, commencing in 2009 (Table 2.7). The required consumption levels for 2008 reflect existing blending by Pertamina, with biofuel blends only being sold

in certain retail outlets in selected provinces. The 2008 blending ratios will be applied nationally in 2009, which will mean a significant expansion in biofuel consumption.

Article 6 of the regulation states that a licensed biofuel entity that is performing the obligations for mandatory biofuel consumption may be given incentives (either fiscal or non-fiscal) in accordance with the prevailing laws and regulations. No further details or guidelines were provided in the legislation.

The new legislation requires that fuel blenders place a higher priority on using domestically-produced biofuels, and biofuel producers are expected—where possible—to use domestic feedstocks, equipment and labour. Biofuels can also be imported and exported under license.

Interestingly, the blending percentage for non-Public Service Obligation (PSO) transportation fuels, which are not subsidized, is higher than that for PSO transportation fuels (Table 2.7). This seems to suggest that the government predicts that biofuels will continue to be more expensive than petroleum fuels. Otherwise, the higher blending percentage would presumably be applied to subsidized fuels, to reduce the fuel subsidy burden.

Table 2.7 Minimum obligations for biodiesel utilization

Sector		Oct.–Dec. 2008	2009	2010	2015[1]	2020[1]	2025[1]
Biodiesel		**% of total diesel consumption**					
Household		-	-	-	-	-	-
PSO transportation[2]		1 (existing)[3]	1	2.5	5	10	20
Non-PSO transportation[2]		-	1	3	7	10	20
Industrial and commercial		2.5	2.5	5	10	15	20
Electricity generation		0.1	0.25	1	10	15	20
Ethanol		**% of total gasoline consumption**					
Household		-	-	-	-	-	-
PSO transportation[2]		3 (existing)[3]	1	3	5	10	15
Non PSO transportation[2]		5 (existing)[3]	5	7	10	12	15
Industry and commerce		-	5	7	10	12	15
Electric generation		-	-	-	-	-	-
Straight vegetable oil fuel		**% of total liquid fuel consumption**					
Household		-	-	-	-	-	-
Industry and Transportation	Industry	-	-	1	3	5	10
	Marine	-	-	1	3	5	10
Electricity generation		-	0.25	1	5	7	10

Notes: [1] To be adjusted in line with global specifications and domestic requirements; [2] PSO is Public Service Obligation—subsidized consumer fuels. [3] For the remainder of 2008, biofuels would continue to be supplied only in selected service stations and provinces.

Source: Regulation of Minister of Energy and Mineral Resources, 32/2008. Appendix 29/2008, 26 September 2008.

The Ministry of Energy and Mineral Resources held a seminar on 13 October 2008 with key stakeholders to discuss implementation of the mandatory blending mandate. Speakers included representatives of the Oil and Gas Institute (Lemigas), Pertamina, the Association for Production of Biofuels in Indonesia (APROBI), the Indonesia Chambers of Commerce, and the standing committee of Desa Mandiri Energy.[10]

Pertamina indicated that it was ready to implement the regulation, noting that it is already selling Bio Solar, Bio Pertamax and Bio Premium at locations within Jakarta, Surabaya, Bali and Malang. Both Pertamina and APROBI presented information regarding the amount of biofuels required to fill the new mandates, compared with production capacity (Table 2.8).

Biodiesel production capacity in 2009 will approach three billion litres, far exceeding the volume required to fill the mandate for that year (around 266 million litres). Ethanol production capacity is expected to reach 213 million litres in 2009, higher than the volume needed to fill the one per cent consumption mandate—around 187 million litres. However, APROBI noted that actual production levels in 2009 are likely to be around 112 million litres (Tjakrawan, 2008). Presumably, some facilities are planning to produce below capacity or new capacity will not come into production until later in the year.

Table 2.8 Estimated volumes of biofuels required to fill mandates

	Units	2009	2010	2015	2020	2025
Biodiesel[1]						
Consumption requirement	%	0.01	0.025	0.05	0.1	0.2
Volume required to fill mandate	million litres	290	748	1 820	4 430	10 780
Estimated production capacity	million litres	2 865	4 680			
Ethanol[1]						
% blending requirement	%	0.01	0.03	0.05	0.1	0.15
Volume required to fill mandate	million litres	200	635	1 285	3 120	5 695
Estimated production capacity	million litres	213[2]	3 955			

Notes: [1] Based on 2007 rates of petroleum fuel consumption (26.6 billion litres of diesel and 18.74 billion litres of gasoline), rising at four per cent per year (based on an average annual rate of increase for Indonesia between 1980 and 2006 (see Energy Information Administration, www.eia.doe.gov). [2] While production capacity is expected to reach 213 million litres by the end of 2009, Tjakrawan (2008) estimates that actual production will be only 112 million litres for the year.

Numbers have been rounded.

Sources: 2007 petroleum fuel consumption: Faisal (2008); Consumption requirements: Government Regulation 32/2008, Appendix; Remainder: GSI calculations based on biofuel production date in Chapter 3, this report.

[10] *Desa Mandiri Energy* is an information sharing platform for renewable energy and energy conservation established under the Directorate of New Energy and Energy Conservation.

3 Status and structure of the biofuel industry

Accurate data on biofuel production and consumption in Indonesia are difficult to gather. The volatile prices of agricultural commodities and crude petroleum oil since 2006 have lead to drastically different outlooks for Indonesia's biofuel industry, depending on when the industry was examined. During times of relatively good economic prospects for Indonesian biofuel production, such as in 2006 and late 2008, plans for expansion and development of new biofuel plantations and refineries have been promulgated. At other times, high feedstock prices have precipitated dramatic reductions in production levels, temporary suspension of operations and permanent cancellations or closures.

Where discrepancies in data regarding current production levels could not be reconciled, all sources are provided. Forecasts relating to 2010 and beyond should be treated with some caution, as any change in profitability for the sector could alter plans for new biofuel-related developments and government policies that support such developments.

3.1 Biodiesel

As of November 2008, there were 11 commercial-scale biodiesel producers in Indonesia and further three producing less than 1 000 tonnes per year (Table 3.1). Total production capacity was 1.6 million tonnes (1 810 million litres) [11] per year. All biodiesel was produced from crude palm oil.

Table 3.1 Biodiesel plants (tonnes per year)

Company	Location	2008		2009		2010
		Capacity	Production[1]	Capacity	Production[1]	Capacity [e]
Existing facilities						
Asian Agri Tbk	Lubuk Gaung, Dumai	200	70	200	80	200
BPPT	Serpong, Banten	0.3	0.3	0.3	0.3	0.3
Darmex Biofuel	Bekasi, East Java	150	30	150	60	150
EAI	Jakarta	0.5	0.5	0.5	0.5	0.5
Energi Alternatif Indonesia PT	Jakarta	0.3	0.3	1	1	1
Eterindo Wahanatama Tbk	Gresik, East Java & Tangerang, Banten	120	120	240	240	240
Ghanesa Energy Group	Medan, North	3	3	10	10	10

[11] One tonne of biodiesel equals approximately 1136 litres, based on an average biodiesel density of 0.88 tonnes per m^3 (density will vary with temperature).

Company	Location	2008		2009		2010
		Capacity	Production[1]	Capacity	Production[1]	Capacity [e]
	Sumatra					
Indo Biofuels Energy	Merak, Java	60	60	160	100	160
Multikimia Intipelangi	Bekasi, East Java	5	5	10	10	10
Musim Mas Group	Medan, North Sumatra	50	10	350	100	350
Permata Hijau Group	Duri, Sumatra	200	75	200	120	200
RAP	Bintaro, Jakarta	1	1	1	1	1
Sumi Ashi	Bekasi, Java, and Lampung	100	50	200	100	200
Wilmar Group	Dumai, Riau	700	300	1000	300	1000
New facilities planned for 2010						
Pertamina	Several locations					425
Platinum	Serang, Banten					17
PT Perkebunan Nusantara (PTPN)	Medan					4
SINAR MAS	Dumai, Riau					340
Bakrie, Indofood, Asianagra Sumi Asih	Sumatra, Java					510
Sweden Bioenergy	East Nusa Tenggara					300
Total	**(tonnes)**	**1 590 100**	**725 100**	**2 522 800**	**1 122 800**	**4 118 800[e]**
	(million litres)	1 805	825[2]	2 865	1 275[2]	4 680[e]

Notes: [1] Production commitment by company; [2] production figures for 2008 vary widely between sources (see Table 3.2) and therefore estimates for 2009 should also be treated with caution; e = estimate; numbers have been rounded.

Sources: 2008–09: Tjakrawan (2008); 2010: Legowo (2008).

The Association for Production of Biofuel Indonesia (APROBI) states that total production in 2008 is expected to be around 725 000 tonnes (824 million litres) (Tjakrawan, 2008). In June 2008, the U.S. Department of Agriculture's Foreign Agricultural Service (2008a) reported 2008 biodiesel production at 90 000 tonnes (Table 3.2). According to F.O. Licht (2008), biodiesel production in Indonesia was 125 000 tonnes in 2007 and would be 250 000 tonnes for 2008. Repeated attempts to reconcile these numbers, through queries to APROBI and government officials, were unsuccessful.

Table 3.2 Biodiesel production, consumption and trade (tonnes)

	2004	2005	2006	2007	2008
Production	0	8 000	70 000	100 000 (125 000)[1]	90 000 (250 000)[1] (750 000)[2]
Imports	0	0	0	0	0
Exports	0	6 000	46 000	80 000	80 000
Consumption	0	2 000	24 000	20 000	10 000

Sources: Except where noted, U.S. Department of Agriculture (2008a); [1] F.O. Licht (2008); [2] Tjakrawan (2008).

3.1.1 Distribution, sales and exports

Pertamina is the only commercial blender and supplier of biodiesel in Indonesia. Two facilities, operated by Eterindo Group and Indobiofuel Energy, currently supply Pertamina. Some product is also used by producers within their own companies to meet their transport fuel needs. Smaller facilities produce only small batches for research purposes.

Pertamina began selling biodiesel blended with petroleum diesel in May 2006, under the brand name "Bio Solar." Initially, Bio Solar was a blend of 95 per cent automotive diesel fuel and five per cent biodiesel (B5). A total of 217 million litres of the blend was sold in 2006, at the same price as subsidized automotive diesel, IDR 4 300 (US$ 0.48) per litre.

Due to high biodiesel prices, Pertamina lowered the biodiesel content of Bio Solar to 2.5 per cent in April 2007 (see also Chapter 4). Some 555 billion litres of the blend were sold in 2007. The amount of pure biodiesel consumed in 2007 was therefore estimated to be approximately 16 000 tonnes (Table 3.3), although the U.S. Department of Agriculture (2008a) reported that Pertamina purchased 20 000 tonnes in the same year. Domestic consumption of biodiesel is likely to be lower for 2008, given that Pertamina further reduced the biofuel content of the blend to one per cent in May that year.

Table 3.3 Biodiesel sales by Pertamina

	Volume blended fuel	% biodiesel	Estimated volume pure biodiesel	
	(litres)		(litres)	(tonnes)
2006	217 048 000	5%	10 852 400	9 553
2007	555 141 000	5% to April, 2.5% for remainder of year	18 504 700	16 290
2008 (to June)	285 240 000	2.5% to May, 1% for remainder of the year	6 417 900	5 650
Total	1 057 429 000		35 775 000	31 500

Sources: Consumption of blended fuel: Faisal (2008); Pure biodiesel consumption: GSI estimate.

As of October 2008, Bio Solar was sold from 232 retail stations in three Indonesian provinces: 202 in Jakarta, 19 in Suabaya and 11 in Bali.

The majority of Indonesia's biodiesel is exported (Table 3.2), primarily to Australia, the European Union and the U.S. (U.S. Department of Agriculture, 2008a). Two producers, Wilmar Group and Musim Mas, produce the majority of Indonesia's biodiesel exports, with Wilmar Group alone supplying 70 per cent (all of which goes to Australia) (personal communication with Wilmar Group, 24 October 2008). Both Wilmar Group and Musim Mas own plantations as well as biodiesel processing facilities have established port facilities, and therefore are able to keep production costs low.

3.1.2 Feedstock

Palm oil is likely to be the main biodiesel feedstock in Indonesia for some time, given its abundant supply and that Indonesia is a net exporter. The seeds of *Jatropha curcus* are under development, although in 2007 at least two companies were making preparations to use jatropha seeds as a feedstock (U.S. Department of Agriculture, 2007a). The Indonesian Government reports that biodiesel feedstock plantations will increase dramatically by 2010, based on plans by the private sector (Table 3.4).

Table 3.4 Estimated land usage for biodiesel feedstocks, 2008 and 2010 (million hectares)

Feedstock	Biofuel-related plantations as of June 2008	Planned new plantations by 2010	Total
Oil-palm	0.40 (of a total 6.8)	3.06	3.46
Jatropha curcas	0.15	1.54	1.69
Total	**0.55**	**4.6**[1]	**5.15**[1]

Notes: The 10-times increase of plantation area in two years, predicted by government sources, appears implausible.

Source: Legowo (2008).

3.1.2.1 Palm oil

Indonesia is the world's leading producer of palm oil, and the second largest exporter (after Malaysia). In 2008, the Indonesian industry is forecast to produce almost 20 million tonnes of palm oil, overtaking Malaysia as the world's top producer (Table 3.5). Around five million tonnes is expected to be consumed domestically, mostly as raw material for cooking oil, while the remaining 15 million will be exported. Exports of CPO were valued at over US$ 8 billion in 2007.

The land under oil-palm cultivation in Indonesia has expanded ten-fold since 1985, covering more than 6.8 million hectares by June 2008 (Legowo, 2008). It is expected to reach 10 million hectares by 2010. Production is dominated by a few large plantation operators, an estimated 30 per cent of which are currently controlled by Malaysian interests (Guerin, 8 February 2007).

Approximately 400 000 hectares (six per cent) of Indonesia's total area of oil-palm plantation is used to supply domestic biofuel production (Legowo, 2008). The government expects this to increase to 3.46 million hectares by 2010 with the establishment of new oil-palm plantations dedicated to feedstock production and expansion of the government's rural energy self sufficiency programmes (Legowo, 2008).

These rates of growth reflect global trends in consumption. The UN Food and Agriculture Organization (2006) predicted that the global consumption of palm oil by the non-food sector will grow in the future by 3.2 per cent per year (including for energy) compared with 1.5 per cent for the food sector.

Table 3.5 Indonesian palm oil production and distribution (million tonnes)

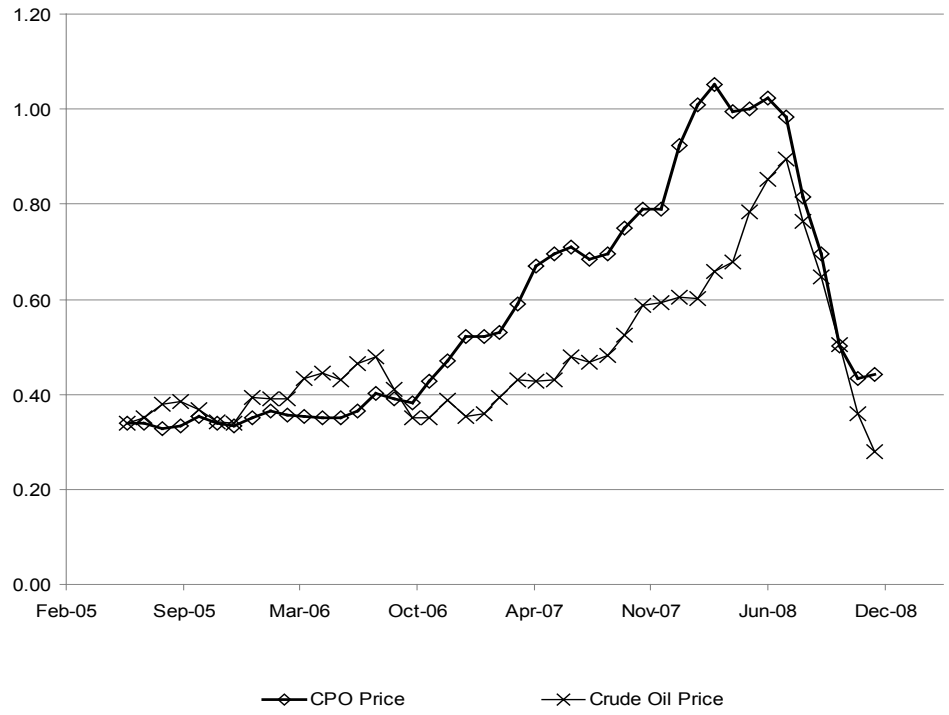
	2006	2007	2008	2009
Production	16.6	17.9	18.7	19.7
Exports	11.8	13.5	14.1	14.8
Consumption	4.5	4.3	4.6	5

Notes: Exports and consumption may not equal production, due to utilization of stocks.

Source: U.S. Department of Agriculture, 2008b.

The price of crude palm oil rose dramatically from late 2006 to mid-2008 (Figure 3.1). During this time, its value was significantly higher than petroleum oil, making biodiesel more expensive than petroleum diesel. Crude palm oil prices reached record highs in March 2008 at over US$ 1410 per tonne, before dropping dramatically, along with petroleum prices, in the second half of 2008.

Figure 3.1 Prices of crude palm oil and crude petroleum oil, June 2005 to December 2008 (US$ per litre)



Sources: Petroleum prices: Indonesia Minas 34, Energy Information Administration (www.eia.doe.gov); Crude palm oil prices: Malaysian Palm Oil Board (www.mpob.gov.my).

3.1.2.2 *Jatropha*

Jatropha curcus is considered a high-potential biodiesel feedstock because it can grow in a variety of climates and soils with relatively little chemical inputs or water. Indonesia has a large area of degraded former-forested land, some of which might be suitable for conversion to jatropha plantations. As of June 2008, there were approximately 150 000 hectares of jatropha plantations in Indonesia (Legowo, 2008). The government predicts that this will expand by 2010 to over 1.5 million hectares, based on planned new plantation developments in provinces across Indonesia (Table 3.4; Legowo, 2008).

Details of the cost of producing biodiesel based on jatropha were not available for Indonesia. The Chinese Government has calculated the cost of jatropha-biodiesel production at US$ 570 per tonne (information was not available as to the yields, irrigation levels or fertilizer use assumed in the calculations; see the Global Subsidies Initiative, 2008).

However, the realistic prospects for jatropha biodiesel production are uncertain. Estimates of the cost of producing jatropha *oil* vary from US$ 511 to $ 1 752 per tonne, due to the uncertainty in extractable oil content (particularly from feedstock grown on marginal land). Refining costs add another US$ 657 to $ 1 898 per tonne of biodiesel (Weyerhaeuser *et al.*, 2007), leading to total cost of jatropha-biodiesel production in the range of US$ 1 168 to US$ 3 650 per tonne.

The Indonesian Government estimates that one hectare of jatropha could produce around five tonnes of jatropha oil (Legowo, 2008). This is highly optimistic, as other studies show yields of around half this amount (Murry, 2008). There is considerable uncertainty about jatropha yields because interest in jatropha as a biofuel feedstock only commenced in earnest in 2005, and cultivation requires five years for full yields to become apparent. Yields from wild jatropha feedstock are around 1.7 tonnes per hectare. Estimates of the production potential of new cultivars will remain guesses until yields plants mature and bear fruit. It will take several years to gain reliable data on yields from new seedstock.

The land quality, water and fertilizer required to produce these yields are not known. Studies have shown that yields from low-productive, un-irrigated lands can be much lower. Elsewhere, yields of seed (which are around 35 per cent oil by weight) range from about two tonnes per hectare per year (un-irrigated) to over 12.5 tonnes per hectare per year, after five years of growth (*Jatropha World*, 2008). Hence, jatropha yields on some land may be too low for jatropha-based biodiesel oil to be profitable or, if it is to be profitable, could lead to competition with food crops for arable land, water or fertilizers.

The UK biofuels company, D1 Oils, plans trials to assess the cultivation potential of jatropha on the island of Sumatra (Biofuels International, 16 May 2008). The trials will be carried out in co-operation with University of Bengkulu (UNIB) in south-west Sumatra and will test the performance of jatropha in poor soil conditions common in Indonesia. The trials will compare growth and yield under different schemes of fertilizer application to determine the optimum level of fertilizers for plant growth and yield.

According to the government Roadmap for jatropha developed in 2006, the jatropha-based biodiesel industry would generate 100 000 skilled jobs and up to 10 million unskilled ones by 2009 (Ministry of Energy and Mineral Resources). Legowo (2008) reported that 121 000 plantation jobs had been generated in the jatropha industry by June 2008 (approximately one job per hectare of plantation).

3.2 Ethanol

Indonesia has in the past been a significant producer and exporter of beverage and industrial-grade ethanol. However, the Indonesian sugar industry has been in decline as most sugar mills in Indonesia are still run by state-owned enterprises, and many use outdated technology from the Dutch colonial period. Indonesia became a net sugar importer in the 1960s. In 2005, eight major operators produced over 130 million litres of ethanol (all grades). Most of the facilities are located on the island of Java and use molasses as a feedstock.

Fuel ethanol production commenced in Indonesia in 2006, with around 6 000 tonnes produced that year, rising to approximately 10 000 tonnes in 2007 (U.S. Department of Agriculture, 2008a). At the time of writing estimates of production levels in 2008 were uncertain. Total production capacity for the year is 114 000 tonnes (Table 3.6) but actual production is likely to be well below capacity. In June, the U.S. Department of Agriculture (2008a) predicted that production for 2008 would be 8 000 tonnes. Tjakrawan (2008) said that known production commitments were around 11 000 tonnes for the year, but production figures were not available for all facilities.

As of June 2008, there were three commercial-scale fuel ethanol facilities in Indonesia and one facility producing for research purposes only (Table 3.6). All facilities used sugar molasses or cassava as a feedstock. Total fuel ethanol capacity is estimated to be 114 000 tonnes in 2008, rising to 167 000 tonnes in 2009, due to the expansion of existing facilities. Legowo (2008) reports a further 12 small businesses producing between 50 and 1000 tonnes of fuel ethanol per month. Ten new commercial facilities are planned for 2010, as well as several smaller-scale facilities. These new facilities and the further expansion of existing plants could result in production capacity exceeding three million tonnes (almost four billion litres) in 2010.

Table 3.6 Fuel-ethanol producers (millions of litres per year)

		2008		2009		2010	
Producer name	**Location**	**Capacity**	**Production[1]**	**Capacity**	**Production[1]**	**Capacity$_e$**	**Feedstock**
Existing facilities in 2008							
Anugrah Kunia Abadi & BPPT	Lampung, Sumatra	2.5	2.5	2.5	2.5	2.5	Cassava
Medco Ethanol	Lampung, Sumatara	60	n.a.	60	n.a.	270	Cassava
Molindo Raya	Malang, East Java	12	12	50	50	150	Molasses
Sugar Group	Lampung, Sumatra	70	n.a.	100	n.a.	530	Molasses
Expected facilities by 2010 (Legowo)							
Sampoerna	Ponorogo, Madiun, Pawonsari, East Java					600	Cassava
Indo Lampung	Lampung, Sumatra					150	Molasses

		2008		2009		2010	
Producer name	**Location**	**Capacity**	**Production[1]**	**Capacity**	**Production[1]**	**Capacity$_e$**	**Feedstock**
Salim Group	South Sumatra					70	Sugar
Sungai Budi	Lampung					120	Cassava
Berlian Energy	Cianjur, Bondowoso					1.8	Sugar
Wilmar Group	Lampung, Sumsel					70	Sugar
Satria, Broenzeoak	East Nusa Tenggara and Kalimantan					300	Sugar
Mitsui PETROBRAS	Papua and Kalimantan					500	Sugar
SORINI TBK	Southeast Sulawesi					200	Cassava
Angel Product	Southeast Sulawesi					10	Sugar
EN3 Korea	South Sulawesi					180	Cassava
Small producers for Pertamina	Several locations					200	Sugar
Community project scale	Several locations					600	n.a.
Total (millions litres)		144.5	>14.5	212.5	>52.5	3 960	
('000 tonnes)		114	>11	167	>41	3 120	

Notes: [1] Company production commitments; e = estimate; numbers have been rounded.

Source: 2008–09: Tjakrawan (2008); 2010: Legowo (2008)

3.2.1 Distribution, sales and exports

To date, Pertamina has been the only distributor of fuel-ethanol sold in Indonesia. In 2006 it sold 1.4 million litres of E5 under the brand name "Bio Premium" at a single pilot gas station in Malang, East Java. Confining the initial launch of Bio Premium to a single gas station was a conscious decision designed to minimize Pertamina's losses incurred by the negative margin existing between the cost of production and the market price for ethanol. In 2007, a second Bio Premium outlet was added, in Jakarta. Bio Premium was sold at the same price as subsidized gasoline ("Premium"), IDR 4 500 (US$ 0.50) per litre, while the cost of ethanol was IDR 5 000 (US$ 0.55) per litre (Faisal, 2008).

Pertamina also began supplying "Bio Pertamax" in 2006, a high-performance gasoline blended with five per cent ethanol. No fuel subsidies are provided for Bio Pertamax. It is sold at 46 retail stations throughout Indonesia.

Due to the government's unwillingness to provide additional subsidies to cover the cost of ethanol blending in Bio Premium, Pertamina reduced the ethanol content of the fuel to three per cent in April 2007. Unlike biodiesel, the biofuel content was not lowered again in 2008. Pertamina continued to acquire ethanol at a price of IDR 5 000 during the first half of 2008, which was at times cheaper than petroleum gasoline (Faisal, 2008).

Pertamina is unable to procure less-expensive ethanol from foreign suppliers due to a volumetric import tariff which, based on current world market prices for ethanol, would be equivalent to around a 200 per cent *ad valorem* tariff. Ministry of Finance Decree No. 89/PMK.04/2006 specifies a specific-tariff of IDR 10 000 (US$ 1.078) per litre on ethanol imports in addition to an *ad valorem* tariff of 30 per cent. Through the end of 2008, Pertamina had used no imported ethanol to produce Bio Premium, and all Indonesian-produced fuel ethanol was consumed domestically (U.S. Department of Agriculture, 2008a).

Table 3.7 Sales of ethanol fuel by Pertamina (litres)

Product	Volume blended fuel	Estimated volume pure ethanol
2006		
Bio Premium	1 408 000	70 400
Bio Pertamax	16 000	800
2006 total (tonnes)	1 424 000 (1 121)	71 200 (56)
2007		
Bio Premium	3 776 000	113 280
Bio Pertamax	9 958 000	298 740
2007 total (tonnes)	13 734 000 (10 814)	412 020 (324)
2008 (to June)		
Bio Premium	2 000 000	60 000
Bio Pertamax	7 456 000	223 680
2008 total (to June) (tonnes)	9 456 000 (7 446)	283 680 (223)
Total ethanol (tonnes)	24 614 000 (19 000)	766 900 (600)

Source: Consumption data: Faisal (2008); estimated volumes of pure ethanol: GSI calculation.

3.2.2 Feedstock

The main feedstock in use in Indonesia is sugar molasses and cassava. Approximately 27 000 tonnes of molasses was processed into fuel ethanol in 2006, dropping to 23 500 tonnes in 2007, with an estimated 25 000 tonnes predicted in 2008 (U.S. Department of Agriculture, 2008a). Two plants are producing ethanol from cassava.

Based on private-sector plans for new plantations, the government expects that plantations for ethanol feedstock will expand from 0.1 million hectares to almost 1.4 million hectares by 2010 (Table 3.8).

Table 3.8 Estimated land usage for ethanol feedstock, June 2008 and 2010

Feedstock	Plantations as of June 2008	Planned new biofuel-related plantations, by 2010	Total
Cassava (biofuel feedstock only)	52 000	630 000	682 000
Sugar (all end uses)	420 000	278 000	698 000
Sweet sorghum (all end uses)	20	17 180	17 200
Total	**97 020**	**925 180**	**1 397 200**

Source: Legowo (2008)

3.2.2.1 Sugarcane

Sugar is considered a commodity strategic to the Indonesian economy, employing 900 000 farmers and about 1.3 million labourers. In 2008, sugar plantations covered between 350 000 hectares (U.S. Department of Agriculture, 2008c) and 440 000 hectares (Legowo, 2008). The island of Java accounts for around two-thirds of the area harvested; production is concentrated in the east. The majority (64 per cent) of Indonesia's sugar production occurs in Java at 46 mills (all but three of which are state-owned), with the balance produced by 58 sugar mills outside of Java. Many of the mills still use antiquated technology.

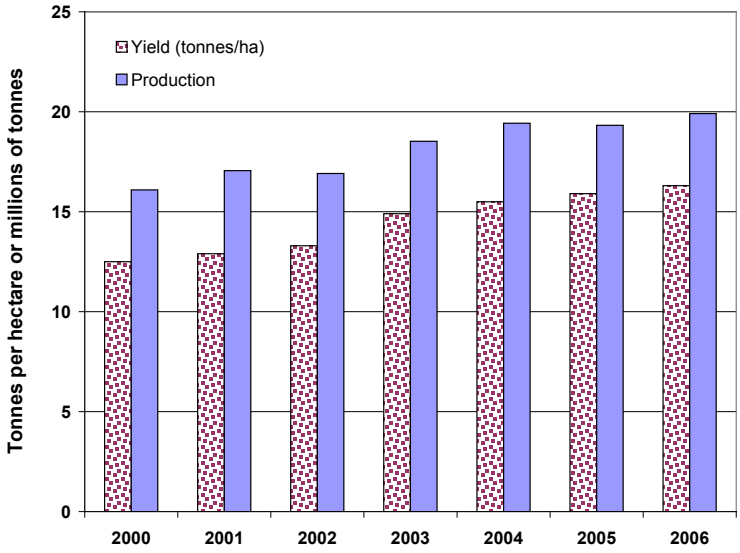
In 2008–09, Indonesia is expected to produce an estimated two million tonnes of white sugar, a slight increase compared with 1.95 million tonnes in the previous year (U.S. Department of Agriculture, 2008c). Imports of plantation white sugar are expected to decline to 110 000 tonnes while imports of raw sugar are estimated to increase to 2.2 million tonnes.

The government aspires to make Indonesia self-sufficient in sugar by 2009 by boosting production to 2.8 million tonnes in 2008 and achieving self-sufficiency (three million tonnes) in the following year. To this end, it has proposed an IDR 50 billion (US$ 5.5 million) subsidy package for upgrading machinery for sugar producers (*The Jakarta Post*, 22 September 2008). The industry has committed to spend IDR 400–500 billion on upgrading their mills, with the government contributing 10 per cent of the costs.

3.2.2.2 Cassava

Cassava is the fourth most important food crop in Indonesia after rice, maize and soybeans (Onwueme, 2000). In 2000, 70 per cent of Indonesia's cassava production was used for human consumption. It is also used as animal fodder and, more recently, as a feedstock for ethanol production. The country produced some 20 million tonnes in 2006, farmed on 1.2 million hectares. Between 2000 and 2006, average yields increased by one-third, to 16.3 tonnes per hectare, helping to boost production despite a five per cent decline in area planted (Figure 3.2). Most Indonesian provinces produce some cassava, but about the majority (about three quarters) of production takes place on the island of Java and the Sumateran province of Lampung.

Figure 3.2 Cassava production and yields in Indonesia (2000–06)



Data source: Ministry of Agriculture (2007).

The government has highly ambitious plans for ethanol production from cassava. The Ministry of Agriculture's 2006 Action Plan foresees production of cassava for fuel ethanol reaching 32 million tonnes in 2025 (yielding five billion litres of ethanol), which would require an additional 1.36 million hectares dedicated to the crop (Table 3.9). These plans are not on-track, however, and as of mid-2008, only two facilities were capable of producing fuel-ethanol from cassava (compared with the 30 facilities envisaged in the Action Plan).

The government estimates that 52 000 jobs have been created in the cassava plantation sector, owing to biofuel production (Legowo, 2008). This appears to have been calculated as one job per hectare of plantation. If this is the case, it would approach the government's target in its 2006 Action Plan, of 41 000 plantation jobs by 2008. The level of cassava planting has fallen short, however: only 52 000 hectares were planted to cassava as of June 2008, compared with the 300 000 hectares envisaged in the Action Plan (Legowo, 2008).

Table 3.9 Action plan for cassava-based ethanol development

Activities	Units	2006	2007	2008	2009	2010	2015	2020	2025
Gasoline demand[1]	billion litres	17.17	18.37	19.66	21	22.51	31.57	44.28	62.11
Ethanol blend rate	%	1%	4%	7%	10%	10%	10%	10%	10%
Ethanol substitution	billion litres	0.17	0.735	1.375	2.100	2.250	3.155	4.430	6.210
Ethanol from cassava[2]	billion litres	0.14	0.59	1.1	1.7	1.8	2.5	3.5	5.0
Cassava production for ethanol	'000 tonnes	895	3 820	7 150	10 920	11 700	16 420	23 020	32 300
Land area	'000 hectares	38.5	161	300	458	491	690	967	1 357
Farm labour[4]	individuals	5 000	22 000	41 000	62 000	66 000	93 000	130 000	183 000
Fertilizer									
- Urea (at 200 kg/ha)	tonnes	7 535	32 105	60 060	91 730	98 280	137 920	193 393	271 310
- TSP (at 100 kg/ha)	tonnes	3 770	16 050	30 030	45 860	49 140	68 960	96 700	135 650
- KCl (at 50 kg/ha)	tonnes	1 880	8 030	15 015	22 930	24 570	34 480	48 350	67 830
Pesticides (at two litres/ha)	tonnes	75	320	600	920	980	1 380	1 930	2 710
Processing units or factories		7	30	56	85	91	128	179	251

[1] The government's projections of gasoline demand used in this Action Plan appear to assume a rate of seven per cent increase per year. The average rate of increase in Indonesia's crude oil consumption between 1980 and 2006 was around four per cent. Elsewhere in this report, the GSI has used the four per cent estimate for annual growth in petroleum consumption.

[2] Government assumptions: Processing unit per factory per year produce = 60,000 litres x 330 day = 19,800,000 litres. [3] Factory investment per unit = IDR 125 billion; Assuming 0.135 full time workers per hectare per year.

Source: Ministry of Agriculture, 2007.

The economic viability of cassava production is also uncertain. Brazil, the world's leading cassava producer, failed to develop ethanol production from cassava (Masami Kojima, personal communication, December 2008). Cassava does not have the equivalent of sugar bagasse that can be used for power generation. Without such a by-product, an external energy source must be used. In the only cassava-based ethanol project in Brazil, the fuel used for power generation was wood. Having to rely on an external source of energy increased the cost of energy relative to ethanol manufacture from sugarcane. Developing large-scale farming of cassava proved to be difficult because the pests and diseases plagued the crop. Cassava is usually harvested manually, making it labour-intensive and time-consuming. For all these reasons, a cassava-based ethanol industry has not developed in Brazil, and there is no commercial ethanol production using cassava.

3.2.2.3 Sweet sorghum

The stalks of sweet sorghum can be used for ethanol production, with the seeds used for human consumption or animal feed. It is a drought-resistant plant and can grow in saline-alkaline soils (FAO, 2002). It is potentially suitable for sandy, degraded land affected by deforestation. Currently there are only two sites growing sweet sorghum for

biofuels in Indonesia, each only 10 hectares, presumably for research purposes. Legowo (2008) expects that the area under sweet sorghum will increase to 17 000 hectares by 2010.

3.3 Future export opportunities

Mandates for biofuel consumption in the European Union and the United States, supported by subsidies, could significantly expand the export market for Indonesian biofuel in the future. Both jurisdictions expect to increase imports over time as domestic biofuel production will not be able to keep up with mandated consumption. Tariffs on ethanol are high in both the EU and the United States but the tariff rates for biodiesel are generally low, at around five per cent in most OECD countries (Steenblik, 2007), permitting market access for palm biodiesel. Quality standards, especially cloud point, are a greater barrier.[12]

The European Commission is considering a target of replacing 10 per cent of its liquid transport fuels with biofuels by 2020. Domestic production is unlikely to be able to meet this level of biofuel blending. The European Commission forecasts that, by 2020, 27 per cent of biodiesel will be produced from imported vegetable oils: approximately 5.5 billion litres of vegetable oil per year (Joint Research Centre, 2007). The figure is expected to be much higher given that higher volumes of imported oils would also be required to replace domestically-produced rapeseed and soy oil in the food market. Assuming that second-generation biofuels are not commercially viable at that time, 80 per cent of EU biodiesel production would, in effect, be met by imports (Joint Research Centre, 2007). A large proportion of this is expected to be met by imported palm oil (Joint Research Centre, 2007; Oxfam, 2008). This presents a major export opportunity for Indonesia, as the world's leading palm oil producer and second largest exporter.

However, Indonesian producers may soon need to demonstrate compliance with stringent sustainability criteria to gain access to European markets. Certification schemes are under consideration within the European Union and Switzerland intended to ensure that biofuels and their feedstocks are produced sustainably (see Chapter 5 for further discussion).

Currently, 64 per cent of the EU's biodiesel is produced from rapeseed, 16 per cent soy, seven per cent palm and 13 per cent other (U.S. Department of Agriculture, 2008d). Palm-oil is a cheaper feedstock than rapeseed or soy, with higher oil yields per hectare. The use of palm biodiesel is currently constrained in cooler countries due to its high cloud point. However, this deficiency can be partially overcome by adding additives and "winterizing" the fuel to lower its cloud point.

Other potential markets are primarily developed countries that are net oil importers, including the Australia, Japan, South Korea and the United States. Wilmar Group alone is responsible for 70 per cent of Indonesia's current biodiesel exports, all of which go to Australia (personal communications with Wilmar Group, 24 October 2008). The Australian Government is currently undertaking a review of fuel tax arrangements,

[12] The "cloud point" is the temperature at which pure biodiesel begins to congeal. This temperature varies with the properties of the biodiesel, depending on the feedstock used. Biodiesel from palm oil has a higher cloud point that biodiesel made from canola oil.

including the exemption on excise tax for biodiesel. A decision to reduce or remove the exemption would make palm methyl ester more expensive than petroleum diesel, pricing it out of the Australian market.

Indonesian biofuel current and future exports are therefore at the mercy of other governments' subsidy- and market-access policies, as biofuels are not currently viable without some form of government support.

4 Current subsidies to biofuels

This chapter identifies subsidies provided by the Indonesian Government at various stages of the biofuel production, distribution and consumption process, and develops an aggregate total for biofuel subsidies in 2006, 2007 and 2008 (to June).

A degree of uncertainty exists when calculating the subsidies provided by the Indonesian Government to its biofuel industry, given that limited information is available on implementation of the government plans that were announced in the early stages of Indonesian biofuel development (primarily in 2006). This may be because plans were cancelled or delayed, or because of transparency in government expenditure is not high in Indonesia.

The 2006 Open Budget Index ranked Indonesia in its middle tier, as "providing some information to citizens" on fiscal expenditure.[13] The key budget document, the executive budget statement, scored 45 per cent (where a 100 per cent ranking would provide the public with a comprehensive picture of government financial activity). Pre-budget statements and in-year reports remain unavailable to the public. Many federal budget documents are not available online (Wara Hapsari, personal communications, 18 November 2008). In some cases, it has been necessary to rely on media reports of government funding announcements, when official sources were not available.

Some funding allocated to biofuel programmes may also be diverted due to corruption. In 2007, Indonesia scored 2.3 out of 10 on Transparency International's Corruption Perceptions Index, ranking 143rd out of 179 countries (Transparency International, 2007).[14] Kuncoro and Henderson (2006) report the findings of a 2001 survey where firms reported spending an average of eight per cent of costs on bribes and over 10 per cent of management time in "smoothing business operations" with local officials.[15] However, due to the uncertainty around this figure, we have presented the total pledged funding but note that these estimates may over-state actual transfers to the extent that some funding may have been diverted due to corruption.

All reported funding commitments are included below. The aggregate subsidy total—presented in Section 4.2—provides a figure for both the total funding commitments and the likely amount actually dispersed (excluding commitments that could not be verified with official sources and those for which no details of implementation were available). The estimates start with the year 2006, as no biofuel production of significance existed in previous years.

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13 www.openbudgetindex.org/CountrySummaryIndonesia.pdf

14 The Corruption Perception Index score relates to perceptions of the degree of corruption as seen by business people and country analysts, and ranges between 10 (highly clean) and 0 (highly corrupt).

15 The Kencoro and Henderson (2006) study utilized a data set collected in 2001 the University of Indonesia covering 1808 firms in 64 (out of about 300) district government areas.

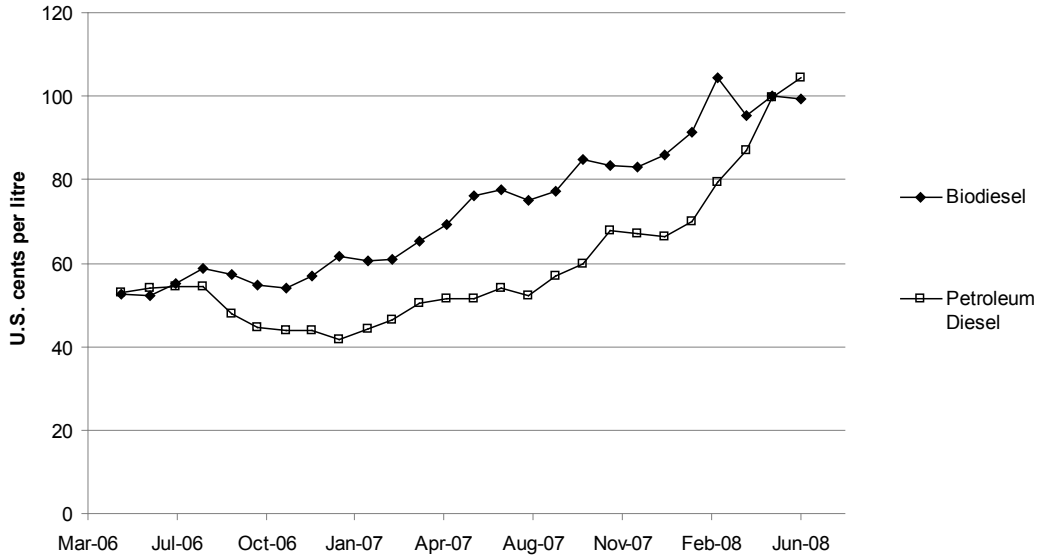
4.1 Subsidy elements

4.1.1 Output-linked support

Output-linked support can take the form of direct support, such as per-litre payments for biofuel production, and indirect support through measures that artificially elevate the prices received by producers (market price support such as import tariffs, government procurement, or mandatory consumption policies).

To the end of 2008, the primary source of out-put linked support for biofuels in Indonesia was the government's instruction to Pertamina to sell blends of ethanol and biodiesel, from 2006. This resulted in significant subsidies, as Pertamina was required to sell biofuels at the same price as petroleum fuels. The government subsidizes biofuels at the same level as petroleum fuels, leaving Pertamina to cover the difference when biofuels cost more to procure than fossil fuels (U.S. Department of Agriculture, 2008a). For most of the time period between 2006 and 2008, biodiesel was more expensive to procure than fossil diesel (Figure 4.1).

Figure 4.1 Prices for biodiesel and petrodiesel, March 2006 to June 2008



Source: Faisal (2008)

As a consequence of this gap, Pertamina announced losses in 2006, 2007 and 2008 totalling IDR 360 billion (US$ 40 million) from biofuel blending (Table 4.1). In order to reduce these losses, Pertamina repeatedly lowered the biofuel content of its blends. As Pertamina is a government-owned enterprise, its losses can be considered a government subsidy.

Table 4.1 Cost to government of supplying biofuel blends

	Pertamina's cost of supplying blended fuel (above sales revenue)	Subsidies paid by government to Pertamina	Pertamina's loss due to biofuel blending	Cost to government and Pertamina of supplying blended fuel	Cost per litre pure biofuel [1]	Cost per litre pure biofuel [1]
	(billion IDR)	(billion IDR)	(billion IDR)	(IDR per litre)	(IDR)	(US$)
Biodiesel						
2006	246.5	235.3	11.2	1 136	1032	0.11
2007	1 051	1 019	32	1 893	1729	0.19
2008 (to June)	1 364	1 048	316	4 782	49 237	5.42
total biodiesel (million US$)	2 662 (293)	2 302 (253)	359 (40)			
Ethanol						
2006	1.192	1.1	0.092	847	1 307	0.14
2007	5.149	4.292	0.857	1 364	7 565	0.83
2008 (to June)	6.648	5.356	1.292	3 324	21 533	2.37
total ethanol	12.989 (1.4)	10.748 (1.2)	2.241 (0.25)			
Total (million US$)	**2 674 (294)**	**2 313 (254)**	**361 (40)**			

Notes: [1] The cost per litre was calculated by the GSI, based on the quantities of blended fuel sold (see Chapter 3) and the per cent blend, as reported by Pertamina. However, some of the resulting subsidy estimates could be dubious: per-litre subsidies for 2006 and 2007 are significantly lower than in other biofuel-subsidizing countries (e.g., see Steenblik, 2007) and the estimates for biodiesel subsidies in 2008 are unusually high (even taking into account the record-high feedstock prices during that time). Repeated attempts to clarify these data with Pertamina were successful.

Source: Pertamina's losses: Faisal (2008); Subsidy per litre: GSI calculations based on data from Faisal (2008).

4.1.2 Subsidies to intermediate inputs

There are a range of measures in place to encourage the development of new biofuel feedstock plantations, and the renewal of existing plantations, and to improve seedling quality and encourage value-added production.

4.1.2.1 Interest-rate subsidies for development of biofuel energy and revitalization of plantations

In 2006, the government established a subsidized credit scheme for farmers with several government-owned banks to support plantation development and revitalization, including for biofuel crops (Ministry of Finance Regulations No. 117/PMK.06/2006 on the Credit for the Development of Biofuel Energy and Plantation Revitalization) (Ariati, 2007). An agreement was signed with the banks (PT BRI, PT Bank Mandiri, PT Bank Bukopin, PT Bank Sumut and BPD Sumbar) in December 2006.

To fund the project, IDR 1 trillion (US$ 110 million) was allocated for the interest rate subsidies in the 2007 financial year (Bank Indonesia, 2007). For palm, rubber and cocoa plantations, the interest-rate subsidy was five per cent. The subsidy is available for five years for cocoa and palm plantations, and seven years for rubber. As of September 2008, the government had not provided an interest-rate subsidy for jatropha plantations (Kusdiana and Sudrajat, 2008). For cassava and sugarcane farmers, the interest rates were nine per cent and 12 per cent, respectively, compared with a market rate of 18 per cent. Details of the disbursement of these funds were not available.

4.1.2.2 Other programmes and commitments

A further IDR 2 trillion (US$ 220 million) was reportedly allocated in the 2007 federal budget for procurement of biofuel crop seedlings (Hudiono, 2006). Whether these commitments were implemented is not known.

The government also provides interest rate subsidies for projects that have potential to enhance food security. In 2007, this programme was extended to projects that could also improve energy security, including biofuel developments (Regulation 79/PMK.05/2007) (Legowo, 2008).

Through the Agribusiness Development Program of the Directorate General of Plantations, the government spent IDR 7.8 billion (US$ 860 000) on producing jatropha seeds in 2006. In the same year, IDR 33 billion (US$ 3.5 million) was allocated to build five jatropha seedling facilities. A further IDR 30.7 billion (US$ 3.2 million) was allocated for interest rate subsidies for developing palm oil seeds. In addition, five Provinces in Java and Sulawesi have allocated IDR 249 million (US$ 27 000) to establish seed nurseries.

4.1.2.3 Tax concessions to encourage value-adding

In February 2008, the government introduced a system to progressively tax CPO exports in line with the CPO price traded in the Rotterdam commodity market. This was done to discourage exports when prices are high. Palm oil is an important food staple in Indonesia as well as an input to manufacturing. Policy arrangements for the export tax also work in favour of protecting domestic users of CPO, including biodiesel manufacturers. The tax is set at 15 per cent if CPO is US $1 100–1 200 per tonne. It increases to 20 per cent if the price is US$ 1 200–1 300 and 30 per cent if the price exceeds US$1 300 per tonne.

4.1.2.4 Fertilizer subsidies

The Indonesian Government's subsidies for fertilizer have risen dramatically over recent years. The subsidy is reported to have been IDR 2.5 trillion (US$ 275 million) in 2005, IDR 3 trillion (US$ 333 million) in 2006, IDR 7 trillion (US$ 770 million) in 2007, IDR 15 trillion (US$ 1.65 billion) in 2008 and rising to IDR 17 trillion (US$ 1.87 billion) in 2009 (*Antara News*, 11 December 2008).

4.1.3 Subsidies to factors of production

Government Regulation No. 1/2007, adopted in January 2007, provides for income-tax reductions on investments in specific regions or industries, including the bio-energy

sector (Ariarti, 2007). These include lower stamp duties; a 30 per cent reduction of tax from net income from the total investment, applied for six years (or five per cent per year); accelerated depreciation and amortization; a loss-carry-forward facility for a period of up to 10 years; lower income tax on royalties earned by foreign taxpayers (10 per cent compared with 15 per cent normally) and possibly lower if stipulated in the provisions of an existing applicable tax treaty; and VAT exemptions for selected strategic goods. The take-up of the programme is not known.

Government Regulation No. 8/2007 on the establishment of the Government Investment Board may also support biofuel projects, by facilitating investment.

The Government of Indonesia was reported to have set aside IDR 10 trillion (US$ 1.1 billion) in its 2007 budget to support infrastructure for biofuel production (*Alternative Transportation Fuels Today*, 13 March 2007). As of November 2008, it was not clear whether these funds had been dispersed, nor were guidelines available regarding how the programme would operate.

4.1.4 Labour

The Government has a strong interest in developing the biofuels industry due to its labour-intensive nature, but has not issued any policy statements that it intends to support the labour employed, other than with training programmes. In 2006 the Ministry of Agriculture allocated IDR 60 billion (US$ 6.6 million) for a training programme to develop jatropha seed. Sub-national governments have also supported jatropha development. See also the discussion of employment impacts in Chapter 6.

4.1.5 Land

Since 1990, Indonesia has deforested around 28 million hectares under permits from the Ministry for Forestry for conversion of forest to plantations (mostly palm) but only nine million hectares or palm or pulp-wood plantations have been established (FAO, 2005). Companies were clearly using the plantation conversion concessions to harvest timber and then move on (Greenpeace, 2007). The ability to harvest timber on these concessions therefore appears to provide a valuable subsidy to prospective palm oil plantation companies, who can use funds from the sale of timber to cross-subsidise plantation establishment.

4.1.6 Research and development

Research on renewable energy from plant sources (including palm oil and jatropha) was funded by the Ministry of Agriculture in 2006 at IDR 300 million (US$ 33 000).

The MoRT is currently carrying out a research programme (agriculture to agro-products throughout the value-chain) on biofuels in addition to granting research funds to public universities. Details of the funding were not available.

4.1.7 Support for consumption

Consumption of domestic biofuels is subsidized indirectly, through the practice of charging the same retail price for biofuels as for subsidized petroleum products. The net

effect for consumers is that of a price subsidy born by the Pertamina. See Section 4.1.1, output-linked support, for further details.

In 2007, the government exempted the biofuel component of fuel sales from the 10 per cent value added tax (VAT). The effect of the exemption has been taken into account in Pertamina's net losses as a result of biofuel blending.

The Ministry of Transportation (MoT) and Ministry of Environmental Affairs (MoEnv) have impressed on local transit authorities the environmental benefits of running their public buses on biodiesel. It is unclear to what extent public buses, if any, are running on biofuel blends.

4.2 Aggregate support

Calculations of aggregate subsidies are made by summing each type of subsidy mentioned in Section 4.1. As no subsidies were made available in previous years, aggregate subsidies are derived by calculating public spending related to biofuel development in 2006, 2007 and 2008 (to June). The subsidy levels estimated in this study are based on government reporting and should be considered rough estimates.

The total reported budget allocations for biofuels in 2006, 2007 and 2008 (to June 2008) is estimated to have been around IDR 15 trillion (US$ 1.6 billion) for the three years. However, it is unlikely that all these funds were actually spent. Actual support levels are more likely to have been around IDR 1 793 billion (US$ 197 million), comprising losses accrued by Pertamina due to the purchase and sale of biofuels, support for feedstocks, interest-rate subsidies for plantation development, and research and development.

Table 4.2 Total subsidies from 2006 to June 2008

Support type	IDR (billion)	US$ (million)	Notes
Market price support	0	0	
Output-linked support			
Pertamina's losses	361	40	
Subsidies to intermediate inputs			
Interest rate subsidies for plantation development and renewal	1 000	110	US$ 310 000 dispersed, as of June 2007
Seedling development for biofuel crops	2 000	220	Reported 2007 federal budget commitment
Agribusiness Development Programme	71.5	7.9	For palm and jatropha seed and seedling cultivation
Provincial programmes	0.25	0.027	Java and Sulawesi, for oil-palm seed nurseries
Fertilizer subsidy	30.7	3.38	Totalled IDR 6.5–7 trillion (US$ 720 million) in 2007
Factors of production—capital			
Infrastructure subsidies	10 000	1 100	Reported 2007 federal budget commitment
Interest payment subsidies	1 000	110	Reported 2007 federal budget commitment
Tax reductions for biofuel-related investments	n.a.	n.a.	Government Regulation 1/2007
Factors of production—labour			
Training programme support	60	6.6	Training related to jatropha cultivation
Research and development			
Jatropha	300	33	
Ministry of Research and Technology biofuel programme	n.a.	n.a.	
Consumption			
VAT exemption	n.a.	n.a.	Taken into account with Pertamina's net losses
Total reported budget allocations	14 795	1 625	
Likely total subsidies [1]	1 795	197	

Notes: [1] Excludes 2007 Reported Budget commitments that could not be verified with official sources.

n.a. = no data available.

Source: GSI calculations.

4.3 Future subsidies

The Indonesian Government's new mandatory consumption requirements will significantly increase the level of support for biofuels. They will guarantee a fixed level of domestic demand for biofuels, regardless of their price. When biofuels are more expensive than petroleum fuels, this higher cost will have to be borne by the government (as direct producer subsidies or through Pertamina, a state-owned enterprise) or passed on to consumers in the form of higher prices. In either case, there would be a transfer of wealth from motorists or taxpayers to biofuel producers, who would have the advantage of guaranteed sales regardless of the price of their product.

By instituting a mandate, the government is either hoping that biofuels will become consistently cheaper than petroleum diesel or deciding to pay higher fuel subsidies in order to develop a domestic biofuel industry.

Historically, biofuels are more expensive to produce than fossil fuels, and therefore require government subsidies. Even in Brazil, where ethanol is produced efficiently from sugarcane, subsidies were provided for many years to establish the industry. In some OECD countries where biofuel subsidies have been provided for decades, there are no signs that the industry will graduate from support in the near future (Steenblik, 2007). Even in the presence of high subsidies, biofuel producers have been forced out of business.

4.3.1 Biodiesel

During the short history of its use in Indonesia, biodiesel has consistently been more expensive to procure than petroleum diesel (see Figure 3.1), hence Pertamina's losses as a result of selling Bio Solar.

International prices for vegetable oil prices have been more expensive than those for diesel for all of the past 15 years, hence producers would earn more by selling the vegetable oil on the international market than by converting it to biofuel (Kojima, Mitchell and Ward, 2007). Mandating the conversion of vegetable oil to biodiesel under such circumstances would force its use for a lower value end-use, which is bad for the economy.

Future prices are difficult to predict. The petroleum and agricultural commodity markets have been highly volatile in recent years. The *OECD-FAO Agricultural Outlook* suggests that a persistent rise in demand for vegetable oils will result in a long-term price trend of these products averaging about 60 per cent higher prices in the 2008–17 period than the average levels in previous years (OECD-FAO, 2008). Even if CPO prices fell to 2006 levels, palm biodiesel would still require government support to be economically viable.

Furthermore, palm oil and petroleum oil prices have been following a similar trajectory in recent years (see Figure 3.1), which lessens the likelihood that palm oil will be cheap when petroleum oil prices are high—the conditions needed to make palm biodiesel economically viable.

4.3.2 Ethanol

Indonesia does not have a history of large-scale fuel-ethanol production and distribution. To date, most ethanol has been produced from molasses, which is a by-product of sugar

refining and therefore a relatively cheap feedstock. However, this resource is limited and future production will need to utilize sugarcane or cassava, which is likely to increase costs.

In addition, ethanol requires special distribution and storage infrastructure, given that it must be prevented from absorbing water. Ethanol blends well with gasoline but, as an alcohol, also mixes with water. Ethanol, whether pure or in a gasoline blend, will attract and absorb atmospheric or other water. Because it mixes easier with water than gasoline, the ethanol will be drawn from the gasoline into the water at the bottom of the storage tank, separating from the gasoline. The product in the tank is no longer a homogeneous blend of ethanol and gasoline, but two layers of product: a layer of gasoline on top and an ethanol layer on the bottom referred to as "phase separation." In OECD countries, governments have heavily subsidized infrastructure that protects ethanol and ethanol blends from contamination with water (e.g., Koplow, 2007; Quirk *et al.*, 2008).

4.4 Accessing other countries' subsidies

The majority of Indonesian biodiesel is exported, and exporters are likely to be benefiting from subsidy policies in OECD countries (notably Australia, the EU and the United States) that provide direct payments or tax benefits for biofuel blending or consumption. Hence, despite uneconomic international prices for biodiesel, some producers can sell biodiesel to more profitable markets thanks to U.S. and EU subsidies. Box 4.1 describes a recent situation in which some shipments of Indonesian biodiesel may have been benefiting from subsidies provided by both the EU and the United States.

Box 4.1 "Splash and dash"

The United States provides a tax credit for biodiesel blended with fossil diesel fuel. Until recently, the tax credit was applied to blends exported to other countries as well as to fuel consumed in the U.S. The credit provided one cent for every per cent of biodiesel blended, hence a 99.9 per cent blend would get almost US$ 1.00 per gallon in tax credits (Evans, 2008).

The scheme was originally intended to benefit U.S. biodiesel producers, but owing to a loophole in the law, biodiesel could be imported and blended with 0.1 per cent fossil diesel then re-exported, with the blender claiming the full tax credit. Once the "splash" of fossil-diesel had been added, the fuel is then "dashed" to Europe where it could benefit from fuel-tax exemptions that effectively raise the price that fuel blenders were willing to pay for biodiesel. The majority of biodiesel involved in "splash and dash" was expected to come from Southeast Asia (Indonesia and Malaysia) and Latin America (Argentina and Brazil).

EU producers protested against the U.S. scheme, claiming that the subsidized imports undercut their biodiesel sales. The EU Trade Commissioner requested an investigation and threatened a retaliatory tariff. This loophole has now been closed.

The Australian federal government provides an excise tax rebate, provided as a per-litre grant to producers, that exactly offsets the $A 0.38143 fuel excise duty. The grant is not available for imported ethanol but it covers both imported and domestically produced biodiesel. Domestic production of biofuels (as well as imported biodiesel) will continue to be effectively excise-free until 30 June 2011. After that, excise duties for both biofuels will rise until, by 2015–16, they will be equivalent to 50 per cent of the excise payable on petrol and diesel on an energy-equivalent basis. As mentioned in Section 3.3, a significant proportion of Indonesian biodiesel exports go to Australia.

In Europe, the Biofuels Directive of 2003 promotes the use of biofuels for transport, with the aim of reducing greenhouse gas emissions and dependence on fossil fuels. To implement the Directive, EU Member States are allowed to support biofuels through a multitude of policies at the local, regional, national and Commission levels. These policies include exemptions from or reductions in fuel-excise taxes, which would cover imported biofuels. As mentioned in Section 3.3, tariffs are prohibitively high for ethanol imports into most EU countries, but the import tariff on biodiesel is only 6.5 per cent.

Some Member States that have specified minimum market shares for biofuels will need to import biofuels if domestic production is insufficient to meet the mandated consumption level. Such policies would benefit the biofuel producers, even if in other countries impose higher costs on consumers who have no choice but to purchase biofuels, regardless of the source and cost.

There is unlikely to be sufficient vegetable oil produced within Europe to meet the Commission's projected targets for biofuel blending. One fifth of current global production of vegetable oil would be needed to replace 10 per cent of just the EU's current road transport diesel demand (Greenpeace, 2007).[16] A significant proportion of biodiesel or feedstocks would need to be imported and palm oil is currently the most productive source of biodiesel fuel (in terms of energy yield per hectare).[17] However, as discussed further in the Chapter 5, sustainability criteria could restrict market access.

One major company predicted demand growth for biodiesel of 52 million tonnes between 2005 and 2030 in the EU alone, given rising transport fuel needs (Neste Oil, 2007, cited in Greenpeace, 2007). Meeting this level of growth through palm oil would require more than 15 million hectares of mature oil-palm plantations: nearly three times the area currently planted to oil-palms in Indonesia (Greenpeace, 2007).

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16 Ten per cent of Europe's mineral diesel used in 2005 = 17.3 million tonnes. Given the energy content of 1 tonne of diesel is equivalent to 1.1 tonnes of vegetable oil, 19 million tonnes of vegetable oil would be needed to replace 17.3 million tonnes of petroleum diesel. According to the United States Department of Agriculture, in 2005–06 global vegetable oil production from soya, palm and rapeseed was 87.43 million tonnes. Therefore, 19 million tonnes of vegetable oil would be the equivalent of 22 per cent of global production of soya, palm and rapeseed oil production in 2005–06 (Greenpeace, 2007).

17 Oil-palm is one of the highest yielding oil plants, producing between 1.8 and 8.1 tonnes of oil per hectare per year (Ardiansyah, 2007).

5 Social and environmental impacts

Biofuels have received considerable support from some developed- and developing-country governments on the assumption that they would deliver multiple social and environmental benefits. The Indonesian Government has been primarily motivated by the potential of biofuels to increase rural employment, raise incomes for farmers, improve energy security and develop a new export industry. The stated objectives of other governments' biofuel policies usually also include reducing greenhouse gas emissions or urban pollution.

The ability of biofuels to deliver against all of these objectives is uncertain: evidence is mounting of unintended negative consequences of pro-biofuel policies that can undermine governments' policy objectives. On the social and economic side, these include upward pressure on food prices, detrimental effects on other businesses (such as food-processors and feedlots), and the opportunity cost of government expenditure. Environmental concerns include high energy inputs (including of petroleum fuels), increased land clearing and increased agricultural intensity (greater use of water, chemical fertilizers and pesticides).

Before the advent of biofuels, similar issues were raised in the context of palm oil production in Indonesia. Oil-palm has been a powerful instrument for economic and social development but it has also been associated with dispossession of land by local communities, exploitation of labour, deforestation and pollution (Wakker, 2005). The development of palm biodiesel has therefore been highly controversial.

There are several ways that biofuel support policies can affect social and environmental outcomes in Indonesia. Indonesian policies will have a direct effect, now and over the longer-term. Other countries' biofuels policies will also affect Indonesia because they may stimulate demand for exports of Indonesian biofuels or feedstocks, and because they have indirect effects in the Indonesian economy (for example, by raising commodity prices). There is also the influence that expectations about current or future policies, regardless of actual implementation, can have on investment decisions and market speculation.

The social and environmental impacts of the Indonesian Government's biofuel policies are likely to have been small through to late 2008, given the low levels of biofuel production to date. The biofuel facilities are currently operating below capacity. The 725 000 tonnes of biodiesel forecast to be produced in 2008 would require a similar volume of crude palm oil (CPO) as input—approximately four per cent of total palm oil production. The majority of the country's ethanol is produced from molasses, a by-product of sugar milling, and thus is unlikely yet to be generating flow-on effects to the economy, employment or the environment.

However, the government's biofuel mandates will lead to a significant increase in biofuel production and consumption. By 2010, the Department of Energy and Mineral Resources expects biodiesel production capacity to more than double, and ethanol capacity to increase by over 20 times its current level (Legowo, 2008). The area of biofuel feedstock plantations is expected to increase by 10 times over the same time period, to over six million hectares (see Chapter 3). If these plans are fulfilled, the social and environmental consequences are likely to be significant.

5.1.1 Social impacts

5.1.1.1 Employment and income

The Department of Energy and Mineral Resources estimates that, as of June 2008, the biofuel industry was employing 1 040 people in processing and distribution (Legowo, 2008).[18] Legowo also states that approximately one million jobs had been created in the plantation sector (including 348 000 jobs in growing feedstocks for local community biofuel use). This number appears to be an over-estimate, given limited biofuel production to-date.

The federal government's "Losari Concept" (see Chapter 2) envisages that replacing 10 per cent of fossil diesel with domestically produced biodiesel would require 100 new biodiesel plants. Four of these would have annual capacities of 100 000 tonnes, around 44 would have capacities of around 30 000 tonnes and the remainder, of 3 000 tonnes. Assuming that a 100 000 tonne plant might employ 20 people,[19] a 30 000 tonne plant 10 people and a 3 000 tonne plant the equivalent of five full-time equivalent positions; total direct employment of these 100 new plants might be in the order of 1500 people (GSI estimates). Assuming a similar number of jobs in the ethanol sector would raise this number to around 3 000.

In addition, new employment could be created if new areas are brought under cultivation of feedstock. However, if crops are diverted from other uses (such as cassava from food or industrial starch production, or sugarcane from sugar production), then few new jobs would be created in the farming sector but jobs could be lost in industries disadvantaged by diversion of its inputs to biofuels.

Of the total six million hectares under palm plantation in Indonesia in 2007, around 2.6 million hectares were owned or farmed by smallholders, 2.7 million by private companies and more than 0.6 million by state-owned enterprises (Ardiansyah, 2007). Increased demand and higher CPO price are likely to assist these landowners.

The original government Action Plans for cassava and jatropha biofuel production envisaged huge employment benefits: 1.1 million new jobs in jatropha production and processing by 2009; and over 66 000 new farm labourer jobs in cassava by 2010, with more jobs in processing (Tables 3.5 and 3.10). These are unlikely to be realized in the foreseeable future, as there is currently no commercial production of biodiesel from jatropha in Indonesia and only two plants producing ethanol from cassava.

5.1.1.2 Food prices

Biofuel production to date in Indonesia has diverted a minimum amount of food commodities to fuel domestically, due to low production levels. However, the government's biofuel mandates will result in escalating amounts of palm oil, sugar and

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[18] The on-farm employment figure appears to have been calculated at one person per hectare of biofuel feedstock plantation.

[19] The estimate of 20 staff per 100 000 tonne capacity plants is based on average employment levels by biofuel facilities in OECD countries, observed by GSI staff in reviewing company websites for biofuel plants in the Australia, Canada, the EU and the United States.

cassava being diverted to biofuel production. All of these crops are important staple foods in Indonesia.

As mentioned in Section 2.1.1.1, cassava is the fourth most important food crop in Indonesia, and is the primary food source for many of Indonesia's poorest people. Average per person sugar consumption is approximately 17 kilograms per year (U.S. Department of Agriculture, 2008c), growing at around six per cent per year (Reuters, 18 December 2008). Indonesia is struggling to become self-sufficient in sugar supply for food and beverage consumption, without accounting for increased demand for ethanol production.

Palm oil is used for cooking and in food processing. For the poor, cooking oil is an important source of calories. It can also be a major food expense for households that grow their own food but must buy oil with which to cook it. The average per-person domestic consumption of palm oil for food is approximately 16 kg per person per year.[20] Despite being a net exporter of palm oil, Indonesian consumers are vulnerable to price rises and shortages, as evidenced by riots over rising vegetable oil prices in January 2008. The poor suffer food shortages, not because there is no food, but because they can't afford it.

The government predicts that cultivation of oil-palm, sugarcane and cassava will increase in order to supply biofuel production. If crop production does not increase in line with demand by biofuels, competition between food and fuel will push-up prices. This situation was experienced in early 2008, when the FAO listed Indonesia as one of 36 countries requiring urgent assistance to respond to critical food shortages.[21]

Expanding global biofuel production has been demonstrated to affect food prices and scarcity. In 2007, the world produced approximately 70 million litres of biofuels, converting millions of tonnes of sugarcane, corn, wheat, sugar beet, rape seed oil, soy oil and tallow into fuel (Steenblik, 2007). A sizeable portion of this production occurred in OECD countries and Brazil, supported by government incentives, which totalled over US$ 15 billion in 2007 alone.[22] Converting agricultural commodities into biofuels contributed to a surge in demand and a decline in stocks over the past two years that was not accompanied by an increase in supply (due to a range of factors including poor harvests in various parts of the world) (FAO, 2008).

Estimates vary regarding of the relative role of biofuels in the 2007 and early 2008 food price rises. The IMF estimated that biofuels accounted for almost half of the increase demand in major food crops in 2007 (IMF, 2008), while the OECD estimated that around 60 per cent of the increase in consumption of cereals and vegetable oils was due to biofuels (OECD, 2008). Mitchell (2008) estimated that biofuels contributed to 75 per cent of the recent food price rises. According to Oil World, a forecasting service in Germany, biofuels accounted for almost half the increase in worldwide demand for

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20 Estimated domestic food consumption for 2008 = 3 700 000 tonnes (U.S. Department of Agriculture, 2008d). The population of Indonesia is 235 million (CIA World Factbook).

21 www.fao.org/docrep/010/ah881e/ah881e02.htm

22 GSI data compiled from *Biofuels – At What Cost* reports from 2007 and 2008. See Steenblik, 2007, Koplow, 2007 and Quirke *et al.*, 2008.

vegetable oils in 2007, and represented seven per cent of total consumption of the oils (cited in Bradsher, 2008).

Higher commodity prices translate into higher income for plantation owners and some farmers, processors and exporters, and the government (due to higher taxation income). However, higher food prices can undermine the purchasing power of the poor, including in Indonesia (World Bank, 2008b). Poor households may spend around 75 per cent of their income on food, with many sacrificing education or medical care in order to afford basic foods, and others unable to afford sufficient food (Ivanic and Martin, 2008). Higher food prices affect urban and rural poor alike, as most rural households are net consumers rather than producers of food. Ivanic and Martin (2008) estimated that 100 million people fell into poverty because of it.

The government is keen to develop non-food biofuel crops, such as jatropha. However, jatropha production may not necessarily reduce the conflict between food and fuel. Jatropha is understood to be capable of growing on poor lands that are not otherwise capable of producing reliable food crops. However, studies have shown that yields from low-productive, un-irrigated lands can be low (Jatropha World, n.d.). Yield is a function of factors such as water, nutrients, heat and plant age. Seed production ranges from about two tonnes per hectare per year (unirrigated) to over 12.5 tonnes per hectare per year, after five years of growth. Hence jatropha may yet compete with food crops for arable land, water or fertilizers, if it is to be profitable.

5.1.1.3 The potential for land grabs

The continued expansion of plantations as a result of biofuel production could have negative impacts on some local communities at the site of new developments. Social impacts associated with the development of plantations (especially by logging companies and operators of palm-oil plantations) have attracted considerable attention in recent years as they negatively and disproportionately impact indigenous peoples, often depriving them of their land and their means for subsistence (e.g., Wakker, 2005).

The Indonesian Constitution bestows on the State the power to control and (re)allocate natural resources for public purposes. The ambiguity contained in this power provides the government with broad discretion over policies concerning land and forest conversion. Decisions on the maximum and minimum area to be used for palm oil and other commercial crop plantations are in the hands of the Minister of Agriculture (Geurin, 2007). It is the local administrations in the respective provinces, however, that officially dispense concessions to the plantation companies—usually for 35 years on a renewable basis—based on the availability of land, population density and other factors.

Unjust land-acquisition, due to corrupt community leaders or local governmental officials, has created friction between local leaders and their own communities, sometimes erupting into violence (Wakker, 2005). According to a study conducted by Sawit Watch and its partner organizations in 2006 (cited in Wakker, 2005), four main factors have typically created the conditions for such conflicts:

- contradictory laws which fail to secure indigenous rights while encouraging land expropriation for commercial projects under the pretext of "national interests";
- an absence of regulations obscuring procedures for the recognition of collective land rights enforced by customary-law communities;

- weak institutional capacity both in the national land agencies and district bureaucracies which makes recognition of customary rights even more difficult; and
- national and regional policies as well as spatial planning processes which favour the conversion of traditional lands and forests into oil-palm plantations in order to increase national and regional revenues.

Other sources of friction include information asymmetry, the use of force and human-rights abuses, unpaid compensation and benefits, and breach of contract timetables.

5.1.1.4 Rural self-sufficiency

As discussed in Section 2.5, the National Energy Policy envisages an increase in the use of vegetable oil in place of, or blended with, kerosene (a mix that it calls "bio-kerosene"). Kerosene is widely used in stoves for cooking, especially in rural areas. To this end, the government launched a "village-level energy self-sufficiency program" to help villages meet their own energy needs. Rural energy self-sufficiency could significantly reduce the fuel-subsidy burden given that a large proportion of total subsidies are spent on kerosene. It would also reduce transport costs and improve fuel supplies for rural communities.

An important potential source of oil for this scheme is jatropha, which the government hopes could be cultivated on marginal land that is unsuitable for food production. However, jatropha oil is more expensive than kerosene, at present, and therefore the cost of production of jatropha-based fuel would need to decline significantly for this programme to become economically viable or result in fuel-subsidy savings.

In terms of growing jatropha, local circumstances would need to be considered carefully to ensure developments are environmentally, economically, culturally and socially appropriate. Achten *et al.* (2007) found that that jatropha-based biodiesel production, when derived from plantations based on wasteland reclamation, could be a useful driver of rural development. However, in India, government promotion of jatropha plantations is said to be occurring at the expense of arable land and farmers. A study by Navdanya, a programme of the Research Foundation for Science, Technology and Ecology (RFSTE), found that farmers have been forced to replace food crops with jatropha or risk losing their land or even going to prison.[23] Farmers were also reported to have been promised subsidies for growing jatropha, which never materialized leaving the farmer financially disadvantaged. Jatropha is not currently used for purposes other than biodiesel production and therefore farmers growing the crop would have no alternative markets or use for jatropha if the market for biodiesel were to collapse (for example, due to a change in government support policies).

5.1.2 Environmental impacts

5.1.2.1 Deforestation

Indonesia has the highest rate of deforestation of any major forested country (FAO, 2005) and, once the effects of deforestation are taken into account, Indonesia has been

[23] www.navdanya.org/news/5dec07.htm

found to be the third highest global carbon emitter after China and the United States (Greenpeace, 2007). The key environmental concern regarding Indonesia and biofuels is whether biofuel production—either in Indonesia or other countries—is contributing to this destruction.

Indonesia's forests are among the most biologically diverse in the world and store vast quantities of carbon. In terms of numbers of distinct species, they are home to around 10 per cent of the world's flowering plants, 17 per cent of its birds, 12 per cent of its mammal, 16 per cent of its reptiles and 16 per cent of its amphibians (Collins, Sayer and Whitmore, 1991, cited in Wakker 2005). Deforestation in Indonesia has been associated with biodiversity loss, declines in the populations of iconic species (including Orang-utan, the Sumatran Tiger and Indian Elephant), forest fires and soil degradation (Koh and Wilcove, 2008; Wakker, 2005). Estimates of above-ground carbon storage range from 230 tonnes per hectare to 390 tonnes per hectare, for undisturbed rainforest, higher when soil carbon is taken into account (Ardiansyah, 2007).

Conversion of forest to crops as a result of biofuel policies would undermine the environmental credentials of biofuels, particularly those relating to greenhouse-gas emissions. The primary concern has been the possible expansion of palm oil production due to increased demand for vegetable oils, given that the land type most suitable for conversion to oil-palm is lowland evergreen tropical rainforest (Wakker, 2005). Koh and Wilcove (2008) analyzed FAO land-cover data during the period 1990–2005 and found that at least 56 per cent of oil-palm expansion in Indonesia occurred at the expense of forests.

However, the incremental effect of biofuel production on deforestation in Indonesia is difficult to ascertain. There are many other factors involved, particularly the lucrative gains from timber sales (both legal and illegal) and high CPO prices due to non-biofuel factors (e.g., rising demand in China and India and crop failures affecting supply of other vegetable oils).

Koh and Wilcove (2008) found that between 1990 and 2005, Indonesia's forest cover declined by 28 million hectares, while around 1.7 million hectares of forest was converted to oil-palm (around six per cent of total deforestation). The Indonesian Ministry of Forestry claimed in April 2007 that of the total 23 million hectares of natural forests that had been allocated for conversion to oil-palm, only two million hectares were being properly managed (i.e., had a plantation established). Almost 400 firms were served notice, that they had deforested land without fulfilling their part of the bargain. Oil-palm plantations were evidently not the primary driver of deforestation during this time. Companies gained the profits of timber sales without the expense and risk of investing in a plantation.

In May 2008, Didiek Hadjar Goenadi, executive director of the Indonesian Palm Oil Association (GAPKI), said that palm oil companies would cease to convert forest to oil-palm plantations and only develop "idle land," including former forest concession areas (Simamora, 2008). Indonesian Ministry of Forestry statistics (cited in Ardiansyah, 2008) indicate that around eight million hectares of land within the forest estate are considered degraded, with another 15 million classified as degraded outside of the forest estate. Didiek estimated that Indonesia has some seven million hectares of such land suitable for oil-palm plantations. Later, in August 2008, GAPKI is reported to have rejected the ban on converting natural ecosystems for oil-palm estates, saying the ban would hurt the economy, increasing unemployment and poverty (*Mongabay.com*, 28 August 2008).

Forest is still being cleared for plantations even when pre-logged land is available. The sales of the timber helps finance establishment of the plantation (Greenpeace, 2007; Wakker, 2005). Fertiliser costs can also be higher on previously logged land, where soils may have been degraded. Also, palm plantation companies control large landbanks of forested areas yet to be cleared. If the "idle land" includes secondary (previously logged) forest, the biodiversity impacts of conversion to oil-palm could be similar to that which would occur through the conversion of primary forest, given that secondary forests have been found to be up to 80 per cent as species-rich as primary forest (Koh and Wilcove, 2007).

Most new palm developments are occurring in Kalimantan and West Papua, where monitoring by the federal government is difficult due to inaccessibility and poor mapping. In May 2008, WWF representatives reported that palm oil plantations had expanded into protected forests in West Kalimantan: subsidiaries of Sinar Mas Group (a palm oil producer with plans to expand into biodiesel) were believed to be involved in clearing 160 000 hectares of forest bordering the Betung Karihun National Park (*Asia News*, 2008).

The oil-palm plantations for biodiesel production are expected to increase by over three million hectares by 2010 (Legowo, 2008). Based on the findings of Koh and Wilcove (2008) that at least 56 per cent of historical oil-palm expansion has occurred at the expense of forest, one could estimate that at least half of the additional hectares to supply domestic palm-biodiesel might result in deforestation (1.5 million hectares). Oil-palm plantations are also expanding *independently* of biofuels, given rising global demand in the food and industrial sectors, and therefore the additional clearing for biodiesel production could be expected to occur on top of the underlying rate of conversion.

Record-high prices for palm oil in early 2008, at least 50 per cent of which can be attributed to global biofuel production (Mitchell, 2008), also increased the incentive to expand plantations. High commodity prices have been correlated with higher rates of clearing and burning of Amazon rainforest.[24] Searchinger *et al.* (2008) found that increased demand for agricultural commodities due to biofuel production could lead to conversion of natural ecosystems to farmland.

Commodity prices will also affect government's decisions to invest in infrastructure or support policies for industry, such as roads or port facilities to improve access and transport. Such infrastructure will allow greater expansion of the industry than otherwise possible or economic.

Box 5.1 Palm oil production – threats to biodiversity

Monocultures have well known deficiencies. They are more prone to pest infestations, and therefore require higher levels of pesticides than do mixed cropping systems, and can require high levels of chemical fertilizers, depending on soil quality. They also have poorer water-absorption capabilities (compared with virgin forests) thus creating more runoff water, which carries with it some of the pesticides and nutrients applied to the crop. These problems are not exclusive to oil-palm plantations, but as palm plantations are set to replace an increasing number of ecosystems, they warrant further examination.

[24] http://news.mongabay.com/2008/0117-amazon.html

Palm plantations can host a maximum of 20 per cent of the species of natural forest (Wakker, 2005). The degree to which they decrease biodiversity can be ameliorated to a surprising extent. Oil-palm plantations have been documented as providing habitat for numerous plant, fungi and insect species, as well as larger animals such as birds. Supporting environmentally sound plantation practices can underpin the continuity of wild flora and fauna, albeit within a differing ecosystem dynamic.

In 2002, WWF summarized the key elements for sustainability in the palm oil industry such as: the maintenance of HCVFs (High Conservation Value Forests), sound environmental management techniques, a proficient regulatory framework, and transparency. HCVFs are defined as forests of outstanding and critical importance due to their high environmental, socio-economic, biodiversity, or landscape values.

The identification of HCVFs requires a multi-scale effort. First, rapid assessment and mapping of potential HCVF areas is required at a global or continental scale based on indicators of biologically or environmentally important forest values. These areas would need to be further refined within ecoregions and a more detailed investigation within a given landscape required to delineate actual HCVFs, including local stakeholder consultation, to identify forests that meet community needs and maintain cultural identity, and scientific research to identify biologically important forest stands and those critical for maintaining ecosystem functions and populations of endangered species.

Thus by working in coordination with environmental experts and local organizations to identify, develop tools, and promote the concept of HCVFs, the Government of Indonesia should be able to adopt the concept of HCVFs as a useful guide in creating environmentally sensitive procurement policies for forest products as well as for land acquisition and forest clearing permits.

5.1.2.2 Jatropha and conversion of "marginal land"

The long-term sustainability implications of large-scale jatropha plantations are not yet known, due to jatropha's recent emergence as a bioenergy crop. As discussed in Section 5.1.1.4, Achten *et al.* (2007) found that jatropha plantations could have overall favourable benefits for sustainable development, as long as only wastelands or degraded grounds were converted for cultivation. As for other crops, conversion of natural forest would have severe net negative environmental implications, including for greenhouse-gas emissions. Impacts on soil, water, and biodiversity would also depend on local circumstances. Nevertheless, the authors maintained that jatropha used for wasteland reclamation and biodiesel production could be useful drivers of rural development. Local circumstances would need to be considered carefully in each case to ensure such developments are environmentally, economically, culturally and socially appropriate.

5.1.2.3 Greenhouse gas emissions

Biofuels are often considered "carbon neutral" as carbon dioxide (CO_2) sequestered during growth of the feedstock is equivalent to the CO_2 emitted when burning the fuel. However, studies have shown that nitrous oxide (N_2O, a greenhouse gas with a warming potential 296 times that of CO_2) is often released with the use of fertilizers, and that CO_2

is emitted when the soil is tilled (thus exposing carbon in the soil to oxygen), as well as from machinery used in the production and distribution of biofuels. These contribute to the net emissions profile of biofuels.

When taking these factors into account in palm biodiesel production, Beer *et al.* (2007) found that palm biodiesel resulted in a saving in GHG emissions of 80 per cent when compared with petroleum diesel. As noted in the previous section, many palm plantations have been established on former forested land. When emissions associated with clearing were taken into account for palm biodiesel, the GHG emissions for palm biodiesel sourced from cleared rainforest or peat swamp were found to be eight to 21 times higher than those of petroleum diesel (Beer *et al.,* 2007).

If the GHG emissions from forest clearing are considered as a one-off "debt" that can be repaid over time (given the emissions profile of biodiesel compared with fossil diesel), then converting tropical rainforest in Malaysia to palm biodiesel would result in a "carbon debt" that would take around 86 years to repay (Farigone *et al.,* 2008). Until that time, burning fossil diesel would have caused less total GHG emissions. Converting peatland forest (where the peat is less than three metres deep) to palm production would result in significantly higher GHG emissions, caused by the effect of draining and subsequent oxidising of the peat. The biofuel carbon debt under this scenario was estimated to require approximately 420 years to repay. If the peat layer were three metres, it would emit carbon for 120 years, resulting in a biofuel carbon debt that would take 840 years to repay (Farigone *et al.,* 2008). Burning of the peat would accelerate the release of carbon emissions (Beer *et al.*, 2007 and Hooijer *et al.*, 2006).

An estimated 27 per cent of new concessions for palm oil plantations in Malaysia and Indonesia are on peatland rainforests (Farigone *et al.,* 2008). Deforestation data for Sarawak showed that around 50 per cent of forest land cleared from 1999 to June 2006 was located on peatlands (Hooijer *et al.*, 2006). Field observations and rapid assessment of satellite data suggest that many of these areas were cleared for oil-palm plantations (*Ibid*). A recent Greenpeace (2007) study found that the peat soils of the province of Riau have the highest concentration of stored carbon per hectare of anywhere in the world. One quarter of Indonesia's palm oil plantations exist in Riau, with another three million hectares intended for conversion over the next decade.

Oxfam (2008) has estimated that by 2020 emissions associated with Indonesian and Malaysian palm oil production due to EU biofuel policies (both for biodiesel use and replacing diverted domestic edible oils) would total around 4.6 billion tonnes of CO_2.

There is also an opportunity cost for using arable land to grow biofuel crops. If the aim is to reduce emissions, it would be better to retain or replant forest on this land. Righelato and Spracklen (2008) found that between two and nine times more carbon emissions are avoided by trapping carbon in trees and forest soil than by replacing fossil fuels with biofuels. Taking this into account, the authors considered that, on a lifecycle basis, the emissions cost of biofuels exceeds that of fossil fuels.

Box 5.2 Palm oil production – the special problems of peat soils

Peatlands store vast quantities of carbon: between one fifth and one third of all carbon stored in the terrestrial biosphere (Greenpeace, 2007). Around 22.5 million hectares of peatland are found in Indonesia.

Large areas of Indonesia's peatlands have been cleared of forest cover, drained and developed for farming or, more typically, oil-palm plantations. Carbon is released by clearing peatlands of their natural vegetation, draining of their moisture content (as is required for the soil to serve as an adequate substrate for most farm crops or plantations, including oil-palms) and by burning. Exposing the peat to air, either by clearing or draining, allows the stored carbon to oxidize, releasing CO_2 into the atmosphere. Drainage of tropical peat forest to one metre's depth results in emissions of 80–100 tonnes of CO_2 per hectare per year over several decades (Hoojer *et al.*, 2006). Fire would increase the rate of release. Left undisturbed, mature bogs eventually metamorphose into lignite, the predecessor of coal deposits.

Each year, the degradation of Indonesia's peatlands releases around 1.8 billion tonnes of carbon dioxide (Hoojer *et al.,* 2005), equivalent to the total reduction in annual emissions required for industrialized nations under the Kyoto Protocol (Greenpeace, 2007).

Peat bogs act like enormous natural sponges, storing 15–20 times their dry weight in water (Greenpeace, 2007). Once drained and the mosses die, however, they tend to become hydrophobic. And though they may contain huge amounts of water, the water contained in bogs tends to flow sideways, with little absorbed by the soil layers above. Thus even limited drainage can increase the risk of fire, contribute to downstream flooding in the wet season, and yet provide no relief to downstream droughts in the dry season. Peat fires are difficult to extinguish, may last for extended periods, and may spread to neighbouring forests or grasslands.

Hooijer *et al.* (2006) found that Indonesia's peat bogs emitted between 355 and 874 million tonnes of CO_2 in 2006, with a likely value of 632 million tonnes. They estimated also that, between 1997 and 2006, global emissions from peat fires (Indonesia represents 90 per cent of the total) averaged 1 400 million tonnes per year.

Drafting effective regulations to manage peat bogs has proved to be difficult. A regulation issued by the government in 1990 (Presidential Decree No. 32/1990) forbade development on peatland deeper than three metres. However, Greenpeace (2007) investigators found peat up to eight metres in depth inside some concession areas in Riau Province, as well as evidence of illegal clearing of peatland and intentional burning. Mapping used to allocate concessions had not been verified on the ground, causing concessions to be granted on deep peatland, where development is illegal.

The government's decree, even if effectively enforced, currently allows drainage of the outer zone of a peat dome that would consequently lead to subsidence of the deeper parts of the dome, making it legally eligible for reclamation.

5.1.2.4 Pollution

Biofuel refineries can pollute air, water, and produce construction waste. In the U.S., for example, ethanol and biodiesel fuel production led to almost 400 instances between 2001 and 2007 in which the plants fouled the air, water or land or violated regulations intended to protect health or the environment (Beeman, 2007). The biggest problem was meeting sewage pollution limits and preventing wastes from spilling into waterways. Refineries also exceeded limits for hazardous air pollutants and illegally burnt or dumped

waste. One biodiesel plant was cited for a fish kill caused by the improper spreading of liquid wastes (Beeman, 2007).

Air pollution can arise during the conversion of land to oil-palm plantations, as burning is the cheapest and most efficient means for clearing land of vegetation prior to establishing a plantation (Wakker, 2005). The Association of South East Asian Nations (ASEAN) developed an Agreement on Trans-boundary Haze Pollution, signed in 2002, to bring haze pollution under control in Southeast Asia (ASEAN Secretariat, 2008). However, the problem has been intractable in Indonesia. The serious regional health impacts of haze have caused Malaysia, Singapore and Thailand in particular to place pressure on Indonesia to control its forest fires (many of which are directly related to planting oil-palm; Wakker, 2005).

Oil-palm plantations have been associated with elevated concentrations of sediment, agro-chemicals and nutrients in rivers and streams (Wakker, 2005). Soil disturbance during land clearing and planting causes erosion. Processing of palm oil creates palm oil mill effluent, a mixture of water, palm biomass and oil, which is high in nitrogen (Wakker, 2005). The effluent can lead to eutrophication of waterways, if discharged or allowed to seep into watercourses.

Through the application of best practices, however, negative environmental impacts arising from biofuel facilities and feedstock production can be substantially reduced (Box 5.3). In the case of oil-palm, such measures can include terracing of slopes to reduce long-term erosion, recycling of palm effluent as an organic fertilizer, improving palm effluent treatment techniques, zero-burning practices for replanting, and integrated pest management (such as using owls to reduce rodents, rather than poison) (American Palm Oil Council, 2008). The extent to which such methods are practiced, however, is difficult to ascertain.

Box 5.3 Palm oil production – measures to improve sustainability

Use of chemical pesticides can be reduced through integrated pest-management systems. Several plantations are using barn owls to control rodents, for example. This practice is reported to allow reductions in the use of rodenticide by 70–100 per cent (American Palm Oil Council, 2008). The rhinoceros beetle has been kept in check by establishing leguminous cover crops and using shredded palm stands as fertilizer. Non-occluded spherical and granulosis viruses as well as the *Cordyceps* fungi can be employed to control caterpillars. Regular inspections, selective application of insecticide, and trunk injection or spot spraying with pyrethroid or *Bacillus thuringiensis* formulaes, can control bagworms and caterpillars. Predatory pentatomid bugs such as the *Cantheconidea furcellata* and *Platynopus melacanthus* are also a good method of biocontrol for worms and caterpillars.

Fertilizer use can be reduced by shredding and composting unproductive palm stands. Savings of US$ 300–400 per hectare may be achieved in this manner. Leguminous cover crops such as *Mucuna bracteata*, *Pueraria phaseoliodes*, and *Calopogonium caeruleum* can abate beetle infestations and help fixate nitrogen and enhance soil nutrients. *Vetiver* and *Guatemala* grass can enhance soil fertility and reduce erosion. Additionally, commercial crops such as teak (*Tectonia grandis*), sentang (*Azadirachta excelsa*) and bamboo (*Bambusa spp*) can be planted around and within palm fields. Other beneficial plants such as *Euphorbia heterophylla*, *Cassia cobanensis*, *Antigonon leptopus* and *Turnera subulata* can be used to suppress leaf pests and increase floral biodiversity.

Using treated oil-palm biomass may also replace the need for fertilizers. Oil-palm mills produce large amounts of by-products, particularly Palm Oil Mill Effluent (palm effluent) and Empty Fruit Bunches (EFB). Typical rates of waste generation are 0.1 tonnes of effluent and 0.2 tonnes of EFB for every tonne of fresh fruit bunches processed.

Raw palm effluent is high in biochemical oxygen demand (BOD) and is acidic. A Presidential Decree ratified in 2001 (PP No. 82, 2001) sets an acceptable range for acidity and BOD. Preferable methods of treatment include using digesters and aerobic ponds to produce an anaerobic sludge. Anaerobic treatment is preferred because the sludge from treated effluent contains high levels of plant nutrients. The application of sludge in the palm fields can be carried out using a tractor-tanker system. Applying around 500 litres of sludge annually could reduce each tree's input by: 1.96 kg of urea, 1.83 kg of Christmas Island Rock Phosphate, 1.45 kg Muriate of Potash (MOP) and 2.3 kg of kieserite. Furthermore, anaerobic digestion produces volatile fatty acids, which are then converted into methane (and CO_2) and can be used to produce biogas and fertilizers. There are other alternatives, but extended aeration tends to produce lower levels of solids (thus lower levels of fertilizers), pond systems require huge areas and have a long retention time, and bioreactors require more electricity. Another viable alternative is composting, but it is management-intensive and is more affected by external influences, such as rain, as well as temperature and moisture fluctuations.

There are two preferred ways of dealing with EFB, namely composting and mulching. Composting, which involves chopping up and stacking EFB to decompose over a period of up to 70 days, can be effective, but it requires careful management. Mulching can be carried out only once a year. Mulching increases the organic-matter content of soils, improves soil structure, increases infiltration and aeration, reduces run-off, improves soil water retention, increases soil micro-fauna activity, increases cation-exchange capacity and reduces fluctuations in soil temperature. However, as EFB mulching incurs additional costs, its benefits can be maximized by using it as a soil amendment where growing conditions are poor, such as on lateritic and sandy soils.

Water runoff and subsequently the components it carries can be minimized by planting shrubs or other greeneries between plots or retaining original forest cover near the plantations whenever possible. As mentioned above, leguminous cover crops assist moisture retention and soil conservation by reducing the energy of rainwater droplets, decreasing surface velocity, physically restraining soil movement, improving soil aggregation and porosity, and increasing biological activity in the soil. Other alternatives include the creation of surface structures such as slit pits or close-ended trenches.

5.1.2.5 Enforcement and monitoring

Enforcement and monitoring of oil-palm plantation development is challenging for the Indonesian Government. Development is frequently occurring in the outer reaches of the archipelago, where official presence is low and mapping poor. Recently Greenpeace (2007) revealed serious breaches on Indonesian law including operating without concession title, illegal clearing of forests and intentional burning. Such breaches were, at the time, unchallenged by authorities.

Nellemann *et al.* (2007) found that illegal logging was taking place in 37 of 41 surveyed Indonesian national parks. Indonesian Government resources to control illegal logging were extremely limited compared with the scope of the challenge. The use of bribery and armed force by logging companies was reported as commonplace and park rangers had insufficient resources and training to respond effectively. The study found that there were around 2000 field rangers to monitor activities in 35 national parks, covering an area of 108 000 square kilometres. Monitoring Indonesia's approximately six million hectares of existing palm oil plantations for environmental violations, and its growth by around 1.87 million hectares per year, would be a significantly greater challenge.

Better mapping and on-ground verification of conditions could improve the assignment of concessions, particularly in regard to avoiding deep peatlands (see Box 5.2), while improved resourcing and training of field personnel could improve enforcement. The development of Quick Response Ranger Units (SPORC – *Satuan Khusus Polisi Kehutanan Reaksi Cepat*) is a promising response by the Indonesian Government to illegal logging (Nellemann *et al.*, 2007). If successful, similar teams could be established to monitor new palm plantation development. Meaningful results would depend on resources (such as air and ground vehicles, communication and positioning technology) as well as government willingness to clamp down on corruption and to prosecute offenders.

5.1.2.6 Sustainability and certification

Indonesian producers may soon need to demonstrate compliance with stringent sustainability criteria to gain access to European markets. Certification schemes are under consideration within the European Union and Switzerland intended to ensure that biofuels and their feedstocks are produced sustainably. Switzerland passed legislation in 2007 that requires all biofuels, by 1 July 2008, to demonstrate sustainability in order to qualify for tax advantages. The regulations to implement the legislation were still under development, as of October 2008 (Steenblik *et al.*, 2008).

At this stage, the proposed EU and Swiss certification schemes do not take into consideration the indirect, or displacement, effects of biofuel production. A recent report commissioned by the United Kingdom government (Gallagher *et al.,* 2008) concluded that biofuel feedstock production should avoid agricultural land that would otherwise be used for food production:

> *During the period to 2011–12, comprehensive, mandatory sustainability criteria within the EU Renewable Energy Directive should be implemented for biofuels and bio-energy, including requiring feedstock that avoids indirect land-use change.*

The report recommended that biofuel use should be slowed until controls are put in place that demonstrably addresses displacement effects. This is likely to be a difficult hurdle for producers to meet.

Voluntary certification schemes are also being developed to provide assurance to consumers that the palm oil they buy comes from sustainable sources. The Roundtable on Sustainable Palm Oil (RSPO) was established in 2004 to bring the commercial sector together with conservation organizations, civil society groups, governments and other stakeholders. It aims to promote the production, procurement and use of sustainable palm oil. The RSPO essentially provides a platform for stakeholders to discuss and

develop a definition of sustainable palm oil. So far, the RSPO has developed a set of voluntary principles and criteria.[25]

The reaction from the environmental community to the RSPO has been mixed. Greenpeace (2007), for example, judged that "the RSPO and its members have taken few meaningful steps to end the devastation and injustice linked to the [palm oil] industry and its expansion."

In summary, certification may assist in reducing some of the direct negative environmental impacts from established biofuel facilities and oil-palm plantations through good management practices. However, there is no way a certification scheme can manage indirect effects, such as an expansion of agricultural production into natural ecosystems due to increased demand. Nor can the biodiversity or other ecosystem services of the original forest (even secondary forest) can be replicated in a plantation.

[25] www.rspo.org

6 Conclusions and recommendations

This report set out to provide a comprehensive survey of policies to support liquid biofuels in Indonesia. Although data and resource limitations prevented us from identifying and quantifying all the subsidies intended to support the country's ethanol and biodiesel industries, we believe we have identified the major ones. We hope that other researchers will be able to build on this study, correct errors and continue the process of quantifying support to the industry.

The picture that emerges from our analysis shows that Indonesia has been slow to implement its ambitious plans for biofuel production and consumption. This has largely been due to dramatic rises in feedstock prices in 2007 and early 2008, which led the government to abandon its early targets for development of the industry and some of its biofuel-related commitments. The government allowed Pertamina to drop the biofuel content of blended fuel in 2007 and 2008, when biofuel prices were high. It appears that trillions of rupiah (hundreds of millions of U.S. dollars) in funds appropriated for biofuel development were never disbursed.

Lower prices for agricultural commodity prices in the second half of 2008 have renewed interest in biofuels, both in the government and the private sector. However, it remains to be seen whether new policies, such as the mandatory consumption requirements to come into effect from 2009, will be more robustly enforced than earlier policies. Petroleum oil and biofuel prices have also declined, leaving profit margins small—subsides are likely to be needed in the foreseeable future to make biofuel production and consumption feasible in Indonesia. Yet the subsidy arrangements for the new biofuel mandates have not been disclosed, and Pertamina could again act unilaterally to reduce its biofuel use.

Indonesia does not currently have the production capacity to meet its biofuel mandates from domestic production. Successful implementation of the mandates therefore also depends upon private-sector decisions to build new plants, or reliance on imported biofuels. In addition, significant new storage and distribution infrastructure will be required to facilitate an expansion in ethanol consumption. As evident during 2007 and early 2008, the private sector can quickly cancel plans for new biofuel-related investments in response to changing market conditions.

6.1 Findings

The Indonesian Government has ambitious plans to develop biofuels. In 2005 it announced plans to develop biofuels as an alternative energy source, as a means to create demand for its agricultural sector, new markets for its commodities and to generate rural employment. The government set a target for five per cent of total energy needs to be met by biofuels in 2025. Biofuels were also intended to provide energy to remote rural settlements, which currently depend on long, costly supply lines.

Total support to the biofuels sector in Indonesia is estimated to have been around IDR 1 800 billion (US$ 200 million) for the period from 2006 to June 2008. This figure includes losses by Pertamina, the national oil company, as a result of a government policy requiring it to purchase biofuels and to resell them at a loss. Subsidies also included support for feedstock development. A further IDR 13 trillion (US$ 1.43 billion)

was reported to be allocated in the 2007 federal budget for biofuel infrastructure and plantations development and legislation is in place to provide tax reductions for biofuel-related investments. However, low fiscal transparency in Indonesia makes it difficult to determine the extent to which these funding commitments have been spent.

Future implementation of biofuel policies is uncertain. As for previous biofuel policies, the implementation of the government's new mandate could depend (whether wisely or simply pragmatically) on whether it decides that biofuels are an economically competitive alternative to their petroleum-equivalents, taking into account prices of feedstocks and petroleum. The government has, to date, shown only a limited appetite to support biofuel production under un-economic market conditions. This flexibility discourages investors, who seek the certainty of government support, but is good for taxpayers who thereby are saved from paying for biofuels regardless of the cost.

The government is championing jatropha oil. The government hopes that jatropha will be suitable for cultivation on marginal land that is unsuitable for food production. The jatropha oil could be processed into a kerosene replacement in villages or for electricity generation. Depending on the international price of petroleum, such an approach could reduce transport costs for fuel and improve supply for rural communities. This programme has yet to be implemented but could assist sustainable development of rural areas, as long as jatropha is developed only on wasteland and does not replace food crops or natural ecosystems. Jatropha oil is currently more expensive than kerosene. The cost of jatropha biofuel production would need to be reduced significantly, or oil prices rise dramatically, for this policy to be cost-effective or result in fuel subsidy savings.

Environmental pressures of biofuel. Given current low levels of biofuel production in Indonesia, domestic biofuel policies are unlikely to be having major environmental impacts at this stage. And some environmental damage linked to palm oil has been the result of logging carried out by companies with licenses obtained on the premise that they would develop the land for palm oil. These loggers obtained licenses to convert forests into palm oil plantations, but only harvested the timber and abandoned the land. While a total of around 23 million hectares of forest was allocated for conversion to palm oil, only two million hectares were found to be under formal cultivation. The Indonesian Ministry of Forestry has placed a moratorium on licensing for new forest conversions and outstanding licenses are slated to be revoked and reallocated to new investors.

Nevertheless, reports of forest being converted to oil-palm are not uncommon, including protected areas in Borneo. Biofuels might contribute to incentives for the establishment of new oil-palm plantations by raising demand and prices. However, other factors (such as demand for timber) also contribute, regardless of biofuel production. Banning or certifying biofuels would therefore have a limited impact. The problem can only be solved by real political will to prevent deforestation, and improve governance and enforcement.

Fear of land grabs persist. Smallholders and locals are still at risk of land mis-appropriations as governance and enforcement capacity remains underdeveloped. The palm oil boom, which benefited corporations sometimes at the expense of the rural poor, left behind an enduring legacy of mistrust. The government has yet to put policy measures in place to address potential abuse.

Possibility of sustainable expansion of feedstocks. Oil-palm is a vital crop for the Indonesian economy, particularly the rural sector. Further expansion is inevitable, given the economic benefits that would be delivered to communities, companies and the government. Restricting expansion of oil-palm and jatropha plantations to existing degraded land could facilitate sustainable development, given the vast tracts of forest that are reported by the Indonesian Government to have been cleared of their native vegetation and abandoned in a degraded condition.

If such "degraded land" is secondary tropical forest, then conversion to oil-palm or jatropha will have negative environmental impacts that resemble conversion of primary forest, particularly for carbon release and biodiversity. However, if these lands are bare and eroding, conversion to palm or jatropha could stabilise soils and result in a net uptake of CO_2, as well as a profitable crop.

Most other negative environmental impacts from biofuels facilities and existing oil-palm plantations can be avoided through good management practices. Improvements in palm oil yield through planting of higher-yielding varieties and improved management practices could also increase the supply of biofuel feedstocks without conversion of forest. Therefore the expansion of biofuel production in Indonesia need not come at the expense of the natural environment.

6.2 Recommendations

The unintended consequences of biofuel production have the potential to undermine their hoped-for social and environmental benefits. There may be scope, however, for biofuels to have a useful role in rural energy self-sufficiency, where the higher costs of biofuels are warranted due to difficulties of supplying fossil fuels to these areas.

The study concludes with several basic recommendations for the government of Indonesia. In our opinion, it should consider the following:

Eliminate subsidies on petroleum-derived transport fuels. The government's recent actions to move domestic retail fuel prices towards the world price are commendable. To reduce dependence on petroleum fuels—the government's primary declared aim in promoting biofuels—it should start by allowing market pricing of fossil fuels. Removing subsidies for petroleum-derived fuels would reduce consumption and free up government resources. Subsidizing biofuels, generally a more expensive alternative than their fossil-fuel equivalents, is like trying to put out a fire with gasoline.

The biofuel mandates should be removed. There is no evidence to suggest that the economics of the biofuel industry is likely to change in the foreseeable future. Commodity markets are volatile and therefore biofuels could be profitable at times, but experience from other countries has shown that biofuels are consistently more expensive than fossil fuels, requiring long-term government support to remain competitive.

The biofuels industry should be allowed to function in response to market signals—consistent with environmental and social standards—so that the industry establishes itself on a sustainable rather than a government-dependent basis. The new mandates lock in a new form of fuel subsidy that is delinked from market forces, thus creating new inefficiencies in the economy that would likely require painful reform in future years.

Re-evaluate the government biofuel plan. The government needs to undertake an integrated evaluation of its blueprint for biofuel development. This initial investigation

shows that policy in this area has been poorly coordinated and policy aims as well as beneficiary targeting have not been clearly articulated. Significant scope exists for improving transparency in the conduct of the current biofuels initiative.

The government should consider revising its energy-security strategies. Energy efficiency programmes might deliver greater reductions in energy use at a cheaper cost than subsidizing expensive alternative fuels, with less impact on food resources for the poor and fewer environmental consequences.

Increase transparency. More information is needed to better understand the development of biofuels in Indonesia. The apparent resolve of the government to continue its biofuel development program provides a case for better monitoring. A need exists for more comprehensive and accurate information on the manner in which subsidies to biofuels are being implemented.

Advocacy and environmental monitoring needed. Leaving aside the question of whether the capacity and resources exist for implementing the current national plan for developing biofuels, considerable risks have been identified relating to the deficits in capacity for good governance. This study highlights the need for good governance as a means to ensure that illegal land appropriations and environmental degradation is not a result—directly or indirectly—of the expansion of biofuels.

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The Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD)

The International Institute for Sustainable Development's Global Subsidies Initiative shines a spotlight on subsidies – transfers of public money to private interests – and the ways in which they can undermine efforts to put the world on a path toward sustainable development.

Subsidies have profound and long-lasting effects on economies, the distribution of income in society, and the environment, both at home and abroad. Subsidies have shaped the pattern and methods of agricultural production, even in countries that now provide few or no farm subsidies. They have encouraged fishing fleets to search farther and deeper than ever before, aggravating the problem of over-fishing. They have fueled unsustainable energy production and wasteful consumption patterns.

While subsidies can play a legitimate role in securing public goods that would otherwise remain beyond reach, they can also be easily subverted. Special interest lobbies and electoral ambitions can hijack public policy. When subsidies result in a fundamentally unfair trading system, and lie at the root of serious environmental degradation, the question has to be asked: Is this how taxpayers want their money spent?

The GSI starts from the premise that full transparency and public accountability for the stated aims of public expenditure must be the cornerstones of any subsidy program. In cooperation with a growing international network of research and media partners, the GSI is endeavouring to lay bare just what good or harm public subsidies are doing; to encourage public debate and awareness of the options that are available; and to help provide policy-makers with the tools they need to secure sustainable outcomes for our societies and our planet.

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