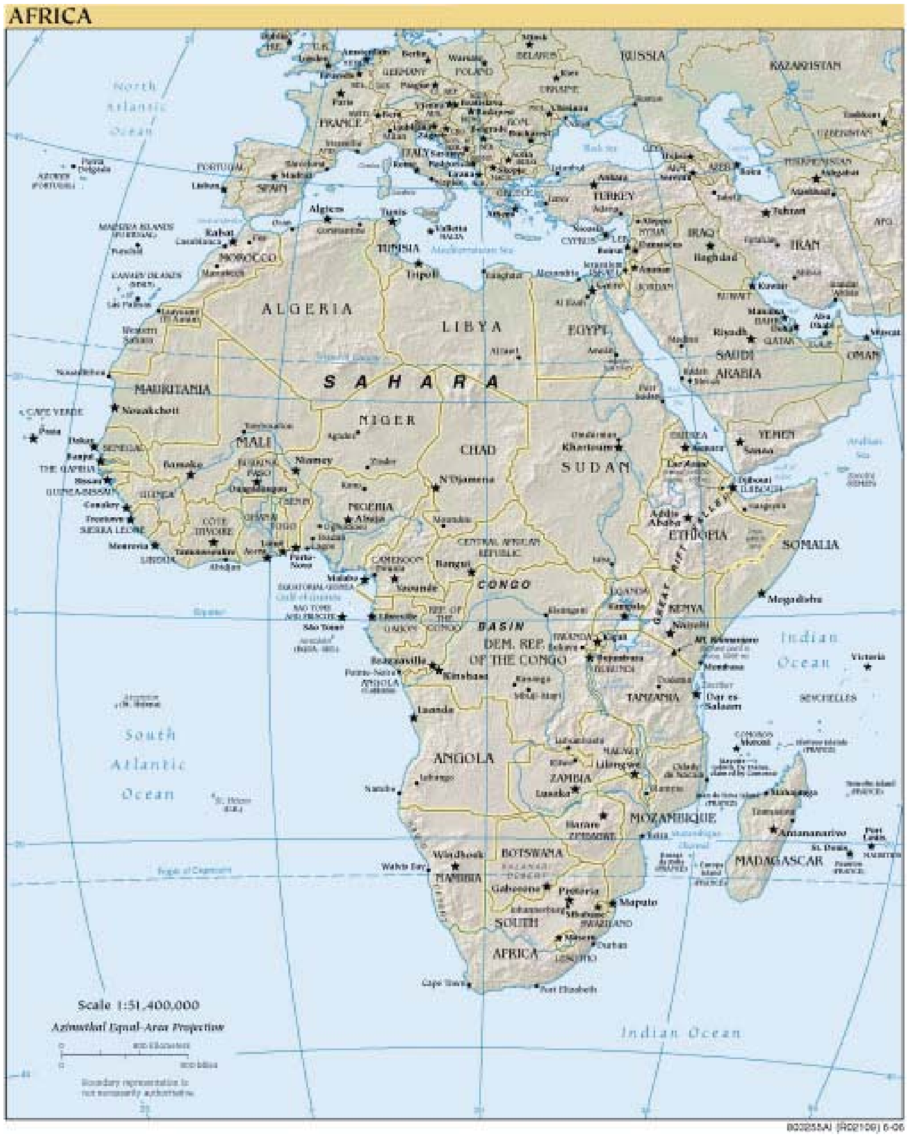
5. AFRICA



Source: World Factbook

A) INTRODUCTION

Sub-saharan Africa's interest in biofuels is principally driven by the region's extreme rural poverty and the dire need for stable agricultural development and employment. This motivation exists in both energy-resource rich countries like Nigeria and South Africa and in resource limited ones such as Zambia. Climatic conditions are generally suitable for the cultivation of biofuels feedstocks. The potential land and human capital available for biofuel activities outstrips that of almost any other geographic region. For example, in Nigeria, it is estimated that high-yield sugarcane operations could be extended to a land area ten times that currently under cultivation. In Mozambique, the government is considering an ambitious land concession program to promote private sector biofuels development that would involve the transfer of up to 3.5 million hectares in seven provinces, with the possibility of expansion into additional provinces. The challenge is to put in place the myriad legal, institutional, and organizational elements essential to creation of a viable industry. South Africa is probably best equipped to meet these demands.

Prepared by Garten Rothkopf

B) GOVERNMENT POLICIES

Government efforts in all the countries under review are in their early stages. None of the countries has thus far created a formal legal or regulatory structure for a biofuels sector. South Africa is expected to set out the basic principles of such a regime in the near future. In other countries, planning has just begun. Development initiatives are nonetheless proceeding in an ad hoc fashion, largely through direct government investment or directives to state-owned companies to establish biofuels production facilities. Rural development is a central objective in much of the planning, which focuses on small-scale farmers, out-grower schemes, widespread land concessions, and the development of small-scale production units throughout the country. Once clear plans have been approved, the implementation phase will draw heavily on the governments' reserves of expertise, and technical assistance could play a critical role.

Relationship with Brazil
All the countries under review have turned to Brazil for cooperative arrangements. Among the most important are a Trilateral Task Force on Biofuels established by South Africa, India, and Brazil, memoranda of understanding between the Nigerian national oil company and Brazilian entities to supply ethanol to Nigeria, and an agreement among Mozambique, Brazil, and the United Kingdom to promote a sustainable biofuels industry in southern Africa.

C) CURRENT SITUATION

There is currently no significant biofuels production in these four countries. The only measurable importer was Nigeria, which imported 180 million liters of ethanol in 2005. Plans have been announced for biodiesel and ethanol production in Mozambique and an ethanol plant directed by Ethanol Africa in the heart of South Africa's corn-producing region. Nigeria is studying both cassava and sugar cane as potential ethanol feedstocks.

D) PRIVATE SECTOR

A variety of companies are making initial investments in the field. Ethanol Africa is building an ethanol plant in South Africa, with a special emphasis on small farmers, and is interested in building a further seven plants there. D1 Oils Africa is considering biodiesel investments in South Africa, and there is serious Chinese interest in ethanol production in two Nigerian states. One interesting biodiesel initiative is being led by telecommunications companies seeking to develop small scale biodiesel production to power mobile base stations around Nigeria, where electricity is not available.

E) RESEARCH & DEVELOPMENT

R&D activities in all the countries are in their earliest stages. Mozambique is working with the Climate Change Corporation of the UK and with a US NGO, Technoserve, on biodiesel research. South Africa is engaging its university system and has established a postgraduate program on Renewable and Sustainable Energy Studies. It is also promoting research on alternative indigenous crops, such as sweet sorghum. In Nigeria, the national oil company is partnering with both domestic and international research institutions, such as the International Institute of Tropical Agriculture and the Nigerian Cereals Institute to examine appropriate sugar cane and cassava varieties, and with Nigeria's National Space Research and Development Agency to examine the use of space mapping technology to improve cassava cultivation.

Source: World Factbook

A) INTRODUCTION

Mozambique is often touted as one of the world's potential new "bioenergy superpowers". Favorable climatic conditions, large uncultivated tracks of arable and marginal lands, stable political conditions, a growing economy, and an ample low wage workforce lead many international experts to consider Mozambique a potential major player in the biofuels industry, perhaps on par with Brazil.

International investors, in cooperation with the government of Mozambique and other national actors, are beginning to explore investment possibilities in the country's biofuels industry. No large-scale production units are yet in operation, but a number of projects are in the pipeline. These should be carefully monitored in the months ahead to evaluate the viability of a Mozambican biofuels industry as well as the government's commitment to ensure it provides the necessary environment for its success.

The stakes are high for Mozambique, as the potential productive capacity of the country's biofuels industry could lift many Mozambicans out of poverty, diversify the sugary industry's sources of income, and reduce Mozambique's dependence on foreign energy, resulting in foreign exchange savings.

B) GOVERNMENT POLICIES

Mozambique first highlighted the need to promote renewables in the country's Action Plan for the Reduction of Absolute Poverty (2001-2005). It specifically stated that one of the main objectives of the nation's energy program is to promote the use of new and renewable energy sources in the electrification of remote areas. Since then, the government has engaged in a multi-level strategy to promote the biofuels industry.

The government is investing directly in the biofuels sector, including the construction of a US$14 million biodiesel plant near the capital Maputo, with the aim of targeting the European Union market.[1] It has also directed two of its state oil companies, Empresa Nacional de Hidrocarbonetos (ENH) and Petromoc, to invest in the biofuels sector. Petromoc has three biofuels projects (see Private Sector below) with a combined potential capacity of approximately 280 million liters per year of ethanol and biodiesel.

Additionally, it has embarked on an ambitious land concession program managed by Mozambique Bio-Fuel Industries Lda (MBFI), a government-sponsored company established to encourage and support the development of a national infrastructure for a biofuels industry. The program's objective, launched in February 2006, is to eradicate poverty through a private enterprise funded biofuels industry. The Mozambican Government is to provide 3.5 million hectares of land in seven provinces with approximately 500,000 hectares per province (that number could grow to 10 provinces if the program is successful). The primary energy crops are expected to be jatropha and oil palm for the production of biodiesel and cassava for ethanol production.

- Zabezi Province: Districts of Morrumbula, Pebane
- Manica Province: Districts of Machaze, Guro, Tambara
- Nampula Province: Districts of Mossuril, Memba, Nacroa, Erati, Nacala-a-Vehla,

Lalaua
- Inhambane Province: Districts of Mabote, Funhalouro, Panda, Vilanculos, Govuro
- Gaza Province: Districts of Chicualacuala, Massangena, Chigubo, Mabalane
- Tete Province: Districts of Cahorra Bassa, Changara, Macoe, Macanga, Zumbo, Maravia
- Niassa Province: Districts of Nipepe, Metarica, Cuamba, Mandimba, Ngauma, Lago, Lichinga

The program is to be managed by MBFI and consists of joint ventures and partnerships between financial institutions, the commodity off-takers, and foreign and Mozambican investors. The primary energy crops are expected to be jatropha, curcas, and oil palm for the production of biodiesel and cassava for ethanol production.

The government is also considering the introduction of biofuels specific legislation, including ethanol blending requirements as well as tax incentives and a customs duty exemption for ethanol and biodiesel production.[2]

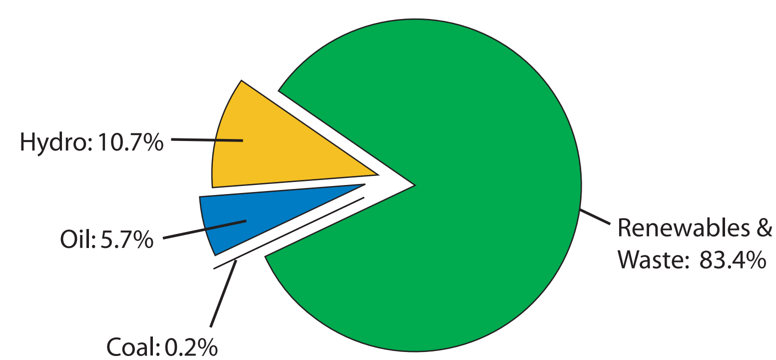
Relations with Brazil
The United Kingdom, in cooperation with Brazil and Mozambique, recently launched a Joint Task Force on the promotion of a sustainable biofuels industry in southern Africa. The partnership is expected to provide solutions to the global need for low carbon transport fuels.[3]

Bilateral cooperation is also underway. Petrobras and Empresa Nacional de Hidrocarbonetos (ENH), Mozambique's national oil company, signed a memorandum of understanding in October 2006 for onshore and offshore oil and natural gas exploration as well as for biofuels research and production in Mozambique. The research will focus on biodiesel production from jatropha and ethanol production from sugarcane.[4]

C) CURRENT SITUATION

Energy Matrix
Biofuels are being considered by the government of Mozambique as a potentially significant component of the country's energy matrix. Biomass already represents the majority of Mozambique's energy matrix, as most rural communities depend on wood fuel for cooking and heating, and household energy supply in urban centers is predominantly based on charcoal. The country's average annual oil import bill is roughly $270 million, equivalent to approximately 11% of total imports.[5]

Chart 5.1a: Share of Total Primary Energy Supply (2003)



Source: IEA

Poverty and population growth are the principal drivers of Mozambique's current energy mix. The government is searching for ways to facilitate the development of its biofuels industry in an effort to substantially reduce current levels of absolute poverty in Mozambique through foreign exchange savings, new and more stable markets for its commodities, as well as market-based rural development.

Production and Consumption Capacity
Many international experts and government leaders in Mozambique are touting the country as a potential "bioenergy superpower" on par with Brazil, as it has suitable agro-climatic and agro-ecological conditions for a range of energy crops, abundant arable land resources, and a largely rural population (among the poorest in the world) ready for employment and increased incomes. More specifically, Mozambique has 36 million hectares of arable land, of which only 9% is in use. There are an additional 41.2 million hectares of marginal land, of which 3.3 million have the potential for irrigation (less than half this land is irrigated now).

As there is no established biofuels industry in Mozambique, there is no current production or consumption to report. It should be noted that the country produces the cheapest sugar in the world, at a cost of between $75 and $100 a ton.[6] Furthermore, the industry is slowly recuperating from years of conflict and increased sugar production from 39,000 tons in 1998 to 265,000 tons in 2005, with a production target of 325,000 tons by 2008.[7] Jatropha also grows very well on Mozambique's marginal lands and is expected to contribute to the competitiveness of the country's nascent biodiesel industry.

D) PRIVATE SECTOR

As discussed in the Government Policy section above, the government of Mozambique is supporting the growth of its biofuels industry by directing its state oil companies to invest in biofuels projects as well as through the implementation of an ambitious land concession scheme. The government is also supporting other private actors in the development of the industry in Mozambique.

In March 2006, Mozambican state oil company Petromoc and the Committee for the Facilitation of Agriculture between Mozambique and South Africa (Cofasoma) agreed to invest $125 million in a factory to produce ethanol from sugarcane. The agreement also includes investment of some $225 million in associated infrastructure in the district of Moamba, including a road and bridge to access the factory. Of the direct investment of $125 million, $45 million has been earmarked for the agricultural project and the remainder for the ethanol distillery. The factory will have an annual production capacity of around 220 million liters of ethanol. In its initial stage, around 10,000 hectares of land owned by Cofamosa will be used for sugarcane production, but this is expected to climb to 29,000 hectares when the project is fully underway. According to the two companies, this project alone could net the country some $110 million, $60 million from exports and the remainder through import savings.[8]

Petromoc is also studying the possibility of setting up two biofuels production units, one in the center and one in the south of the country. The first would be an ethanol plant requiring an investment of $28 million for the production of 33 million liters of ethanol per year. The initiative also includes the cultivation of sweet sorghum to supplement sugarcane. The second will be a biodiesel plant requiring an investment of $30.2 million for the production of 40 million liters of biodiesel per year. The operating costs are expected to be around US$0.33/liter for the ethanol unit and US$0.41/liter for the biodiesel unit.[9]

The pace of investment is picking up. In July 2006, sugar producer Tongaat-Hulett announced plans to incorporate a 17.6-million liter/year ethanol plant at its Xinavane plant.[10] The following month, TechnoServe, a US-based NGO supporting local development initiatives, assisted local government and businessmen to set up two biodiesel production units from copra oil in the provinces of Inhambane and Zambezia. The units, which are operating on an experimental basis, were set up adjacent to the copra oil facilities of Somoil and Madal in the two provinces. They have a capacity to produce one million liters of biodiesel annually.[11]

Finally, as of September 2006, the following initiatives were being implemented:

Table 5.1a: Biofuels Initiatives

Initiative	Location/Province	Area (hectares)
Deulco	Inhambane e Sofala	10,000 e 5,000
Mozambique Biofuels Industries	All provinces	1,500-4,500 in each province
ECOMOZ	Maputo	3,000
Grown Energy Zambezi	Zambezia	160,000
Companhia de Monapo	Nampula	190
Local Trader	Niassa	59
Madal	Zambezia	40
Caritas	Manica	140
Envirotrade	Sofala	4

Source: Ministry of Energy[12]

E) RESEARCH & DEVELOPMENT

Research and development efforts in the biofuels industry in Mozambique are relatively limited. Sweden is supporting research in the wide-scale production of biodiesel through a memorandum of understanding signed with the Mozambican authorities in May 2006. The cooperative agreement calls for Swedish technical experts to study the situation on the ground and prepare a development plan.[13]

Technoserve is collaborating with the Institute of Agricultural Research of Mozambique and the International Center for Research of Agro-Forestry to create a jatropha research and monitoring unit. The project aims to define provenance selection, design management practices (including pest and disease management), and specify optimal post-harvest and processing techniques.[14]

The UK-based Climate Change Corporation (C3) is working with the government of Buzi district in the central Mozambican province of Sofala on a project to produce biodiesel from jatropha. C3 will supply inputs and has signed an agreement with the Buzi government establishing the principles to be followed by any farmer who wishes to take part. The government has been encouraging peasants to grow jatropha as a cash crop. Farmers who agree to plant at least one hectare of land with jatropha may join the program. As a demonstration, the project has planted 1,500 seedlings in various parts of the district. C3 will supply the farmers with seeds and needed technology (including training) and has promised to purchase their entire crop. To avoid jatropha becoming a monoculture, the farmers involved will also be given seed for beans.[15]

F) CONCLUSION

Mozambique's huge, untapped agricultural resources, in terms of both land and labor, provide the basis for developing an extensive biofuels industry. The government is investing directly in biofuels production, as is the national oil company, and in 2006 it launched a program to offer large land concessions for private sector production of ethanol and biodiesel feedstock, primarily jatropha, palm oil, and cassava. However, biofuels legislation has not yet been introduced, significant private sector interest has not been identified, and large regulatory, infrastructure and organizational challenges remain. A new agreement for Swedish technical assistance may speed a biofuels development plan that can address these multiple issues.

Endnotes

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Source: World Factbook

A) INTRODUCTION

While Nigeria is the largest oil producer in Africa and the tenth largest producer of crude oil in the world, most of its refineries are in disrepair and it imports about 70 percent of its fuel requirements. These difficult realities have been at the core of Nigeria's drive to develop a biofuels industry capable of providing it with both greater energy independence and a new and self-sustaining industry capable of helping lift its rural populations out of poverty.

The Nigerian government has been focused on a top-down and supply-led approach to developing an ethanol industry. Sugarcane and cassava are the primary feedstocks. Nigeria is believed to have the potential for world class sugarcane productive capacity and is the world's leading producer of cassava. The government has actively supported the development of an ethanol industry, but there have been few tangible results. A number of projects are nevertheless being evaluated and a few memoranda of understanding have been signed for large ethanol producing projects.

B) GOVERNMENT POLICIES

The policy environment has always been a challenge in Nigeria, and the biofuels industry is no exception. The government has charged the Nigerian National Petroleum Corporation (NNPC) with leading the country's efforts in biofuels production. In August 2005, the NNPC established a Renewable Energy Division (RED) to introduce and sustain the production of biofuels, with the aim of integrating the agricultural sector into the downstream petroleum industry.[2] RED is primarily focused on the establishment of an ethanol industry, beginning with the development of a supportive policy and regulatory framework, research and development geared toward improving crop yield, selection of land for cassava and sugarcane to ethanol projects, development of business plans for piloting cassava and sugarcane plants, and the engagement of the financial community.

At this stage, policies are expected to emphasize the emergence of integrated operations with the potential for good economic performance. At the same time, policies will aim to set out the best conditions for the development of an out-grower scheme in order to involve local communities in the production of feedstock for the industry. They also intend to promote access to international industry skills and financing to underpin the sustained growth of the industry.

The NNPC plans will be supported by the Renewable Energy and Energy Efficiency Partnership (REEEP), a public-private clean energy partnership established at the World Summit for Sustainable Development. REEEP is providing part of the funds (70,000 euros) for detailed feasibility studies to establish the supply chain for several new ethanol production plants.[3]

There are plans for a 10-20,000 hectare sugarcane plantation fitted with an ethanol production unit capable of producing 70-80 million liters annually, and an integrated 5-10,000 hectare cassava plantation fitted with an ethanol production unit capable of producing 50-60 million liters annually. Ethanol will be commercialized by NNPC as a motor fuel for blends up to 10%. Cogeneration facilities will also be created to generate electricity from waste. The projects are expected to be managed by the Renewable Energy Division of the Nigerian National Petroleum Corporation.[4]

Furthermore, Nigeria's National Automotive Council has disclosed plans to introduce a 10% ethanol and 90% Premium Motor Spirit blending (E10) as an experimental alternative fuel energy for vehicles in Nigeria before the end of 2006.[5]

Relations with Brazil

Like Brazil, Nigeria is taking a top-down, supply-led approach. But the government is not just looking to Brazil for information; it also plans to kick start the industry through a Brazilian import partnership.

In 2005, the Renewable Energy Division (RED) signed two memoranda of understanding with Petrobras and COIMEX of Brazil to commence import of ethanol and to develop capacity for sustainable local production.[6] The deals are designed to initially supply Nigeria with ethanol in order to develop the market and fuel supply infrastructure. The import reception facilities at Atlas Cove in Lagos and Mosimi Depots in Ogun State are already being modified in preparation for the distribution of biofuels.[7]

An official agreement was reached between Petrobras and NNPC in January 2007, and Brazil is to export 20 million liters of ethanol from the port of Rio de Janeiro to Lagos in late February. This supply will be used to help the Nigerian government implement its 10% ethanol blend policy for gasoline, and Petrobras will also supply NNPC with technical support for the program.[8]

C) CURRENT SITUATION

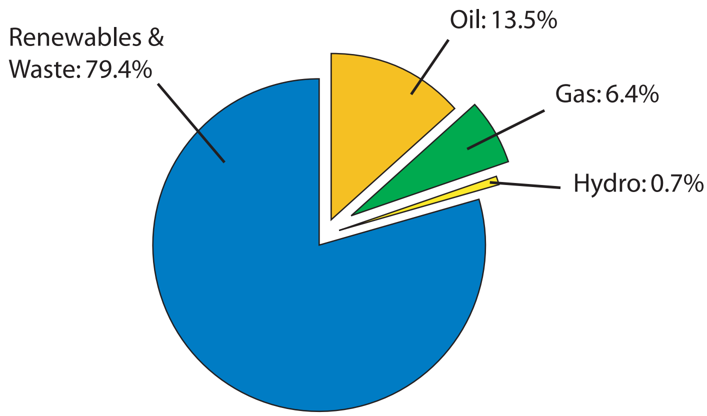
Energy Matrix

High oil prices were the driving force behind Nigeria's economic growth in 2005. The country's real gross domestic product (GDP) grew approximately 4.5 percent in 2005 and is expected to grow 6.2 percent in 2006 The Nigerian economy is heavily dependent on the oil sector, which accounts for 95 percent of government revenues.

A closer look at the country's energy matrix shows that while Nigeria is the largest oil producer in Africa and the tenth largest producer of crude oil in the world, its population does not enjoy the benefits of the country's natural resources. Approximately 70%

of the rural population relies on traditional biomass (largely wood) for their energy needs.

Chart 5.2a: Share of Total Primary Energy Supply (2003)



Source: IEA Energy Statistics

The diversification of the matrix to include renewable sources of energy is considered an important opportunity for improving Nigeria's energy security as well as empowering rural farmers by generating greater earnings. So far, Nigeria has not developed its own biofuels industry. In 2005, it imported all 180 million liters of ethanol it consumed.

Production and Consumption Capacity
While Nigeria does not currently have an operational biofuels industry, it does have a biofuels plan that is part of the nation's alternative energy development strategy. The program is predominantly directed at ethanol production using cassava and sugarcane as feedstocks. Palm oil biodiesel production is also said to be under study.[9]

Ethanol
Two potential crops have been identified for Nigeria's fuel ethanol initiative: sugarcane and cassava.

Nigeria is thought to be the world's leading producer of cassava with about 35 to 40 million metric tons (mt) produced annually on an estimated 3 million hectares of Nigeria's more than 70 million hectares of agriculturally suitable land.[10] Today, Nigeria is able to produce just 15-20 mt/hectare, compared to a yield of 25-30 mt/hectare in other countries, but the introduction of improved cassava varieties could increase yields to between 60 and 70 mt/hectare.[11]

Cassava is produced as a food crop in Nigeria and the government's recent declaration that cassava flour must constitute 10 percent of bread flour effective July 2006 guarantees that cassava will continue to remain a staple food throughout the country.[12]

The second proposed crop is sugarcane. Although the cultivation of industrial sugarcane suffered a serious setback due to the poor past performance of government-owned sugar companies (now privatized), there is huge potential for growing sugarcane on a large scale in Nigeria, particularly along the Niger and Benue rivers. The total land area in Nigeria dedicated to sugarcane is about 43,000 hectares which produce 18 mt/hectare for a total of 776,000 mt.[13] However, national statistics suggest that more than 400,000 hectares of land could support high-yield sugarcane operations. The states of Jigawa (northern Nigeria), Benue and Taraba (middle belt region of Nigeria) are all targets for further agricultural development, and further feasibility studies are planned for individual locations within each state.[14]

Nigerian domestic demand for ethanol in 2005 was 180 million liters, all of which was imported. According to the Nigerian government's Public Communications Unit, in order for the country to meet its national demand for ethanol it would need approximately 120 small-scale (5,000 liters/day capacity) plants. One plant of this size is expected to provide employment for at least 400 to 500 persons per year along the value chain.[15]

The hope is that the future industry could radically change the agricultural sector in Nigeria, which is currently dedicated to food production. According to the Renewable Energy and Energy Efficiency Partnership, the first stage of the country's biofuels program would generate $150 million annually and create over 200,000 jobs, a number significantly higher than the Nigerian government estimate.[16]

Biodiesel

The biodiesel effort in Nigeria is predominantly driven by a new initiative led by the GSM Association, a global trade association, through its development fund. The fund was started in 2005 to offer consulting support for projects that use mobile technology to improve social, economic, and environmental welfare in developing countries (see the Private Sector section below).

D) PRIVATE SECTOR

On January 30, 2007, the NNPC Renewable Energy Division closed bidding for expressions of interest in four large-scale joint ventures to support the launch of a biofuels industry in Nigeria. The initial phase of the program will include two sugarcane plantations of 20,000 hectares, each with an ethanol, sugar and cogeneration plant; a cassava farm of 10,000 hectares and a corresponding ethanol plant; and a palm-oil plantation of 20,000 hectares with an oil-extraction and biodiesel-conversion plant. The program will also develop research projects to boost the nation's cassava and palm oil output. The NNPC, which will act as off-taker for 100% of the biofuels produced, is seeking strategic investors to own and manage the operations. It is expected that this program will give way to the establishment of several ethanol plants at an average cost of $60 million each.[17]

China is the leading foreign investor in the developing Nigerian ethanol industry. Two projects have recently been signed by state governments and Chinese firms for ethanol production. Nigeria's central state of Niger and the Chinese government signed a memorandum of understanding for the establishment of the first ethanol plant in the state, with cassava as a feedstock. The project is expected to cost approximately $90 million. A Chinese company will serve as a consultant to the project, which is expected to source 85% of the project investment through a soft loan from the Chinese government at a 3% interest rate. The balance will be financed by the state government through local banks. The state government has already released US$233,000 to local cassava farmers to facilitate mass production of the commodity in the state. When completed, the project would have the capacity of converting 150,000 tons of cassava into ethanol for both local consumption and exports. Production costs are expected to be lower than petroleum products. The project is planned to be completed within two years.

The Ebonyi State Government has signed a Memorandum of Understanding with Viscount Energy (Nigeria) Limited, a Chinese-supported Nigerian firm, to establish a US$80 million ethanol producing factory using both cassava and sugarcane. Proponents of the project believe the factory will hire no fewer than 100 permanent staff and establish a large cassava and sugarcane plantation in the state.[18]

Private sector involvement in biodiesel production is being led by telecommunications companies, including Telefonaktiebolaget, LM Ericsson, the GSM Association (GSMA), and the MTN Group. Rather than produce biodiesel for transport fuel, these organizations are experimenting with using biodiesel to power mobile network equipment. The trial is funded by the GSMA's Development Fund and is establishing a supply chain that includes buying locally produced crops and processing them into biodiesel. The fuel will be made from groundnuts, pumpkin seeds, and palm oil and will replace diesel, which is commonly used to power mobile base stations in remote areas where electricity is not available. The trial project will initially center on a base station in Lagos and later expand to rural regions in the southeast and southwest of Nigeria. Because only about 25 percent of Nigeria is connected to the electricity grid, MTN currently uses an extensive grid of generators to power its network.[19]

E) RESEARCH & DEVELOPMENT

The NNPC is leading efforts in biofuels R&D through partnerships with domestic and international research institutions, including the University of Agriculture, Makurdi, the International Institute of Tropical Agriculture, and the Nigerian Cereals Research Institute.

NNPC and the University of Agriculture, Makurdi, in Abuja have signed a consultancy service agreement to study high yielding cassava and sugarcane in the country. The consultancy agreement will enable the NNPC to establish the framework and set out the principles under which the university would provide technical assistance on the ethanol fuel program.[20]

Cooperative agreements are also on the table between the Renewable Energy Division of NNPC and the International Institute of Tropical Agriculture (a leading research institute for cassava production) as well as the Nigerian Cereals Research Institute (a national research institute with a mandate to research sugarcane). These agreements will focus on the low yield problems typical of many varieties of both sugarcane and cassava in Nigeria. Once the agreements are signed, researchers will investigate how to produce and multiply cassava and sugarcane seedling varieties with the improved productivity and higher yields necessary for commercially viable production. NNPC is also seeking to create commercial partnerships with local businesses so that negative impacts on food markets are minimized, while also building local support for the long-term development of this new industry.[21]

Finally, the International Institute of Tropical Agriculture (IITA) has signed a memorandum of understanding with Nigeria's National Space Research and Development Agency (NASRDA) on remote sensing and its value as a tool for agricultural development in the country. The MOU provides for an initial two years of collaborative research work on the use of space technology for the improvement of cassava cultivation. The project will involve the use of IITA's expertise in the area of Geographic Information Systems (GIS) and baseline mapping of cassava farms to determine the extent of cassava production in the country. It will also involve the use of space technology to assemble critical data on soil testing, and water and solar energy requirements of the crop in different agro-ecologies.[22]

F) CONCLUSION

Nigeria imports ethanol, but has no domestic biofuels production. However, its large land area creates enormous potential for the production of biofuel feedstocks. Yields for cassava, of which Nigeria is thought to be the world's largest producer, could be increased dramatically, and arable land suitable for sugar cane is estimated at ten times that currently under cultivation. While the government has issued various biofuels directives, a concrete industry program has yet to emerge. R&D activities are largely in the planning stage. However, there are indications of serious Chinese investment interest, and two MOUs have been signed for ethanol production in the Niger and Ebonyi States.

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Source: World Factbook

A) INTRODUCTION

Historically, incentives for investment in both energy efficient technologies and renewable energy in South Africa have been weak, partly due to the country's inexpensive and abundant coal. In November 2003, the South African Minerals and Energy Department drafted its first White Paper on Renewable Energy, which sparked initiatives in a number of renewable energy technologies, including biofuels. A National Biofuels Strategy is expected to outline a policy for mandatory blending, incentives and support mechanisms, and vertically integrated production models to prevent the formation of monopolies.

The country's local biofuels industry association, SABA, claims that it has the potential to produce 10% of South Africa's petrol and diesel needs by 2010, which given the current pace of investment and the lag time between investment and production, seems overly optimistic. South Africa currently consumes about 11 billion liters of gasoline and 8 billion liters of diesel a year.[1] It is also envisaged that the production of biodiesel could create 38,500 farm-level jobs. Ethanol-from-maize production could result in 17,000 farm-level jobs by 2015.[2]

B) GOVERNMENT POLICIES

The South African government has enacted a number of policies and legislative initiatives to support the development of renewable energy generally and biofuels in particular. The government's 2003 *White Paper on Renewable Energy* was designed to help the renewable industry (including biomass, wind power, solar power, and small-scale hydropower projects) by identifying market rules, sources of financing, and required technologies for new entrants in the sector. In addition, the Gas Act (Act 48 of 2001) and amended Petroleum Products Act provide a basis for the integration of renewable energy-derived liquid fuels such as biodiesel and ethanol into the petroleum industry's regulatory framework.

Furthermore, in December 2005, the South African cabinet established a Biofuels Task Team (comprising national departments and state entities) to develop an industrial strategy focused on job creation. The cabinet authorized this team to engage interested stakeholders and report on the financial implications of a modest biofuels industry.

The Biofuels Task Team was scheduled to publish a National Biofuels Strategy by October 2006.[3] While the study is not expected to be made public until December 2006, it is believed to provide four main recommendations:

1) Mandatory Blending of 10% for ethanol and 5% for biodiesel;
2) Incentives to encourage the local production of biofuels and B5 and E10 blending, including import tariffs, fuel levy concessions, and support from the Department of Agriculture for new farmers ranging from financing to professional advice and access to research;
3) Structuring projects with a vertically integrated production model that a focus on Black Economic Empowerment (BEE) and rural development, with projects acting as an anchor for economic development by combining them with other high value-added crops and agro-processing; and
4) Controlling production costs and distribution logistics by developing projects to meet regional demand for liquid fuels.

The plan reportedly also recognizes the need for significant investment in agriculture, plants, and equipment to meet the expected E10 and B5 target blends. Domestic and international investors are reportedly ready to make substantial investments in biofuels capacity, but are waiting for government direction, particularly the level of mandatory blending and the timeframe during which it will be implemented.

The government estimates that if incentives are introduced, established commercial farmers could produce a billion liters of ethanol and 200 million liters of biodiesel a year. Government support, in combination with appropriate project structuring, could also secure an annual supply of feedstock crops from emerging farmers. These can be used to produce about 200 million liters of ethanol and 250 million liters of biodiesel. It is envisaged that the production of ethanol from maize could result in 17,000 farm-level jobs and that biodiesel could create 38,500 farm-level jobs by 2015.[4]

In addition to the national strategy, the government has taken certain actions that should promote ethanol demand, namely a prohibition of the addition of lead-based additives into petrol and the reduction of the sulfur content of diesel starting January 1st, 2006 and the decision by the Minister of Finance in February 2006 to increase the fuel levy reduction for biodiesel to 40 percent from 30 percent. The National Treasury also introduced accelerated depreciation for biodiesel capital expenditures.

Relations with Brazil

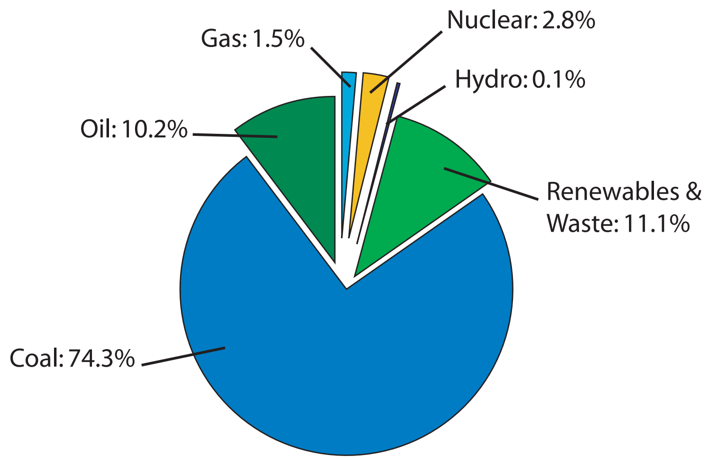
The first India, Brazil, South Africa (IBSA) summit, which took place in Brasilia in September 2006, was a watershed moment for South-South biofuels cooperation and led to the signing of a memorandum of understanding on biofuels and the decision to create a Trilateral Task Force on Biofuels to work on concrete areas of common interest. The meeting also resulted in the signing of a memorandum of understanding by South Africa's state-owned Central Energy Fund (CEF) and Brazil's Petrobras to conduct a feasibility study on the introduction of ethanol in South Africa.[5]

C) CURRENT SITUATION

Energy Matrix

South Africa has an energy-intensive economy. The economy relies on low-cost electricity and coal to power energy-hungry industries such as mining and metals processing. Economic growth and improved distribution of electricity to households have resulted in significant increases in electricity demand. The country also relies on coal and liquid fuels for chemical processing, heating, transport, and other activities. The renewable contribution to energy supply is relatively limited, with renewables contributing an estimated 9 percent of the country's energy needs.[6]

Chart 5.3a: Share of Total Primary Energy Supply (2003)



Source: IEA Energy Statistics

The proportion of final energy consumption currently provided by biomass is largely a result of poverty (e.g., wood and animal waste used for cooking and heating). The government's medium-term (10-year) target is a 10,000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar, and small-scale hydro. The renewable energy is to be utilized for power generation and non-electric technologies such as solar water heating and biofuels.[7]

South Africa currently consumes about 20 billion liters of fuel a year, and the market is growing. The number of cars on the country's roads is expected to increase from about six million this year to nine million in 2013. However, the blending of biofuels with fossil fuels is still voluntary.

Production and Consumption

The country's local biofuels industry association, SABA, claims that it has the potential to produce 10% of South Africa's gasoline and diesel needs by 2010. South Africa currently consumes about 11 billion liters of gasoline and 8 billion liters of diesel a year.[8]

Ethanol

Ethanol could be an important contributor to South Africa's energy diversification. Crops under consideration for ethanol production include sugarcane, sweet-stem sorghum, sugarbeet, maize, and cassava. Table 5.3a below indicates the potential contribution that ethanol from biomass could make to South Africa's energy supply:

Table 5.3a: Potential Ethanol Production by Feedstock

Crop or Biomass Source	Energy Content of Potential Annual Ethanol Production PJ (TWh)
Cassava	72.3 (20.1)
Sugar Cane	11.1 (3.1)
Bagasse	5.6 (1.6)
Molasses	2.3 (0.6)
Maize	22.5 (6.3)
Sorghum straw	5.1 (1.4)
Wheat straw	7.0 (1.9)
Forest	3.4 (0.9)
Sawmills	0.7 (0.2)
Total	130 (36.1)

Source: SECCP[9]

In 2006, only 1.5 million hectares of maize were planted in South Africa, a third of the area suitable for cultivation. It is believed that South Africa can comfortably produce a maize harvest of up to 14 million tons a year, which will supply sufficient maize for local consumption and biofuels production.

The South African sugarcane crop for the 2005/2006 season was of 21 million tons, representing an increase of 1.95 million tons (10.25%) over the previous season.[10] A survey based on production conditions in Brazil – which share some similarities with production conditions in South Africa – shows that sugar cane has an energy output relative to energy input of 8.3, compared with sugar beet at 1.9, maize at 1.6, and wheat at 1.2. Besides the production of ethanol, the sugar industry can also contribute to the generation of electricity by the combustion of cane fiber residue, known as bagasse. Some of South Africa's existing sugarcane producers already use bagasse to cogenerate steam and electricity for their processing plants.[11]

Biodiesel

Crops under consideration for biodiesel production include sunflower, rapeseed, soy bean, and jatropha. It is estimated that the agricultural sector has the potential to produce more than 1.4 billion liters of biodiesel annually from these various oilseed crops. This level could be achieved in two ways: 650,000 hectares of commercial maize production could be converted to oilseed crop production, or the government could implement an agricultural production revitalization program in disadvantaged rural areas. The latter would make 2.3 million hectares of land available for oilseed crop production. Either approach would make a contribution of more than 20 percent towards South Africa's diesel consumption of 6.8 billion liters a year.[12]

D) PRIVATE SECTOR

A number of large firms are considering investing in biofuels plants in South Africa. In ethanol, the state-owned Industrial Development Corporation (IDC) and the Energy Development Corporation (EDC), a division of the Central Energy Fund (CEF), are set to begin a viability study on producing ethanol as a blend stock fuel.[13] Ethanol Africa's first ethanol plant is being built at Bothaville in the Free State province. Bothaville lies in the centre of the South African maize triangle and has been carefully selected to ensure ready access to maize supplies, as well as access to the required logistical and infrastructure support.[14] The facility at Bothaville is expected to be fully operational by the end of 2007 with the capacity to produce 473 million liters of alcohol and 63 million liters of biodiesel each year. The plant will also produce 270 tons/day of distillers' dried grains as well as co-products, which will be either a high-protein animal feed or an organic fertilizer. Following successful start-up of the Bothaville facility, Ethanol Africa has plans for an additional 7 ethanol plants over the period 2008 to 2012, which will be located elsewhere in the Free State, Mpumalanga, and the North West province. The company believes that at full capacity, its eight plants could supply up to 12.5% of South Africa's fuel requirements by 2015.

Ethanol Africa's crop securitization division, EA Crop Securities, is managing the company's emerging-farmer program, which is one of the first programs to focus on small-scale farmers. These farmers could potentially supply up to 30% of the maize required as feedstock by the Bothaville plant. The emerging-farmer program will assist small-scale farmers with detailed grower plans, budgets and cash flows, financing, and mentorship, and will assist commercial farmers hit hard by negative movements in the maize market.

To finance the venture, Ethanol Africa plans to list on the Alternative Investment Market of the London Stock Exchange to raise $92 million for the roll out of the company's first plants in South Africa. The company will also raise $65 million in a private share sale. The South African government has the option to buy a 25.1% stake in the company through the Energy Development Corporation (EDC), which is part of the state-owned Central Energy Fund. Should the EDC exercise its option, the transaction could be funded by the state-owned Industrial Development Corporation, which earlier this year announced that it would be investing in at least five biofuels projects.[15]

Biodiesel projects include Sasol Nitro's early 2006 memorandum of understanding with the state-owned Central Energy Fund (CEF) for biodiesel production. The objective is a 100,000 tons/year biodiesel-from-soybean plant.[16] Biodiesel producer D1 Oils Africa, the southern African subsidiary of biodiesel producer D1 Oils, has also entered into a joint venture with Africa-focused agricultural commodities trading group Southern Alliance. The two companies plan to combine forces to manage all aspects from crop cultivation to bio-diesel production. The joint venture, known as D1 Trading Africa, is expected to provide the company with a leading position in the market for the procurement of biodiesel feedstock in southern Africa, by securing sufficient feedstock and leveraging existing operations in the transport and trade of seeds, seedlings and seedcake, and the processing and supply of oil to biodiesel refineries.[17]

E) RESEARCH & DEVELOPMENT

A number of South African government agencies have been involved in research and development projects internally as well as with academic and other institutions in South Africa.

The Central Energy Fund (CEF) has recently formed the South African National Energy Research Institute (SANERI) to specifically engage in renewable energy research and development. SANERI has awarded Stellenbosch University the responsibility to act as the hub of a postgraduate program in Renewable and Sustainable Energy Studies. The primary objective of the program will be to train scientists and engineers with the required technical expertise to unlock the country's renewable energy resources and implement appropriate technology for using sustainable energy. It is expected that the first postgraduate students will start their studies in February 2007.[18]

Additionally, South Africa's Department of Science and Technology (DST) has been providing financial support to the Council for Scientific and Industrial Research (CSIR) to conduct research into biodiesel by-products. The main objective of the research is to improve the nutritional value of oil cake, thereby increasing its use in animal feed, specifically pig and poultry diets and fish food. Research will also be conducted into its possible future use beyond animal feed. A secondary objective is to increase the economic viability of biodiesel and create manufacturing industries in semi-urban and rural areas.[19]

South Africa is also closely watching the biofuels progress taking place in India, and is eager to learn from India's experience planting 140,000 hectares of jatropha on marginal lands.

For ethanol, research is underway to investigate the potential of cultivating sugar beet. Trials in the Eastern Cape indicate that one hectare can produce up to 95 tons of sugar beet, which could then be used for ethanol production. Sweet sorghum is also being studied. This highly fermentable indigenous crop requires only about 40% of the water needed to grow sugar beet, tolerates environmental stress better than sugar cane, and economically rivals sugar cane production as a feedstock for ethanol.[20]

F) CONCLUSION

By far the most developed sub-Saharan African country, South Africa has the institutional capacity and industrial base to rapidly expand biofuels production. The government will soon release a National Biofuels Strategy containing key elements of a regulatory and incentives framework. The state-owned Central Energy Fund is working with Brazil's Petrobras on an ethanol feasibility study, and private sector initiatives have been announced for modest corn-based ethanol units to be located around the country. Investment capital is being sought on the London Stock Exchange for biodiesel projects. All these activities are in their early stages, but offer cause for optimism that South Africa can begin realizing its substantial biofuels potential.

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Source: World Factbook

A) INTRODUCTION

While Zambia does not have a biofuels industry today, the government has recently begun to explore ways to promote its development, motivated by the need to diversify its national energy matrix, decrease its dependence on foreign oil suppliers, reduce unsustainable renewable energy consumption, and advance its development agenda.

On the private sector side, there is clearly interest in investment opportunities in the biofuels industry. However, the current policy void has kept many potential investors from entering the market. It appears that the Zambian government is primarily betting on the financial resources and technical know-how of the country's large sugarcane producers to kick start the industry. One of Zambia's advantages, besides its potential land and human resources for the production of biofuels, is its strategic position with ready local and regional markets.

B) GOVERNMENT POLICIES

The Zambian government has begun exploring renewable energy, but has yet to develop a comprehensive national strategy. A number of government sponsored initiatives, such as the December 2004 ministerial dialogue, have produced recommendations for the development of a biofuels industry. This dialogue concluded that the government should introduce a clear policy to promote the use of ethanol as an octane enhancer; set high standards on the use of ethanol and biodiesel blends; develop an agricultural policy for out-grower schemes; encourage private sector participation in ethanol-production and blending; build technical capacity; and establish fiscal incentives.[1]

Prepared by Garten Rothkopf

Various signals, including statements by high-ranking officials, suggest that the government is serious about facilitating the development of a biofuels industry. However, legislation concretizing that ambition has not yet appeared.

Relations with Brazil

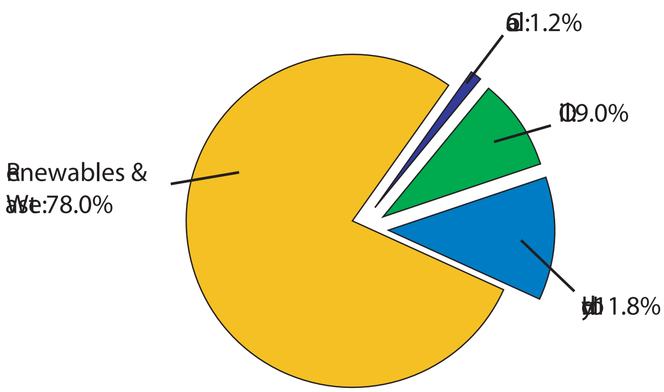
The March 2006 visit to Brazil by Zambia's minister of foreign affairs is considered a landmark in the political dialogue between the two countries. It resulted in the decision to open embassies in each other's capitals. The future Embassy of Zambia in Brasilia will be the country's first resident diplomatic mission to be established in Latin America. Both countries expressed their will to foster bilateral contacts on all levels,[2] which could facilitate cooperation on biofuels, particularly technical support for the development of the Zambian industry

C) CURRENT SITUATION

Energy Matrix

To date, Zambia has not developed its own biofuels industry. However, biofuels are being considered by the Zambian government as a potentially significant component of the country's energy matrix. The efforts to develop a biofuel industry are based on energy security concerns, foreign exchange concerns, as well as the fact that Zambia's population is highly dependent on woodfuel and charcoal for energy. Most rural communities depend on wood for cooking and heating, and household energy supply in urban centers is predominantly based on charcoal.

Chart 5.4a: Share of Total Primary Energy Supply (2003)



Source: IEA Energy Statistics

Production and Consumption Capacity

Since there is no established biofuels industry in Zambia, there is no current production or consumption to report. However, an analysis of the sugarcane industry's productive potential is presented in the chart below.

Table 5.4a: Projected Ethanol Production Statistics

Company	**Solid Sugar** *(tonnes)*	**Molasses** *(tonnes)*	**Potential Ethanol Available x 10^6 Liters**
Zambia Sugar	233,763	52,000	14
Kafue Sugar	15,000	6,000	4
Kalungwishi Sugar	4,000	1,800	0.5
	252,763	59,800	18.5

Source: Partners Africa[3]

Projected demand has likewise been calculated, although based on very rough estimates of the country's total vehicle fleet, which is between 60,000 and 150,000.[4] Using this approximation, ethanol demand is projected to range between just over 20 million liters and 60 million liters, depending on the blend.

Table 5.4b: Projected Ethanol Demand in the Transport Sector

Year	2005	2010	2015	2020
Gasoline	**147,564**	**163,723**	**181,651**	**201,542**
5%EB	15.25	16.92	18.78	20.83
10%EB	30.51	33.85	37.55	41.67
15%EB	45.76	50.77	56.33	62.50

Source: Partners4Africa

If Zambia's three major sugar producers dedicated their total supply of molasses to ethanol production (an unlikely scenario), they could satisfy the country's needs in 2015 with a 5% blend. As will be detailed in the following section, the expansion of productive capacity is underway.

D) PRIVATE SECTOR

There is clearly a private sector interest in investment opportunities in the biofuels industry in Zambia. However, the current policy void has kept many potential investors from entering the market. Zambia's president, Mr. Levy Mwanawasa, recently announced that a number of investors had plans to open ethanol plants in Zambia once the government adopted legislation mandating ethanol blends in domestic fuel consumption. He urged the ministry of Energy to quickly decide the issue of ethanol in the country's petroleum products.[5]

Illovo subsidiary Zambia Sugar has announced that it has the capacity to produce between 12 million liters and 13 million liters of ethanol at the present level of sugar production. ZS currently produces 50,000 metric tons of molasses and intends to increase its capacity to 100,000 metric tons by 2010. This would double its ethanol capacity to at least 22 million liters if the company chose to engage exclusively in ethanol production. Currently almost all the molasses ZS produces goes into the domestic livestock sector (a few tons are exported within the region).[6]

Spanish and Indian investors are reportedly competing to invest in a US$150 million sugar plantation Zambia plans to establish by the end of 2006. Zambia Investments Centre (ZIC) said a feasibility study had been concluded on the Luena sugar plantation in the north of the country, which will process sugar as well as ethanol. Luena has 100,000 hectares of virgin land of which only 30,000 hectares will be used for growing and processing sugarcane while the rest has been earmarked for growing other export crops. The project will grow sugarcane on a 10,000-hectare farm while 20,000 will be for small-scale farmers on an out-grower scheme to be supported by the project. The plantation will have the capacity to produce 250,000 tons of sugar. Luena will be Zambia's second biggest sugar producer after Zambia Sugar Plc. The government is said to have committed $30 million for infrastructure such as roads, health institutions, schools, water, and power for the surrounding community. There are no details on when actual production of sugar or ethanol will start.[7]

Biodiesel production, while receiving somewhat less attention from the Zambian government than ethanol, is being pursued by D1 Oils Africa, the African subsidiary of biodiesel producer D1 Oils. The Zambian government, which appointed D1 Africa as a member of its task-force committee on renewable energy to develop a policy on biodiesel for the country, is supporting the company's effort to plant feedstock in the country over the next five years. One of the main projects underway in the area is the Kachumu Community Development Network (KCDN) triangular farming block, a 15,000 hectare public-private partnership initiative to encourage rural development in northern Zambia. D1 Africa also expects to set up a refinery to produce biodiesel, which will not only create employment and bring economic empowerment in the area, but will also go a long way toward alleviating the fuel problem in the country.

This is a pilot project, which forms part of the spatial development approach for Zambia and may be replicated in other provinces if successful. Other projects being undertaken with communities in Zambia include the Lumwana Chiefdom, the Ntambo Chiefdom, and the Mumena Chiefdom in the North Western province; the Mpezeni Chiefdom Community in the Eastern province; the Hope Development Institute in the Northern province; and the Nkumbula community in the Southern province. Many of the projects are being undertaken on an out-grower basis whereby D1 Africa provides technical advice and seeds for planting, and then enters into off-take agreements guaranteeing the purchase of the commercial seed crop. Projects are to be financed by the private sector, government initiatives, or funds from international financial institutions, such as the World Bank or African Development Bank. As of March 2006, D1 Africa had planted over 4,900 hectares of jatropha, providing employment for more than 1,200 people. Additionally, D1 Oils is conducting a detailed feasibility study to grow jatropha on some of the bigger mine properties situated in the Copperbelt and North Western provinces, with a view to providing on-site biodiesel for their operations.[8]

E) RESEARCH & DEVELOPMENT

Research and development efforts in the biofuels industry in Zambia are limited. The only known major R&D project to date was commissioned by the government to assess the possibility of producing fuel from ethanol at the Zambia Sugar Plc Nakambala sugarcane plantation in Mazabuka. This project is currently being touted as Zambia's flagship public-private biofuels initiative.[9] The environment for R&D is nevertheless likely to improve as laws are passed regarding biofuels production and private sector investment in the industry grows.

F) CONCLUSION

Zambia currently has no biofuels industry, minimal R&D activity, and no legislation creating a regulatory framework of incentives for its establishment. Potential exists for limited sugarcane-based ethanol production and several private sector groups have announced plans for ethanol plants and increased cane production. Also, D1 Oils Africa has begun small-scale work on oil seed-based biodiesel. However, significant progress will depend on the creation of a reliable regulatory environment and infrastructure support.

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[9] "Biodiesel taking root in Zambia," Creamer Media's Engineering News Online, June 2006, 23 Oct. 2006 <http://www.engineeringnews.co.za/eng/news/today/?show=88105>.

6. ASIA

Source: World Factbook

A) INTRODUCTION

Asia, home to 60% of the world's population and the world's fastest growing economies, is of paramount importance to the world's energy picture. As with other regions, the rising cost of oil, concerns about energy security and worsening pollution, and the need to meet Kyoto Protocol commitments have been the key drivers of government-backed biofuels programs.

The Asian biofuels industry is led by China, the world's third-largest ethanol producer, and India. Both regional powers are projected to see biofuels demand grow more quickly than supply. Meanwhile Japan, the world's third-largest oil consumer, is one of the fastest growing consumers of biofuels, despite the lack of concrete government policies to encourage biofuels consumption. In the Southeast Asian countries of Malaysia, Indonesia, the Philippines, and Thailand as well as South Asia's Pakistan, the biofuels industry is only just taking off. All these countries, however, have an eye on eventually producing biofuels for export markets. Finally, the Asia-Pacific agricultural power, Australia, rounds out the group with a potentially self-sufficient biofuels industry.

B) GOVERNMENT POLICIES

The biofuels industries in Asia are all driven by government policies, but they are at various stages of implementation and provide different levels of support. India, Thailand, and the Philippines have implemented mandatory blends for both ethanol and biodiesel in transportation fuel. In Malaysia, a mandatory blend is only in effect for biodiesel. In Pakistan, a mandatory ethanol blend is still under consideration. In China, Japan, and Australia, governments have said it is unlikely that a mandatory blend will be adopted, although this does not rule out the possibility.

The motivations behind Asian governments' biofuels policies vary considerably, although they are all part of a worldwide trend toward renewable energy. In China, which saw its oil import bill swell 40.7% to $47.72 billion in 2005, the primary consideration is diversifying the national energy mix to improve energy security and preserve foreign currency reserves. Accordingly, the government has set aside $187.5 billion for the development of renewable energy resources such as biofuels. The situation is similar in India, which is not only projected to overtake China as the world's most populous country by 2030, but also to account for a third of total global energy demand by 2050. Developing biofuels for transportation is critical for both countries because they are host to the world's fastest growing auto markets.

The governments of Malaysia and Indonesia are more motivated by the development of biodiesel export industries, as evidenced by the low levels of projected domestic consumption. As the world's largest producers of crude palm oil (CPO), a biodiesel feedstock, both countries have potential to capture the growing European biodiesel market. Thailand, the world's largest producer of cassava (an ethanol feedstock), also has an eye on export markets. The country is considering plans to utilize excess cassava and sugarcane feedstock, which traditionally has been exported, for ethanol production directed at overseas markets. Meanwhile, the Philippines is motivated by a mixture of energy security and export considerations. In the short-term, the country hopes to decrease oil imports by increasing biofuels consumption, but in the long-term it also hopes to become a net exporter of biofuels.

Meanwhile, Pakistan's ethanol initiative resulted directly from the end of its preferential tariff status in the EU, which had allowed the South Asian country to become the EU's second-largest ethanol exporter after Brazil. With Pakistan ethanol tariffs now at the full rate, the local sugar industry has been furiously lobbying the government to implement a nationwide mandatory ethanol blend that could sop up excess supply.

Australia, which depends heavily on agricultural exports for its economic prosperity, has adopted a cautious approach towards biofuels. Unlike other Asia-Pacific countries, which are either constrained by a lack of arable land or sufficient levels of feedstock, Australia has to balance improving energy security against preserving its profitable agricultural export regime. Finally, the biofuels initiative of the only other developed Asian country covered in this report, Japan, is primarily motivated by the need to meet its Kyoto Protocol commitments, which call for the reduction of greenhouse gases by six percent from 1990 levels by 2012.

Intra-Regional Cooperation

1. China-Malaysia
In August 2006, the two countries signed an R&D cooperation pact to jointly develop biofuels and biomass production technologies, with a particular focus on the exploitation of biomass produced on oil palm plantations.

2. India-Indonesia
Also in August 2006, the countries signed a deal to reduce tariffs on CPO in an effort to promote palm-based biodiesel in India, the largest importer of Indonesian CPO.

3. Malaysia-Indonesia
In July 2006, the countries announced that they would devote six million tons of CPO

each (nearly 40% of their individual CPO output) to biodiesel production. This pledge followed a memorandum of understanding (MOU) signed in May to promote their respective agricultural products in the international market.

4. Greater Mekong Sub-region
Although it is not clear that any government-level agreements have been signed, biofuels stakeholders from the Greater Mekong Sub-region (GMS), which includes Thailand, southern China, Myanmar, Cambodia, and Vietnam, have been exploring the possibility of cross-border cooperation. This would enable the GMS countries to capitalize on the comparative advantages of their neighbors. Thailand, for example, lacks cheap labor and large tracts of land to cultivate feedstock crops (which Laos and Myanmar have in abundance) but possesses significant technology and expertise.

Relations with Brazil
Brazil has concluded MOUs on cooperation in biofuels-related areas with the three largest energy consumers in Asia: China, Japan, and India. In June 2006, China's National Development and Reform Commission (NDRC) and Brazil's Mines and Energy Ministry signed an MOU to share information on policies and projects. It will also promote joint venture projects in oil, natural gas, renewable energy, biofuels, power, and mineral resources. In February 2005, the Japan Bank for International Cooperation (JBIC) signed an agreement with Brazil's Ministry of Agriculture, Livestock and Supply stating terms of reference for the future implementation of a bilateral biofuel program to export Brazilian ethanol and biodiesel to Japan. This was followed by the establishment of the Brazil-Japan Working Group on Biomass to share information and explore possible opportunities for bilateral cooperation. In 2002, India and Brazil signed an MOU for the specific purpose of promoting technological research cooperation on the use of ethanol as a transportation fuel. The main goal of the MOU was to provide the proper diplomatic framework allowing Brazil to share its advanced technological expertise on ethanol for transportation with India.

In Southeast Asia, Brazil has signed an MOU with Thailand to exchange biofuels information and expertise, which includes the annual export of 300,000 liters of Brazilian ethanol. Brazil sees Thailand as a gateway for exports to the rest of the Asian region, including China, South Korea, and the ASEAN countries, especially since it has no major agreement on biofuels with, even if it does export small amounts of ethanol to, the other ASEAN countries.

C) CURRENT SITUATION

Although China and India are among the world's largest producers of ethanol, production of ethanol (and biodiesel) is still very much in the early stages. Billions of dollars are only now being poured into infrastructure development, the expansion of energy crop cultivation, and research into potential feedstocks. It will take a number of years before the fruits of this investment will be apparent. China, for example, produced one million tons of fuel ethanol in 2005. The increase in the cultivation of biofuels feedstock like cassava is projected to boost production to 8 million tons by 2020.

On the demand side, biofuels consumption is growing rapidly, propelled by mandatory blend policies and other government economic tools such as tax subsidies. If the Japanese government implements a mandatory 10% ethanol blend, the country will require an astounding 6 billion liters of ethanol annually, which is good news for ethanol exporting countries like Brazil

D) PRIVATE SECTOR

The extent of private sector involvement in each country's biofuels industry depends largely on the makeup of the country's economy and the incentives offered by the government. In China, where the strategically-important energy industry is dominated by the central, provincial, and municipal governments as well as by state-owned enterprises, private sector participation is minimal. It is not feasible to get involved in the Chinese biofuels industry without substantial government subsidies. In India, on the other hand, the most significant forays into the biofuels sector are by the country's largest private firms such as Reliance Industries, which have the money and supply network to support such a large undertaking.

In countries where there is one main biofuels feedstock, such as sugarcane for Pakistan's ethanol industry and palm oil for Malaysia and Indonesia's biodiesel industries, the private sector drive is led by the sugar and palm oil plantation companies. In particular, the campaign to implement a mandatory ethanol blend in Pakistan is spearheaded by the sugar industry, which also controls the country's ethanol refineries.

Oil refiners, although generally state-owned or at least state-controlled, are also key in the biofuels industry. In countries like Australia, the relatively modest scale of the country's biofuels program can be attributed to the powerful oil lobby, which is reluctant to see a large-scale adoption of biofuels in the transportation sector. Similarly in Japan, the influential oil industry is seen as a major impediment to the implementation of a nationwide mandatory ethanol blend. The auto industry also has a key role in biofuels. In particular, auto majors such as Honda and Toyota are developing engines conducive to biofuels usage.

Transnational private sector investment is also growing, particularly where there is synergy between the biofuels industry of two countries. This trend is the strongest in Malaysia and Indonesia, as both countries are concentrating on palm oil-based biodiesel. With Malaysia fast running out of land for new palm oil plantations, Indonesia, with its huge tracts of available land, is a top choice for Malaysian plantation companies seeking to increase capacity. The largest foreign investors in Indonesia are Malaysian plantation companies lured by Indonesia's cheaper land and labor and by Jakarta's promise that state-owned companies would act as stand-by purchasers of biodiesel.

E) RESEARCH & DEVELOPMENT

In Asia, R&D work is led by governments and state-sponsored research institutes. Private sector players such as auto manufacturers and biofuels producers also play a role, and they frequently cooperate with research institutes to develop more energy-efficient forms of biofuels or more efficient biofuels production technology.

Although the focus differs from country to country, the following R&D themes are apparent:

1. Jatropha-focused
India, China, the Philippines, and to a lesser extent, Thailand, are pouring hundreds of millions of dollars into the development of jatropha as a biodiesel feedstock and the examination of its potential impact on vehicles and the environment.

2. Second-generation biofuels
While seeking to expand cultivation of traditional biofuels feedstock such as sugarcane and cassava, governments and research institutes are also concentrating on developing second generation biofuels such as cellulosic technology, or the production of biofuels from biomass derived from forests.

3. Impact on car engines
This is mainly an issue in Southeast Asian countries such as Malaysia, Indonesia, Thailand, and the Philippines, where the relative novelty of biofuels as a transportation fuel has led to wariness on the part of consumers. This has resulted in extensive research on the impact of different biofuels blends on car engines.

4. Focus on non-grain feedstock
This is an issue for the larger countries such as China and India where food security is a concern. China's ethanol program was initiated at the turn of the century in part to deal with a grain surplus, which has since run out, and alternative feedstocks such as sweet sorghum are currently being studied. India has an official policy of not using food sources as biofuels feedstock, hence the strong emphasis on jatropha development.

Source: World Factbook[1]

A) INTRODUCTION

Australia depends heavily on large agricultural exports for its economic prosperity. Unlike in other Asia-Pacific countries, which are constrained by the lack of arable land, the question is not whether the country has sufficient feedstock capacity to produce biofuels, but whether it wishes to improve energy security at the expense of profitable agricultural exports. Australia is taking a cautious but positive attitude towards biofuels and has set a relatively modest goal of producing 350 million liters of biofuels by 2010.

B) GOVERNMENT POLICIES

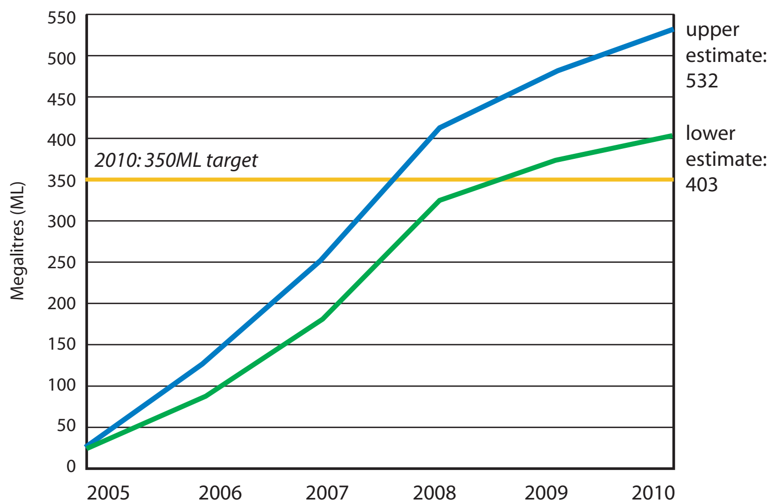
In 2004, the Australian government unveiled an energy white paper, titled Securing Australia's Energy Future, which presented a national strategy to deliver "prosperity, security and sustainability" for the country's energy outlook. One of the key tenets of this blueprint is the promotion of cleaner and more efficient energy technologies such as biofuels. To further this goal, the government established a US$392 million Low Emissions Technology Fund, which seeks to support industry-led projects that showcase the commercial viability of new energy technologies with low greenhouse gas emissions. The fund is expected to eventually leverage at least $783 million in private sector investment.[2] This goal will be supported by other programs such as the Remote Renewable Power Generation and Greenhouse Gas Abatement programs which will also distribute $1.08 billion in grants for greenhouse technology projects.[3]

Biofuels

Following the announcement of the Biofuels for Cleaner Transport policy in 2001, which set a target of producing 350 million liters of biofuels by 2010, a Biofuels Taskforce was commissioned by the government to draw up a blueprint for achieving this goal. The Taskforce presented its report to the prime minister in August 2005 with a total of 47 conclusions and a series of recommended actions. In particular, it singled out low consumer confidence and high commercial risk as key barriers to achieving the target.[4]

The Biofuels Taskforce Report was a precursor to the Action Plan for Biofuels, which was issued by the Australian government in 2005 following consultation with and receipt of individual action plans from oil majors and other industry stakeholders. It reiterated the 2001 target of producing 350 million liters of biofuels by 2010 and projected that the target could be met as early as 2008, with a possible production total of 500 million liters in 2010.[5]

Chart 6.1a: Projected Biofuels Production in Australia



Source: Office of the Prime Minister[6]

Government initiatives to promote a sustainable biofuels industry include[7]:

- The Biofuels Capital Grants Program (Table 6.1a), which gave out $29.6 million in grants to three ethanol and four biodiesel projects in 2004/2005 to support production expansion;[8]
- Mandating that all government vehicles to use E10;
- Simplifying the ethanol label, with the assistance of the four major local auto manufacturers;
- Ensuring the safety of using biofuels use by increasing the number of fuel quality compliance inspections;
- Initiating a program to test E5 and E10 blends on vehicles;
- Conducting a study to evaluate the local health benefits of using E10; and
- Considering minor specification changes that could help encourage biofuels development.

Table 6.1a: Successful Biofuels Capital Grants Program Applicants

Organization	Location	Fuel	Annual Capacity	Grant
CSR Distilleries Operations	Sarina, Qld	Ethanol	26 million liters	$4.16
Rocky Point Sugar Mill and Distillery	Woongoolba, Qld	Ethanol	15 million liters	$2.4
Lemon Tree Ethanol Pty Ltd	Deniliquin, NSW	Ethanol	36.6 million liters	$5.85
Biodiesel Industries Australia	Rutherford, NSW	Biodiesel	8 million liters	$1.28
Biodiesel Producers Ltd	Barnawatha, Victoria	Biodiesel	60 million liters	$9.6
Australia Renewable Fuels	Port Adelaide, SA	Biodiesel	44.7 million liters	$7.15
Riverina Biofuels Pty Ltd	Deniliquin, NSW	Biodiesel	44.7 million liters	$7.15

Source: Biofuels Taskforce[9]

Both fuel ethanol and biodiesel are now effectively fuel-tax free because they enjoy production grants of 30 cents per liter, which cancel out the equivalent fuel tax of 30 cents per liter.[10] The subsidy was first granted in 2002 and has been extended from the original end date of June 2008 to June 2011. Biofuels will incur fuel tax beginning July 2011, and tax rates will be increased in five equal stages to the final tax level in 2015 (Table 6.1b). When taxed, biofuels will become eligible for a fuel tax credit equivalent to the amount of fuel tax paid when bought or imported minus a road-user charge. This is expected to boost biofuels consumption as the fuel tax on alternative fuels is levied at a 50% discount to the full energy content rate, which should keep the tax rate for alternative fuels below the road user charge in the short-term. The Australian Bureau of Agriculture and Resource Economics (ABARE) has estimated that government assistance to the biofuels industry could cost $93 million annually to 2009/10, a sum which will eventually drop to $35 million per year by 2015/1.

Table 6.1b: Fuel Tax Rates for Biofuels (July 2011 to July 2015)

Fuel Type *(US Cents per liter)*	1 July 2011	1 July 2012	1 July 2013	1 July 2014	1 July 2015
Ethanol	1.97	3.94	5.90	7.87	9.84
Biodiesel	2.99	5.98	8.99	12.01	15.04

Source: The Treasury [1]

Once the subsidies are eliminated in July 2011, domestically-produced ethanol and imported ethanol will be treaty equally. The domestic ethanol industry must therefore take advantage of the five years to 2011 to improve its cost effectiveness; currently Brazilian ethanol can be imported more cheaply than domestic ethanol can be produced.[12]

Another tax reform that affects the biofuels industry is the Fuel Tax Bill, passed in June 2006. It was first mooted as part of the 2004 energy white paper, which called for replacing the existing complex system of rebates and grants with a single fuel tax credit system. Although the bill will allow for fuel grants to continue under the Energy Grants (Credits) Scheme for alternative fuels, the grants will gradually be reduced to zero in five equal annual steps between July 2006 and July 2010 (Table 6.1c).[13] However, the Biofuels Taskforce says the elimination of alternative fuel grants will have little impact on the industry, as a user would need to use either a 100% ethanol or 100% biodiesel blend in order to qualify for an on-road alternative fuel grant. This opinion is backed up by data showing that there were only five claims for ethanol and none at all for biodiesel in 2003-04.[14]

Table 6.1c: Biofuels Fuel Credit Rates (2006 to 2010)

Fuel Type (US Cents per liter)	1 July 2006	1 July 2007	1 July 2008	1 July 2009	1 July 2010
Ethanol	13.110	9.829	6.533	3.277	0
Biodiesel	11.658	8.744	5.809	2.915	0

Source: The Treasury[15]

Biodiesel

In comparison to ethanol, policies to encourage production and consumption of biodiesel are much less developed. Following the recommendation by the Biofuels Taskforce that the government work with the Australian biodiesel industry to suggest B5, B20, and B100 as the standard forms of biodiesel,[16] a draft government position on biodiesel standards was released for public comment in 2006 and standards are expected to be finalized by the end of 2007.[17] The Biodiesel Association of Australia has also reserved judgment on the possible impact of the Fuel Tax Bill on the industry, arguing that the structure of the bill would actually make biodiesel in most applications more expensive than fossil diesel.[18] It also asserts that eliminating the excise exemption in 2011 will not give the biodiesel industry sufficient time to build the necessary infrastructure and attain needed economies of scale.

Local Government Involvement

Queensland, Australia's largest sugarcane state, has published the Queensland Ethanol Industry Action Plan 2005-2007 which allocated $7.3 million to support programs promoting the consumption of E10. To achieve this, the state government has implemented the Queensland Ethanol Conversion Initiative, which includes rebates for cleaning tanks to enable the storage of E10, the organization of operational guidelines for engine conversion, diesel ethanol blends and other related issues as well as the construction of blending and distribution facilities for E10 and diesel ethanol blends.[19]

It has also launched a number of ethanol related grants, including but not limited to the $10 million Sugar Industry Innovation Fund (SIIF), which has so far dispensed grants to Mackay Sugar Co-operative to investigate the integration of best practices ethanol technology and Bundaberg Sugar to conduct a financial feasibility study of new developments in ethanol.[20] To encourage demand, the state government will also mandate the use of E10 in government vehicles as well as lobby the central government to mandate nationwide fuel standards and consumption.[21]

The state government of New South Wales has gone a step further, with Premier Morris Iemma announcing in October 2006 that ethanol will make up 10% of fuel consumption in the state by 2011. A task force has been commissioned to formulate an implementation plan for the mandated use of E10 gasoline. It is expected to be a controversial process, and oil major Caltex immediately announced its opposition to the proposal.[22]

Meanwhile, South Australia has taken the lead in the promotion of biodiesel. As part of the state government's drive to reduce greenhouse gas emissions, a new clean-fuel initiative was launched in February 2005 that requires all metro trains and diesel buses to use a 5% biodiesel blend starting March 2005. The state government has also implemented a public tender system to determine fuel suppliers for the delivery of biodiesel.[23]

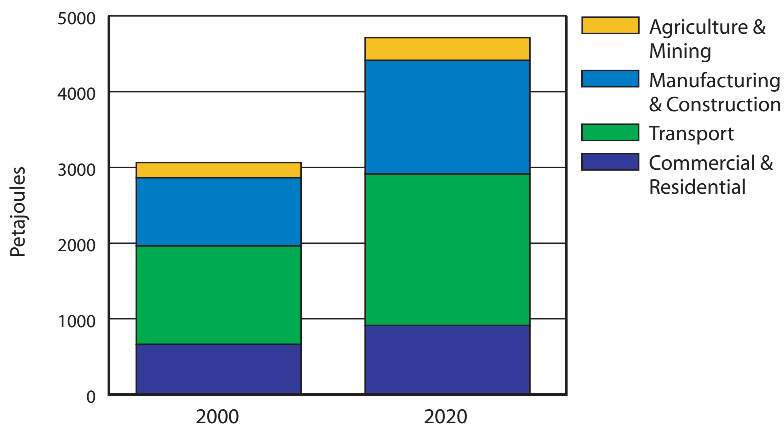
Relations with Brazil

Following the establishment of diplomatic relations in 1945, Australia and Brazil have worked together on a range of multilateral issues, with a particular focus on mining, biotechnology, and innovation. Brazil is Australia's largest South American trading partner, and bilateral trade reached $1.2 billion in 2005.[24] Although there are presently no agreements on biofuels, Brazil and Australia published a joint statement in January 2006 calling for exchanges between experts to study bilateral cooperation on biofuels.[25]

C) CURRENT SITUATION

Australia is the world's largest exporter of coal, and it generates $24 billion annually through energy exports. However, energy demand in the country is projected to surge 50% by 2020. The energy industry has predicted that $37 billion in energy investments will be required by 2020 to meet demand.[26]

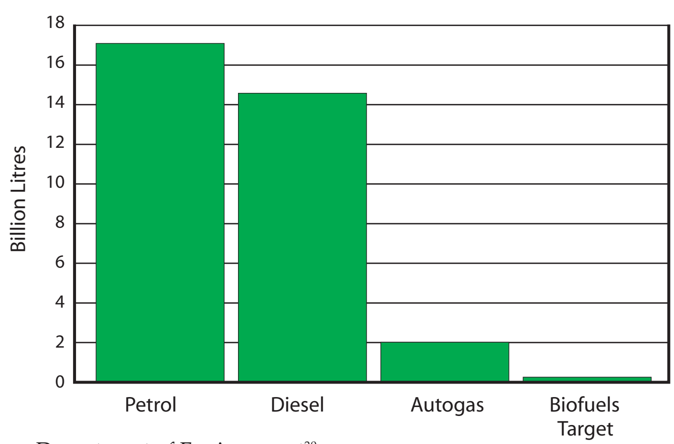
Chart 6.1b: Final Energy Consumption by Sector



Source: ABARE Australian Energy[27]

In 2001, the transport sector accounted for 41% of final energy use, virtually all of which was derived from petroleum products (Chart 6.1c). Transport is projected to account for 90% of the total increase in final consumption of petroleum between 2000 and 2020.[28] Australia's oil imports have been rising steadily and helped swell the country's balance of payment deficit by $4.7 billion in 2004/05. According to GeoScience Australia, if the country were forced to rely on its own oil resources to meet its energy needs, known oil reserves would last fewer than nine and a half years.[29]

Chart 6.1c: Current Annual Fuel Sales

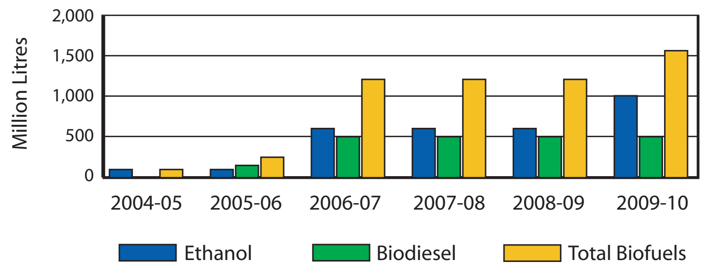


Source: Department of Environment[30]

Ethanol

In 2005, Australia produced 125 million liters of ethanol, of which 60 million liters was fuel ethanol.[31] Currently, there are only three commercial producers of fuel ethanol (Manildra Group, CSR Distilleries, and the Rocky Point Sugar Mill and Distillery) which have a combined annual capacity of 75 million liters. Three additional projects have been funded under the Biofuels Capital Grants Program (Table 6.1a), which will provide an additional 77.5 million liters in annual capacity. According to the Biofuels Taskforce Report, other ethanol projects have been proposed that could, in theory, bring total fuel ethanol capacity to approximately one billion liters by 2010 (Chart 6.1d).[32]

Chart 6.1d: Current and Potential Biofuels Production Capacity

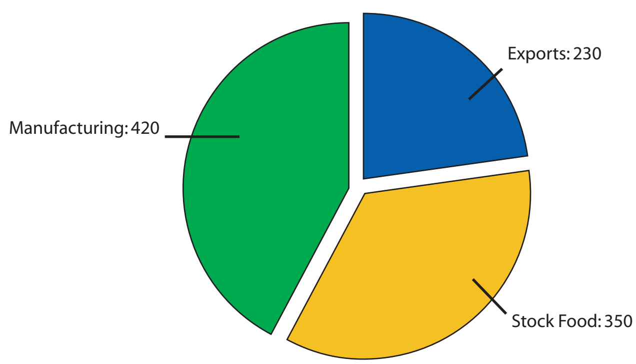


Source: Biofuels Taskforce[33]

Ethanol-blended gasoline, usually E10 (with a 10% ethanol blend), is not widely available in Australia, although the number of gas stations offering E10 rose from just 70 in June 2005 to 400 in October 2006.[34] Fuel ethanol sales are volatile in Australia, dropping from 56 million liters in 2002/03 to 28.7 million liters in 2003/04 and then rising again to 40 million liters in 2004/05. The government has projected that sales will increase in 2005/06 and 2006/07 to reach 84 million and 134 million liters respectively.[35]

The main feedstock for ethanol in Australia is waste starch and degraded wheat feedstock, which is utilized by the country's largest fuel ethanol producer, the Manildra Group.[36] However, an increasing number of new ethanol plants are choosing sugarcane molasses, of which Australia's annual output is one million tons.

Chart 6.1e: Molasses Production and Consumption in Australia (100,000 tons)



Source: CSR Ethanol[37]

The most important supply-side driver for Australia's ethanol industry would be the implementation of mandatory ethanol fuel blends. Table 6.1d shows the required feedstock for ethanol blend mandates of 2%, 5%, and 10%.

Table 6.1d: Required Feedstock for Ethanol Mandates

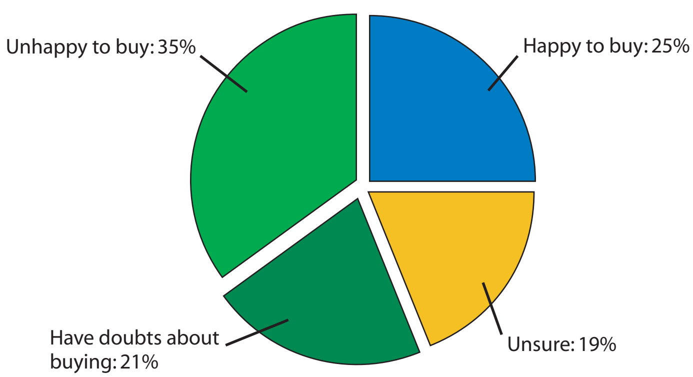
	2% Mandate		5% Mandate		10% Mandate	
Feedstock	**Ethanol** *(million litres)*	**Feedstock** *(metric tons)*	**Ethanol** *(million litres)*	**Feedstock** *(metric tons)*	**Ethanol** *(million litres)*	**Feedstock** *(metric tons)*
Wheat	552	1,227,000	1,381	3,068,000	2,762	6,137,000
Sorghum	552	1,236,000	1,381	3,090,000	2,762	6,180,000
Raw Sugar	552	921,000	1,381	2,302,000	2,762	4,603,000
Molasses C	552	2,058,000	1,381	5,145,000	2,762	10,289,000

Source: NRMA[38]

Because Australia is a net exporter of wheat and sugar, the country's ability to produce sufficient feedstock to support the needed ethanol is not in doubt. The only question is whether Australia can do so without damaging its agricultural exports, which are a vital part of the national economy.[39]

On the demand side, one of the largest obstacles to the development of the ethanol industry in Australia is consumer apathy. Relatively few Australians are inclined to buy ethanol, and concerns about its effect on their vehicles and on performance is pervasive.[40]

Chart 6.1f: Motorists' Views on E10



Source: ANOSurveyFebruary 2[4]

Biodiesel

In 2005, Australia's biodiesel industry had an annual capacity of 337 million liters. The industry leader is Australian Biodiesel Group, with an annual capacity of 200 million liters.[42] According to the Biofuels Taskforce Report, other biodiesel projects have been proposed, including four sponsored by the Biofuels Capital Grants Program (Table 6.1a) that could add approximately 508 million liters in biodiesel capacity over the short to medium term. This would in turn boost Australia's total biodiesel capacity to more than 800 million liters by 2009 (Table 6.1e).

Prepared by Garten Rothkopf

Table 6.1e: Biodiesel Plants in Australia (Operational and Expected)

Organization	Location	Annual Cap. *(Million Liters)*	Expected Operational Date
Australian Biodiesel Group	Berkley Vale, NSW	40	Operational
Australian Biodiesel Group	Narangba, Qld	160	Operational
Australian Renewable Fuels	Largs Bay, SA	45	Operational
Biodiesel Indust. Australia	Rutherford, NSW	8	Operational
Eco Tech Bio Diesel	Narangba, Qld	30	Operational
Evergreen Fuels	Mossman, Qld	N.A.	Operational
Future Fuels	Moama NSW	N.A.	Operational
Vilo Assets Management	Laverton Victoria	50	Operational
Australian Renewable Fuels	Picton, WA	45	N.A.
Axiom Energy	Geelong, Victoria	150	June 2007
Biodiesel Producers	Barnawartha, Victoria	60	N.A.
Biosel	Sydney, NSW	4	2007
Natural Fuels Australia	Darwin, NT	147	Oct. 2006
Riverina Biofuels	Deniliquin, NSW	45	July 2007
Biosel	New South Wales	24	2007/2008

Source: NRMA (National Roads and Motorists' Association)[43]

At present, biodiesel sales are restricted to a small number of outlets providing biodiesel for commercial customers. The most common biodiesel blend is B5, although higher biodiesel blends have been employed by local governments and research institutions.[44]

The dominant feedstock for biodiesel production in Australia is waste cooking oil and tallow (or animal fats). Although there are limited supplies of both (Table 6.1f), experts say that they are more than sufficient to produce enough biodiesel to meet the government target of 350 million liters by 2010.

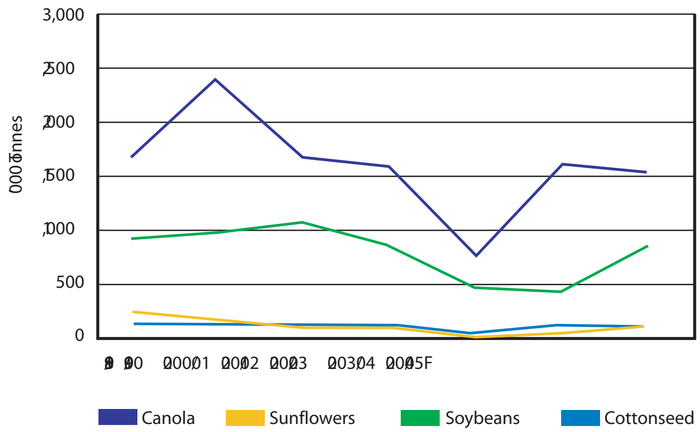
Table 6.1f: Available Biodiesel Feedstock in Australia

Feedstock	Quantity Available Per Year
Waste Cooking Oil	600 million liters collected/available
Tallow	400 million liters exported/available
New Oil (Canola)	740 million liters grown/exported

Source: Quantity[45]

New biodiesel plants, however, are expected to dry up the supply of waste cooking oil, and the industry needs to find alternative feedstock, such as canola and other oil seeds (Chart 6.1g), to maintain capacity expansion without compromising the country's food supply.

Chart 6.1g: Oilseed Production in Australia



Source: Australian Oilseeds Federation[46]

As with the ethanol industry, weak consumer confidence could hamper the growth of the biodiesel industry. This is especially true since not all auto manufacturers in Australia include biodiesel usage under their warranties and many do not recommend its use. (Table 6.1g)

Table 6.1g: Australian Manufacturers' Policies on Biodiesel

Australian Manufacturers/Importers	Company Policy on Biodiesel
BMW, Chrysler, Ford, Hyundai, Jeep, Kia, Land Rover, Mercedes Benz, Volkswagen	Not Recommended
Holden	Max. 5% biodiesel (Except Rodeo model – no biodiesel)
Mazda	Max 5% biodiesel, subject to all other fuel standards being maintained
Mitsubishi	Use at own risk, problems not covered under warranty
Nissan	Max. 5% biodiesel
Peugeot	Acceptable for some models, up to max. 30% biodiesel
Alfa Romeo, Audi, Fiat, Renault, Ssangyong	No response to RAC inquiries

Source: RAC (Automobile Club of Western Australia)[47]

The full support of the auto industry is needed to increase consumer confidence in biodiesel. Ethanol sales reportedly surged 44% in the second-half of 2005 following the agreement by international auto companies to officially label their Australian-made cars as E10-compatible.[48]

D) PRIVATE SECTOR

The largest private sector players in the biofuels industry are the foreign oil majors, which control the retail transport fuel industry. They are led by BP Australia, which announced in March 2006 that it had signed contracts with Bulwer Refinery in Queensland and Primary Energy in Western Australia. These agreements, together with a memorandum of understanding with CSR Distilleries, would allow BP Australia to acquire sufficient ethanol to provide consumers with more than 200 million liters of biofuels annually by 2008, which is more than half of the national target of 350 million liters.[49]

Meanwhile, Caltex, which has sites selling E10 in Queensland and New South Wales, is more active in biodiesel, and sells B5 and B20 blends in New South Wales and South Australia.[50] Smaller local independent players like United, Australian Farmers Fuel, and Neumann Petroleum also sell biofuels across the country. United is the leader, with biofuels available at 50 of its gas stations, while Neumann and Freedom Fuels sell biofuels at 25 service stations each.[51]

The number of ethanol and biodiesel manufacturing plants, which are predominantly private-sector owned, is growing steadily. The Australian Biodiesel Group, which is the country's largest biodiesel producer, is currently pursuing a vertical integration strategy to secure and manage supply.[52] It is facing competition from Australian Renewable Fuels, which is investing in R&D to develop alternative feedstock for biodiesel production (see below).

E) RESEARCH & DEVELOPMENT

The bulk of biofuels R&D in Australia is carried out by local governments or government-affiliated research institutes such the South Australian Research Institute, the CRC for Sugar Industry Innovation through Biotechnology (SIIB), and the Sugar Research Institute (SRI). In particular, the South Australian Research and Development Institute (SARDI) has developed a new biofuels research program, with an initial focus on biodiesel. SARDI has also been engaged by biodiesel company Australian Renewable Fuels to develop feedstocks from crops, microalgae, and other sources (studies have shown that algae can produce up to 60% of their biomass in the form of oil). SARDI is also engaged in using breeding and farming systems to develop mustard and canola varieties specifically for biodiesel production.[53]

Meanwhile, the Rural Industries Research and Development Corporation (RIRDC) has undertaken a study to examine the possibility of producing ethanol from wood products. The project focused on two areas: the hydrolysis of wood to recover the sugars that comprise the cellulose and hemicellulose in the wood feed and the subsequent fermentation of the sugar solution produced, which is more complex than cane sugar or starch sugars, because sugars produced from biomass by hydrolysis are a mixture of six-carbon and five-carbon sugars. RIRDC hopes that its research can contribute to the establishment of a wood-to-ethanol plant.[54]

Academic institutions are also involved in the R&D effort, with the University of New South Wales adopting a R&D focus on improving biocatalysts for the production of ethanol. The research group has already been issued US patents for its work on batch, semi-batch, and continuous processes for C6 sugars using the biocatalyst Zymomonas. If successful, these results could help significantly reduce costs in the production of ethanol from lignocellulosics.[55] Meanwhile, another academic institute, the University of South Australia has linked up with the South Australian Department of Transport to examine the long-term effect of using biodiesel and compressed natural gas in Adelaide metro buses.[56]

F) CONCLUSION

It is clear that production in both ethanol and biodiesel is increasing in the country, and that Australia should have little difficulty meeting the target of 350 million liters by 2010. However, Australia will only become a significant global player in biofuels if the government introduces mandatory biofuels blends. The elimination of subsidies in July 2011 will put domestically-produced ethanol and imported ethanol on level ground and offer a key advantage to the more cost-effective Brazilian ethanol industry.

Expectations for mandatory blends were dealt a blow in November 2006 when Treasurer Peter Costello announced that the government is unlikely to make the blending of ethanol in gasoline compulsory,[57] a position reitereated by the deputy prime minister, who cast biofuel use as a matter of individual choice rather than government policy.[58] Unless state governments follow the lead of New South Wales in implementing state mandatory blends, biofuels consumption in Australia will remain relatively low.

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Source: World Factbook[1]

A) INTRODUCTION

While biofuels production, and ethanol in particular, was originally launched as a short-term solution to reduce the grain surplus accumulated at the turn of the century, it was also intended to improve energy security by diversifying the national energy mix and reducing reliance on imported oil.

The strategic importance of biofuels to China's energy industry has grown as worldwide oil demand and prices have surged. It also reflects the country's move toward sustainable development, which the government has made one of the pillars of its 11th Five Year Plan (2006-2010).

B) GOVERNMENT POLICIES

Renewable Energy

To support the goal of sustainable development, the National People's Congress passed the 2005 Renewable Energy Law, which came into effect in January 2006.[2] The aim of the law is to promote the development and utilization of renewable energy, including hydroelectricity, wind power, solar energy, geothermal energy, biomass energy, and marine energy.[3] According to the State Renewable Energy Medium and Long-Term Development Program, renewable energy in China should account for 16% of the country's total energy supply by 2020. Specific targets were also set out for each renewable energy type.[4]

Table 6.2a: 2020 Targets for Renewable Energy in China

Renewable Energy Type	2020 Target
Hydro Energy	300 million KW
Wind Energy	30 million KW
Biomass Energy	30 million KW
Solar Energy	1.8 million KW
Biogas	40.3 billion Cubic Meters
Solar Heating	300 million Cubic Meters

Source: State Renewable Energy Medium and Long-Term Development Program[5]

According to the WorldWatch Institute, China has become the world's largest investor in renewable energy, with the country accounting for $6 billion of the $38 billion invested globally in 2006.[6] Hydro, solar, and wind energy received the most Chinese government investment.[7] This already sizeable investment was bolstered in October 2006 when Wu Guihui, the Vice Director-General of the NDRC's Bureau of Energy announced that China would invest $187.5 billion to increase the ratio of renewable energy from 7.5% in 2005 to 10% by 2010 and 16% by 2020.[8]

Biofuels
Government oversight of the energy industry, including biofuels, falls under the National Development and Reform Commission (NDRC), which creates policies on the economic and social development. The development of the biofuels industry is also safeguarded under the Renewable Energy Law. According to Article 32, "biological liquid fuels" include ethanol and biodiesel as well as other biomass-derived liquid fuels.[9] The provision specifically encourages the development of energy crops and the production of biofuels. Oil companies face possible fines if they do not obey future fuel blend requirements.[10] Finally, the law singles out renewable energy, including biofuels, as a key area needing investment in R&D.

The NDRC has proposed a three-stage development roadmap for the biofuels industry.

Table 6.2b: Biofuels Development Roadmap (2006 – 2020)

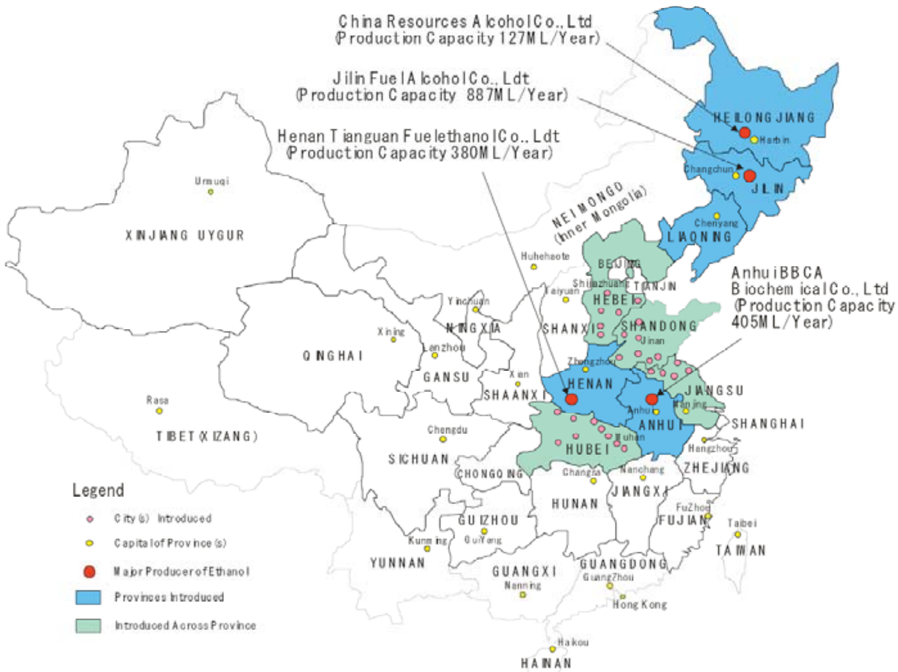
FYP	Period	Goals
11th	2006-2010	Achieve the commercialization of biofuels-related technology
12th	2011-2015	Achieve large-scale production of biofuels
13th	2016-2020	Replace 15% of fossil-based transportation fuel with biofuels Build China's biofuels industry into a globally-competitive force

Source: NDRC[11]

It has been estimated that meeting the 15% target in 2020 will require an annual production of between 10[12] and 12 million[13] tons of biofuels annually.

Ethanol
In February 2006, China unveiled the "Law Concerning Testing for the Extensive Use of Ethanol Blended Gasoline for Automobiles and the Regulations Concerning the Conduct of Testing for the Extensive Use of Ethanol Blended Gasoline for Automobiles", which instructed the five provinces of Jilin, Heilongjiang, Liaoning, Henan and Anhui, which account for 16% of the country's vehicles, to blend 10% ethanol with gasoline (E10). It also provided for the subsequent inclusion of 27 cities in another group of four provinces – Shandong, Jiangsu, Hebei, and Hubei. In May 2006, the NDRC submitted a report to the government proposing that the E10 blend mandate be extended to the cities of Beijing, Tianjin, and Shanghai.[14]

Map 6.2a: Provinces and Cities in China with E10 Blends (End-2005)



Source: Chong Siang Chew, Institute for Energy Economics[15]

The law established a National Ethanol Promotion Team led by the NDRC and supported by the China Petroleum Chemical Corporation (SINOPEC), the China National Petroleum Corporation (CNPC), and a host of other government ministries and agencies.[16] The law also established financial incentives and supplementary policies such as sale prices and transportation methods.

The government will support the fuel ethanol industry through the provision of subsidies, which are necessary given the support the local transportation fuel industry receives. Ethanol subsidies now amount to $176 per ton, which would amount to $176 million when the industry is running at full capacity. Subsidy levels have already dropped from $235 per ton and are scheduled to decrease in phases until they disappear in 2010. This is in line with the government's policy of moving away from grain-based ethanol towards energy crops-derived ethanol.[17]

Biodiesel

There are currently no specific government policies or nationwide standards on biodiesel, and no government subsidies are available to the biodiesel industry. However, industry experts have speculated that this situation could soon change, given that the government has declared the 2008 Olympic Games to be the "Green Olympics", and announced that the Olympics transportation fleet, which will be used to ferry athletes and spectators, will be powered completely by biodiesel.[18] The government has appointed Sinopec to take charge of drafting a national biodiesel standard, which experts believe could be ready by early 2007.[19]

Public Sector Involvement

This key role for Sinopec reflects its prominence in the biofuels industry. Together with CNPC, it controls over 95% of the gas stations in the country. The four main fuel ethanol plants (and any new players) must therefore sell their product to these companies, which blend the ethanol with gasoline and distribute the E10 blend through their supply network.[20]

Sinopec is also involved on the biofuels production side, with plans to link up with China Resources Alcohol, a subsidiary of the China National Cereals, Oils and Feedstuffs Corp (COFCO), to build a 110,000 metric ton cassava-based fuel ethanol plant scheduled to go on-stream by 2007 and to reach a capacity of one million metric tons of fuel ethanol by 2010. It then intends to provide fuel ethanol to the southern provinces of Yunnan, Guizhou, Guangdong, and the Special Administrative Regions of Macau and Hong Kong.[21] Sinopec is currently the only major state-owned enterprise to produce biodiesel, albeit on a small scale (2,000 tons per year). It has already started building a commercial biodiesel plant, which will come on stream in 2008. Biodiesel produced may be blended with fossil diesel to be sold as B20 (diesel with 20% biodiesel blend) at Sinopec gas stations.[22]

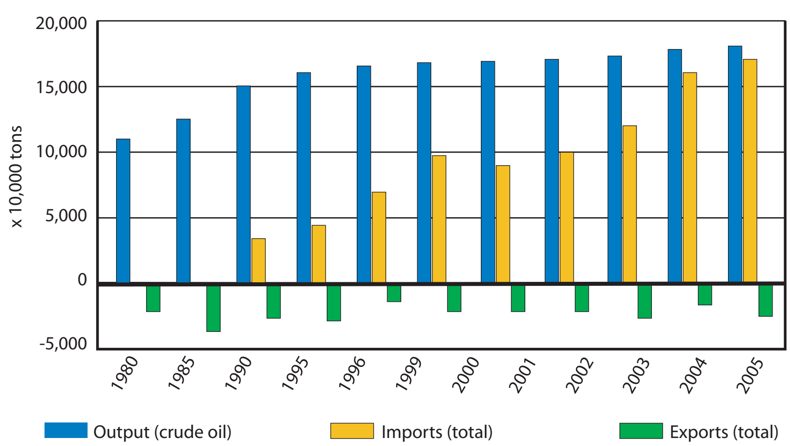
Relations with Brazil

In June 2006, China's NDRC and Brazil's Mines and Energy Ministry signed a Memorandum of Understanding to share information on policies and projects in the mines and energy ministries. It will also promote joint venture projects in oil, natural gas, renewable energy, biofuels, power, and mineral resources.[23] The conclusion of the MOU could be a sign that a long-awaited ethanol trade deal is on the horizon, especially if the 10% blend is extended to more provinces or even nationwide.[24]

C) CURRENT SITUATION

Torrid economic growth for the last quarter century–China averaged 9.88% annual GDP growth between 1993 and 2005,[25] has also transformed China into the world's fastest growing energy consumer (see Chart 6.2a) and the third largest importer of oil behind the US and Japan. In 2004, China's crude oil imports rose a staggering 34.8%, accounting for 30% of the world total.[26] In 2005, China's crude oil imports rose only 3.3% to 126.8 million tons, but its oil import bill surged 40.7% to $47.72 billion due to soaring oil prices.[27]

Chart 6.2a: China's Petroleum Balance

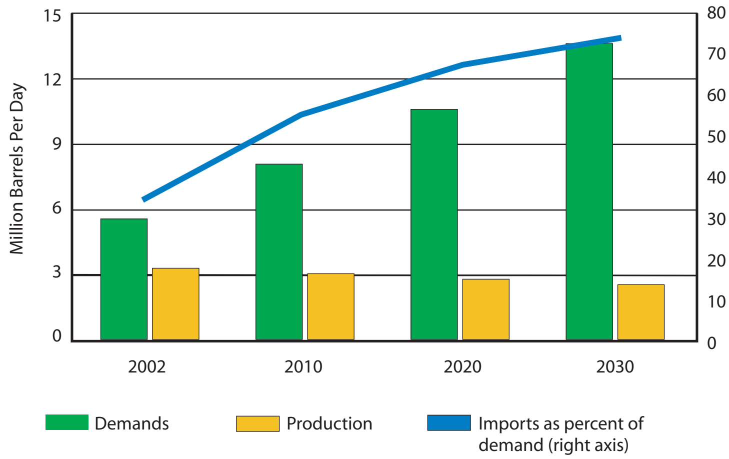


Source: China Statistical Yearbook 2005[28]

With the IEA projecting that China's oil consumption will continue its steady upwards movement even as local production falls (see Chart 6.2b), it is unsurprising that the Chinese government has made developing renewable energy resources a key goal of the 11th Five Year Plan.

Prepared by Garten Rothkopf

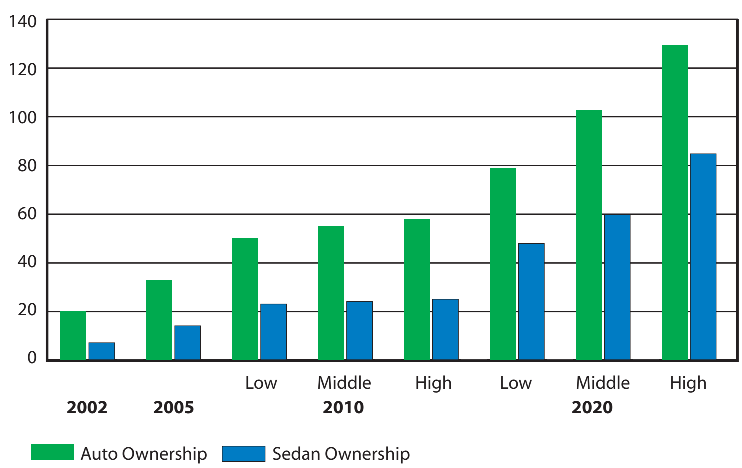
Chart 6.2b: China Oil Demand and Imports Projections



Source: IEA World Energy Outlook 2004[29]

In 2003, the transportation sector accounted for 25% of China's petroleum consumption.[30] That same year, the sale of new cars in the country jumped 80% to 2 million units, making China the fastest growing auto market in the world and rendering it all but inevitable that gasoline consumption will continue to rise[31].

Chart 6.2c: Estimate of China's Car Ownership (Million Units)



Source: Dehua Liu, Tsinghua University[32]

As shown on Chart 6.2c, a middle estimate would see just over 100 million privately-owned vehicles on the roads in 2020, which would translate into gasoline and diesel consumption of 228 million tons.[33] That type of projection has prompted the Henan provincial capital of Nanyang to implement a flex-fuel transportation pilot scheme, supported by the Henan Tianguan Group and Tsinghua University, through which 100 flex-fuel vehicles and four flex-fuel public buses imported from the EU will be tested on the city's roads.[34]

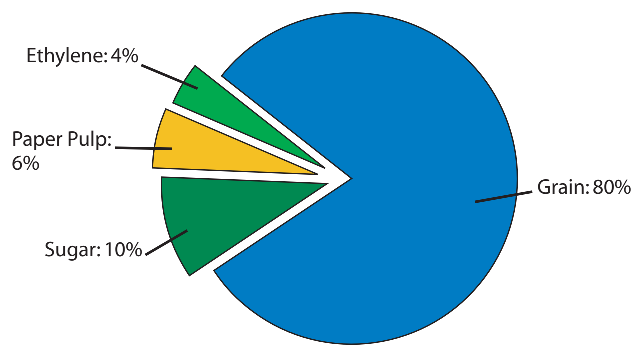
Ethanol

China is the world's third-largest and Asia's largest producer of ethanol. China's ethanol industry is comprised of more than 200 production facilities,[35] with a combined capacity of more than 10 million tons annually.[36] The majority of the country's ethanol output is consumed by industrial sectors such as pharmaceuticals and the beverage industry. In 2005, China produced one million tons of fuel ethanol.[37] According to the NDRC, ethanol-blended gasoline now accounts for 20% of the country's total gasoline supply, with a total of 10.2 million tons of E10 blends produced in the nine aforementioned provinces.[38]

The country's fuel ethanol is supplied by four main state-owned plants: Jilin Fuel Alcohol Company Ltd, Anhui Fengyuan Petrochemical Ltd, Henan Tianguan Group and the Heilongjiang Huarun Jinyu Ltd.[39] They were all established after 2000 to address a surplus of grains, from which 80% of the country's fuel ethanol was produced (see Chart 6.2d). State-owned COFCO is China's largest ethanol producer. It currently operates the Heilongjiang plant and has a 20% stake in the Jilin plant. In October 2006, COFCO announced that it would spend $1.26 billion to boost its ethanol production to 3 million tons over the next three years. This plan includes the establishment of a 400,000 ton-per-year cassava-based ethanol plant in Guangxi Province, two 300,000 ton-per-year sweet sorghum-based ethanol plants in Hebei Province and Liaoning Province as well as the purchase of a 440,000 ton-per-year ethanol plant in Anhui Province.[40]

The rapid increase in ethanol production in the last five years has almost entirely depleted the surplus grain stock, although the NDRC has stated that producing 6 million tons of grain-based ethanol in the 11th Five Year Plan (2006-2010) should not threaten the country's grain security.[41] The volatility of China's grain harvests and the national policy to remain self-sufficient in food production, however, has prompted policymakers and ethanol producers to look for feedstock alternatives.

Chart 6.2d: Breakdown of Ethanol Feedstock in China (Current Situation)



Source: Dehua Liu, Tsinghua University[42]

The primary candidates for alternative feedstocks are sweet sorghum, cassava, and sugarcane, the current output levels of which are expected to be sufficient to produce 30 million tons of fuel ethanol.[43] Accordingly, different provinces are conducting ethanol production trials using different kinds of feedstock (see Table 6.2).

Table 6.2c: Trial Tests of Non-Grain Ethanol Feedstock in China

Feedstock	Provinces Involved
Sweet Sorghum	Heilongjiang, Inner Mongolia, Shandong, Xinjiang, Tianjin
Cassava	Guangxi, Guangdong, Yunan, Fujian, Hunan, Sichuan
Sweet Potato	Hunan

Source: Sohu News[44]

Cassava is seen as the energy crop with the most biofuels potential in China; China Agricultural University's Professor Sen Yang estimates that it could produce 4 million tons of ethanol. The cassava-based ethanol drive will be led by Guangxi Province, which accounts for 60% of the national cassava output and is currently planning to establish a one million ton-per-year cassava-based ethanol plant.[45]

Compared to more experienced ethanol producing countries like Brazil and the US, the costs of producing ethanol in China are high. Producing grain-based ethanol costs an estimated $563 per ton, while sugarcane, cassava, and sweet sorghum cost approximately $330/ton.[46] These costs mean that fuel ethanol is only profitable when oil prices stay above $0.76 per liter, which is unlikely in China's heavily-subsidized oil industry and explains the necessity of the $191 million in government subsidies doled out to the ethanol industry annually.[47]

Meanwhile, there have also been calls for China to produce cellulosic ethanol or to develop ways to produce ethanol using stalks and plants that can thrive on land unsuitable for grain production. Such land is concentrated north of the Yellow River and Huaihe River basins and totals 33.34 million hectares. According to Professor Shi Yuanchuan of China Agricultural University, cultivating just 20% of that land with crops such as sugar grass would provide feedstock for an additional 20 million tons of ethanol. In addition, the 1.5 billion tons of stalk produced as a by-product should be able to provide an additional 370 million tons of ethanol.[48] Estimates for the potential of different crops—and China's overall production potential—vary considerably

Table 6.2d: China's Ethanol Production Potential in 2020

	Yield of Fuel Ethanol *(Million t/a)*	
Variety	**Year 2004**	**Year 2020**
Food Crops	0.82	2
Energy Crops	N.A.	6.019
Total	0.82	8.019

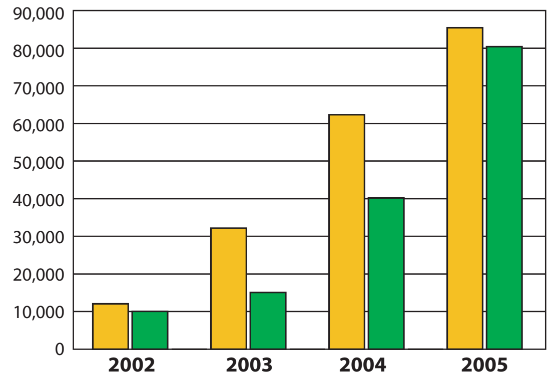
Source: GTZ[49]

According to a GTZ report on liquid biofuels for transportation, China only has the potential to produce slightly more than 8 million tons of ethanol annually by 2020. This estimate is closest to the official target established by the NDRC, which calls for the replacement of 15% of fossil-fuel gasoline in the transportation sector,[50] requiring an annual production of 10 million to 12 million tons of biofuels (both ethanol and biodiesel) by 2020.[51] However, this estimate also means that if, as forecasted, there are 100 million vehicles consuming 228 million tons of gasoline and diesel in 2020, a nationwide 10% blend would result in a biofuels demand of 22.8 million tons, creating a supply shortfall of 12.8 million tons of ethanol.[52]

Biodiesel

As in other Asian countries, the biodiesel industry in China is still in its infancy and consists of only a few plants with limited capacities ranging from 5,000 to 20,000 tons per year.[53] In 2005, China produced 80,000 metric tons of biodiesel, using waste oil as a primary feedstock. It has been estimated that approximately 40 biodiesel plants are being constructed nationwide, which will also rely on waste oil for biodiesel production and have a total estimated production capacity of 200,000 metric tons per year.[54]

Chart: 6.2e: Biodiesel Production and Capacity (2002-2005)



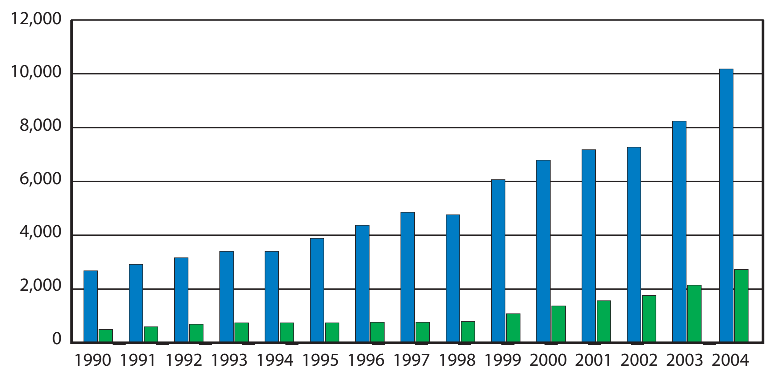
	2002	2003	2004	2005
Capacity mt/y	12,000	32,000	62,000	85,000
Output mt/y	10,000	15,000	40,000	80,000

Source: Wendy Wen, Asia Biofuels Company[55]

At present, biodiesel consumption is very low, in large part because it does not have access to the main distribution networks of China's three large state-owned oil companies, Sinopec, PetroChina and CNOOC, which control a large majority of the country's gas stations.[56] What little output biodiesel producers have managed to sell is through direct marketing to transportation companies. For example, Sichuan Gushan Grease Chemical, which was projected to have a 2005 output of 30,000 metric tons, sells its biodiesel to local gas stations in San Tai County (in Sichuan Province).[57]

Although there are no existing laws or government standards on biodiesel, the strong government endorsement of biofuels and the appeal of biodiesel's cleaner properties to an increasingly green-conscious public make it very likely that biodiesel will soon be accepted as a blending stock for fossil diesel. A national biodiesel blend of between 5 and 20 percent (even if not mandatory) could produce biodiesel demand of between 5 and 20 million tons per year.[58]

Chart 6.2f: Consumption and Production of Diesel in China (1990 to 2004)

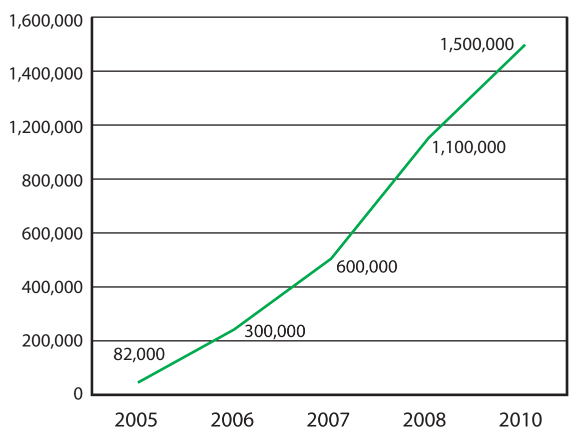


Source: Dehua Liu, Tsinghua University[59]

The Chinese biodiesel industry is expected to take off in the next five years and may attain a production total in excess of one million tons in 2010 (see Chart 6.2g). In the short-term, waste cooking oil is expected to be sufficient to support growing biodiesel production. In 2005, 19.14 million tons of edible oils were consumed, approximately 35% of which became waste that could be converted into biodiesel.[60]

In the long-term, China needs to cultivate crops specifically for biodiesel production if it hopes to eventually implement a nationwide biodiesel blend without significant imports. Given China's dependence on vegetable oil imports[61] and limited arable land for new crops, the country should focus on crops that can survive on wastelands or desert areas. Experts have recommended the following six crops (in order of merit) as the most suitable choices to feed the Chinese biodiesel industry: jatropha curcas, euphorbia tirucallie, cornus vilsorniana, idesia polycapa, rapeseed, and soy.[62]

Chart 6.2g: Biodiesel Capacity Forecast (2005-2010)



Source: Wendy Wen, Asia Biofuels Company[63]

Ensuring sufficient feedstock is only one of the elements necessary for a viable biodiesel industry. Given that biodiesel prices are higher than fossil diesel prices, government subsidies (similar to those granted to the fuel ethanol industry) are necessary to make the sector commercially viable. Similarly, a strong national biodiesel policy that includes national standards, incentives to plant biodiesel feedstock crops, and access to public sector gasoline supply networks would be helpful.

D) PRIVATE SECTOR

China's biofuels industry is dominated by the central government, provincial and municipal governments, and certain state-owned companies. Although there are hundreds of small private-sector alcohol production plants, they only produce alcohol for industrial consumption and do not produce fuel ethanol.[64] The majority of the funding is provided by the government, which has committed $187.5 billion to renewable energy over the next three to five years.[65] As in other countries that have heavily subsidized gasoline sectors, investing in the Chinese biofuels industry is not yet commercially viable – at least not without heavy government subsidies. Moeover, China's energy industry is dominated by large state-owned enterprises that have strangleholds on gasoline and diesel supply networks. Even when they have no operational responsibilities, investors may be hesitant to invest in the biofuels industry until the E10 blend is extended to more provinces or a biodiesel blend is implemented.

Foreign private sector involvement is also limited and skewed towards the biodiesel industry, which is more in need of foreign expertise. UK-based biodiesel producer D1 Oils Plc has signed an MOU with the Center for Energy and Environment Protection under the Ministry of Agriculture to promote the production of jatropha-based biodiesel in southern China. Under the terms of the MOU, the joint venture will establish a seed farm to demonstrate jatropha growing and explore opportunities for establishing small-scale pilot refinery operations in the country.[66] D1 Oils also has plans to set up a 500,000 ton jatropha-based biodiesel plant in Sichuan province.[67] Another foreign biodiesel producer, Austria-based Biolux, recently invested $154 million to construct a wholly-owned biodiesel plant in Nantong City, which will use rapeseed oil as a feedstock. The plant is expected to have an eventual capacity of one million tons, which will be directed toward export markets.[68]

E) RESEARCH & DEVELOPMENT

The slow development of renewable energy in China has been attributed to weak independent technology development in the country; the majority of renewable energy equipment used in China is imported at high cost. This situation is changing however. In February 2006, the National Medium and Long-Term Outlines for Scientific and Technological Development (2006-2020) singled out energy as an area requiring "urgent support" and mapped out a series of government-funded plans to encourage energy-related R&D.[69] One of these proposals is a special fund for the development of renewable energy, which will be managed by the Ministry of Finance and the NDRC. The fund sees biomass energy (which it defines as ethanol, biodiesel, biomass power generation, and methane) as the top candidate for R&D funding.[70]

Funded by government agencies like the Ministry for Science and Technology, the bulk of China's R&D is conducted by university-affiliated research institutes. They are led by the New Energy and Chemical Engineering Departments of Tsinghua University, China's top university, which have developed a new enzymatic approach that significantly reduces the negative impact of both methanol and glycerol on enzymatic activity in the production of biodiesel from local wood plant oil or grease trap waste.[71] Another significant R&D player is the Biomass Engineering Center at the Chinese Agricultural University (CAU), where top researchers are among the main advocates of a new Chinese national biomass to ethanol project. R&D at CAU is particularly focused on cellulosic ethanol technology.[72] This is also true at the East China University of Science and Technology, which in December 2005 reported progress in its project to distill ethanol from cellulose raw materials (at an annual capacity of 600 tons) through acid hydrolysis.[73]

A large chunk of R&D in the country is also devoted to developing non-grain feedstock, or energy crops, for ethanol. To study the feasibility of sweet sorghum as an ethanol feedstock, the National Sorghum Study Center, Shenyang Agriculture University, Heilongjiang Academy of Agriculture, Jilin Academy of Agriculture, China Academy of Agriculture, and the Beijing Sustainable Agriculture and Economic Plant Institute came together to hold joint planning tests in Beijing, Liaoning and Henan, where they assessed the suitability of ten popular strains of sweet sorghum in different areas of northern China. The Chinese Academy of Agriculture Engineering, National Sorghum Breeding Center, Renewable Energy Laboratory of Henan Agriculture University, and the Ecology and Genetic Improvement Laboratory of Shenyang Agricultural University are researching the different species of sweet sorghum as well. Similarly, much R&D has been conducted with regard to the suitability of cassava as an ethanol feedstock. For example, the Fujian Agriculture and Forestry University has developed promising cassava varieties with high potential biomass yield and high photosynthetic rate for energy production.[74]

F) CONCLUSION

China may soon become a major importer of ethanol if the E10 blend is extended across the country. Local production will not be able to meet expected demand even though the country is examining alternative feedstock for ethanol such as cassava and sweet sorghum. Demand for biodiesel could actually overtake that of ethanol, given the high consumption of diesel in the country. However, the spread of biodiesel will depend on the cultivation of sufficient feedstock and a supportive government policy that includes substantial incentives. In the short to medium-term, progress will depend heavily on government policy, as private investment is limited.

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A) INTRODUCTION

India imports more than 70% of its energy needs and is home to the fastest-growing motor vehicle industry in the world after China. These factors have accelerated the government-backed development of a biofuels industry to diversify the national energy mix. India's huge land mass and long agricultural tradition give it the potential to become a world leader in both ethanol and biodiesel. However, India is just beginning its biofuels program, and because it has chosen to produce ethanol from lower-yield sugarcane molasses and promote jatropha-based biodiesel, which has not been commercially proven, the viability of the program remains uncertain.

B) GOVERNMENT POLICIES

In 2002, rising oil import bills prompted the Planning Commission of the Indian government to establish the Committee on Development of Biofuel in a bid to diversify the national energy mix. In April 2003, it submitted a report, which surveyed the country's potential in biofuels and recommended establishing a National Mission on Biodiesel.[2]

To better coordinate the different ethanol and biodiesel-specific policies (see below) that have since been implemented, the Ministry of New and Renewable Energy is in the process of drawing up a draft National Policy on Biofuels. One of its recommendations is the creation of a National Biofuel Development Board, which will be headed by the prime minister.[3]

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Ethanol

Under the Ethanol Blending Program (EBP), the blending of 5% ethanol in gasoline was made mandatory in nine states and four union territories in January 2003.[4] Oil companies were offered incentives such as an exemption in the excise duty. However, difficulties in obtaining sufficient ethanol were reported in the states of Maharashtra, Goa, Gujarat, Andhra Pradesh, and Karnataka; indeed, oil companies were able to purchase only 196 of the 363 million liters needed in early 2004 as a result of lower sugar production due to drought.[5]

In October 2004, the policy was amended to oblige oil companies to adhere to the EBP only if:

- The price of ethanol for supply of ethanol-blended petrol is comparable to the price of ethanol for alternative use.
- The delivery price of ethanol offered for the EBP in a particular state is comparable to the import parity price of petrol in that state.
- The ethanol industry of that state is able to maintain the availability of ethanol for the EBP at such prices.[6]

As a result, ethanol blending was halted until late 2005, when a stronger sugar crop raised the availability of sugarcane molasses for ethanol production. In October 2006, the blending of 5% ethanol with gasoline was made mandatory for all private and public sector oil companies. It was also announced by the Petroleum Ministry that, pending the availability of sufficient ethanol, 10% ethanol-blended gasoline would be introduced in June 2007.[7]

Biodiesel

As discussed above, the findings of the Committee's Report resulted in the creation of a National Mission on Biodiesel, which is sometimes known as the National Mission on Jatropha because of its choice of jatropha as the main feedstock. Because India is facing a shortage of both edible and non-edible oils[8] and does not use food crops as fuel feedstock, jatropha, which is inedible and thrives even in marginal lands, is a logical choice. The Mission, which received approval in principle from the Planning Commission in January 2006,[9] is structured in two phases:

1. A Demonstration Project to cultivate jatropha on 400,000 hectares to be implemented by 2006-07.
2. A self-sustaining expansion of the project starting in 2007 and culminating in the production of sufficient biodiesel to meet a 20% blend requirement in 2011-12.[10]

It will be led by the Ministry of Rural Development (MoRD), which has been appointed as the lead ministry and supported by six micro-missions.[11]

Meanwhile, to boost biodiesel consumption, the Ministry of Petroleum and Natural Gas implemented a biodiesel purchase policy that came into effect in January 2006. The policy requires public sector oil marketing companies to purchase biodiesel at Rs.25 per liter for blending with diesel from 20 purchase centers. An initial blend of 5% biodiesel was stipulated, with the option of increasing the blend to 20% in phases.[12]

Local Government Involvement

Local governments have also contributed to the development of the biofuels industry. The Tamil Nadu state government has committed to cultivate jatropha, sugar beet, and sweet sorghum on a contract farming basis as part of its alternate cropping strategy. The Andhra Pradesh state government has drawn up a draft biodiesel policy, which calls for the cultivation of 607,000 hectares of jatropha over the next four years[13] and provides subsidies of up to 90% to promote drip irrigation for that crop. It has also granted $219,000 to fund R&D in biofuels-related activities and pledged to reduce the value-added tax for biodiesel plants located in the state.[14]

Uttaranchal State has established its own Biofuel Board to coordinate the planting of jatropha on 210,360 hectares of unirrigated, degraded forest land in stages by 2012 and to establish the capacity to process 600,000 tons of jatropha seeds into biodiesel. Chhattisgarh State has also set up a biofuels development authority to double the current batch of 80 million jatropha seedlings. It will also set up pilot jatropha demonstration plantations in each of its districts.[15]

Public Sector Involvement
The state road transport corporations of the major sugar producing states are also heavily involved in the nascent biofuels sector. For example, the Haryana State Road Transport Corporation is testing out biodiesel on 20 Haryana Roadway buses, which will soon be increased to 150.[16] The Karnataka State Road Transport Corporation (KSRTC) has 5,000 buses that have been running on diesel blended at 10% with oils extracted from the pongamia plant for the last three years.[17] In June 2006, Pune became the third Indian city to test-run its public buses on biodiesel, and 10 Pune Municipal Transport (PMT) buses are now operating on a 20% biodiesel blend.[18]

Meanwhile, Indian Railways has successfully run a trial on a diesel locomotive using 5,000 liters of imported soybean biodiesel and is now considering an ambitious project in which it hopes to exploit nearly 90,000 hectares alongside its rail tracks for farming biofuels crops such as jatropha. On August 10 2006, International Biodiesel Day, Indian Railways ran a "bio-locomotive" entirely on biodiesel.[19]

Financing for biofuels projects is mainly extended by state financial institutions. The National Bank for Agriculture and Rural Development (NABARD) is the leading bank supporting biodiesel programs in rural areas. It offers services such as 100% refinancing to rural banks at a concessional rate of interest for the development of marginal lands, refinancing of biodiesel expeller units, and co-financing of biodiesel manufacturing plants. NABARD also supports state governments' biodiesel programs through its Rural Infrastructure Development Fund.[20]

Financial Incentives
It has been reported that the Ministry of Finance is against granting biofuels an excise duty exemption because biodiesel-blended diesel and ethanol-blended gasoline are being sold at the same price as fossil diesel and gasoline even though a lower duty is already imposed on biofuels. However, the Finance Ministry has acquiesced to a lower customs duty rate on non-indigenous manufacturing equipment for processing oilseeds if used in industrial projects with less than $1.1 million in plants and machinery. Industrial projects with plants and machinery exceeding $1.1 million are already eligible for 10% import tariffs under a separate arrangement for project financing.[21]

Relations with Brazil
In 2002, India and Brazil signed an MOU to promote technological research cooperation on the use of ethanol as a transportation fuel. The main goal of the MOU was to provide a diplomatic framework that would allow Brazil to share its advanced technological expertise on ethanol for transportation with India.[22] In March 2003, India's Uttam Group, one of the country's leading manufacturers and suppliers of sugar plant and machinery, formed a joint venture with Brazil's Dedini, the world's largest supplier of alcohol distillation plants, to offer Indian sugar mills "flexible technologies and complete turnkey solutions" for the manufacture of fuel ethanol. The joint venture offers sugar mills the flexibility to manufacture ethanol not just from molasses, but also from secondary cane juice, leaving the primary juice for sugar production.[23]

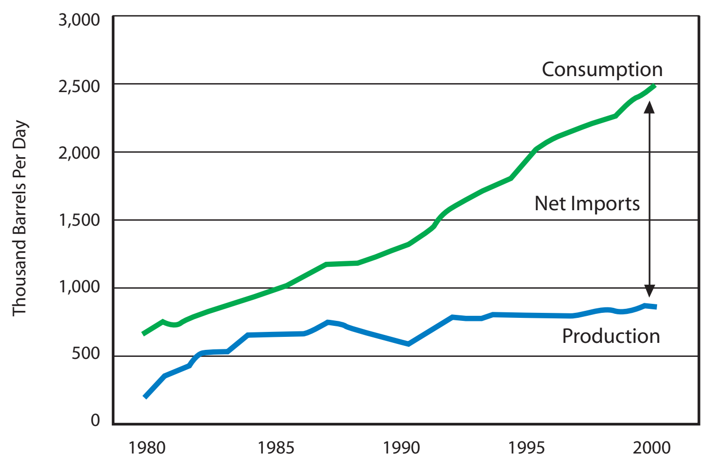
The existence of this official framework as well as growing trade between India and Brazil (bilateral trade hit $2.3 billion in 2005) has led to a flurry of ethanol-related deals. In April 2006, the state-owned Oil and Natural Gas Corporation (ONGC) offered Brazil's Petrobras an equity and technology stake in a venture to set up a greenfield ethanol refinery to produce ethanol-blended oil products.[24] In May 2006, Bajaj Hindusthan, India's largest sugar and ethanol manufacturing company, which has a sugarcane crushing capacity of more than 61,600 tons-a-day, announced plans to set aside $500 million to acquire mills in Brazil. A major factor in the decision-making was the significantly lower cost of Brazil's ethanol production. These acquisitions are projected to increase the company's total cane crushing capacity to 110,000 tons by the end of 2006.[25] Because of the difficulty of increasing India's sugarcane area due to lack of available land and competition with other food sources, Bajaj Hindusthan hopes to establish plants in countries with large sugarcane outputs in order to increase its ethanol production capacity from 320,000 to 800,000 liters a day. Brazil, with its huge land availability, is a key country for consideration.[26] In September 2006, Reliance Industries announced its intention to set up a large-scale ethanol plant in Brazil, but no concrete plans have been made.[27]

India was the largest importer of Brazilian ethanol in 2005 (410 million liters) due to a poor sugarcane harvest. Its imports from Brazil are projected to rise further following the implementation of the mandatory blend (see below).

C) CURRENT SITUATION

As is typical with rapidly growing economies, India's energy demand has surged in recent years. Oil constitutes 34% of India's total energy consumption and with domestic production leveling off, the country imported nearly 1.7 million barrels per day (bbl/d) in 2005. Consumption is projected to rise from 2.5 million bbl/d in 2005 to 3.1 million by 2010.[29]

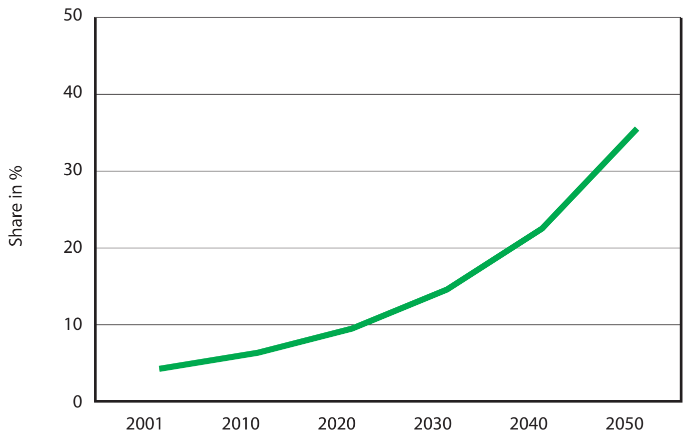
Chart 6.3a: India's Oil Production and Consumption (1980-2005)



Source: EIA[30]

With the UN predicting India will overtake China as the world's most populous country by 2030, India is expected to account for a third of the world's total global energy demand by 2050.[31]

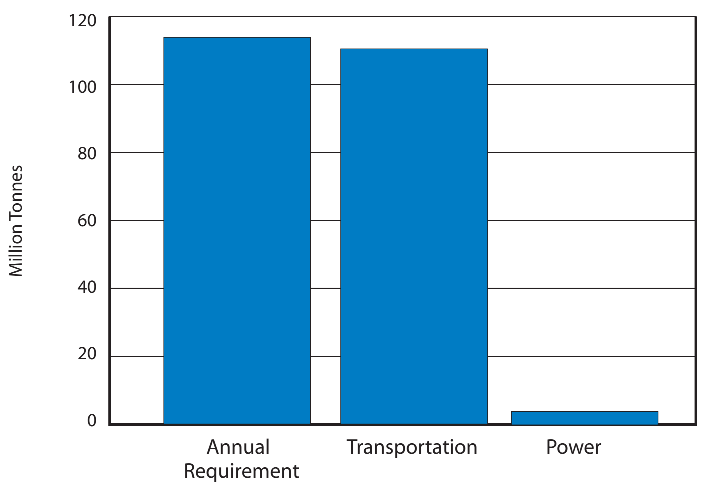
Chart 6.3b: India's Share of Total Global Energy Demand



Source: IEA[32]

The transportation sector accounted for 90% of India's oil consumption in 2005, and it is slated to grow considerably. The consultancies Booz-Allen Hamilton and McKinsey estimate that the Indian domestic new passenger car market (which produces one million new cars annually) will double by 2010 and cross the 3.5 million mark by 2015.[33] In this context, it is clear that promoting biofuels for transportation in India is critical.

Chart 6.3c: Annual Requirement for Oil



Source: Ministry of New and Renewable Energy[34]

Ethanol

India is the second-largest producer of ethanol in Asia after China. In 2005, India produced 1.7 billion liters of ethanol, of which 200 million liters were fuel ethanol. The ethanol industry is fragmented, with 120 separate producers. Most producers, however, are concentrated in the sugarcane growing states of Maharashtra and Uttar Pradesh. Other states including Tamil Nadu, Andhra Pradesh, Karnataka, and Gujarat have small numbers of ethanol producers.[35]

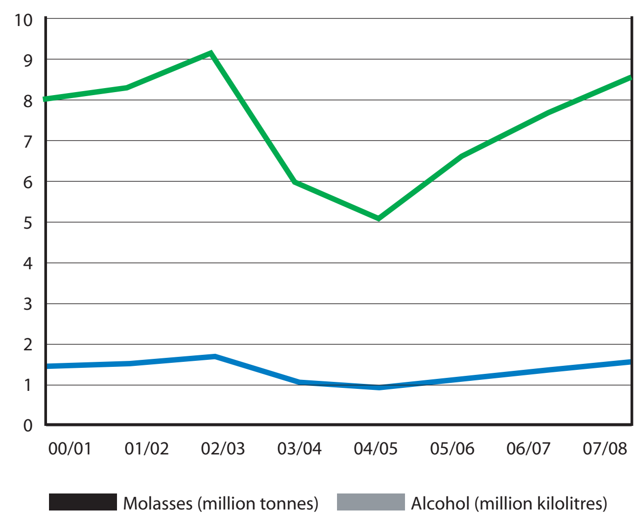
In keeping with its policy of not using food crops as energy sources, India produces ethanol from sugarcane molasses rather than from sugar directly. The lower sucrose content in molasses as compared to sugarcane juice means that the country's ethanol yield is only a sixth of Brazil's even though the countries are almost even in terms of sugarcane production.[36]

Table 6.3a: Sugarcane Production in India

Year	Area (100,000 ha)	Yield (t/ha)
1950-51	1707	32.10
1960-61	2415	45.50
1970-71	2615	48.30
1980-81	2667	57.80
1990-91	3686	65.40
1995-96	4147	67.80
2002-03	4361	64.60
2003-04	3900	60.5
2004-05	3700	N.A.

Source: Singh J P and Shree Renuka Sugars[37]

Chart 6.3d: Molasses and Alcohol Production in India



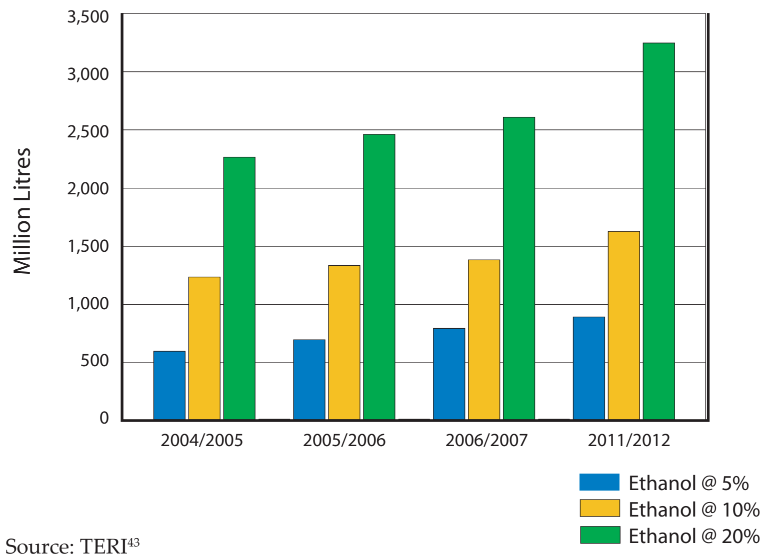
Source: [illegible][38]

It seems unlikely that the area under sugarcane cultivation will grow significantly, and the government projects an increase of only 0.6 million hectares in the country's 10th Five Year Plan (2002-2007). This assessment is backed up by industry experts, who project that the total area under sugarcane cultivation is unlikely to exceed 5 million hectares. Sugarcane cultivation is a water-intensive process which India's agricultural industry can ill afford; 310 of the 470 districts in the country already have overexploited water resources. There are also objections in the country to the allocation of scarce water resources for the cultivation of a cash crop.[39]

Sufficient Ethanol?

The sugar industry has said that output will be sufficient to meet demand for the nationwide 5% ethanol blend and even for the proposed hike to 10% in June 2006,[40] but other industry stakeholders disagree. Private sector oil refiner Reliance Industries has said that it is opposed to the 5% ethanol blending policy because Indian ethanol capacity is insufficient to meet such a goal. It has estimated that the policy would require that its refineries secure an additional 150 million liters of ethanol, which even its new Maharashtra sugar plants will be unable to sustain.[41] Other energy analysts have expressed concern that by trying to reduce its reliance on oil imports, India may instead become dependent on ethanol imports, especially since sugar output in India has had a history of volatility, as evidenced by the 2004 hiatus in the Ethanol Blending Program (see above).[42]

Chart 6.3e: Ethanol Requirement in Transportation Sector

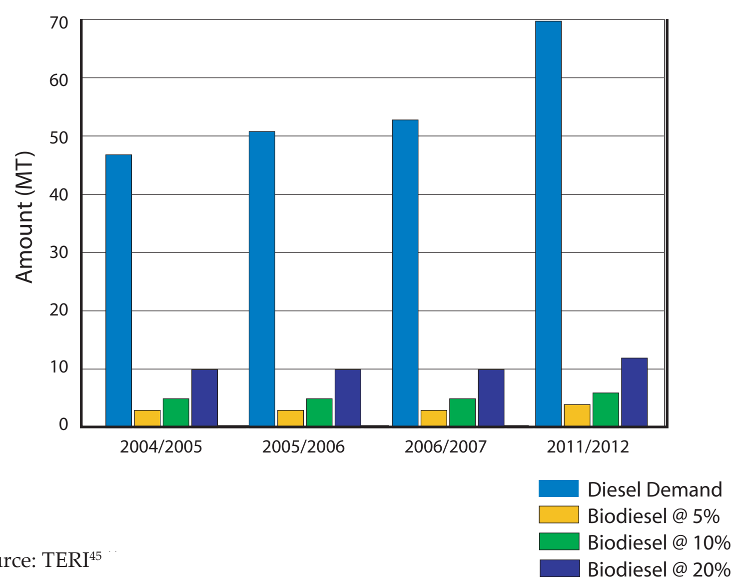


Source: TERI[43]

Biodiesel

There is a huge market for biodiesel in India, where 80% of auto fuel is diesel.[44] India's young biodiesel industry, however, is still largely operating on an experimental scale. In 2005, two small biodiesel plants, Aatmiya Biofuels and Gujarat Oleo Chemicals, went on-stream. Achieving the National Mission on Biodiesel's goal of a 20% biodiesel blend by 2013 (for blend breakdowns see Chart 6.3f) depends first and foremost on the expansion of jatropha cultivation to produce sufficient biodiesel feedstock.

Chart 6.3f: Biodiesel Demand in Transportation Sector



Source: TERI[45]

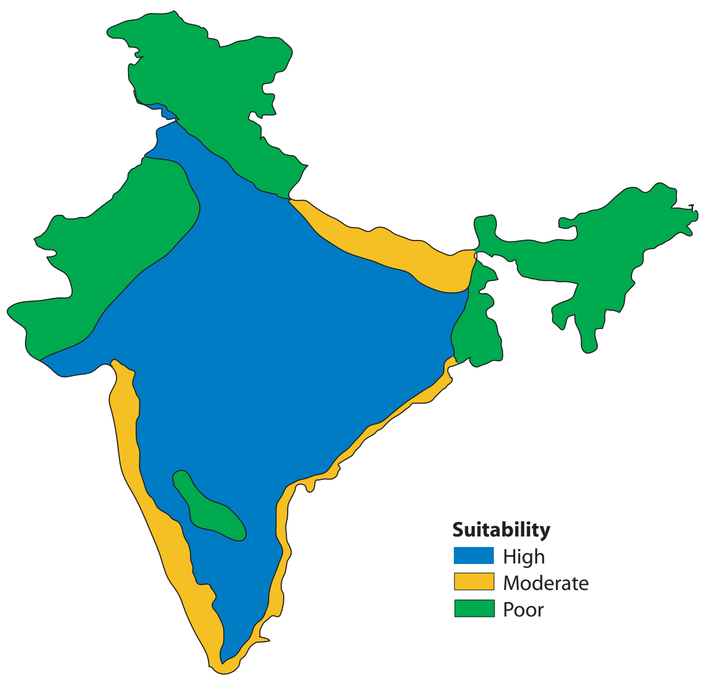
Given that the Indian government has already identified 39 million hectares of land suitable for growing jatropha[46] (for the geographical spread see Map 6.3a), meeting the target of roughly 11 million hectares is realistic.

Table 6.3b: Diesel & Biodiesel Demand & Area Required under Jatropha for Different Blending Rates

Year	Diesel Demand *(MMT)*	Biodiesel @ 5% *(MMT)*	Area for 5% *(Mha)*	Biodiesel @ 10% *(MMT)*	Area for 20% *(Mha)*
2001-02	39.81	1.99	n/a	3.98	n/a
2006-07	52.33	2.62	2.19	5.23	8.76
2011-12	66.90	3.35	2.79	6.69	11.19

Source: Report of the Committee on Development of Biofuels[47]

Map 6.3a: Suitability Map for Jatropha



Source: GTZ[48]

Carbon Credit Market
According to Rabo India Finance, India's Multi-Commodity Exchange is likely to be the third exchange in the world with a license to trade in carbon credits. India is the third most prolific country behind China and Brazil in accumulating carbon emission reduction units (CERs), and Indian companies are on an investment spree in greenhouse-gas reduction projects, as evidenced by the government's approval of 226 projects, which could translate into about 250 million CERs with potential revenue of $1.25 billion.[49] Previously the domain of sugar companies involved in the ethanol industry, companies from the chemical and other industries are also subscribing, no doubt enticed by the jump in registered deals worldwide from just $377 million in 2004 to $9.4 billion in 2005.[50]

D) PRIVATE SECTOR

Private sector oil and petrochemical giant Reliance Industries (RIL) is probably the company most involved in all stages of the biofuels supply chain. Earlier this year, RIL invested $500 million to set up a biodiesel refining plant in Andhra Pradesh and has also started a pilot project to cultivate jatropha on 81 hectares of land.[51] In May 2006, RIL announced plans to set up three sugar factories, each with the capacity to crush more than 10,000 tons of cane per day, in Maharashtra. The venture will be the first sugar factory to convert the entire sugarcane juice, instead of just sugarcane molasses, to ethanol. RIL is also planning to produce ethanol directly from grains, turnips, and damaged grains. However this plan may be delayed as the required cellulosic technology has yet to be commercially tested.[52]

Another major business house, the Tata Group, has expressed interest in establishing a biofuels pilot plant near its fertilizer plant in Babrala. The conglomerate is also studying cash crops for farmers that can be refined into ethanol as well as methods to produce ethanol from cellulosic materials.[53] The Tata companies are also promoting biodiesel consumption through their car manufacturing arm, Tata Motors, which is involved in biodiesel R&D work.

Unsurprisingly, most players in the ethanol industry come from the sugar industry. Shree Renuka Sugars, a fully integrated sugar company which owns India's largest sugar refinery, was granted approval by the Indian government to set up the country's first special economic zone (SEZ) for sugar and ethanol in Karnataka state. The SEZ will include an integrated sugarcane processing complex with a cane crushing capacity of 5,000 tons of cane per day, a distillery, and a cogeneration plant. The venture will enjoy SEZ perks such as exemptions from income, sales, and purchase taxes, as well as the waiver of the domestic sugar release mechanism.[54]

Meanwhile, foreign companies are also investing in India's biofuels industry. UK-based D1 Oils Plc, a global producer of biodiesel with major operations in Asia, Oceania, and Africa, has formed a joint venture with Mohan Breweries & Distilleries Ltd called D1 Mohan Bio Oils Ltd to plant jatropha in southern India on a contract farming model that extends financial support to farmers through loan financing from the State Bank of India and Indian Bank.[55]

E) RESEARCH & DEVELOPMENT

Although ethanol and other biodiesel feedstocks have not been entirely neglected, jatropha is the primary focus of biofuels R&D. Under the supervision of the government's Planning Commission, several different research task forces have been established. For example, the Ministry of Forestry would oversee R&D on jatropha planting on forest lands while the Ministry of Petroleum would conduct research on trans-esterification processes. The R&D committee has also identified a number of areas that require particular attention, including technology practices for adoption at the grassroots level and research on jatropha inter-cropping for agriculture applications as well as the blending and storage of jatropha-based biodiesel.[56]

The ministries are joined in the R&D effort by academic and research institutes. For example, the Punjab Agricultural University has been examining the impact of plant oils and their esters on diesel engines for the last two decades. It has established a 60-liter batch reactor for bulk production of jatropha-based biodiesel. The Indian Institute of Petroleum has been pursuing a project called "Liquid Fuels From Renewable Resources" which concentrates on the use of non-edible oils for biodiesel production. The Indian Institute of Chemical Technology has developed a patented catalyst-free process to extract oil from jatropha that is insensitive to moisture.[57]

Meanwhile, R&D by private sector companies is generally concentrated on engine development and modification. Tractor firm Mahindra & Mahindra has established a pilot plant utilizing karanj[58] as a feedstock for biodiesel production and has successfully carried out tests using this fuel in its tractors.[59] Tata Motors has teamed up with the Indian Oil Corporation (IOC) in an informal project to study the feasibility of using biodiesel in its vehicles. The project involves 43 buses running 160 kilometers a day on a 10% biodiesel blend, and may be expanded to include all buses in Tata Motors' 160-strong fleet.[60]

Foreign companies, cognizant of the potential of India's biofuels industry, have also invested in R&D efforts, usually in conjunction with a local partner. Together with the local Council for Scientific and Industrial Research and Germany's University of Hohenheim, German automaker Daimler Chrysler is carrying out a public-private partnership to test the feasibility of jatropha-based biodiesel on internal combustion engines using feedstock from plantations in Gujarat and Orissa.[61] British Petroleum (BP) has linked up with The Energy and Resources Institute on a $9.4 million project to test the feasibility of producing biodiesel from jatropha. The decade-long project will cultivate jatropha on approximately 8,000 hectares of marginal lands and produce 9 million liters of biodiesel annually as well as install the necessary equipment for seed crushing and oil extraction and processing.[62]

F) CONCLUSION

Although it is the second-largest producer of sugar in the world, India is unlikely to become an ethanol exporter. Food security concerns in the country mean that sugarcane will remain primarily destined for sugar production, thus restricting ethanol feedstock to molasses, which results in a lower output. Although sugarcane production may grow marginally, India lacks the available land necessary for a significant increase. The country is exploring other means of producing ethanol, such as through cellulosic materials, but this technology will not be commercially viable in the medium-term. It is likely therefore that India will have to import ethanol to meet the demand generated by mandatory blends, especially as the country's growing industrial sector consumes ethanol for the manufacturing of products such as petrochemicals and pharmaceuticals. The biodiesel industry is also in an uncertain position because jatropha-based biodiesel is still commercially untested. However, firm government support behind the National Mission for Biodiesel as well as the potential price competitiveness of the fuel blend may make the country's biodiesel effort a qualified success

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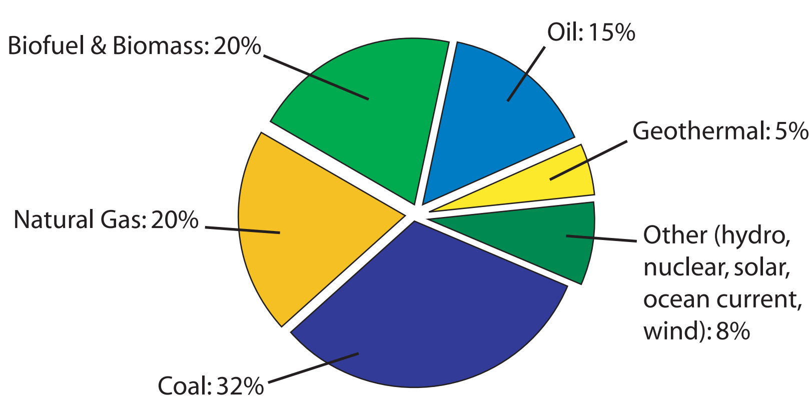
A) INTRODUCTION

Indonesia is the only Southeast Asian member of OPEC to become a net importer of oil over the turn of the century. In 2005, it imported 30% of its energy needs, a dependence that has been attributed to declining oil reserves and poor exploration techniques.[2] In particular, heavy subsidies on gasoline have rendered alternative sources of energy economically untenable. With the lack of private sector investment and weak government support, biofuels development in Indonesia has been disjointed until very recently, and largely limited to laboratory production trials and pilot projects

B) GOVERNMENT POLICIES

Indonesia's national energy policy is overseen by the Agency for Coordination of National Energy (BAKOREN), a cabinet-level agency comprised of the Ministry of Energy and Mineral Resources, the State Ministry for Research and Technology, the State Ministry for National Development Planning, the State Ministry for Environment, and the Ministry of Industry. BAKOREN launched the Green Energy Initiative 2020 in 2005, which called for the maximum and most efficient utilization of renewable energy and the development of clean, high performance fossil fuels.[3] The initiative calls for increasing the share of biofuels in the national energy mix from today's 0.2% to 20% in 2025. (See Chart 6.4a below).[4]

Chart 6.4a: Projected Energy Mix in 2025



Source: Department of Energy & Mineral Resources[5]

Prepared by Garten Rothkopf

There is currently no national policy on biofuels and no legislation implementing mandatory blends. However, a number of government publications indicate that this situation will soon change. In May 2005, the Ministry of Energy and Mineral Resources unveiled the Blueprint for National Energy Management. It sets the target of replacing 2% of fossil diesel with biodiesel and 2% of gasoline with a 10% ethanol blend by 2010, with incremental increases to follow. Replacing 2% of gasoline with a 10% ethanol blend at 2010 gasoline levels would require 420 million liters of ethanol annually[6] (see Table 6.4a) and 100,000 hectares of cassava cultivation. Displacing 2% of fossil diesel would create a demand of 800 million liters in 2010 (see Table 6.4b), which would require 205,000 hectares to be cultivated with either palm oil or jatropha.

Table 6.4a: Ethanol Roadmap

	2010	2015	2025
Gasoline Displacement	2%	3%	5%
Liters of Ethanol Needed (E10 blend)	420 million	N.A.	N.A.

Source: Ministry of Energy and Mineral Resources[7]

Table 6.4b: Biodiesel Roadmap

	2010	2015	2025
Diesel Displacement	2%	3%	5%
Liters of Biodiesel Needed	800 million	1.5 billion	4.7billion

Source: Forum Biodiesel Indonesia 2005[8]

In January 2006, Presidential Instruction 2006/No.1 called for speeding up the supply and utilization of biofuels. Details on the actual implementation of the policy are vague, although it is expected to be included in an upcoming draft law on national energy.[10]

Financing

To support such lofty biofuels production goals, Energy Minister Purnomo Yusgiantoro has estimated that Indonesia would need to raise $22 billion over the next five years. This would help finance Jakarta's plan to turn at least five million hectares of former forest land into plantation land for palm oil, jatropha, sugar cane, and cassava,[11] as well as fund the $110 million promised to farmers to help them plant biofuels crops.[12] To solicit financing, Jakarta is investing $22 million to set up a venture capital company, to be called the Lembaga Pembiayaan Bahan Bakar Nabati, in a bid to manage the $2.5 billion it intends to seek from multilateral institutions like the Asian Development Bank as well as private investors. The company would then offer up to 70% financing for biofuels projects in the country.[13]

Investment Incentives

There are currently no incentives for biofuels projects. However, in May 2006, Energy and Mineral Resources Minister Purnomo Yusgiantoro revealed that the Finance Ministry is considering fiscal incentives related to taxation and customs duties for biofuels production equipment and simplifying the procedure for obtaining licenses. Meanwhile, other ministries would work on investor-friendly policies such as simplifying land use permits to encourage the production of raw materials.[14]

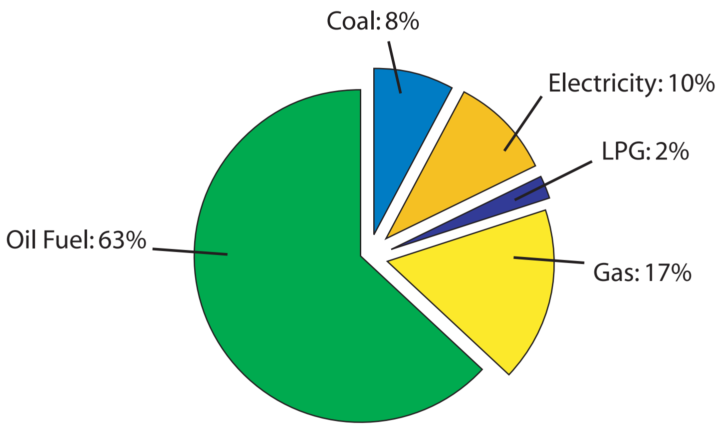
Relations with Brazil

Indonesia has concluded several trade agreements with Brazil, but none of them are in the area of biofuels or biomass trade and cooperation.

C) CURRENT SITUATION

For many years, Jakarta kept the price of oil artificially low through a series of large subsidies. However, the government was unable to sustain the heavy fiscal burden when global oil prices surged in 2003 and finally increased fuel prices by 126% in October 2005.[15] This decision paved the way for a state-backed effort to develop the biofuels industry. At the same time, the price competitiveness of biofuels against fossil fuels has started to attract private sector investors.

Chart 6.4b: Indonesia Total Energy Supply (2003)



Source: BPPT[16]

Ethanol
According to the Ministry of Industry, Indonesia produced 170 million liters of ethanol in 2005, with the bulk of it going to the beverage and pharmaceutical industries.[17] There are seven operational ethanol plants in Indonesia, each with a daily capacity of between 30,000 and 90,000 liters, but little of the current output goes to fuel ethanol. National ethanol production is expected to rise when local oil company PT Medco Energi International's new 180,000 liter-a-day[18] ethanol plant is completed in Lampung.[19] The plant will use both cassava and sugarcane molasses, which are the two main ethanol feedstocks in Indonesia.

Cassava is favored because the country is a net importer of sugar. In 2004, Indonesia imported 1.4 million tons of sugar to supplement domestic production of 2 million tons.[20] Cassava, by contrast, is Indonesia's third-largest crop. Indonesia was the world's fourth-largest producer of cassava in 2004 (20.4 million tons).[21] However, falling yields have converted the country from a net exporter to a net importer of cassava.[22] If Indonesia wishes to become a serious ethanol producer and exporter, it will have to expand the cultivation of both cassava and sugarcane, as envisaged in the government's plan.

Biodiesel
In May 2006, state-owned Pertamina, which held a monopoly over downstream oil distribution and the marketing of fuel products until 2001, began selling biodiesel in three of its gas stations. These pilot projects will be used to gauge how and when supply should be increased across the country.[23] Two biodiesel blends, B10 and B5, are being sold and are supplied from the government's Agency for Assessment and Application of Technology (BPPT). This agency also runs a palm oil-based biodiesel plant with a production capacity of 1.65 tons a day. BPPT also operates the East Java plant of chemical producer Eterindo Wahanatama.[24]

The Indonesian Investment Coordinating Board granted licenses to seven companies to build biodiesel plants in 2005,[25] and Indonesia's biodiesel output is expected to rise steadily (see Table 6.4c). Output should be further boosted by the Energy and Mineral Resources Ministry's plan to finance 11 biodiesel plants with a combined annual capacity of 29 million liters by the end of the year.[26]

Table 6.4c: Projected Biodiesel Capacity

Year	Capacity *(Million Liters)*
2007	187
2008	377
2009	1200
2010	1337

Source: Ministry of Energy and Mineral Resources[27]

The main feedstock for Indonesian biodiesel is palm oil. In 2005, Indonesia had 3.92 million hectares of palm oil under cultivation, with a yield of 3.52 tons per hectare and an output of 13.8 million tons. It is projected to produce 13.7 million tons of palm oil in 2006.[28] Land-rich Indonesia is slated to overtake Malaysia, which is quickly running out of available land, as the world's largest producer of crude palm oil (CPO) in 2007.[29] Malaysian plantation companies are showing strong interest in Indonesian land, and it is likely that the majority of the 5 million hectares of land slated for biofuels cultivation will be devoted to palm oil. (For more background on Indonesia's cooperation with Malaysia in the field of palm oil, please see the country report on Malaysia.)

Due to concerns over the use of palm oil as both a food crop and an energy source, Indonesia is also looking into jatropha as an alternative biodiesel feedstock. The non-edible plant boasts a number of advantages including very high oil content and the ability to thrive on marginal lands. Studies have shown that the eastern islands of Indonesia, where some 3.67 million hectares of dry or barren land exist, are ideal for jatropha cultivation.[30]

Production/Supply Chain Infrastructure

Although Indonesia possesses abundant raw materials, it lacks the necessary infrastructure for a widespread biofuels initiative. First, the lack of a clear legal framework makes it difficult for biodiesel manufacturers to secure financing and structure their ownership.[31] This uncertainty is exacerbated by the dearth of banks and financial institutions willing to extend loans to what they deem a risky industry. Second, even though Indonesia's fiscal situation has improved greatly since the 1997 Asian financial crisis, it is still considered a high-risk country for foreign investors. Third, the lack of distribution and fueling infrastructure makes it difficult to establish a countrywide biofuels market. Fourth, the absence of standardization, accreditation, and certification for both ethanol and biodiesel makes it difficult to ensure a quality product and gain consumer confidence.[32]

D) PRIVATE SECTOR

Private sector players are only now entering the Indonesian biofuels industry, having stayed away because of the inability of alternative fuels to compete against the country's heavily subsidized oil. As in Malaysia, local investors were led by plantation companies eager to gain economies of scale from vertical integration. In fact, the country's first privately-owned biodiesel plant, called Bakrie Rekin Bio-Energy, which is expected to come on-stream in mid-2008 with an annual capacity of 60,000 to 100,000 tons, is a joint venture between PT Bakrie Sumatera Plantations and construction firm PT Rekayasa Industri. The feedstock, which is to be a combination of CPO and jatropha, will be provided by Bakrie Sumatera's plantations.[33]

However, the country's largest agriculture company by market value, PT Astra Agro Lestari, has held back from investing in palm oil-based biodiesel because it is not confident that the venture is commercially viable. The company is, however, considering using jatropha as a feedstock because it is not a food source and is less subject to price volatility.

Indonesia has also managed to attract investment from Wilmar International, one of Asia's largest integrated agribusiness groups. The Singapore-based company has announced plans to build three palm oil biodiesel plants in its fully integrated manufacturing complex in Riau, Indonesia, where they will have access to Wilmar's own dedicated port. They are expected to be completed in early 2007 and will have a combined annual production capacity of 1.05 million tons, an output that would make Wilmar the region's largest palm oil-based biodiesel producer.[34]

The largest foreign investors in Indonesia however, are Malaysian plantation companies. According to the Indonesian Mines and Energy Ministry, three Malaysian firms, Golden Hope Plantations, Genting Berhad, and Sime Darby have committed to invest in local biodiesel.[35] With Malaysian plantation land running out, Jakarta's offer of five million hectares of land for biofuels crops cultivation is very attractive, especially when coupled with promises that state-owned Pertamina and state electricity utility PLN would act as stand-by purchasers of biodiesel.[36] The cheaper manufacturing and labor costs in Indonesia make it an attractive location for biodiesel plants. In fact, Malaysia's largest conglomerate, Genting Berhad, has committed to invest in a project covering one million hectares.[37]

E) RESEARCH & DEVELOPMENT

Indonesia's biofuels R&D efforts are dominated by the state sector. In fact, the state-run Agency for Assessment and Application of Technology (BPPT) carried out the country's first laboratory tests in both ethanol and biodiesel. It is joined by the State Ministry for Research and Technology (SMRT), which has a priority program to provide fiscal research incentives such as tax deduction and research funding based on a competitive and top-down basis as well as non-fiscal research incentives such as technical assistance and the synergizing of research from the public and private sectors.[38]

Other state research institutes such as the Research and Development Center for Oil and Gas Technology (LEMIGAS) and the Ministry of Forestry have concentrated their efforts on developing commercially viable methods of producing biogas from palm oil waste and lignocelluloses via a fermentation process.[39]

Academic institutions have also joined the R&D fray, but with a focus on jatropha as a biodiesel feedstock. For example, the Faculty of Chemical Engineering in the Bandung Institute of Technology recently operated a Mitsubishi Strade fueled with 100% jatropha-based biodiesel on a 3,200 kilometer trip from West Timor's Atambua to Jakarta.[40]

As private sector involvement in the biofuels industry has only started within the last year, there is currently no significant private sector-sponsored R&D in Indonesia.

F) CONCLUSION

Indonesia has ambitions to become the region's largest producer of both ethanol and biodiesel.[41] While it certainly has the land and natural resources to support such an undertaking, it lacks the two most fundamental ingredients: a strong infrastructure and sufficient investment. Hence, Jakarta should prioritize adopting a legal framework, improving the country's transportation infrastructure, and creating national biofuels standards. A clear show of government commitment will attract the first wave of investment which would in turn provide the necessary financing for much-needed improvements in infrastructure. Only then can Indonesia compete for global leadership in biofuels.

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A) INTRODUCTION

Japan, the world's third-largest oil consumer, is one of the world's fastest-growing consumers of biofuels, despite the lack of concrete government policies to encourage their consumption. The country produces little ethanol and has consequently become a major importer. However, there are signs that the government is now committed to encouraging biofuels production and consumption, which should increase Japan's importance in the biofuels sector.

B) GOVERNMENT POLICIES

As part of its commitment under the Kyoto Protocol to reduce greenhouse gases by six percent from 1990 levels during the 2008 to 2012 period,[2] Japan is promoting the development of new energy sources such as biofuels, which is relatively carbon neutral. The Agency for Natural Resources and Energy has announced a target of replacing about 500 million liters of transportation fuel annually with ethanol and biodiesel by 2010.[3] There are no compulsory blends in Japan, however, partly because of opposition from the influential oil lobby and other consumer goods manufacturers.

Ethanol

Despite the absence of manadatory measures, Japan does promote a 3% blend of ethanol in gasoline. To encourage private sector involvement in the ethanol industry, the Agriculture Ministry has committed $71 million to construct three ethanol plants with a combined annual capacity of 15 million liters. They are expected to use local crops such as rice, low-quality wheat, sugarbeet, and sugarcane as feedstock. A separate proposal by the Hokkaido Prefectural Union of Agricultural Cooperatives calls for the construction of a 15 million liter-a-year ethanol plant in 2007. The Agriculture Ministry estimates that Japan has sufficient feedstock to produce 100 million liters of ethanol annually but has set a more modest target of 50 million liters by 2011.[4] To achieve this target, it plans to designate special biofuels districts starting in fiscal year 2007, where drivers will be encouraged to use gasoline with a 3% blend. The Ministry has also set aside $91.2 million to build related infrastructure such as biofuels-capable gas stations.[5]

Biodiesel

Japan currently has no legislation regulating biodiesel standards. However, the Agency for Natural Resources and Energy expects legislation soon allowing for a 5% biodiesel blend, which experts hope will help create standards and inspire consumer confidence.[6] However, as with the ethanol law, it will not be mandatory and refiners will have a choice as to whether they wish to sell the biofuel. The government is also considering offering financial incentives to biodiesel producers.[7]

Meanwhile, the Japanese Ministry of the Environment has set a target for increasing biodiesel production from the current 5 million liters to between 10 million to 15 million liters annually by 2010. In accordance with the national practice of using waste oil as a biodiesel feedstock, government policies are being drafted to encourage more efficient collection of waste cooking oil from households, where 90% of the 140,000 tons of waste cooking oil are now discarded.[8] To prompt grassroots involvement in biodiesel production, the government also has plans to construct five small-scale biodiesel plants.[9]

Relations with Brazil

In February 2005, the Japan Bank for International Cooperation (JBIC) signed an agreement with Brazil's Ministry of Agriculture, Livestock and Supply stating terms of reference for the future implementation of a bilateral biofuels program to export Brazilian ethanol and biodiesel to Japan. This was followed by the establishment of the Brazil-Japan Working Group on Biomass to share information and explore possible opportunities for bilateral cooperation.[10]

In May 2005, following a high-profile visit to Brazil by then Japanese prime minister Junichiro Koizumi, Japanese companies committed to invest up to $2 billion in the Brazilian ethanol sector. JBIC, which signed agreements with Brazil's Petrobras, the National Bank of Economic and Social Development (BNDES), the Ministry of Science and Technology, and CVRD, was the chief Japanese partner. The deal with BNDES resulted in more than $500 million in JBIC loans for Clean Development Mechanism projects, as established in the Kyoto Protocol.[11] Japanese investment is expected to finance the installation of new refineries, increase the area under sugarcane cultivation, and modernize infrastructure necessary for transporting ethanol.

In 2005, Japan imported 510 million liters of ethanol,[12] more than 80 percent of which came from Brazil. However, these ethanol imports were intended solely for use in the chemicals and alcoholic beverages industries. With the passage of legislation allowing for the blend of 3% ethanol in transportation gasoline, Brazilian ethanol companies are optimistic that the ethanol trade with Japan will increase dramatically (see Table 6.5a) and may even eventually reach 6 billion liters annually.

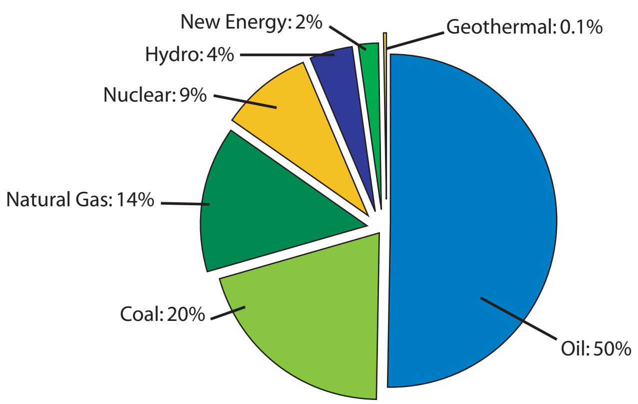
This expectation has led to the creation of the Brazil-Japan Ethanol Company, a joint venture between Petrobras and Nippon Alcohol Hanbai, which will operate in Japan and import and commercialize up to 20 million liters of sugarcane-based ethanol from Brazil by 2008.[13] Other commercial Japan-Brazil arrangements include an agreement between Petrobras, CVRD and Mitsui to study ethanol logistics in Brazil.

C) CURRENT SITUATION

Energy Matrix

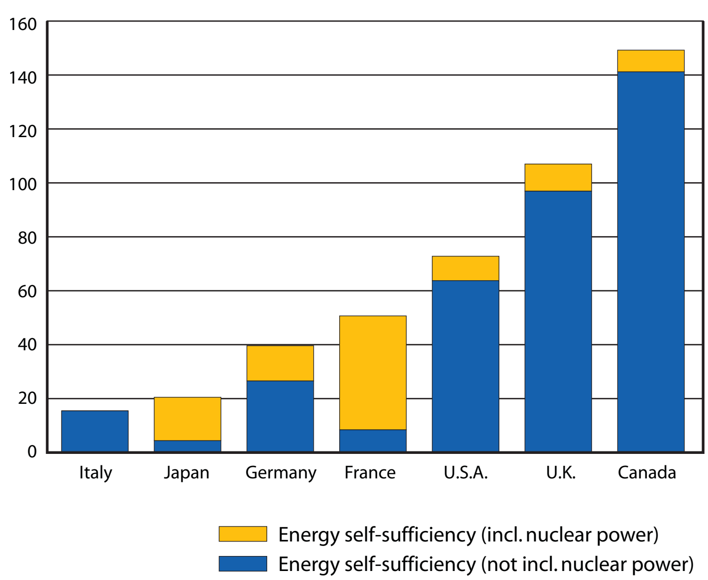
Japan is heavily dependent on oil, although its share of the country's energy matrix declined from 77% in 1973 to 50% in 2003.[14] Oil alternatives such as nuclear power and natural gas now play a significant role. However, given that both natural gas and the uranium used for nuclear power generation are imported, Japan is far from self-sufficient in energy, especially when compared to other developed countries. As such, plans to develop new energy resources[15] are underway despite the high capital costs required to increase new energy sources to the stated goal of 3% of the overall energy supply by 2010.[16] Japan has also set a goal of reducing its dependence on fossil fuels 20% by 2030.[17]

Chart 6.5a: Primary Energy Supply in Japan (2003)



Source: Agency for Natural Resources and Energy[18]

Chart 6.5b: Japan's Energy Self-Sufficiency Compared to Other Major Countries



Note: *Figures for electric power include imports and exports as primary energy.*
Figures in excess of 100% indicate exports.

Source: for Natural Resources and Energy[19]

Prepared by Carten Rothkopf

Plans to diversify Japan's energy supply are especially important given the trend of rising energy demand in the country. In particular, energy demand has grown 2.1 times in the transport sector between 1973 and 2003, because of rising vehicle ownership and declining fuel economy.[20]

Ethanol

Japan currently produces no fuel ethanol, and the approximately 100 million liters in synthetic and fermentation ethanol it produces annually go largely to its industrial and beverage industries.[21] This amount is supplemented by ethanol imports (Japan imported 510 million liters of ethanol in 2005).[22] Just six gas stations in the country sell 3% ethanol-blended gasoline (E3).[23]

According to the Japan Automobile Manufacturers Association (JAMA), there are 70 million automobiles in Japan with a combined annual fuel consumption of 60 billion liters.[24] If the 3% ethanol blend is implemented nationwide, demand for ethanol would reach an estimated 1.8 billion liters. If the blend is later extended to 10%, the annual ethanol requirement would hit 6 billion liters.[25]

Table 6.5a: Potential Ethanol Requirements in Japan

Ethanol Blend	Ethanol Requirement *(Billion Liters)*
3%	1.8
10%	6.0

Source: JAMA[26]

Meanwhile, the Petroleum Association of Japan, which comprises 17 companies in the refining and oil marketing industries, has announced that gasoline blends containing 7% ethyl tertiary butyl ether (ETBE), which is an additive made by mixing ethanol and iso-butylene, will be available for general public consumption by 2010. This is expected to create domestic ethanol demand of 350 million to 400 million liters.[27]

Biodiesel

According to the Japanese Ministry of the Environment, Japan produced 5 million liters of biodiesel in 2005.[28] The biofuel is mainly produced by municipal governments and the feedstock is primarily waste oil. Because Japan is heavily dependent on imported vegetable oil, the recycling of 450,000 metric tons of waste oil generated annually has become a national practice.[29] In recent years, companies such as Tohoku Eco Systems, Ishibashi Petrol, Aburatou Shoji, and Someya Shoten have begun converting waste canola cooking oil into biodiesel at their plants. These commercial companies were joined by municipal governments in Shiga Prefecture, like Yokkaichi City and Shinashi Town, where waste cooking oil-derived biodiesel is used to power government vehicles. These locally-led biodiesel efforts have been labeled the "Nanohana Projects"[30] and have quickly spread to more than 102 municipal governments across the country.[31]

D) PRIVATE SECTOR

Private sector involvement in the biofuels sector is led by the Petroleum Association of Japan (PAJ). Oil companies are joined by other Japanese industrial giants like Nippon Steel, Asia's second-largest steelmaker. It has announced the launch of a pilot plant to process the carbohydrates contained in food waste into sugar, which will then be fermented into ethanol and blended with gasoline at a 3% level. Studies have projected that 10 tons of such food waste, which will be collected from supermarkets, restaurants, schools, and hospitals, can produce 397 liters of absolute ethanol daily. Construction on the plant, which will be located in Kitakyushu City in southern Japan, began in September 2006, and the facility should be operational by April 2007.[32]

In addition, the country's largest refiner and auto manufacturer, Nippon Oil and Toyota Motors, announced in October 2006 that they would commence a joint development study together with the Malaysian national oil company Petronas in 2007, with the aim of producing palm oil-based biodiesel by 2009. Under this arrangement, Petronas would provide the palm oil feedstock, Nippon Oil would develop refining technologies to convert palm oil into biodiesel fit for transportation fuel, while Toyota would run tests to ensure the safety of palm-oil based biodiesel in auto engines.[33]

Toyota is joined by fellow automaker Honda in developing engines suited to biofuels usage. In 2006, Honda unveiled flex-fuel versions of its Fit and Civic models, which are equipped with exhaust sensors able to detect automatically the fuel mixture in the tank and capable of running on 20 to 100 percent ethanol mixes. Honda's flex-fuel operations are in addition to the R&D work the company has accomplished in developing ethanol produced from biomass sources (please see the R&D section below).

Trading conglomerate Mitsui & Co. has an agreement with Brazil's Petrobras and CVRD to study ethanol logistics in Brazil that supplements an earlier agreement between Petrobras and Mitsui to conduct ethanol export studies.[34] Meanwhile, Mitsui Engineering & Shipbuilding Co (a subisidary of Mitsui) is exploring the feasibility of producing ethanol from agricultural wastes sourced from Malaysia such as felled oil palm trunks, empty fruit bunches, fibrous fruit wastes, and kernel shells. If successful, the company will build a $3 million pilot plant within the next two years and begin trial operations by 2010.[35]

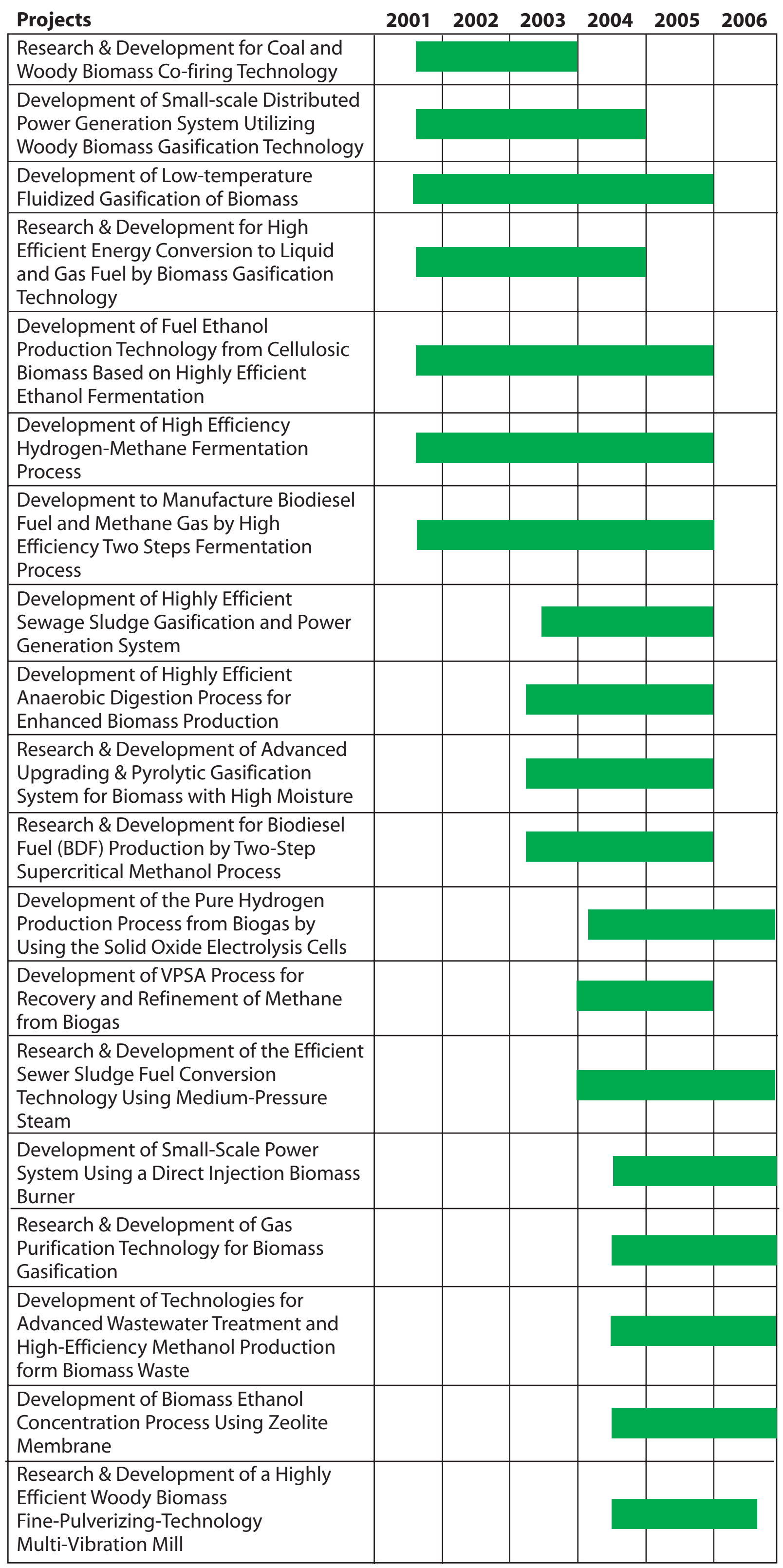
Future private sector investment plans include the creation of Japan's first plant for commercial production of cellulosic ethanol in January 2007. The plant will be operated by Bio-ethanol Japan Kansai Co Ltd, a joint venture between Taisei Corp and four other Japanese firms, and is expected to produce 1.4 million liters of ethanol from waste wood annually with plans to raise output to 4 million liters within two years.[36]

E) RESEARCH & DEVELOPMENT

Japan is an R&D powerhouse and leads the world in the number of patent applications submitted in the area of climate change and biomass research. In fact, the 20 most frequent applicants between 1998 to 2002 were all Japanese companies.[37]

Japan's R&D efforts in biofuels in particular are led by the New Energy and Industrial Technology Development Organization (NEDO), which is Japan's largest public R&D management organization and promotes the development of advanced industrial, environmental, new energy and energy conservation technologies. In addition to studies on the local alternative energy sector, NEDO has frequently forged links with foreign governments and research institutes to conduct studies on foreign biofuels markets. These efforts include an MOU with the Thai Ministry of Industry to undertake a project which aims to introduce technology for producing ethanol as a transport fuel from bagasse and molasses.[38] Diagram 6.5a below gives more examples of the kind of biomass R&D projects that NEDO has or is currently engaged in.

Diagram 6.5a: NEDO Biomass R&D Roadmap



Source: DRMI[39]

Prepared by Garten Rothkopf

Commercial players are also involved in R&D process. In October 2006, researchers at Asahi Breweries, in conjunction with the National Agricultural Research Center for Kyushu Okinawa Region, successfully cultivated a sugarcane variety three meters tall with twice the yield as normal sugarcane, able to thrive even in poor soil, and capable of surviving droughts and typhoons. The new variety has been labeled "Monster Cane" or, more formally, "high-biomass sugarcane" and is expected to be harvested soon to serve as feedstock for a pilot ethanol plant run by Asahi Breweries. The aim is to produce ethanol from cane at a cost of just 25 cents per liter, which would be nearly cost competitive with Brazil and go a long way to making ethanol competitive with fossil gasoline.[40]

With the increasing role that biofuels are to play in the transportation sector, automakers are also investing in R&D. For example, Honda's R&D arm, in conjunction with the Kyoto-based Research Institute of Innovative Technology, claims to have developed the world's first practical process for producing ethanol out of cellulosic biomass. This involves the creation of large volumes of ethanol from biomass such as wood and leaves through the use of a micro-organism that can convert sugar into alcohol while reducing interference from fermentation inhibitors, which are produced when the hemicellulose is separated from the cellulose, thus yielding ethanol more efficiently.[41] Honda has plans to construct a test plant in 2008 but has yet to discuss the commercial use of the fuel produced via this method.

F) CONCLUSION

It is clear that limitations on feedstock will make Japan a major importer of fuel ethanol. At the very least, a non-mandatory 3% blend will create demand of 400-500 million liters. A nationwide mandatory blend at that level would raise ethanol requirements to 1.8 billion liters, and a 10% nationwide mandatory blend will require a whopping 6 billion liters. Many industry watchers say this final scenario is unlikely, at least within the next decade, given the influence of the oil companies in Japan. However, new Prime Minister Shinzo Abe has publicly backed the biofuels initiative and called on agriculture minister Toshikatsu Masuoka to ensure that 10% of national gasoline demand is substituted with biofuels.[42]

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Source: World Factbook[1]

A) INTRODUCTION

Of all the Asian countries covered in this report, Malaysia is the only one that currently has no plans to develop and promote ethanol as an alternative fuel.[2] While acknowledging the merits of ethanol as a clean energy, the government has chosen to focus first on developing palm oil-based biodiesel, introducing it for public consumption, and nurturing it as a key export product. As the largest producer of crude palm oil (CPO) in the world, Malaysia has also announced its intention of becoming the world's largest biodiesel producer, an ambition supported by a strong National Biofuel Policy and backed up with financial incentives to attract both local and foreign investment.

B) GOVERNMENT POLICIES

National Biofuel Policy

In March 2006, Malaysia unveiled its National Biofuel Policy, which aims to reduce the country's dependence on fossil fuels by promoting environmentally-friendly, viable, and sustainable sources of energy. The five key elements in the plan are:[3]

1. Biofuel for Transport: B5 diesel, a blend of 5% processed palm oil and 95% fossil diesel will be applied to the land and sea transportation sectors;
2. Biofuel for Industry: B5 diesel will also be introduced in the industrial sector to fuel construction machinery, boilers, and generators;
3. Biofuel Technologies: R&D as well as commercialization of biofuels technologies to be funded by both the government and private sector (including venture capital firms);
4. Biofuel for Export: Encourage the construction of plants to produce biofuels for export to meet growing global demand;
5. Biofuel for Cleaner Environment: Increase the use of biofuels to minimize the emission of greenhouse gases and improve the quality of the environment.

The policy also lays out a three-stage implementation phase[4]

1. Short Term: Establishing standard specifications for B5 diesel, requiring selected government departments to register their diesel vehicles for B5 diesel trials, installing B5 diesel pumps for the public at selected gas stations, educating the public on the use of B5 diesel, and conducting voluntary trials on B5 diesel for the industrial sector;
2. Medium Term: Establishing standard specifications for palm oil-based biodiesel for domestic use and export, encouraging engine manufacturers to extend their warranties to include the use of B5 diesel through extensive B5 diesel warranties, enacting legislation to mandate B5 diesel, and promoting commercial biodiesel through

Prepared by Garten Rothkopf

the Malaysian Palm Oil Board (MPOB);
3. Long Term: Gradually increasing the proportion of processed palm oil in the diesel blend and facilitating the uptake of biofuels technology by foreign and domestic companies.

Biodiesel Licenses

The government is now in the second phase of the National Biofuel Policy and has approved 32 biodiesel projects with a combined capacity of 3 million tons during the last year. In July 2006, however, the Malaysian Industrial Development Authority (Mida) stopped issuing licenses for new biodiesel manufacturing projects pending a study of the palm oil downstream industry. This action was a response to growing concerns that unbridled investor enthusiasm could deprive the food market of palm oil, which is widely used in cooking, as well as threaten supplies for the industrial sector, or otherwise drive up prices.[5] In September 2006, the Plantation Industries and Commodities Ministry warned that companies not completing the construction of their biodiesel plants within the set timeframe risk the revocation of their licenses, a warning seen as another attempt to weed out speculators.[6]

Local Government Involvement

Biofuel hubs are also being established by state governments. In August 2006, the southernmost Johor state established the 480-hectare Tanjung Langsat Biofuel Park, which is expected to produce its first biodiesel in September 2007. The hub also includes the Tanjung Langsat Industrial Estate, which has the largest concentration of palm oil refineries in the world, with a capacity of 7 million tons a year generated by 17 refineries. The biofuels park's competitive advantages include its proximity to two ports (Pasir Gudang Port and Tanjung Langsat Port), bulk installation facilities, and easy access to inputs and materials from both palm oil and petroleum industries.[7]

Sabah State in West Borneo, Malaysia's largest palm oil-producing state, has established a biofuels and palm oil processing hub called the Palm Oil Industrial Cluster (POIC). The hub aims to become a regional bioprocessing center where both local and foreign biomass and oils are processed into liquid biofuels. It is also seeking to concentrate R&D efforts in biotechnology and cultivation research in a bid to become a local knowledge hub. POIC intends to attract investors by investing in necessary infrastructure such as ports and harbors to facilitate the export of liquid biofuels as well as by improving and expanding existing rail and road transport networks.[8]

Investment Incentives

Because biodiesel is included in the list of products encouraged by the government under the Promotion of Investments Act of 1986, biodiesel projects are eligible for Pioneer Status or the Investment Tax Allowance. Pending the fulfillment of specific criteria, biodiesel projects could also be considered for other incentive programs.[9]

Cooperation with Indonesia

Together, Malaysia and Indonesia account for 80% of the world's CPO production. In July 2006, the two countries announced that they would devote six million tons of crude palm oil each for biodiesel production, an amount equivalent to 40% of their individual CPO output.[10] This announcement followed an MOU signed in May 2006 to jointly promote their agricultural products abroad.[11] With Malaysia fast running out of land for new palm oil plantations (see below), Indonesia, with its huge tracts of available land, has emerged as a top choice for overseas expansion.[12]

Relations with Brazil

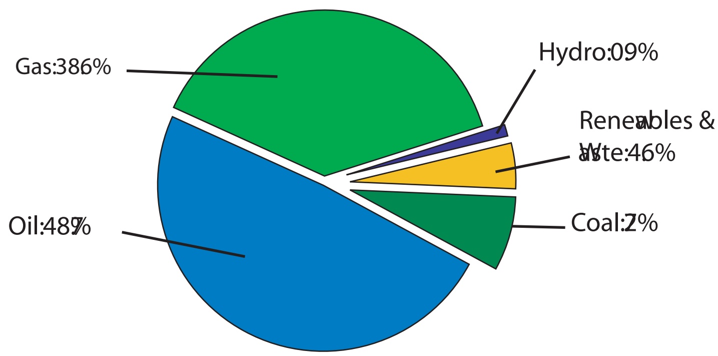
Malaysia has no agreements with Brazil in the area of biofuels or related topics.

C) CURRENT SITUATION

Energy Matrix

Faced with declining oil reserves, Malaysia is redoubling efforts to develop renewable energy. The Ninth Malaysia Plan (2006-2010) calls for the development of solar and wind energy, with a special emphasis on biofuels, with the aim of making the country a leader in palm oil-based biodiesel.[14] It also projects that the share of oil in the energy supply will fall to 44.7% by 2010 from 48.7% in 2003 as a result of an increase in renewable energy sources.

Chart 6.6a: Malaysia's Total Energy Supply (2003



Source: IEA[15]

Biodiesel

Although research into the viability of biodiesel has been underway for decades, commercial production only began once it became clear that a National Biofuel Policy would come into effect. In early 2005, nine biodiesel plants held licenses and planned to go on-stream at various stages over the next several years.[16] The Plantation Industries and Commodities Ministry has projected that Malaysia will produce 140,000 tons of biodiesel in 2006, with the possibility of output more than doubling to 300,000 tons by December 2007.[17] It is expected that 20 biodiesel plants, which will utilize 2 million tons of palm oil in feedstock, will come on-stream by 2007.[18]

Table 6.6a: Biodiesel Plants in Malaysia in 2005

Company	Partner	Capacity/Year	Value	Location
Loreno Sdn Bhd	Italian	60,000	RM 90 mil	KG Acheh, Lumut
Golden Hope/Rubiatech Sdn Bhd	MPOB	60,000	RM 40 mil	Banting
Golden Hope Bioganic	-	30,000	RM 10 mil	Banting
Kumpulan Fima	MPOB	60,000	RM 40 mil	Port Klang
Carotino	MPOB	60,000	RM 40 mil	Pasir Gudang
Kulim (M) Bhd/Natoleo	CremerOleo GMBH	100,000	-	Tanjung Lansat
Golden Hope	-	150,000	RM 100 mil	Bintulu
POIC Sabah	Ecosolution Co Ltd (South Korea)		RM 180 mil	
Bio Energy International plc			RM 200 mil	

Source: MPOB[18]

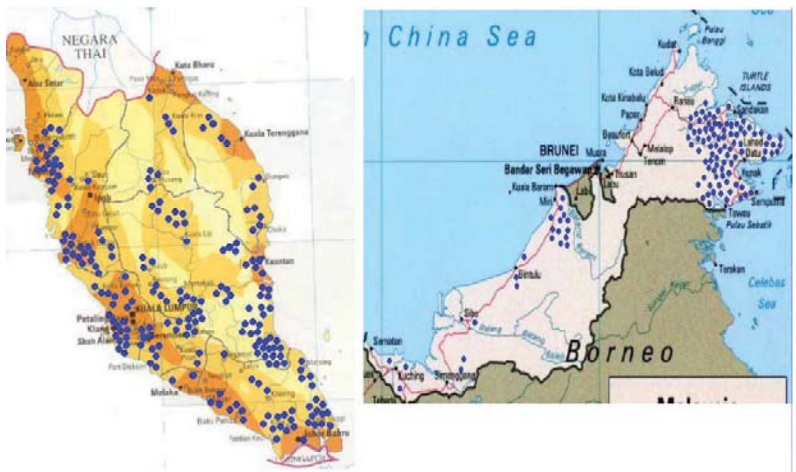
The granting of 32 licenses over the last year has led to projections that Malaysia's biodiesel capacity will surge to 3 million tons when all plants come on-stream. Even this increase, however, falls short of the national target of 6 million tons.[20] Once the B5 diesel blend comes into effect, 500,000 tons of diesel will be displaced by the 5% fully refined liquid palm oil, which will in turn save Malaysia $275 million in foreign exchange annually. Excess biodiesel is expected to be exported to Europe, particularly Germany, the world's largest consumer of biodiesel.[21]

There is also the potential of selling carbon credits under the Clean Development Mechanism (CDM) program.[21] There is also potential for selling carbon credits under the Clean Development Mechanism (CDM) program.[22]

Palm Oil

Palm oil is Malaysia's largest agricultural commodity, constituting 70% of the country's agricultural sector, and Malaysia is the largest producer of palm oil in the world. The largest palm oil-producing state is Sabah, which accounts for 30% of the country's output. Johor state hosts the largest concentration of refineries

Map 6.6a: Palm Oil Distribution in Malaysia

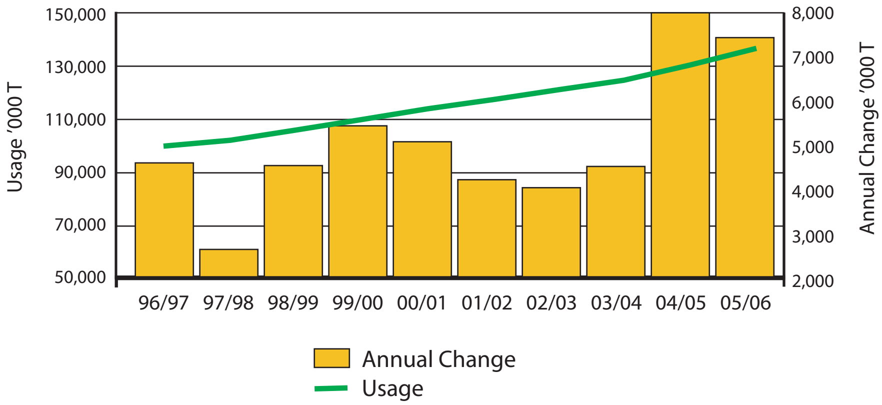


Source: SIRIM Berhad[23]

In its 2006/2007 Economic Report, the Ministry of Finance has projected a 2006 palm oil output of 15.6 million tons, a 4.3% increase from 2005, and a further 3.8% growth next year to hit 16.2 million tons in 2007. The report also projects that Malaysia may export 14.6 million tons of palm oil, a 4.4% increase from 2005.[24] The increase reflects growing demand for Malaysian palm oil as biodiesel is introduced around the world.

While Malaysia is currently the largest CPO producer in the world, it is projected that Indonesia will surpass it in 2007.[25] Malaysia has almost run out of land for new plantations. Land dedicated to palm oil cultivation increased only 3% to 4.2 million hectares in 2005, a substantial slowing from the previous year's 4.5% increase. According to the 2006/2007 Economic Report, 90% of the area under cultivation is covered with mature palms, and yields should start falling in the next few years.[26] The Plantation Industries and Commodities Ministry has urged oil palm plantation owners to raise their palm oil output by replanting high-yielding clones, but easy access and cheap land prices in nearby Indonesia have made companies reluctant to adopt the more expensive high-yield clones.[27]

Chart 6.6b: Demand for Malaysian Palm Oil



Source: MPOB[28]

The intensified focus on the palm oil industry has led that sector, the most heavily-taxed in the country, to advocate reduced taxes on labor, palm oil exports, land, and mills and refineries. Industry leader Golden Hope Plantations has called for the government to introduce new incentives for plantation companies that venture into the biodiesel industry as well as reward those with good pollution control policies.[29]

Obstacles

Although proposed in the National Biofuel Policy, Malaysia has yet to implement a Although it was proposed in the National Biofuel Policy, Malaysia has yet to implement a mandatory B5 diesel blend (commercially known as Envodiesel). 2007 has been proposed as a possible date when oil retailers would have to start supplying the biofuels blend. This hesitant approach (also evident in the cutback in biodiesel licenses) is due to public suspicion as well as reticence from industry stakeholders. The most vocal opponents have been auto engine manufacturers, who are reluctant to extend their warranty to cover Envodiesel use. They argue that the 5% biodiesel blend consists of fully refined liquid palm oil (RLPO) which has never been used in the EU, and that its effect on auto engine performance is unknown.[30] In response, the government has compromised by commissioning a study into Envodiesel (see below), despite the fact that 125 vehicles have already successfully completed pilot tests on 109,000 liters of Envodiesel.[31]

Lingering concerns about the commercial viability of the product are also slowing implementation of the National Biofuel Policy. When oil prices finally started to slide during the summer of 2006, CPO prices dropped 6% over three months as well, causing consternation among biodiesel investors.[32] Malaysian biodiesel manufacturers like Golden Hope tried to assure stakeholders that biodiesel would remain a profitable venture as long as crude oil prices stayed between $50 and $60 a barrel and CPO stays between $382 and $409 per ton.[33] Plantation Industries and Commodities Minister also urged stakeholders to take into account that the attractiveness of palm oil-based biodiesel is not only its price, but also its environmental advantages.[34]

D) PRIVATE SECTOR

The private sector companies most active in the Malaysian biofuels industry are the plantation companies, for whom vertical integration via the biodiesel industry is a logical step. They are led by industry leader Golden Hope Plantations, which has the largest presence in the local biodiesel industry. The plantation company not only announced plans for at least four biodiesel plants with a combined annual capacity of 400,000 tons, which will all come on-stream by 2008, but is also carrying the Malaysian biodiesel flag overseas. In September 2006, it decided to establish a palm oil estate in Venezuela to boost smallholder activities in that country by providing downstream expertise and exporting oil palm seeds, technical know-how, R&D findings, as well as consultancy management services. The company also exported its first shipment of biodiesel from its first complete biodiesel plant in Banting, Selangor to Japan in August 2006.[35]

The growing importance of biofuels in Malaysia is underlined by the entry into the market of the country's largest conglomerates, Genting Berhad and Sime Darby. In addition to its biomass R&D efforts (see below), Genting Berhad also has plans to invest in the Indonesian biodiesel sector (see country report on Indonesia). Sime Darby is seeking to expand its oil palm cultivation from the current 90,000 hectares to 200,000 hectares and has announced plans to establish a biodiesel plant in Pasir Gudang with an annual production capacity of 100,000 tons.[36]

A key feature of the National Biofuel Policy has been to attract foreign investment, and a number of foreign-local joint ventures are underway. Kuala Lumpur-based Zurex Corporation and UK-based Biofutures International PLC have established a 200,000 tons-per-year biodiesel plant in Sabah.[37] More recently, six foreign companies have expressed interest in setting up biodiesel plants in the Tanjung Langsat Biofuel Park.[38]

E) RESEARCH & DEVELOPMENT

R&D in Malaysia's biofuels industry is primarily led by the Malaysian Palm Oil Board (MPOB) and is dominated by palm oil-based R&D. In response to concerns over the suitability of Envodiesel for vehicles, MPOB and Shell announced a joint study on the biodiesel blend in October 2006. In particular, the project will examine if palm oil will clog up a vehicle's fuel-injection system, a principal concern. The results of this research study are important to the development of the local biodiesel industry because convincing results should remove remaining doubts and complement Kuala Lumpur's efforts to promote its use.[39]

In another foreign joint venture R&D project, MPOB and the Department of High-Tech Development and Industrialization of China's Ministry of Science and Technology have signed an MOU to explore new biomass and biofuels technologies. An initial study will establish the scope of cooperation as well as possible joint biofuels R&D projects. In particular, the bilateral partnership is interested in harnessing ethanol from palm-based biomass.[40]

Meanwhile, local companies have also been responding to the government's call for breakthroughs in biomass technology. In August 2005, the Genting Group unveiled Malaysia's first commercially-produced bio-oil, called Genting Bio-Oil, which was produced from solid biomass that is left as waste after edible vegetable oil has been extracted. It is an innovative approach to dealing with the 13 million tons of empty fruit bunches produced in the country annually.[41]

F) CONCLUSION

The most pressing challenge for Malaysia's biodiesel industry is to convince industry stakeholders as well as consumers of the viability and effectiveness of biodiesel as a transportation fuel. However, local consumption will only account for a small part of the biodiesel industry's sales. Even when the 5% biodiesel blend is implemented nationwide, this will only generate demand for 500,000 tons of biodiesel. Malaysia is expected to have a biodiesel output of 3 million tons in 2008 and 6 million tons in the longer-term, and the bulk of this is intended for export markets. Malaysia is unlikely to face a shortage of CPO even as Indonesia emerges as the leading producer. Instead, Malaysian plantation companies will likely continue to expand their palm oil land-holdings in Indonesia. Barring a massive drop in oil prices, Malaysia's ambition of becoming a major player in the global biodiesel trade is within reach.

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A) INTRODUCTION

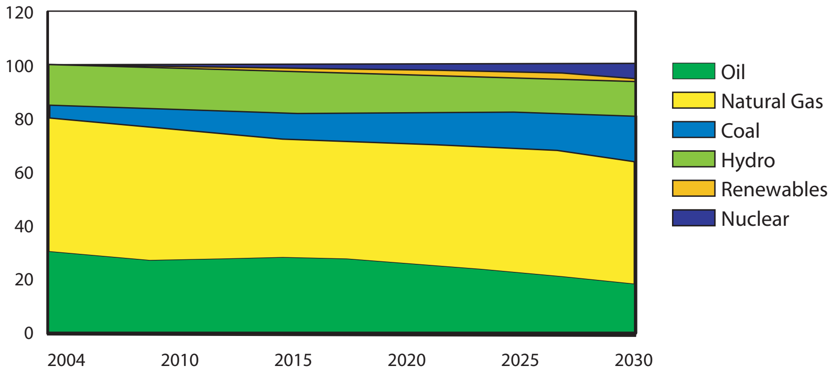
The push to develop a domestic fuel ethanol industry in Pakistan is relatively new and a direct consequence of the Pakistani ethanol industry's loss of tax-free status in the EU in 2005. With a sudden surplus of ethanol, the sugar industry has been furiously lobbying the government to adopt a mandatory ethanol blend in gasoline to boost ethanol consumption. While the government appears receptive to the idea, it has thus far adopted a careful and incremental approach, due to opposition from the oil industry.

B) GOVERNMENT POLICIES

The latest Pakistani energy policy is the 2005 Energy Security Plan, which seeks to maximize the utilization of indigenous resources to meet growing energy demand in an affordable and sustainable manner. It also seeks to have nuclear and renewable energy sources reach 10% of the energy mix by 2030.[2] However, data from Chart 6.7a shows that apart from hydro energy, other sources of renewable energy, including biofuels, are insignificant

Prepared by Garten Rothkopf

Chart 6.7a: Pakistan Energy Mix Plan Projections (Percentages)



Source: Planning Commission[3]

Ethanol

The current drive to develop a local fuel ethanol industry is a direct result of Pakistan's loss of EU "Drug Country" status, following a complaint by India that the EU had violated WTO obligations by only granting tariff preferences to 12 countries and not other developing countries under the EU Generalized System of Preferences (GSP) anti-drug regime.[4] The loss of preferential status in July 2005 meant that Pakistan was no longer allowed to export ethanol duty-free to the EU, a concession that had made the country the EU's second-largest ethanol supplier (after Brazil). Ethanol exports from Pakistan are now subject to the full tariff rate.[5]

Consequently, ethanol exports to the EU have fallen and are expected to remain at low levels. The country has reported that the loss of trade led to the closing of two of the country's seven operating distilleries and that the future of five new distilleries is now uncertain.[6] The Chairman of the Pakistan Sugar Mills Association (PSMA) has alleged that the loss of preferential status is due to the "mafia of international importers of molasses" who are determined to peg the country as only an exporter of raw molasses and prevent it from expanding its value-added ethanol industry.[7]

The fuel ethanol drive is led by the PSMA, which has lobbied the government to implement a national policy for the production of ethanol. The list of recommendations it has submitted includes:[8]

1. The implementation of a mandatory 10% ethanol blend with gasoline after consultation with the oil industry, which can be subsequently increased, with minimal engine changes needed.
2. A blending program with the full support of the government, including the introduction of major incentives to industry stakeholders.
3. The establishment of a target for all automobile companies to produce a fixed percentage of flex-fuel cars by a certain date. The percentage should be incrementally raised in subsequent years.
4. The Ministry of Food Agriculture and Livestock (MINFAL) should explore other biofuels feedstocks such as maize, wheat, rice, potatoes and sorghum.
5. The setting of the fuel ethanol price in accordance with the price of molasses in consultation with industry stakeholders
6. The restriction of molasses exports to ensure the availability of molasses for ethanol feedstock.
7. The replacement of molasses with sugarcane juice as ethanol feedstock after consumption of fuel ethanol rises significantly.

The main obstacle to the implementation of a nationwide mandatory ethanol blend with gasoline is opposition from the influential oil industry, which disputes the PSMA's assertion that $500 million in foreign exchange will be saved through a 10% ethanol blend. The oil industry has also questioned the energy efficiency of ethanol, its environmental benefits vis-à-vis unleaded gasoline, and its effect on engines at higher-blend levels.[9]

Seeking to balance these interests, the government has so far adopted a cautious approach, although it has included legislation to promote a 5% ethanol blend in the 2005 Energy Security Plan.[10] In August 2006, Prime Minister Shaukat Aziz launched a pilot project in which 25 selected vehicles in the cities of Islamabad, Lahore, and Karachi using E10 gasoline would be monitored by the Hydrocarbon Institute and Pakistan State Oil Company (PSO).[11] IIn addition E10 gasoline would be made available at a few selected pumps in those cities. In response to this government initiative, the PSMA has suggested that the government make E10 gasoline available at all PSO gas stations.[12]

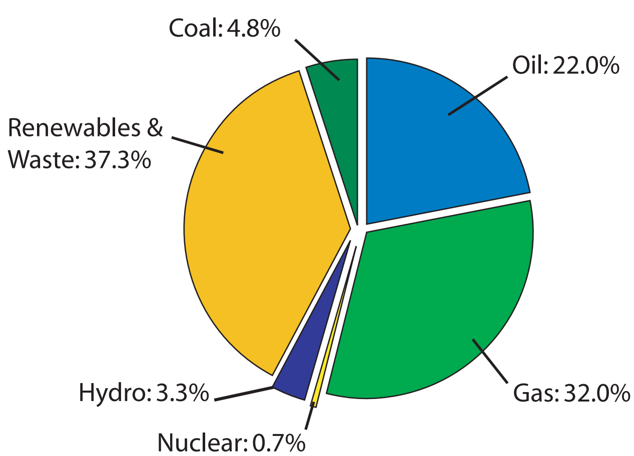
Biodiesel
There are currently no policies or legislation on the utilization of biodiesel in Pakistan.

Relations with Brazil
Following the visit of President Pervez Musharraf to Brazil in November 2004, trade relations between the countries have become closer. According to the Ministry of Foreign Trade, state-owned Pakistan Petroleum Limited (PPL) and Brazil's Petrobras will establish a joint venture to explore oil and gas on the Pakistani coast. Pakistan is also interested in establishing partnerships with Brazil in fuel ethanol technology.[13]

C) CURRENT SITUATION

Pakistan is a net importer of energy, and imported $3.1 billion worth of petroleum products in 2005.[14] In an effort to reduce its imports, the country has adopted a demand suppression policy, which has affected industry and impeded economic growth.[15] There has been a national drive to increase the consumption of natural gas as an energy source, as Pakistan is self-sufficient in that fossil fuel.[16]

Chart 6.7b: Share of Total Primary Energy Supply in 2003



Source: International Energy Agency[17]

Ethanol
Pakistan is a net exporter of ethanol. There are currently 21 ethanol plants in Pakistan, of which 14 were operational at the end of 2005.[18] In 2004/2005, the country had an ethanol capacity of 400,000 metric tons. Local consumption of ethanol accounted for just 2,000 metric tons, with 80,000 tons going to export markets,[19] half to the European Union.[20] According to projections from the PSMA, Pakistan's ethanol capacity will double from 531 million liters (approximately 400,000 metric tons) to 1 billion liters (approximately 800,000 metric tons) when new ethanol plants come online in 2007.[21]

According to Chaudhary Zaka Ashraf, PSMA's chairman, Pakistan's sugar industry will eventually have the capacity to produce more than 3 million tons of ethanol annually.[22]

Table 6.7a: Potential Annual Ethanol Requirements

Percent Blend	Ethanol Requirement *(Metric Tons)*	Forex Savings
10%	160,000	$500 million
20%	320,000	N.A.

Source: Ministry of Industries[24]

Ethanol in Pakistan is produced primarily from molasses, as sugarcane is one of Pakistan's major agricultural crops. According to the Ministry of Industries, between 1994 and 2004, the country produced 1.3 million metric tons of molasses annually with the bulk going to export markets.[25] It is apparent from Tables 7.6b and 7.6c that the country has the capacity to ramp up ethanol production if it cuts back on sugar and molasses exports.

Table 6.7b: Export of Molasses

Year	Quantity *(Metric Tons)*
2000-01	1,190,012
2001-02	1,607,380
2002-03	1,272,630
2003-04	1,457,283
2004-05	1,151,431

Source: PSMA[26]

Table 6.7c: Sugarcane Plantation Area, Production, Yield and Utilization of Sugarcane by Sugar Mills

Year	Area *(Hectares)*	Production *(Metric Tons)*	Yield Per Hectare	Utilization % by Sugar Mills
2000-01	960,000	43,620,000	45.41	67.47
2001-02	999,700	48,041,000	48.06	76.33
2002-03	1,099,700	52,049,000	47.33	80.28
2003-04	1,074,700	53,800,000	50.00	81.19
2004-05	966,600	43,533,000	45.04	73.74

Source: PSMA[27]

Biodiesel

Pakistan currently has no plans to promote biodiesel production, despite the fact that 75% of the country's vehicles run on diesel and domestic supply is only able to meet 38% of demand, resulting in annual diesel imports of 4.5 million metric tons.[28] In fact, the Alternative Energy Development Board only began the process of establishing its first biodiesel pilot plant, which will have a daily capacity of 600 liters, in December 2005.[29]

D) PRIVATE SECTOR

As is typical in nascent ethanol industries, the sugar companies are the most active private sector investors. In the last year, the sugar industry has initiated almost ten ethanol plants with the expectation that a mandatory ethanol gasoline blend would soon be imposed by the government.[30] The largest ethanol plant, with a daily capacity of 165,000 liters, is run by Al-Abbas Sugar Mills, which exports 95% of its output.[31] The next largest ethanol plant, with a daily capacity of 160,000 liters, is run by Shakarganj Mills Limited, which exports 90% of its total production.[32]

E) RESEARCH & DEVELOPMENT

To facilitate efforts to develop alternative forms of energy, the government established the Alternative Energy Development Board (AEDB) in 2003. The organization was subsequently granted autonomous status in April 2005 through a presidential ordinance. While efforts have been concentrated on solar and wind energy, the AEDB has also joined up with the private sector to conduct R&D in biodiesel and fuel cell technology. It was instrumental in facilitating the establishment of the country's first biodiesel production plant.[33]

Under the Prime Minister's directive, the Hydrocarbon Development Institute of Pakistan (HDIP) carried out a feasibility study on E10. The successful results led to government approval of pilot projects for the E10 blend in Islamabad, Lahore, and Karachi in August 2006.[34]

F) CONCLUSION

The verdict is still out on whether Pakistan's transport industry will embrace ethanol, especially given that relatively little gasoline is consumed in the country. Pakistan is also seeking other means to reduce its dependence on imported oil by promoting the use of natural gas vehicles.[35] In May 2006, the Hydrocarbon Development Institute of Pakistan announced that the country had become one of only three countries (the other two being Brazil and Argentina) to possess more than one million natural gas vehicles, having achieved the feat of replacing 15% of its vehicles with CNG cars and constructing 930 CNG stations in under two years.[36] While this may detract from resources and consumers intended for biofuels, it shows that Pakistan is capable of the strong commitment needed for an alternative energy program.

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Source: World Factbook[1]

A) INTRODUCTION

As an archipelagic country with more than 7,000 islands, the Philippines is host to a wealth of natural resources. With its abundance of agricultural commodities such as sugar, rice, and coconut, all of which are feedstocks for ethanol and biodiesel production, the country has the potential to become a major exporter, especially in the field of coco-based biodiesel. The flourishing of the biofuels industry in the Philippines is a strong possibility, given the support of the government, one of the few in Asia to not only implement a National Biofuels Program but also back it up with clear-cut legislation.

B) GOVERNMENT POLICY

In 2003, the Department of Energy released a Renewable Energy Policy Framework, which set the target of increasing the Philippines' renewable energy-based capacity 100% by 2012.[2] This is to be achieved by promoting more private sector participation through special incentives offered by the Board of Investments (see below). While much of the focus was on geothermal energy, in which the Philippines has ambitions to become the world's leader, and wind energy, of which the country hopes to become Southeast Asia's largest producer, efforts were also made to raise the contribution of biomass, solar, and ocean energy from virtually nothing in 2002 to 131 MW by 2013.[3] With this framework as a base, the Philippines government has since carved out biofuels specific legislation.

Table 6.8a: Renewable Energy Policy Framework 10 Year-Targets (MW)

	2002	Target Additional Capacity	2013
Geothermal	1,931	1,200	3,131
Hydro	2,518	2,950	5,468
Wind	0	417	417
Solar, Biomass, Ocean	0	131	131
TOTAL	4,449	4,698	9,147

Source: Philippines Department of Energy

The Renewable Energy Policy Framework is part of the country's 5-Point Energy Independence Agenda[4] which calls for:

- The accelerated development and use of indigenous energy resources such as coal, gas and oil;
- The promotion and increased use of alternative fuels;
- The aggressive promotion, development and use of renewable energy resources;

- Strategic alliances with other countries; and
- Stronger implementation of energy conservation and efficiency measures.

Ethanol Policies

In September 2004, ethanol was included as part of the Department of Energy's Agenda Towards Energy Independence. Next, in November and December 2004, senior officials, including President Gloria Macapagal, consulted with foreign government officials as well as local and foreign experts on the feasibility of a national ethanol program. Finally, following extensive consultation with the Philippine Fuel Ethanol Alliance[5], the National Ethanol Program was launched in May 2005.[6]

Biodiesel Policies

Although a number of different feedstocks are used to produce biodiesel in the Philippines, coco-based biodiesel, or Coco Methyl Ester (CME), is the main product. In May 2003, the government published a guideline (PNS 2020:2003) setting national standards for CME. In February 2004, it released Memorandum Circular No.55 directing all government departments to use the 1% CME biodiesel blend in their vehicles. This was followed by Department Circulars (No. 2004-04-003 and No. 2005-04-003) that promoted the use of CME as an alternative energy. The government also sponsored studies which found that there was an average increase of 1.5 kilometer fuel mileage per liter of 1% CME-biodiesel blend.[7]

Biofuels Legislation

The Biofuels Act (House Bill 4269) was approved in September 2005 by the House of Representatives and seeks to replace 10% of national gasoline consumption with ethanol and biodiesel within the next four years[8]. The bill stipulates that the minimum ethanol blend will be set at 5% for the first two years, with an option to increase to 10% in the next two years. It also mandates the creation of a National Biofuel Board to review and impose minimum biofuels blends. It also states that there will be no reduction in minimum biofuels blends within seven years of the initial fuel blends mandate.[9]

The Biofuels Act (Senate Bill 2226) was approved in September 2006. It affirmed the House Bill's stipulation of a 5% ethanol blend, while mandating a 1% CME blend[10], which would be raised to 2% two years after the legislation goes into effect. A number of disputes slowed passage of the legislation. First, there were differences over the size of tax breaks to be granted to biofuel producers. Second, there were doubts over the competitiveness of CME against diesel. Third, there were concerns over the security of supply for feedstocks such as sugarcane, which is dependent on the quality of harvests.[11] Finally, the influential Chamber of Automotive Manufacturers of the Philippines (CAMPI) stated that biofuels would be incompatible with 40% of vehicles in the country because of their carburetors.[12]

Investment Incentives

To encourage private sector investment, the National Biofuels Act legislation included financial incentives such as a zero rating on value-added tax and duty-added tax, income tax holidays, and a low 1% duty on imports of renewable energy equipment and input for 10 years. It was also stipulated that biofuels would not be taxed higher than petroleum fuels.[13] In addition, government financial institutions were directed to provide priority assistance to biofuels investments. This meant that financing for projects to grow biofuels feedstock were given priority at the Land Bank of the Philippines, the Development Bank of the Philippines as well as the Quedan and Rural Credit Guarantee Corporation. The Development Bank of Philippines also committed $900 million in loans to encourage the development of the Filipino ethanol sector.[14] To complement the above measures, private sector investors could also take advantage of the Board of Investment's Priority Incentives which created an income tax holiday for the first four to six years and additional reductions for local labor expenses and infrastructure investments as well as the employment of foreign nationals for pioneering projects in renewable energy.[15]

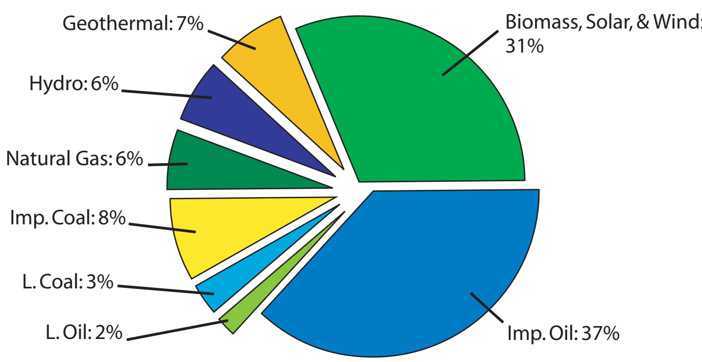
Relations with Brazil

The Philippines imported 3,587 metric tons of ethanol from Brazil in 2005.[16]

C) CURRENT SITUATION

The Philippines possess abundant renewable resources. In 2000, the Department of Agriculture and the Department of Environment and Natural Resources estimated that aggregate biomass supply potential in the country was approximately 253.8 million barrels of fuel oil equivalent (MMBFOE) and projected to grow to 301.5 MMBFOE by 2008, with fuelwood, bagasse, coconut residues, ricehull, and animal waste having the highest biomass potential.[17]

Chart 6.8a: Philippines Energy Power Matrix (2005)



Source: Philippines Department of Energy[18]

Ethanol

The Philippines is a net importer of ethanol, a status it is hoping to change with the launch of the National Ethanol Program as well as the supporting legislation from the National Biofuels Act. In 2005, it imported 37 million liters of ethanol, primarily from China, Thailand, India, Brazil, and Australia.[19] Three ethanol plants run by the National Development Corp. in Negros Oriental are operational and have a combined annual production capacity of 110 million liters.[20] The feedstock of choice in the Philippines is sugar (the country is a net exporter). The government has plans to set up 10 ethanol plants with a combined daily capacity of one million liters (or a combined annual capacity of 365 million liters) to be supported by the creation of 12 new sugarcane plantations.[21]

Table 6.8b: Potential Annual Ethanol Requirements

Percent Blend	Ethanol Requirement *(Million Liters)*
5%	236
10%	536

Source: Philippines Department of Energy[22]

E10, or a 10% blend of ethanol with gasoline, is currently available in 27 Seaoil and four Flying V fueling stations in Manila and two nearby provinces. The sale of the blend is expected to be increased soon to more than 400 stations by these retailers as well as two of their competitors, Unioil and USA88.[23]

Biodiesel

The Department of Energy has accredited three CME manufacturers, Senbel Fine Chemical Co., Chemrez Inc., and RI Chemicals. Together, they have a combined production capacity of 110 million liters of CME annually, which is more than sufficient to meet demand when the 1% mandatory CME biodiesel blend is implemented.[24] Two other CME plants, Romtron CME Plant and Atson Coco Inc, with a daily capacity of 1,000 and 600,000 liters respectively, are awaiting accreditation.[25] CME is currently sold by 192 gas stations run by Flying V and Seaoil as well as 110 retailers and distributors under Senbel and Chemrez.[26] There are plans to export excess CME, and the US, Australia, China, Japan, and Germany have already expressed interest.[27]

Table 6.8c: Projected Annual Demand for Coco-Biodiesel

Petrol Diesel Demand: 700m liters

Biodiesel Blend	Biodiesel Demand
1%	70m liters
2%	140m liters
3%	210m liters
4%	280m liters
5%	350m liters

Source: Philippines Department of Energy[28]

Production/Supply Infrastructure

The Philippines archipelagic structure creates some supply complications. The sugarcane production areas are largely concentrated in the Visayas (in particular the provinces of Negros Occidental and Panay) and Mindanao (in particular the provinces of North Cotabato and Bukidnon), while the majority of consumers are concentrated in major cities like Manila, Calabarzon, and Cebu. Ethanol cannot be delivered through pipelines from distilleries in the Visayas and Mindanao and require expensive transportation through a combination of ships and trucks.[29]

D) PRIVATE SECTOR

In December 2005, Ford Philippines committed to investing $20 million in a flex-fuel engine plant in Rosa, Laguna. The investment followed Ford Asia-Pacific's decision to make the Philippines its ASEAN Center of Excellence for Flexible Fuel Technology. The technology is now commercially available in the country, and the first flex-fuel vehicle model was launched in April 2006.[30]

Meanwhile, UK-based biodiesel producer D1 Oils Plc has established a series of model farms across the Philippines. It regards the country as a major production center for jatropha-based biodiesel and a potential hub for coordinating planting and refining activities across Southeast Asia, together with both government and commercial partners.[31] D1 Oils Asia-Pacific has even teamed up with local mining and resource company Atlas Consolidated Mining and Development Corporation to rehabilitate land previously degraded by mining through bioremediation by using jatropha to replace lost nutrients. The ultimate goal is to plant jatropha on 7,000 hectares of degraded land to produce biodiesel for the power generation of off-grid mining facilities.[32]

Another UK biomass specialist company, Bronzeoak Ltd, has established a joint venture, San Carlos Bioenergy, with the National Development Company to produce fuel grade ethanol from sugarcane juice.[33] The company has a plant scheduled to go on-stream in early January 2007 that is located in San Carlos, Negros Occidental, just 2.5 kilometers from a port.[34]

Local companies are also making significant forays into the biofuels sector. In May 2006, Chemrez Inc opened Asia's largest coco-biodiesel plant in Libis, with the capacity to produce 60 million liters of coco-biodiesel annually. According to experts, adding one liter of coco-biodiesel to every 100 liters of biodiesel will guarantee savings of $20 in fuel consumption and vehicle maintenance monthly.[35] Chemrez is already exporting biodiesel to Japan and Germany, and is currently in negotiations to expand its export markets to include the US, Australia, and China. It is also interested in exporting to European markets including France, Italy, and the Netherlands.

E) RESEARCH & DEVELOPMENT

The public sector's R&D efforts in renewable energy are led by the Energy Research and Development Division (ERDD) of the state-owned Philippine National Oil Co – Energy Development Corp (PNOC-EDC),[36] which supports the identification and exploration of indigenous energy sources such as wind energy and biomass. PNOC-EDC is conducting an experiment in Negros Oriental, where it has planted three varieties of jatropha in a bid to discover which would possess the maximum oil yield and allow the company to produce a minimum of five liters per hectare. Once results are confirmed, PNOC-EDC will build its own jatropha refinery in Negros Oriental, where 18,000 hectares have been identified by the government as possible planting areas for jatropha.[37]

The Sugar Regulatory Administration (SRA) is currently developing a sweet sorghum hybrid called SSH 104, which can be easily converted into ethanol and then combined with gasoline to be used as gasohol. According to William Dar of the India-based International Crops Research Institute for the Semi-Arid Tropics, the Philippines should cultivate sweet sorghum as an ethanol feedstock because it matures in just four months, compared to 12 to 16 months for sugarcane, and thus only requires one-fifth the water. If successfully developed, the SSH 104 would also better tolerate drought, water logging, and high soil salinity.[38]

The academic community is also participating in the national biodiesel R&D effort. The Department of Agriculture has asked state universities and colleges in the Eastern Visayas region to allocate at least 50 hectares of their land for the cultivation of jatropha seedlings.[39] The University of Eastern Philippines has assumed the lead in the development of jatropha, while Leyte State University has set up a two-hectare jatropha plant.

F) CONCLUSION

While it is clear that the Philippines has strong potential in becoming a regional and even global leader in biofuels, particularly in the biodiesel market, well-laid plans may still be derailed by a number of factors. In particular, the feedstocks of choice in the country are all food sources, which are not only affected by capricious harvests, but may also face a future conflict if high demand for biofuels drive the prices of these commodities up, and thus affect the food supply to the country's growing population. There are also concerns that the country is not ramping up ethanol production quickly enough to meet the increased demand expected when the mandatory 5% ethanol blend comes into effect. According to Representative Juan Miguel F. Zubiri, a key proponent of the House Biofuels Bill, the Philippines needs to build at least 25 ethanol plants, much more than the government's proposed 10, in order to avoid having to import fuel ethanol.[40] If so, the Philippines will remain a net importer of ethanol for a few more years yet.

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Source: World Factbook[1]

A) INTRODUCTION

With Thailand's energy demand growth outpacing its GDP growth, the country has become increasingly reliant on imported energy, and energy security has become a pressing concern. With its rich agricultural tradition, Thailand has an abundance of crops that can be used as possible feedstock for biofuels production, and recent crop surpluses could easily be redirected to the biofuels manufacturing industries. This agricultural bounty, together with recent high oil prices and hopes that biofuels production will boost agricultural commodity prices and farming incomes, has galvanized the Thai government to implement programs that are now driving the local biofuels industries. The biofuels program has added prestige and importance in the kingdom because it was initiated by the highly-revered King Bhumipol as part of his drive to encourage rural development in the 1980s via the Royal Chitralada Projects.

B) GOVERNMENT POLICIES

Thailand's renewable energy policy is overseen by the Department of Alternative Energy Development (DEDE), which was established in 2002 by the Government Administrative Act 2545 under the Ministry of Energy (MOE) with a mandate to promote R&D as well as the use of alternative energy.[2] The MOE has established a target of achieving 10% alternative energy usage by 2011.[3]

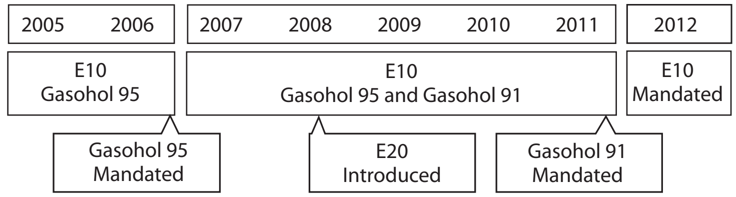
Ethanol

Thailand's ethanol policy is run by the National Ethanol Committee (NEC). In August 2003, the country began mandating a 5% ethanol blend (known as gasohol 95) in five states. To promote its use, the government instituted a tax exemption, and the price of gasohol 95 was fixed below that of gasoline. Initial consumer reaction was encouraging, and the number of stations offering gasohol was expanded from just 730 to 4,000 in 2005, with consumption of gasohol 95 rising to four million liters daily.[4]

The NEC has set an ethanol consumption goal of one million liters/day by mandating the use of gasohol 95. In 2011, a compulsory 10% ethanol blend will be implemented, which will raise the ethanol consumption goal to two million liters/day. This translates to a jump in annual domestic consumption from 365 million liters in 2006 to 730 million liters in 2011.[5] There are also plans to increase ethanol consumption to three million liters of ethanol/day by further MTBE replacement in gasoline 95.

Prepared by Garten Rothkopf

Diagram 6.9a: Gasohol Strategic Roadmap



Source: Committee of Renewable Energy[6]

Biodiesel

When oil prices jumped in January 2004, the Thai government attempted to stabilize diesel prices by providing subsidies from the Oil Fund. This approach was discontinued in July 2005[7] when the fund ran a deficit of $2.5 billion. Floating the diesel price gave a breath of new life to the diesel and biodiesel manufacturing industries. In addition, the exemption of biodiesel from the 0.5 baht/liter ($0.014/liter) oil tax for biodiesel ensures that its price remains below that of diesel and thus competitive.

To organize the industry, the Committee of Promoting Biodiesel Production and Consumption was established. It comprises the Ministry of Energy, the Ministry of Agriculture and Cooperatives, the Ministry of Industry, the Ministry of Public Health, and the Ministry of Natural Resources and Environment.[8] A budget of $32.5 million was also approved to promote biodiesel development between 2005 and 2012. To achieve a final target of producing 8.5 million liters of biodiesel by 2012, the government plans to implement a 5% blend of biodiesel in Bangkok, followed by the southern provinces and finally the rest of the country.

Table 6.9a: Projected Biodiesel Capacity in Thailand (2007 – 2012)

	2007	2008	2009	2010	2011	2012
Biodiesel Plants	3	4	7	17	39	85
Biodiesel Capacity *(ML/day)*	0.36	0.46	0.76	1.76	3.96	8.50

Source: Committee of Renewable Energy[9]

To meet the expected demand of 8.5 million liters, Thailand must produce 4.8 million liters/day of biodiesel from 640,000 hectares of oil palm, import an additional 1.2 million liters/day from 160,000 hectares of land in neighboring countries, as well as rely on 2.5 million liters/day produced from jatropha. These targets are also supported by incentives in the national budget, which allocates $35 million to promote research on oil palm and jatropha as well as develop biodiesel standards, testing, and demonstrations. Another $21.4 million has been set aside to guarantee the seed supply of oil palm and jatropha.

Local Government Involvement

Efforts are being made to encourage biodiesel production at the community level in Thailand. In June 2005, a pilot project was initiated in the northern province of Chiang Mai where a 2% biodisel blend (B2) was used in a test group of 1,000 public passenger pick-ups running in the city. The plan has been well received by Chiang Mai consumers, particularly after engine performance and emission tests were carried out prior to and after biodiesel use. Oil companies participating in the project, including PTT, plan to set up more B2 service stations in the city.[10]

The Ministry of Energy has cited the Chiang Mai pilot project as an example for the rest of the country and plans to spread biodiesel production and usage to 70 communities. This expansion would build a rural production capacity of between 7,000 and 21,000 liters/day to replace up to 2 million liters/year of fossil diesel in the agricultural sector by 2012.[11] So far, Bangkok, Nakorn Ratchasrima, Chon Buri, Samut Prakarn, Nonthaburi, Konkan, Udon Thani, Chiang Rai, Ubon Ratchathani, and Nakorn Srithamarat have adopted similar programs. The Ministry has also described the rural approach as an attractive investment niche for local and foreign private investors.[12]

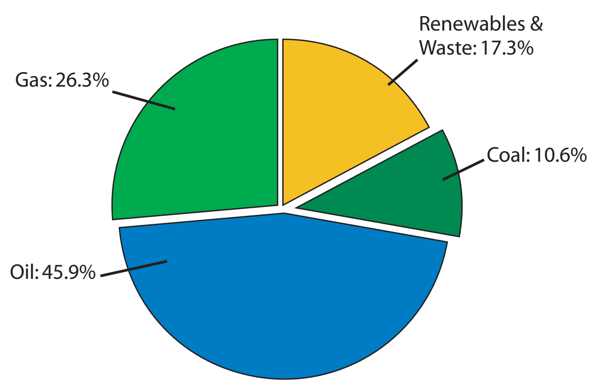
Investment Incentives
Thailand's Board of Investment (BOI) has accorded the biofuels industry duty-free import status as well as an eight-year income tax exemption. In addition, the country's southern provinces have been designated a BOI Special Investment Zone, with $50 million budgeted for palm oil cultivation in those areas.[13]

Relations with Brazil
In September 2004, Brazil and Thailand signed a memorandum of understanding to exchange biofuels information and expertise. This included the export of 300,000 liters of Brazilian ethanol to Thailand. Thailand's Ministry of Energy is eager to emulate Brazil's ethanol success story, particularly with regard to moving up the value chain of agro-energy exports. In return, Brazil sees Thailand as a gateway for exports to Asia, including China, South Korea, and ASEAN.[14]

C) CURRENT SITUATION

Energy Matrix
With its economy growing at an average 5% per year, Thailand's 291 million barrels of proven oil reserves[15] are insufficient to meet demand, and the country depends heavily on imported energy. In 2003, energy consumption in Thailand accounted for 15% of GDP,[16] and the value of energy consumption is expected to increase from $21.3 billion in 2003 to $57.4 billion in 2017. As with most countries, Thailand's primary energy supply is derived from fossil fuels like oil, natural gas, and coal, but it has a higher than average reliance (17.3% in 2003) on energy derived from renewables and wastes (see charts 6.9a and 6.9b). In 2003, the Thai government unveiled a competitiveness strategy that seeks to reduce energy elasticity from 1.4:1 in 2003 to 1:1 by 2007.[17] As the transportation sector accounts for 37% of energy consumption, efforts to promote biofuels consumption as well as the use of fuel-efficient vehicles are strongly encouraged.

Chart 6.9a: Thailand's Total Primary Energy Supply (2003)



Source: IEA[18]

Ethanol
In 2005, Thailand produced 300 million liters of ethanol, of which 60 million liters were fuel ethanol.[19] At the end of 2005, six private sector ethanol plants had gone on-stream with a combined production capacity of 1.1 million liters per day.[20] Altogether, 24 ethanol plants with a total capacity of 4.2 million liters/day were scheduled to go on-stream by the end of 2006.

Table 6.9b: Current Ethanol Production Capacity

Entrepreneur	(l/d)	Raw Material	Province	Commencing Date
1. Pornwilai International Group	25,000	Molasses	Ayuttaya	Oct 2003
2. Thai Alcohol	200,000 #	Molasses	Nakorn Pathom	Aug 2004
3.Thai Agro-Energy	150,000	Molasses	Suphanburi	Feb 2005
4. ThaiGhuan	130,000	Cassava	KhonKhen	System Test Jun 2005
5.International Gasohol Corp.	150,000 350,000	Cassava		Jun 2005 * By 2006
6. KhonKhen Alcohol	85,000	Molassess	Rayong	Aug 2005*
7. Rierm Udom White Sugar	200,000	Cane/Molasses	KhonKhen	By 2006
8. Thai Kanchanaburi Sugar	200,000	Cane/Molasses	NhongBuaLampoo	By 2006
9. MitrPol Sugar	200,000	Cane/Molasses	Kanchanaburi	By 2006
10.Ruam Kaset Industry	200,000	Cane/Molasses	Suphanburi	By 2006
11.Thai RungRueng Energy	120,000	Cane/Molasses	ChaiyaPhoom	By 2006
12.Thai RungRueng Energy	120,000	Cane/Molasses	Saraburi	By 2006
13.East Sugar and Cane	100,000	Cane/Molasses	Petchaboon	By 2006
14.N. Y. ethanol	150,000	Cane/Molasses	SaKeaw	By 2006
15.Rachaburi ethanol	100,000	Cane/Molasses	NakornRatchasima	By 2006
16.Korat Industry	100,000	Cane/Molasses	Ratchaburi	By 2006
17.Auang Wien Industry	160,000	Cane/Molasses	NakornRatchasima	By 2006
18.Mr. Nopporn Wongwatanaseen	100,000	Cane/Molasses	NakornRatchasima	By 2006
19.Somdej (1981)	100,000	Cane/Molasses	Ratchaburi	By 2006
20.Fah KwanThip	120,000	Cassava	UdornThanee	By 2006
21.Siam Ethanol Industry	100,000	Cassava	PaJeenburi	By 2006
22.Picnic Gas and Engineering	500,000	Cassava	ChaiyaPhoom	By 2006
23.Boon A-Nek	500,000	Cassava	NakornRatchasima	By 2006
24.Burirum Ethanol	100,000	Cane/Molasses	Burirum	
Total	**4,210,000**			

Source: DEDE[21]

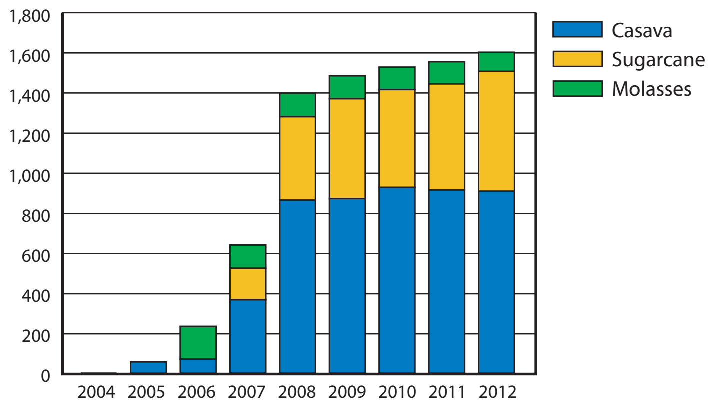
In Thailand, sugarcane and cassava are the main feedstock for ethanol. Sugarcane is grown mainly in the northeastern and central provinces of the country and is usually planted before or after the rainy season with the sugarcane harvest season lasting for four to five months a year. All sugarcane produced is then supplied to the country's 46 sugar factories through contract farming arrangements.[22] In 2004-2005, the country had a sugarcane production capacity of 75 million tons, producing 3.75 million tons of molasses, a by-product that is a popular ethanol feedstock in Thailand.[23] Approximately 50% of molasses is used in local industries such as food, feed, and ethanol distilleries, with the remaining 50% destined for export markets. According to the Cassava Information Network, this excess molasses could be used as feedstock for producing up to one million liters of ethanol daily. In addition, local industries only consume 2 million tons of Thailand's annual sugar production capacity of 7.3 million tons, making Thailand the second-largest exporter of sugar in the world. This excess, too, could be diverted to the ethanol industry, especially since sugar has a higher sucrose-content than molasses.

Thailand is also the world's largest producer of cassava, a starchy crop that is another common ethanol feedstock. It is able to thrive on relatively infertile land where other crops cannot. In Thailand, the crop is cultivated on 1.1 million hectares of land with an annual root productivity of 18 to 20 million tons of fresh roots. Recognizing the commercial potential of cassava, Thailand has developed new cassava varieties with higher starch yield, boosting the production efficiency of cassava roots to 23 tons per hectare.

As with the sugar industry, the local starch industry only requires 8 million tons of fresh roots, leaving 8 million tons to be processed into chips and pellets for export markets, with the remaining 4 million tons going to the local food industry. According to the Cassava Information Network, the 12 million tons of fresh roots not used for the starch industry should be allocated to the ethanol industry, where it will be sufficient to guarantee 2 million liters of ethanol daily at 85% production efficiency.[24] Biotechnology advances including the development of starch-degrading enzymes may further boost production.

Chart 6.9c shows projections from the Thai Parliament's Committee for Renewable Energy for Thailand's ethanol production through 2012, after taking into consideration the additional capacity that can be added when excess sugarcane and cassava is turned into ethanol.

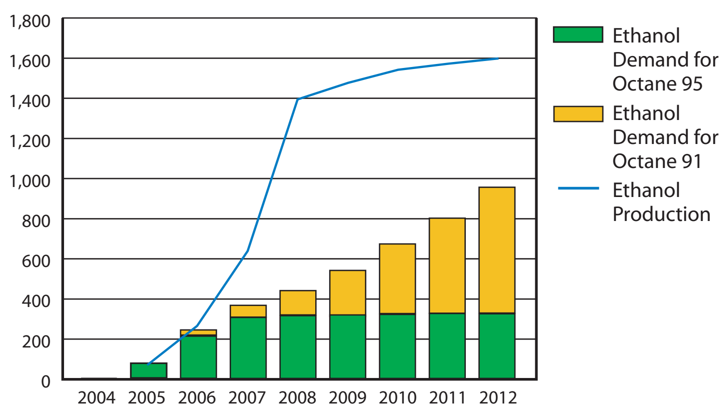
Chart 6.9c: Projected Ethanol Production in Thailand (2004-2012)



Source: Renewable Energy Committee[25]

Because Thailand is projected to have an annual ethanol demand of just 365 liters in 2006 with a mandatory 5% blend and 730 million liters with a mandatory 10% blend,[26] the country could become a major exporter of ethanol in the coming years

Chart 6.9d: Projected Demand and Supply of Ethanol in Thailand (2004 – 2012)



Source: Renewable Energy Committee[27]

Biodiesel

Biodiesel production in Thailand began locally in the early 1980s when farmers in the southern provinces experimented with homemade oils in their pickup trucks and farm equipment.[28] The government only became involved in 2005 when it grew concerned that 46% of the 100 million liters of foreign oil imported each year was diesel.[29] The abolition of diesel subsidies prompted the local industry to become more organized, and biodiesel production began to break out of the laboratory scale.

Biodiesel in Thailand is mainly produced from palm oil, physic nut, and coconut oil. In 2005, Thailand produced 4 million tons of palm which yielded 81,000 tons of palm oil every month. Because local palm oil production only required 68,000 tons per month, the country had an annual surplus of 150,000 tons of palm oil. The surplus could be dedicated to biodiesel manufacturing; current biodiesel production is only 350,000 liters/day.

Biodiesel is currently sold at 35 gas stations owned by PTT and Bangchak Petroleum Public Company (BCP), with a combined sales volume of 113,000 liters/day. Both companies have plans to extend their biodiesel retail operations to 200 stations by the end of 2006.[30]

Infrastructure of Production/Supply Chain

With the national biofuels initiative still in its early stages, no thorough study has been conducted on the state of the Thai biofuels industry's supply chain infrastructure. It is known that the government is seeking to increase palm oil plantation land from the current 160,000 hectares to 640,000 hectares by 2009, primarily in the southern and eastern regions of the country, where the climate is suitable and rural farming communities are large.[31] Biodiesel plants have been planned near plantation grounds and ethanol plants near sugar factories in order to facilitate transportation.

The Thai government has also taken steps to develop a support structure for the farming community as part of its strategy of targeting rural areas in the national biofuels effort through the creation of a Special Purpose Vehicle (SPV).[32] This new financial mechanism is intended to assist farmers in management, marketing, and finance. It will also provide production assistance to farmers and facilitate the local and foreign distribution of their products. The SPV will also offer farmers credit through securitization or by securing loans from financial institutions.

D) PRIVATE SECTOR

Private sector investment received a boost from the October 2006 agreement between the Export-Import Bank of Thailand (EXIM Bank) and Japan's Bank for International Cooperation to support Thai private sector investment in biodiesel and ethanol production in the Greater Mekong Sub-region (GMS), which includes Thailand, southern China, Myanmar, Cambodia, and Vietnam. In particular, the two banks hope to support projects which produce biofuels from cassava and sugarcane.[33] It would also help the GMS countries capitalize on the comparative advantages of their neighbors. Thailand, for example, lacks cheap labor and large tracts of land to cultivate crops that can be used as biofuels feedstock (which Laos and Myanmar have in abundance) but possesses the needed technology and expertise. However, loans are restricted to large-scale operations and will only be extended to those companies or investors that propose to cultivate at least 400 acres of land with a minimum 50-year lease commitment.

State-owned oil and gas company PTT is the main player in Thailand's biodiesel industry. With a current biodiesel production capacity of 600,000 liters/day, PTT is engaged in three palm-oil based biodiesel joint ventures with private-sector companies that should bring its total capacity up to 1.2 million liters/day. The first joint venture with Southern Palm Company will yield a production capacity of 300,000 liters/day and the second with Bio Energy Plus Co. will produce 200,000 liters/day.[34] The third is with Charoen Pokphand Group (CP), a leading agro-industrial and foods conglomerate, to set up a biodiesel plant with a capacity of 100,000 liters/day.[35] The Thai Energy Ministry has expressed its hope that these private-public joint ventures will attract more investment from the private sector, which will encourage farmers to grow more palm. I n fact, the joint venture between PTT and CP also seeks to open up new palm plantation land as well as encourage the cultivation of palm trees in the country's south.

Meanwhile, overseas companies are also seeking to enter the Thai biofuels industry. In July 2004, India's Praj Industries, the world's largest supplier of molasses-based distillery technology, won a contract from Khon Kaen Alcohol Company to construct a 100,000 liters-per-day ethanol distillery based on cane molasses and cane syrup.[36] The distillery is attached to the Khon Kaen sugar mill in Nampong and its products are meant for the gasohol industry. Another Indian company, Pune-based KBK Chem Engineering, also constructed a 200,000 liters-per-day distillery project for Kaset Thai Sugars, which owns one of the world's largest sugar mills.[37]

E) RESEARCH & DEVELOPMENT

The bulk of Thailand's R&D for the biofuels sector is carried out by oil and gas company PTT, the National Science and Technology Development Agency (NSTDA), King Mongkut's University of Technology Thonburi (KMUTT), Prince Songkla University, Chulalongkorn University, the Petroleum and Petrochemical College, and the Royal Thai Navy.[37]

Since 2001, the Royal Thai Navy (RTN) has been conducting an ongoing research project on biodiesel production and demonstration with the sponsorship of the Defense Research and Development Office (DRDO). After the successful establishment of a biodiesel pilot plant with a daily capacity of 2,000 liters, the RTN is currently developing a "continuous type" biodiesel pilot plant which is not only smaller and more compact in size, but also equipped with a higher production capacity, and thus suitable for use by communities in remote areas.[39]

Due to the skeptical public response to the state-sponsored biodiesel blending program, a number of studies have been conducted on the impact of biodiesel on engines. The Thai Navy Dockyard and DEDE successfully carried out tests on four pick-up vans with 2500cc diesel engines, with each running on different biodiesel blends.[40] In October 2006, the Thai Energy Ministry and PTT carried out tests on older cars with carburetor engines with a blend of 90% gasoline and 10% ethanol. The successful outcome of the tests, which found that fuel tanks remained in normal condition, with no residue in the tank or damage to the metal, rubber, and plastic parts, was very important as the country currently has 566,469 cars with carburetor engines.[41]

Aware of the potential of the Thai biofuels industry, foreign companies have also contributed to the R&D effort. In August 2006, Japan's Toyota and PTT signed a memorandum of understanding with Kasetsart University for a joint research effort titled "Collaborative and Development Project on Jatropha Biodiesel for Diesel Vehicles",[42] which will focus on seed selection and the cultivation of Jatropha Curcas. The popularity of jatropha as a feedstock is expected to rise once the 40 new biodiesel plants currently under construction in Asia come on-stream.[43] Toyota, which is providing almost half of the project's research funding, has said that it will produce more biodiesel-friendly engines if the research produces positive results.

Finally, the academic community has also become involved in policy research on biofuels. Funded by the Ministry of Energy and led by the Joint Graduate School of Energy and Environment (JSEE) in the KMTT, a new project titled "Policy Research for the Promotion of Renewable Energy and Energy Efficiency" was conducted from June 2005 to June 2006. It involved more than 30 leading researchers from 10 major universities (including those mentioned above). The scope of the project involved the development of R&D roadmaps that would support national renewable energy development plans as well as improve the country's energy efficiency policy for 2007-2008. It also proposed measures to promote R&D for biofuels and analyzed the human resources necessary for a sustainable renewable energy industry.[44]

F) CONCLUSION

Unlike most other countries, Thailand produces more crops than can be consumed by local food and manufacturing industries. In particular, the sugarcane and cassava surpluses that are currently being exported can easily be redirected to the ethanol and biodiesel manufacturing industries. As local fuel ethanol consumption is likely to consume only a portion of the country's output, Thailand likely will be a significant exporter of ethanol. A slightly different picture exists in the biodiesel industry. Although Thailand has a current palm oil surplus of 150,000 tons, Pornchai Rujiprapa, the deputy permanent secretary for energy, has said it would be insufficient to meet demand. Hence, the government is carefully considering the import of raw materials such as crude palm oil in the initial stages when Thais are still adjusting to the idea of biodiesel as a transportation fuel.[45]

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