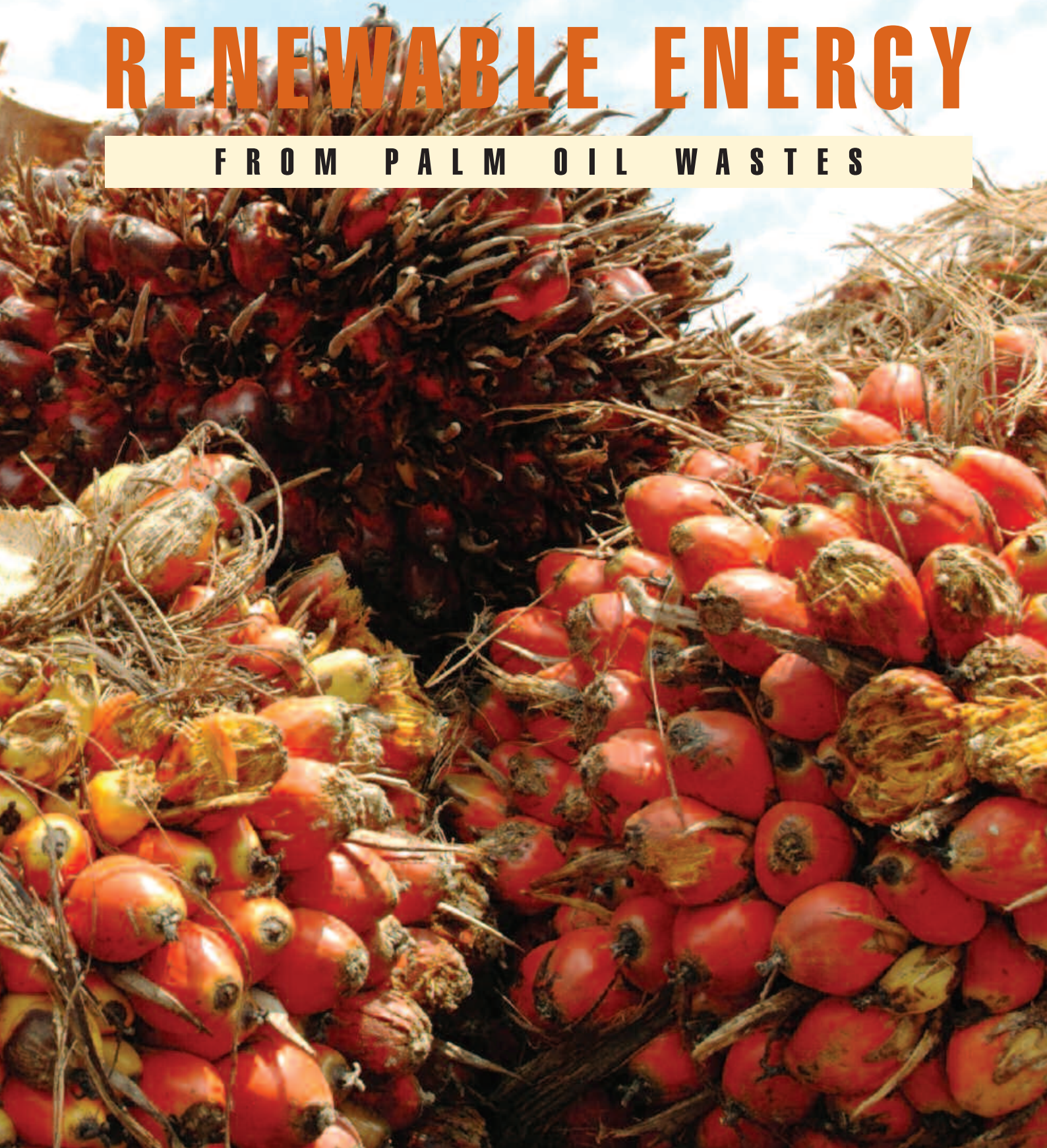




MALAYSIA GENERATING RENEWABLE ENERGY

FROM PALM OIL WASTES



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RENEWABLE ENERGY

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Published by the United Nations Development Programme (UNDP), Malaysia.

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First published August 2007.

ISBN 983-3904-01-3

United Nations Development Programme
Wisma UN, Block C, Kompleks Pejabat Damansara,
Jalan Dungun, Damansara Heights, 50490 Kuala Lumpur, Malaysia.
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Foreword

Soaring energy prices are a reminder of the essential role that affordable energy plays in sustainable economic growth and higher human development. Safeguarding energy supply, especially from clean indigenous resources, has become more pressing than ever. Current patterns of energy generation and use impact negatively on the environment at local, regional and global levels.

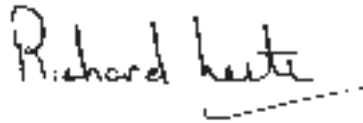
The degradation of our environment due to energy production from fossil fuels, have contributed to a global reevaluation of energy use in all economic sectors. The need for sustainable energy use has become more and more evident. As such, renewable energy is envisaged to become an increasing share of Malaysia's electricity generation. With abundant sources available, such as biomass and biogas, the palm oil industry is likely to become ever more prominent in adopting renewable energy.

In 2002, the government of Malaysia initiated a project Biomass Power Generation and Cogeneration in Palm Oil Industry (BIOGEN) to help promote the use of renewable energy, with support from the United Nations Development Programme (UNDP), the Global Environment Facility (GEF) and the private sector. The project's primary objective is to develop and implement activities that will build stakeholders' capacity and facilitate the greater adoption of renewable energy system. It focuses on palm oil industries and the use of waste material in generating electricity in the mills and selling it to the grid where possible. The information presented in this publication provides an indication of the efforts being made and the related policy implications.

This is the fourth of a new series of periodic publications that report on UNDP Malaysia's work in its energy and environment practice area. The large range of projects being undertaken in this portfolio is designed to support Malaysia's effort to achieve the Millennium Development Goal 7 (MDG7), of ensuring environmental sustainability. The series of publications and updates on particular project may be accessed through UNDP's website, <http://www.undp.org.my>.

I would like to thank the GEF for cofunding this project and Ministry of Energy, Water and Communications (MEWC) for implementing it with UNDP. I would also like to thank other institutional participants and members of the Biogen team (page IX). Special thanks go to the Report Team for their professionalism and good efforts in putting this publication together. I sincerely hope that it will be widely read and will increase awareness of the critical importance of good environmental management on the use of renewable energy.

The project has highlighted a number of important issues and some significant lessons have been learnt. It is hoped that as the project move towards completion, these experiences and the outcomes, in the form of policy development and the demonstration models, will provide exemplars for further steps in renewable energy throughout Malaysia.

A handwritten signature in black ink that reads "Richard Leete". The signature is written in a cursive style with a long horizontal stroke at the end.

Richard Leete Ph.D
Resident Representative
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Abbreviations and Acronyms

AAIBE	Akaun Amanah Industri Bekalan Elektrik (MESITA)	MEWC	Ministry of Energy, Water and Communications
APS	Alternative Policy Scenario (of the International Energy Agency)	MIEEIP	Malaysian Industrial Energy Efficiency Improvement Project
BPMB	Bank Pembangunan Malaysia Berhad (new name for Bank Industri & Teknologi)	MNRE	Ministry of Natural Resources and Environment
CDM	Clean Development Mechanism (Kyoto Protocol)	MPIC	Ministry of Plantation Industries and Commodities
CHP	Combined heat and power	MPOB	Malaysian Palm Oil Board
EFB	Empty fruit bunches	MPOC	Malaysia Palm Oil Council
EPU	Economic Planning Unit	MW	Megawatt
FELCRA	Federal Land Consolidation and Rehabilitation Authority	OECD	Organisation for Economic Co-operation and Development
FELDA	Federal Land Development Authority	OPEC	Organization of the Petroleum Exporting Countries
FFB	Fresh fruit bunches	POME	Palm oil mill effluent
FSM	Full scale model	PORIM	Palm Oil Research Institute of Malaysia
GEF	Global Environment Facility	PTM	Pusat Tenaga Malaysia (Malaysia Energy Centre)
GHG	Greenhouse gas	RE	Renewable energy
GoM	Government of Malaysia	REBF	Renewable Energy Business Facility
Gt	Gigatonnes	REPPA	Renewable energy power purchase agreement
GWh	Gigawatt hour	RISDA	Rubber Industry Smallholders Development Authority
ha	hectare	RSPO	Roundtable on Sustainable Palm Oil
IEA	International Energy Agency	SCORE	Special Committee on Renewable Energy
kt	kilotonne	SESB	Sabah Electricity Sdn Bhd
KTAK	Kementerian Tenaga, Air dan Komunikasi (MEWC)	SREP	Small Renewable Energy Programme
ktoe	kilotonnes of oil equivalent	TNB	Tenaga Nasional Berhad
mb/d	million barrels per day	UNDP	United Nations Development Programme
mtoe	million tonnes of oil equivalent		

Glossary

anaerobic	bacterial process without oxygen
bagasse	residue of sugar cane crushing
baseload	steady flow of power regardless of fluctuating demand
bioenergy	energy produced from organic matter
Biogen	codename of the project
carotenoids	a compound that is a source of vitamin A
cogeneration	production of electricity and thermal energy from a common fuel source
co-firing	burning of secondary fuel (often renewable energy form) with primary fossil-fuel in power plants
<i>force majeure</i>	extraordinary, unforeseen event beyond the control of contracting parties
lignocellulosic	woody biomass (timber, wood chips, straw, manure)
mesocarp	fleshy part of the fruit between the skin and the kernel
oleochemical	chemical derived from oils or fats
primary energy	Energy embodied in natural resources before being converted to more convenient forms, such as electricity and gasoline
pyrolysis	chemical decomposition of organic materials by heat in the absence of oxygen

Participants

Institutional Participants

Executing Agency	Ministry of Energy, Water and Communications Government of Malaysia
Implementing Agency	Pusat Tenaga Malaysia
GEF Implementing Agency	United Nations Development Programme
UNDP GEF	Bangkok Regional Office
Donor Partners	AAIBE, The Government of Malaysia

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- Ministry of Energy, Water and Communications (MEWC)
- Ministry of Natural Resources and Environment (MNRE)
- Malaysian Palm Oil Association (MPOA)
- Palm Oil Millers Association (POMA)
- Malaysian Palm Oil Board (MPOB)
- Energy Commission
- Bank Pembangunan Malaysia Berhad (BPMB)
- Universities

GLOBAL ENERGY PRODUCTION AND CONSUMPTION



World Scenario

The world is facing two energy related threats:

- lack of sustainable, secure and affordable energy supplies; and
- the environmental damage incurred in producing and consuming ever-increasing amounts of energy.

In the first decade of the twenty-first century, soaring energy prices and destabilizing geopolitical events have been a reminder of the essential role that affordable energy plays in economic growth and human development, and of the vulnerability of the global energy system to supply disruption. Safeguarding energy supplies is an international priority, yet current patterns of energy supply and consumption themselves carry the threat of irreversible environmental damage.

The need to curb growth in fossil energy demand, to increase geographic and fuel supply diversity, and to mitigate climate destabilizing emissions such as greenhouse

gases, is more pressing than ever. United Nations' member countries have begun taking initiatives on developing alternative energy scenarios and strategies aimed at a more sustainable and cleaner energy future. The Commission for Sustainable Development (UNCSD) for example, responsible for reviewing progress in the implementation of Agenda 21 and the Rio Declaration on Environment and Development, discusses the use of renewable energy in length and reaffirms commitments by member countries in adopting it where possible. UN Framework on Convention on Climate Change (UNFCCC), started in 1994, sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change and recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The use of renewable energy is further encouraged as the energy sector is

the main culprit in GHG emissions. Kyoto Protocol (started in 1997), strengthens the Convention by committing Annex I Parties to individual, legally-binding targets to limit or reduce their greenhouse gas emissions and the implementation of renewable energy system remains as the most feasible and popular options available.

For the G8 nations, the International Energy Agency (IEA) was requested to prepare a strategy in the form of an Alternative Policy Scenario (APS) that proposes policies and measures for the consideration of governments in order to significantly reduce the rate of increase in energy demand and emissions. The economic cost of these policies, put forward in 2006¹, would be more than outweighed by the economic benefits that would accrue from producing and using energy more efficiently.

With worldwide adoption of stricter environmental standards and guidelines for greenhouse gas emissions, it is becoming clear that renewable energy systems will be credited for their inherent advantage in lowering emissions. These environmental benefits will contribute towards making the delivered costs more palatable and are already the driving force behind policy initiatives in many more advanced countries.

Whether governments of OECD or non-OECD countries will adopt the Alternative Policy Scenario or some elements of it remains to be seen: huge obstacles, ranging from powerful vested interests to public indifference, will have to be overcome. Reconciling the goals of energy security and environmental protection requires strong and coordinated government action and public support.



Meanwhile, fossil fuel demand and greenhouse gas emissions continue on their current unsustainable trajectories. In the following sections, the magnitude and implications of these continuing trends are more fully explored.

Expanding demand for energy

Between 2006 and 2030, unless strong and coordinated government action and public support significantly modify recent trends, global primary energy demand is projected to increase by just over half, or at an annual rate of 1.6%. Over 70% of that increase in demand will be from developing countries, China alone accounting for nearly 30%. This represents a significant shift in the centre of gravity of global energy demand towards countries that are experiencing faster economic (and often population) growth than more advanced countries such as those in the Organisation for Economic Co-operation and Development (OECD).

¹ International Energy Agency, *World Energy Outlook 2006*, Paris.

Sources of energy

Globally, fossil fuels are predicted to remain the dominant source of energy to 2030, accounting for 83% of the overall increase in energy demand between 2004 and 2030. Consequently, their share of total world demand edges up from 80% to 81%. Among fossil fuels, the share of oil is predicted to drop, although oil still remains the largest single fuel in the global energy mix by 2030. Global oil demand, 84 million barrels per day (mb/d) in 2005, is expected to reach 99 mb/d by 2015, and 116 mb/d in 2030.

Coal as an energy source is expected to record the greatest increase in demand in absolute terms and will remain the second largest primary fuel, its share in global demand increasing slightly. China and India alone account for almost 80% of the incremental demand for coal. The share of natural gas is also expected to increase, despite rising prices.

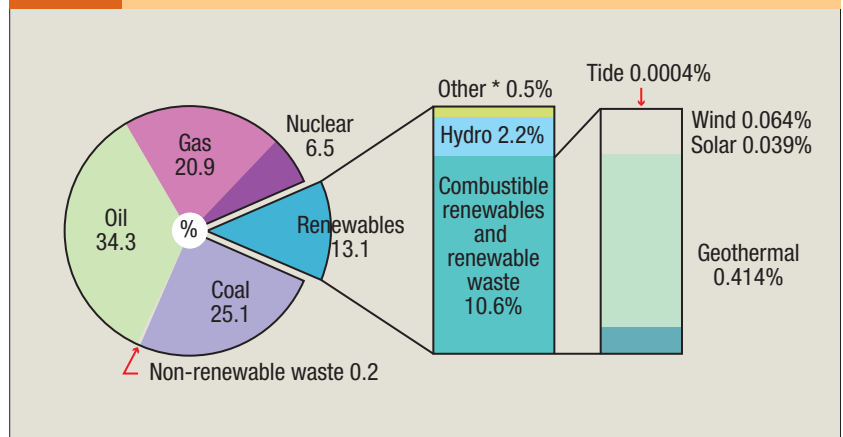
Hydropower's share of primary energy rises slightly, while that of nuclear power is expected to fall. The share of biomass falls marginally, as developing countries switch to using modern commercial energy, offsetting the growing use of biomass as feedstock for biofuels production and for power and heat generation. Non-hydro renewables—including wind, solar and geothermal—grow quickest but from a low base.

In 2004, renewables accounted for 13.1% of the 11,059 million tonnes of oil equivalent (mtoe) of world total primary energy supply (Figure 1). Combustible renewables and waste (97% of which is biomass, both commercial and non-commercial) represented 79.4% of total renewables followed by hydro (16.7%). Renewable energies ('renewables') are

Challenges

- Nearly one-third of the world's population do not yet have electricity or other modern forms of energy supply; and a second third have only limited access;
- Sources of energy are frequently long distances from the point of consumption, resulting in inefficiencies and wastage;
- Almost half of the increase in global primary energy use goes to generating electricity and 20% to meeting transport needs – almost entirely in the form of oil-based fuels;
- Coal, used mainly for power generation, is expected to be the energy source for which growth in demand will be greatest; this implies that mitigating emissions will be an ever greater challenge.

Figure 1 Fuel share of world total primary energy supply, 2004



* Geothermal, solar, wind, tide/wave/ocean. Source: International Energy Agency, Renewables in Global Energy Supply: An IEA Fact Sheet, OECD, 2007, Figure 1.

essential components in the global energy portfolio as they contribute to world energy supply security, reducing dependence on fossil fuel resources, and providing opportunities for mitigating greenhouse gases (Box 1).

In ASEAN countries, renewable energy is already in the generation mix as indicated in Table 1. Most of sources come from hydro, biomass and geothermal.

Box 1 Renewables

Solid biomass: Organic non-fossil material of biological origin that may be used as fuel for heat production or electricity generation.

Wood, wood waste and other solid waste: Purpose grown energy tree crops; woody materials generated by industrial processes (timber/paper industries in particular) or directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, etc); wastes such as straw, rice husks, nut shells, poultry litter and crushed grape dregs.

Charcoal: Solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.

Biogas: Gases composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power.

Liquid biofuels: Bio-based liquid fuel from biomass transformation, mainly used in transportation applications.

Municipal waste (renewables): Wastes produced by the residential, commercial, and public services sectors and incinerated in specific installations to produce heat and/or power. The renewable energy portion is defined by the energy value of combusted biodegradable material, thus excluding any non-biodegradable waste.

Hydropower: Potential and kinetic energy of water converted into electricity in hydroelectric plants ranging in size from very small to huge operations.

Geothermal energy: Energy emitted from within the earth's crust, usually in the form of hot water or steam, exploited at suitable sites for electricity generation after transformation, or utilized directly as heat.

Solar Energy: Solar radiation exploited for hot water production and electricity generation. Passive solar energy for direct heating, cooling and lighting also contributes but is too difficult to measure and record in the data.

Wind energy: Kinetic energy of wind exploited for electricity generation by wind turbines.

Tide/Wave/Ocean energy: Mechanical energy derived from tidal movement, wave motion or ocean current, exploited for energy generation.



Source of Information: International Energy Agency, Renewables in Global Energy Supply: An IEA Fact Sheet, OECD, 2007, Annex 1.

The principal constraint in advancing commercial renewable energy over recent decades has been cost-effectiveness. With the exception of large hydropower, combustible biomass and larger geothermal projects, the average costs of renewable energy are generally not competitive with wholesale electricity and fossil fuel prices.

Problems posed by conventional fuels

Economic and security issues

Rising oil and gas demand, if unchecked, would accentuate the consuming countries' vulnerability to severe supply disruption and associated price escalation. Most developed countries and developing Asian countries are becoming increasingly dependent on

imports as their indigenous production fails to keep pace with demand. Non-OPEC production of conventional crude oil and natural gas liquids is expected to peak by about 2015. By 2030, OECD countries will be importing two-thirds of their oil needs compared with 56% in 2005. A large proportion of the additional imports will originate in the Middle East and be transported along lengthy and vulnerable maritime routes. The concentration of oil production in a small group of countries with large reserves, notably the Middle East OPEC members and Russia, will increase their market dominance and ability to impose higher prices. An increasing share of gas demand is also expected to be met by imports, via pipeline or in the form of liquid natural gas shipped from distant suppliers.

Although most oil-importing economies around the world have continued to grow strongly, they would almost certainly have grown even more rapidly had the price of oil and other forms of energy not increased. The longer prices remain high or rise further, the greater the threat to economic growth in all importing countries. The growing insensitivity of oil demand to price accentuates the potential impact of a supply disruption on international oil prices. In particular, the share of transport demand in global consumption is projected to rise, and as a result, oil demand can be expected to become less and less responsive to movements in international crude oil prices.

Environmental issues

If present production and consumption patterns continue, global energy related to carbon dioxide (CO₂) emissions will increase by 14 gigatonnes (Gt), or 55%, to 40 Gt,

Table 1 Selected renewables indicators for Southeast Asian countries, 2004

Country/Continent	TPES ¹ Mtoe ²	Shares of Renewables in TPES ¹	
		A %	B %
Brunei Darussalam	2.7	0.7	0.0
Indonesia	174.0	30.8	3.8
Malaysia	56.7	5.8	0.9
Philippines	44.3	45.6	21.6
Singapore	25.6	0.0	0.0
Thailand	97.1	16.9	0.5
Vietnam	50.2	50.2	3.0
Asia	1,289.4	31.8	2.4
World	11,058.6	13.1	2.7

A Share of total renewables in TPES.

B Share of renewables excluding combustible renewables and waste.

1 Total primary energy supply.

2 Million tonnes of oil equivalent.

Source: International Energy Agency, *Renewables in Global Energy Supply: An IEA Fact Sheet*, OECD, 2007, Table 1.



between 2004 and 2030, a rate of 1.7% per year. Power generation contributes half of this increase in global emissions. Coal overtook oil in 2003 as the leading contributor to global energy related CO₂ emissions and consolidates its position through to 2030. Emissions are projected to grow slightly faster than primary energy demand, a reversal of the trend evident since 1980, because of the increase in the

average carbon content of primary energy consumption.

Developing countries account for over three-quarters of the increase in global CO₂ emissions between 2004 and 2030. They overtake developed countries as the biggest emitters soon after 2010. China alone is expected to be responsible for about 39% of the increase in global emissions as a consequence of strong economic growth and heavy reliance on coal in power generation and industry, and will overtake the United States as the world's biggest emitter by 2010.

Bioenergy

Traditional uses of biomass

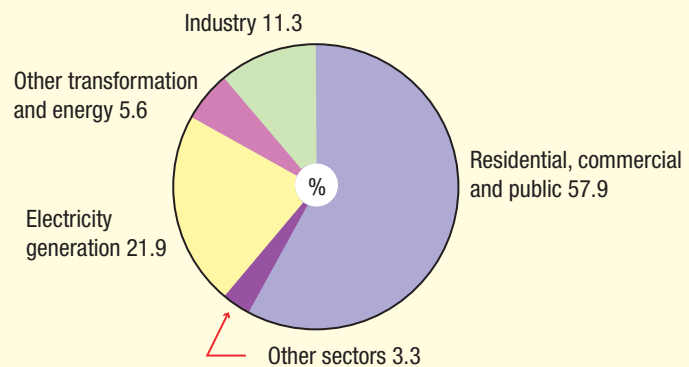
In 2005, 2.5 billion people used firewood, charcoal, agricultural waste and animal dung to meet most of their daily energy needs for cooking and heating. In many countries, these resources account for over 90% of total household energy consumption. The inefficient and unsustainable use of biomass has severe consequences for health, the environment and economic growth. As such, about 1.3 million people, mostly women and children, die prematurely every year because of exposure to indoor air pollution from biomass. The high prices of alternative fuels on international and domestic markets largely preclude a significant shift to cleaner, more efficient ways of cooking and heating.

By 2015, the number of people using biomass for essential domestic purposes is expected to rise to 2.6 billion, and to 2.7 billion by 2030 as population numbers increase. This means that one-third of the world's population will still be relying on

Statistical coverage of renewables

Statistical information on renewables (Figure 2) varies from country to country and from organization to organization. Time horizon, subsidies or taxation, sustainability and environment are all elements that may lead to differences in coverage for policy or practical reasons. Statistics cited in this section are drawn from the IEA Fact Sheet in which the definitions adopted for data compilation are also provided.

Figure 2 Global sectoral consumption of renewables, 2004



Source: International Energy Agency, *Renewables in Global Energy Supply: An IEA Fact Sheet*, OECD, 2007, Figure 4.



biomass fuels, a share barely smaller than in 2005.

Halving the number of households using biomass for cooking by 2015, a recommendation of the United Nations Millennium project, would involve 1.3 billion people switching to liquefied petroleum gas and other commercial fuels. This would not have a significant impact on world oil demand and the equipment would cost less than US\$1.5 billion per year. Vigorous concerted government action, with support from industrialised countries, would be needed to achieve this target, together with increased funding from both public and private sources. Policies would need to address barriers to access, affordability and supply, and to form a central component of broader development strategies.

Modern forms and uses of biomass

Biomass is attractive for use either as a stand-alone fuel or in fuel blends, such as co-firing wood with coal, or mixing ethanol or biodiesel with conventional petroleum based fuels. Anaerobic digestion has major potential in countries with ample resources. Electricity generated from biomass is based on steam turbine technology. Many regions of the world still have large untapped supplies of biomass residues that could be converted into competitively priced electricity using steam turbine power plants.

Biomass combustion for heat and power is a fully mature technology. It offers both an economic fuel option and a ready disposal mechanism for agricultural, industrial and municipal wastes. However, the industry has remained relatively stagnant even though demand for biomass (mainly wood) continues to grow in many developing

Energy and the Millennium Development Goals

There are still 1.6 billion people in the world without electricity. To achieve the Millennium Development Goals relating to environmental degradation and use of solid fuels, this number would need to fall to less than one billion by 2015.

Biomass feedstock and processes

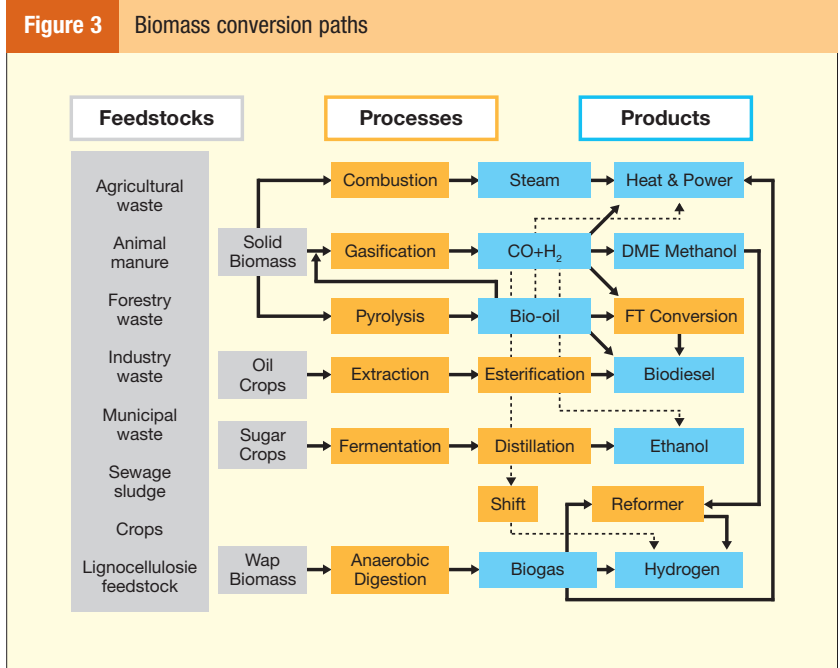
Biomass resources include agricultural residues; animal manure; wood wastes from forestry and industry; municipal green wastes; sewage sludge; and dedicated energy crops such as short rotation (3-15 years) coppice (eucalyptus, poplar, willow), grasses, sugar crops (sugar cane, beet, sorghum), starch crops (corn, wheat) and oil crops (soy, sunflower, oilseed rape, iatropha, palm oil). Organic wastes and residues have been the main biomass sources so far, but energy crops are gaining in importance and market share. Residues, wastes, and bagasse are primarily used for heat and power generation. Sugar, starch and oil crops are primarily used for fuel production.



countries. One of the problems of biomass is that material directly combusted in cooking stoves produces pollutants, leading to severe health and environmental consequences, although improved cooking stove programmes are alleviating some of these effects. A second issue is that burning biomass emits CO₂, even though biomass combustion is generally

considered to be ‘carbon-neutral’ because carbon is absorbed by plant material during its growth, thus creating a carbon cycle.

Biomass can be burnt (or co-fired) to produce electricity and steam in a CHP plant via a steam turbine in dedicated power plants. The typical size of these plants is ten times smaller (less than 100 MW) than coal fired plants because of the limited availability of local feedstock and high transportation costs. Fossil energy consumed for bio-power production using forestry and agriculture products can be as low as 2-5% of the final energy produced. Based on life-cycle assessment, net carbon emissions per unit of electricity can achieve below 10% of the emissions from fossil fuel based electricity.



Source: International Energy Agency, Energy Technology Essentials: Biomass for Power Generation and CHP, OECD, January 2007.

Biofuels

Biofuels are expected to make a significant contribution to meeting global road transport energy needs. They are estimated to account for 4% of road fuel consumption by 2030, up from 1% in 2005; under the IEA’s APS, consumption could be as high as 7%. The United States, European Union and Brazil are likely to remain the leading producers and consumers of biofuels. Ethanol is expected to account for most of the increase in biofuel use worldwide, as production costs are expected to fall faster than those of biodiesel, the other main biofuel.

Rising food demand, which competes with biofuels for existing arable and pasture land, will constrain the potential for biofuel production using current technology. In 2005, about 14 million hectares of land were used for the production of biofuels, equal to about 1% of the world’s available arable land.

This share is expected to rise to 2% by 2030, but if the policies of the APS are adopted, this would amount to 3.5%. The minimal amount of arable land needed in 2030 is equal to more than that of France and Spain, and under the APS would equate to all the arable land in the OECD countries.

New biofuels technology currently being developed, such as lignocellulosic ethanol (Figure 3), could allow biofuels to play a much bigger role than currently foreseeable. However, significant technological challenges still need to become commercially viable. Trade and subsidy policies will be critical factors in determining where and with what resources and technologies biofuels will be produced in coming decades, the burden of subsidies on taxpayers and the cost-effectiveness of biofuels as a way of promoting energy diversity and reducing carbon-dioxide emissions.

MALAYSIA'S ENERGY PROFILE

Energy policy

The crucial role of energy in achieving Malaysia's development aspirations has long been recognized, particularly in the country's five-year plans. An early benchmark was the establishment in 1974 of Petroliaam Nasional Berhad (PETRONAS) as the national oil company responsible for the exploration, development, refining, and marketing of Malaysia's petroleum products. This development, of major significance to the country's economy, has been followed by the formulation of several important policies reflecting the issues challenging the government and the economy.

In keeping with the policies developed over the last four decades, the energy sector is focused on ensuring a secure, reliable and cost-effective supply of energy, aimed at enhancing the competitiveness and resilience of the economy. The Ninth Malaysia Plan 2006-2010 encourages energy efficiency, especially in transport, commercial and industrial sectors, and in government buildings, and aims to diversify fuel sources through greater utilization of renewable energy.

In Malaysia, the transport sector is the largest consumer of energy accounting for 40.5% of the total final commercial energy demand in 2005, followed by the industrial sector (38.6%) and the residential and commercial sector (13.1%), all expected to increase demand by over 6% during the 2006-2010 period.

Electricity accounts for about 19% of the total final energy demand in Malaysia (Table 2). Reported electricity generation does not include electricity generated directly by industrial consumers for their own use. In response to the Government of

Policies at a Glance

Policy / Plan	Broad Objectives
1975 National petroleum policy	introduced to ensure optimal use of petroleum resources, regulation of ownership and management of the industry, and economic, social, and environmental safeguards in the exploitation of this valuable resource
1979 National energy policy	formulated to achieve supply, utilization and environmental objectives
1980 National depletion policy	introduced to guard against over exploitation of oil and gas
1981 Four fuel diversification policy	emphasis given to fuel diversification, designed to avoid dependence on oil; aimed at placing increased emphasis on gas, hydro and coal
2000 Renewable energy as the fifth fuel policy	introduced in recognition of the potential of biomass, biogas and other renewable energy resources
2006 National Biofuel Policy	designed to pave the way for extensive development of the biofuels industry
Seventh Malaysia Plan 1996-2001, Eighth Malaysia Plan, 2001-2005 and Ninth Malaysia Plan 2006-2010	Emphasis on energy efficiency and on generation from renewable sources in an effort to reduce the rapid depletion of other fuel sources



Malaysia's policy, the fuel mix for electricity generation is gradually being modified, with the share of natural gas in particular being

Table 2 Final energy demand by source, 2000-2010

Energy Source	Petajoules			Per cent of Total			Average Annual Growth Rate (%)	
	2000	2005	2010	2000	2005	2010	8MP ¹	9MP ²
Petroleum products	820.0	1,023.1	1,372.9	65.9	62.7	61.9	4.5	6.1
Natural gas	161.8	246.6	350.0	13.0	15.1	15.8	8.8	7.3
Electricity	220.4	310.0	420.0	17.7	19.0	18.9	7.1	6.3
Coal and coke	41.5	52.0	75.0	3.4	3.2	3.4	4.6	7.6
Total	1,243.7	1,631.7	2,217.9	100.0	100.0	100.0	5.6	6.3
Per capita consumption ²	52.9	62.2	76.5				3.3	4.2

¹ Malaysia Plan ² Gigajoules
 Source: Ninth Malaysia Plan 2006-2010.

reduced to about 56% by 2010, and coal increased substantially to 36.5% (from just 8.8% in 2000).

Under the Ninth Malaysia Plan 2006-2010, it was estimated that demand for electricity will reach 20,087 MW in 2010. Renewable energy is expected to contribute 350 MW to the total energy supply by that time: about 300 MW of RE is expected to be generated and connected to the grid in Peninsular Malaysia, and 50 MW to the grid in Sabah.

Configuring a Malaysian response to the global challenge

The increasing demand for fossil fuels, despite their proportional decline, poses a major challenge for the Government of Malaysia. Given the continuation of existing trends, the power sector was forecast to increase GHG emissions by 30% between 1995 and 2005. The two other ongoing UNDP-GEF funded Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) and the Building Integrated

Photovoltaics (BIPV) are the manifestation of Malaysia's commitment to reduce GHG emissions. The Biogen project aims to further mitigate these by progressively replacing fossil fuels used in electricity generation mix with renewable energy resources, especially utilising wastes from the palm oil industry.

In 2001, in a significant step towards encouraging and intensifying the utilisation of renewable energy (RE) in power generation, the Malaysian government launched the Small Renewable Energy Power (SREP) programme. The objective was to encourage the private sector to undertake small power generation projects using renewable resources including biomass, biogas, municipal waste, solar, mini-hydro, and wind energy.

As recently as 2004, the programme was not progressing well due to the uncertainty of long-term fuel supplies, long negotiation of the Renewable Energy Power Purchase Agreement (REPPA) and difficulty in securing loans to finance the projects. However, in 2005, the first grid connected biomass-based power plant in Malaysia,



TSH Bio-Energy Sdn Bhd, commenced operations in Sabah which has an installed capacity of 14 MW where 10MW is for the grid-connection.

Under the SREP guidelines, maximum power export capacity of a small RE plant for sale to the grid is limited to 10 MW, although a plant's overall capacity may be larger. The Special Committee on RE (SCORE), set up under the Ministry of Energy, Water and Communications, coordinates the implementation of the SREP applications and also formulates government's strategy to intensify the development of RE as the country's fifth fuel resource. A technical secretariat was also set up at the Energy Commission (Suruhanjaya Tenaga) to help facilitate the industry's participation in the programme.

The status of generating power from renewable energy sources is immense (Table 3), and by far the most easily accessible and cost-effective feed-stock is readily available in the form of palm oil residues. Traditionally palm oil mills have utilized a proportion of this material to generate the requisite heat and power for extracting oil from the fruit, but huge additional quantities of residues pose a serious disposal problem for the industry. Efficient methods of generating CHP to meet operating requirements, plus a surplus of electricity utilizing the surplus renewable residues for export to the national grid, represents a double benefit for the industry and for the country, while assisting in the reduction of emissions from fossil fuels. In addition, palm oil itself is already being used on a small scale as a biofuel supplement to fossil fuels and more efficient technologies are being developed

Table 3 Status of SREP project, July 2006

Broad Category	Specific type of renewable energy	Number of projects	Capacity (MW) for grid connection	Contribution %
Biomass	– empty fruit bunches	15	103.2	42.3
	– wood waste	1	6.6	2.7
	– rice husks	1	10.0	4.1
	– municipal waste	4	25.0	10.2
Landfill gas		3	6.0	2.4
Mini hydro		23	93.2	38.2
Total		47	244.0	100.0

Source: MEWC, 2006.

The first grid-connected biomass power plant

The first grid connected biomass based power plant in Malaysia started commercial operation early in 2005. TSH Bio-Energy Sdn Bhd, located in Tawau, Sabah, has an installed capacity of 14 MW and is contracted to sell 10MW to Sabah Electricity Sdn Bhd (SESB) for 21 years. The cogeneration plant processes palm oil milling residues (mainly empty fruit branches) as fuel.

The Energy Commission

The Energy Commission (Suruhanjaya Tenaga) was established under the Energy Commission Act 2001 to regulate the electricity supply and piped gas supply industries in Peninsular Malaysia and Sabah, whilst in Sarawak the state Chief Electrical Inspectorate is the regulator of the electricity supply industry under the Electricity Ordinance of Sarawak. It acts as the SREP technical secretariat.

for this purpose. The palm oil industry therefore has considerable potential for supporting the economy through the provision of renewable energy as well as through the traditional export of agricultural commodities.

PALM OIL IN THE GLOBAL MARKET



The uses and potential of palm oil

Palm oil is the second most traded vegetable oil crop in the world after soy, and over 90% of the world's palm oil exports are produced in Malaysia and Indonesia. Palm

oil is still mostly used as an ingredient in the manufacture and further processing of food products (Box 2), but many other uses are becoming increasingly important. In the twenty-first century, concern for serious environmental issues is offering new

Box 2 Uses of palm oil

Palm oil can be used –

As an edible oil:

- a high quality cooking oil
- a component of oil-based fats and margarine used in baking
- an ingredient in wide range of cooking materials, dairy fat substitutes, milks and ice creams
- a fat ingredient in animal feed

As an ingredient for non-edible uses:

- soaps
- biodegradable detergents
- oleochemical products (fatty esters, fatty alcohol, fatty nitrogen compounds, glycerol)

For non-edible applications:

- drilling mud for the oil industry
- epoxidated oil as a plastifier and sterilizer in the plastics industry (PVC)
- gum
- candles
- cosmetics
- printing inks
- metallic soaps for the manufacturing of lubricating greases and metallic driers
- fuels
- greases for lubrication and protection
- cold rolling presses in steel making
- tinsplate rolling
- acids to lubricate fibres in the textile industry

opportunities for diversification of oil palm products. In particular, palm oil based biofuel provides a high quality supplementary fuel for blending with fossil fuels such as petroleum to help meet the growing renewable energy demand emerging in developed countries, especially those of the European Union. Nor is this the only contribution the industry can make to renewable energy: as noted earlier, residue biomass from milling greatly exceeds the quantities required for heat and power to carry out palm oil processing, and the surplus residues can be utilized to generate electricity for the national grid.

Palm oil production and trade

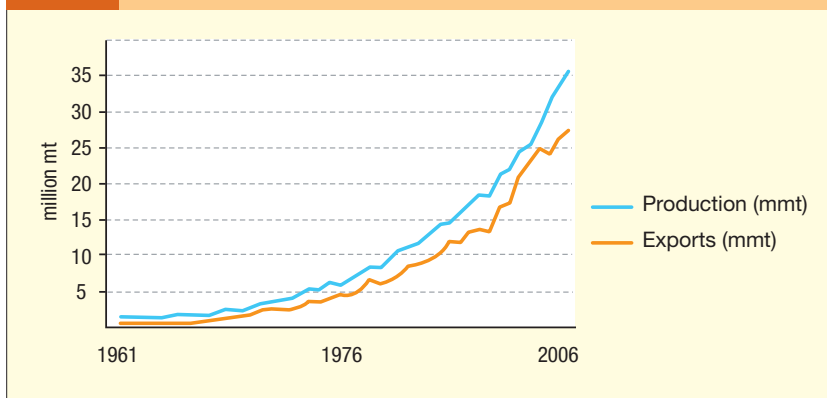
Global palm oil production and trade have risen steeply and continuously (Figure 4) from the 1970s onwards, with average growth rates achieved by oil palm substantially exceeding those of other oils and fats. Factors that explain the interest of the global marketplace in palm oil include:

- the high level of substitutability with other soft oils;
- a high melting point and a low content of trans fatty acids, of special appeal to the food industry;
- reconfirmed health benefits, notably as a rich source of carotenoids.

As a consequence, the share of palm oil in global vegetable oil production more than doubled in the period 1983-2003. This development was accompanied by a strong rise in both the share and overall consumption of palm oil in the global vegetable oil market (Figure 5).

The main competitor for palm oil is soy

Figure 4 Global palm oil production and trade, 1961-2006



Source: Thoenes, P. (2007) *Biofuels and Commodity Markets – Palm Oil Focus*, FAO, Fig. 1.

Figure 5 Average annual growth of palm oil versus other oils and fats, 1996-2006



Source: Thoenes, P. (2007) *Biofuels and Commodity Markets – Palm Oil Focus*, FAO, Fig. 2.

oil. Only in very recent years has the global output of palm oil matched that of soy, whereas for trade, global shipments of palm oil surpassed soy oil in the mid-1970s, and in 2006 palm oil exports were almost double those of soy oil (Figure 6).

A further distinctive feature of palm oil is its very high trade-to-production ratio, which refers to the amount of global production that enters international trade. The ratio for palm oil greatly exceeds that

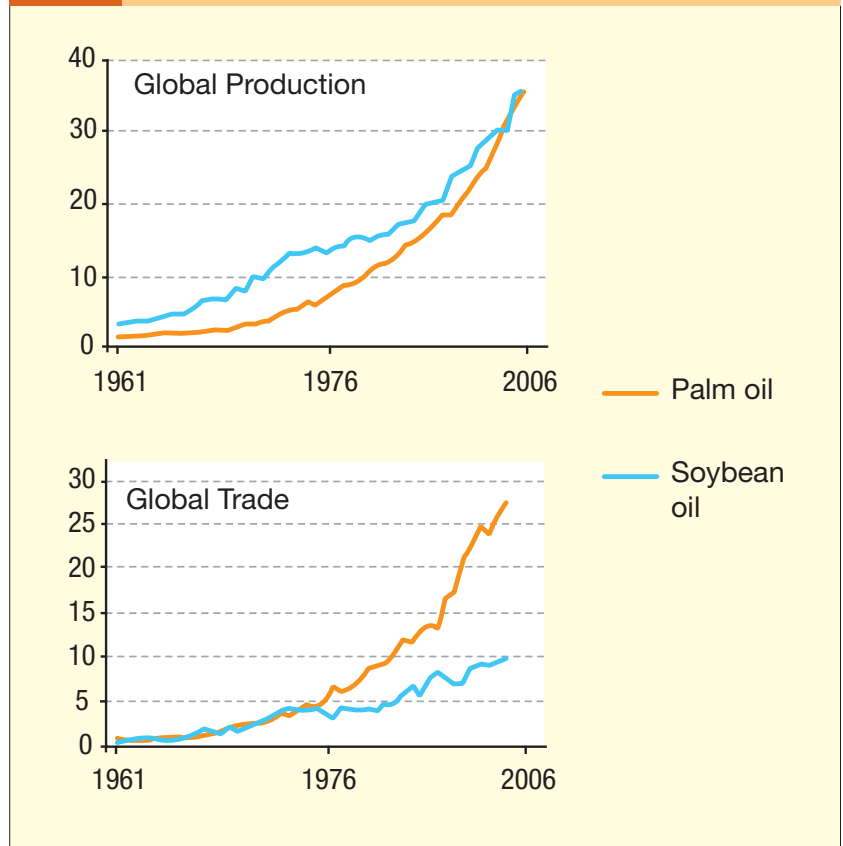


for other oils and fats, oilseeds and other crops in general. This is particularly significant given that just two countries – Malaysia and Indonesia – account for about 90% of both global production and global trade in palm oil.

Oil Palm Industry and the Environment

Throughout its entire development in Malaysia, the oil palm industry has always been linked to the environment. As it is a very land intensive industries, any unplanned development will lead to the degradation of the forest systems (primary or secondary), loss of habitats (plants and animals), extreme land degradation and pollution (water and airborne) due to the use of large quantities of pesticides and herbicides required to maintain the plantation. Besides that, the mills too produce wastes mainly from the EFB and palm oil mill effluent. As such, with the support from the government and MPOC, the Roundtable for Sustainable Palm Oil (RSPO) was established. RSPO consists of palm oil producers, processors, traders, consumer goods manufacturers, retailers and non-governmental organizations (NGOs) and is tasked to develop the principles and criteria of a sustainable palm oil industry, and facilitate the development of sustainable palm oil production. Among the proposed guidelines include commitment to transparency, compliance with all applicable local, national and ratified international regulations, adoption of sustainable cultivation practices (including water management, pesticide control and soil erosion), conservation of resources and

Figure 6 Palm oil versus soy oil – global production and trade, 1961-2006



Source: Thoenes, P. (2007) *Biofuels and Commodity Markets – Palm Oil Focus*, FAO, Fig. 6.

biodiversity and community development. Nevertheless, the industry has long avoided the openings of virgin forest land, which thus minimize environment degradation and enhance the sustainability of oil palm growing. In addition to the current initiatives, the RM20 million Malaysian Palm Oil Conservation Fund (MPOCF) was announced by MPIC in 2006, aims to help protect affected wildlife (including orang utan and other protected species) and to sustain biodiversity conservation programmes that are expected to be beneficial to both the industry and society.



THE MALAYSIAN PALM OIL MARKET

The oil palm is indigenous to West Africa, but the development of oil palm as a plantation crop started in Southeast Asia. Experimental planting began in Peninsular Malaysia in the late nineteenth century and the first commercial oil palm estate was established in Selangor in 1917. During the plantation development phase to about 1960, expansion was relatively slow reaching about 55,000 ha and, primarily because of processing difficulties, cultivation was not widely undertaken by smallholders. Large-scale expansion commenced during the 1960s, mainly in response to the government's diversification policy which aimed to reduce the dependence of the national economy on natural rubber. Rubber prices were continuing to decline, there was mounting competition from synthetic rubber, and the demand for edible oils was expanding.



Modern commercial development

Table 4 Area planted in oil palm by ownership, 2006

Ownership	Hectares	%
Private estates	2,476,135	59.4
FELDA	669,715	16.1
FELCRA	159,780	3.8
RISDA	81,169	2.0
State agencies	323,520	7.8
Smallholders	454,896	10.9
Total	4,165,215	100.0

Source: MPOB (2007) *Review of the Malaysian Oil Palm Industry 2006*, Table 3.

Expansion of processing plant in the estate sector and the establishment of processing cooperatives, together provided the means for efficient processing of both plantation and smallholder palm oil production. The Federal Land Development Authority (FELDA) was a key player in the government's implementation of its diversification and smallholder land settlement policies and is still the largest producer in the industry, owning over 16% of the total planted area (Table 4).

All states in Malaysia produce palm oil but there is wide variation in the crop's distribution. Over 75% of total area planted is located in just four states, Sabah, Johor, Pahang and Sarawak, each of which has over half a million hectares under cultivation. Of the 4,165,215 ha planted in 2006, 3,703,254 or 88.9% is classified as 'mature' and in production (Table 5 and 6).

As a front runner in the development of the oil palm industry, Malaysia has had to develop many of the agricultural and industrial technologies required for the oil palm industry to succeed, including a significant R&D capability. For many decades this relied primarily on the ability of the larger companies to carry out their own research.

In 2005, Malaysia's total land area had –

- 59.5% under forest
- 12.3% planted in oil palm
- 7.1% planted in other agricultural crops

Table 5 Status of palm oil processing plants, 2006

Energy Source	Palm oil mills ¹		Palm oil refineries ²		Palm kernel crushing factories ³		Oleochemical plants ⁴	
	No.	Capacity	No.	Capacity	No.	Capacity	No.	Capacity
Operating	397	86,243,600	517	18,506,400	38	5,144,100	17	2,466,971
Inoperative	7	588,000	3	120,000	8	453,500	0	0
Planned	21	3,936,000	12	4,568,800	7	690,000	3	222,000
Total	425	88,638,400	66	23,195,200	53	6,287,600	20	2,688,971

1 Tonnes FFB/year 2 Tonnes/year 3 Tonnes kernel/year 4 Tonnes/year

Source: MPOB (2007) Review of the Malaysian Oil Palm Industry 2006, Tables 7-10.

Experimentation enabled these companies to enhance their planting materials, carry out agronomic trials, conduct pest and disease research, and design machines for mechanizing some field operations.

The processing of oil palm products occurs in palm kernel crushing factories, oleochemical plants, and palm oil refineries, but by far the most common are the basic palm oil mills. With the plantations they serve, these mills form the fundamental operational units and the basis of this important Malaysian export industry that supplies global markets and has the capability of contributing very significantly to the reduction in GHGs through expanded production of biofuels and biomass based generation of power.

In 1979, the Malaysian government established the Palm Oil Research Institute of Malaysia (PORIM), which was charged with the responsibility of generating information, increasing production and processing efficiency, and expanding uses of palm oil through research and development. This function was taken over by the Malaysian Palm Oil Board (MPOB) when earlier agencies were amalgamated

Table 6 Area planted in oil palm by state, 2006

State	Hectares	%
Johor	671,425	16.1
Pahang	623,290	15.0
Perak	348,000	8.4
Terengganu	164,065	3.9
Negeri Sembilan	161,972	3.9
Selangor	128,915	3.1
Kelantan	94,542	2.3
Kedah	76,329	1.8
Melaka	52,232	1.2
Pulau Pinang	14,119	0.3
Perlis	258	0.0
Peninsular Malaysia	2,334,247	56.0
Sabah	1,239,497	29.8
Sarawak	591,471	14.2
East Malaysia	1,830,968	44.0
MALAYSIA	4,165,215	100.0

Source: MPOB (2007) Review of the Malaysian Oil Palm Industry 2006, Tables 2 and 4.

and is partly funded from a research cess imposed on palm oil millers. Efforts are made to ensure that R&D in the MPOB is in line with the industry's needs and that research findings are disseminated to the industry and offered for commercialisation.

THE BIOGEN PROJECT

Map 1 Graphical representation of the palm oil processing plants, 2006



The Biogen project is jointly funded by the Government of Malaysia (GoM), the United Nations Development Programme (UNDP), the Global Environment Facility (GEF), and the Malaysian private sector. Pusat Tenaga Malaysia (PTM) is the implementing agency under the executing agency, the Ministry of Energy, Water and Communications (MEWC).

Project strategy

The Biogen project strategy involves a number of activities and deliverables that aim to remove barriers to the utilisation of commercially viable biomass based power generation through CHP production in palm oil mills. The ultimate desired outcome is the implementation of a demonstration scheme showcasing a full scale model (FSM) of biomass based power generation with CHP in conjunction with a POME derived biogas system. While biomass utilisation

The Biogen project development objective

The broad objective of the Biogen project is the reduction in the growth rate of greenhouse gas emissions from fossil fuel fired activities and from the decomposition of unused biomass waste from palm oil mills (Map 1). This is to be achieved through the removal of the major barriers to the development of biomass based combined heat and power projects to supplant part of the current fossil fuel electricity generation in Malaysia. Explicitly, the aim of the Biogen project is to reduce the growth rate of greenhouse gas emissions from fossil fired combustion processes by 3.8% by the end of 2008.

is well established, the project is intended to have a capacity building outcome, encouraging a substantial increase in biomass based power generation.

Central to the project strategy is the establishment of an institutional awareness, responsibility and capacity within the Government of Malaysia as represented by MEWC, PTM and MPOB for identifying and removing barriers to the implementation of

these measures in the Malaysian palm oil industry. On the technical and business side, capacity will be established for specialist support and financial assistance. PTM, Bank Pembangunan Malaysia Bhd, and MPOB were designated as the agencies responsible for particular aspects, with the institutional focus located in PTM which has a coordinating role for the project.

The anticipated contribution of renewable energy sources to power generation

As noted earlier, Malaysia has abundant biomass waste resources coming mainly from palm oil, wood and agricultural industries. At the time of the initiation of the project in 1999, a total capacity of about

665 MW was to be expected if the estimated overall potential of about 20.8 million tonnes of biomass residues from these main sources plus the 31.5 million m³ of palm oil effluents (POME), were used for power generation and cogeneration.

These quantities of biomass have expanded significantly since the project's rationale was developed, as shown for 2005 in Table 7. From those data it is estimated that a total of about 2,500 MW capacity can be expected if all potential of the 25 million tonnes of biomass residues from these main sources, in addition to the 39 million m³ of palm oil mill effluents (POME), is used for power generation and cogeneration. In terms of additional potential, there is also a substantial amount of unexploited biomass waste in the form of logging residues, rice straw, palm tree trunks and other residues.

Table 7 Biomass resources potential, 2005

Type of industry	Production kt	Residue	Residue generated kt	Potential electricity MWe
Oil palm	59,800	Empty fruit bunches	12,300	570
		Fibres	8,750	1,080
		Shells	3,940	550
		Total Solid	24,490	2,200
		Others (POME)	38,870	330
Padi	2,141	Rice husks	471	72
		Padi straw	856	83.9
Sugar	1,111	Bagasse	356	0
Wood	2,937,679m ³	Sawn timber	1,692,718m ³	50.11
		Plywood & veneer	121,000m ³	3.6
		Moulding	75,600m ³	2.2
Municipal solid waste	11,940 tonnes per day	Municipal solid waste		N/A

Note: Waste from rice mills is mainly rice husks; palm oil mill waste includes empty fruit bunches; wood waste comprises chips, shavings and sawdust. Palm trunk and fronds, and logging waste left in the cutover forest areas are not included. The potential annual electricity production and power generation capacity were computed on the assumption that all the available biomass resources listed were fully utilized.
Source: PTM, *Comprehensive Biomass Study, 2005*.

These additional biomass residues could further supplement future biomass based power generation if required.

The palm oil industry accounts for the largest biomass waste production in Malaysia, and since the 1960s, all palm oil mills have depended on their own biomass wastes for fuel, mainly the palm kernel shells and mesocarp fibres. Not only does palm oil industry waste, including POME, represent the largest potential for biomass energy utilisation in the country, but this resource is readily available and in need of an efficient and effective means of disposal. When the project was being planned, most of these residues were disposed of through incineration and dumping, with only a very small proportion being used by the mills in a rather inefficient manner for their own heat and power requirements. However, the government has banned the incineration of biomass waste (mainly empty fruit bunches or EFB), and so the mills are obliged to find alternative means of disposing of the unutilized waste.

Other value-added uses of the waste have been investigated with varying degrees of success, but commercialisation of these is not imminent. While palm oil mills with plantations can use their solid biomass waste for mulching and soil conditioning or fertiliser, those without plantations are considering generating electricity that they can sell to the national utility grid. Although palm oil mills are aware of the potential of biogas generated from the biodegradation of POME, they are not currently utilising this gas as there is no requirement to do so and there is little local experience in handling it.

Beneficiaries of the project

- Palm oil millers
- Local boiler manufacturers
- Power equipment suppliers
- Project developers
- Local energy service industries
- Engineering consulting firms
- Financial and banking institutions
- policy makers



Implementing biomass and biogas power generation and cogeneration

Since the palm oil mills have abundant biomass waste resources, their energy systems were designed to be cheap rather than efficient. Most of the existing biomass combustion systems in Malaysia utilize low efficiency low-pressure boilers where the overall cogeneration efficiency is less than 40%. An additional source of energy in palm oil mills is the biogas produced in the anaerobic decomposition (for wastewater treatment purposes) of palm oil mill effluent (POME). However, at that time, POME derived biogas (mostly methane, CH₄) was

not being recovered and used but allowed to dissipate into the atmosphere.

Commercially proven technologies were available in the form of high-pressure boilers for efficient production of power and heat from the biomass resources available. Dual fired boilers capable of burning either diesel oil or natural gas were identified as most suitable for burning palm oil waste since they could also facilitate the use of POME derived biogas as a supplementary fuel.

Key barriers to change

Whilst the concept of biomass based CHP generation for sale to the grid or other consumers is well accepted, lack of experience and a number of barriers have hindered its development.

Key barriers to the development of CHP generation in Malaysia that the project was attempting to overcome, included the following:

- Lack of information services to promote biomass energy development and its applications, which includes,
 - a misconception that the technology is unproven;
 - the belief that the industry lacks the requisite technical ability;
 - the perception that use of biomass is regressive in a modernizing industrial economy;
 - a belief that investors view the generation and sale of electricity as marginal to the core business of the industry.
- Absence of a clear mechanism on renewable energy technology development and applications despite the establishment of a broad regulatory framework.
- Lack of accessible and favourable financing schemes because,
 - in the absence of supporting policies and regulations it is difficult to gain funding support from financial institutions;
 - financing of projects based on renewable energy technologies is an unfamiliar investment and perceived as high risk.
- Uncertain financial viability unless satisfactory pricing arrangements can be



reached, producing power for the utility grid would not be seen as an attractive business venture;

- Lack of successful models to demonstrate viability as there were no precedents beyond the inefficient biomass fired CHP systems already operating in the palm oil and wood industries;



Operational uncertainties

- Biomass fuel supply relating to,
 - reliability of the volume and quality of EFBs;
 - seasonal nature of palm oil milling operations;
 - absence of standard contract procedures for the supply and pricing of EFBs.
- Minimum energy off-take that required,
 - to achieve an availability factor of 90% to baseload allowing for maintenance and forced outages.
- Efficiency of deployment of biomass based energy technology required,
 - review of current practices for incineration of excess biomass;
 - greater sophistication of operation and manpower skills, interconnection safety, synchronization devices and the more rigorous demands of grid electricity generation.
- Recovery of POME biogas for power generation lacked incentives although millers were aware of the technology and there were no restrictions on the release of biogas into the atmosphere.
- Purchase of electricity by the national utility company and other REPPA issues required the clarification and resolution.



Immediate objectives

1. To provide adequate, affordable, accessible and up-to-date information services, continuing education, and awareness improvement on the application of renewable energy resources to prospective RE developers, policy makers and technology suppliers.
2. To strengthen and formulate the policy and regulatory framework to encourage the wide spread adoption of RE projects.

3. To encourage the implementation, the government and financial community will provide financial assistance to the development of sustainable RE financing.
4. To facilitate the effective demonstration of the techno-economic viability, design, development, financing and sustainable operation and maintenance of biomass-based and biogas-based, grid-connected power generation and cogeneration projects.
5. To establish the potential and requirements for the energy applications by providing sufficient support to the technology suppliers.



supported and facilitated the immediate objectives of the project culminating in the contractual arrangements to set up the two full scale demonstration models.

Planned outputs

The project was designed to address the barriers in the development and implementation of biomass-based, grid-connected power generation and CHP specifically in the Malaysian palm oil industry. To achieve this objective the project was organised into five components, each with its own set of outputs that comprised the blueprint to be followed by the participating agencies to achieve the objectives.

The major elements of each of the components proceeded concurrently from the launching of the project at the beginning of 2002, with the objective of completing the existing plans by early 2008. Whilst this account has emphasised some key barriers and operational uncertainties, many initiatives were being undertaken that

Component 1 Biomass information services and awareness enhancement

Outputs

- ~ Comprehensive biomass energy resource inventory
- ~ Biomass energy technologies and technology application database
- ~ Training courses on biomass energy technology
- ~ Integrated information dissemination programme
- ~ Biomass energy technology information exchange service
- ~ Renewable energy (RE) consultancy service industry development
- ~ Rating scheme for biomass based companies

Component 2 Biomass policy studies and institutional capacity building

Outputs

- ~ Biomass policy document and analysis
- ~ Biomass energy utilisation workshop series
- ~ RE electricity generation policy
- ~ RE electricity pricing
- ~ Small RE project (SREP) strategy
- ~ Clean Development Mechanism (CDM) implementation in RE project
- ~ RE electricity policy implementation evaluation



Component 3 Financial assistance for renewable energy projects

Outputs

- ~ Training for financial institutions on financing RE projects
- ~ Establishment of RE fund
- ~ Mechanism for the financing scheme
- ~ Criteria for selecting fund applicants
- ~ Arrangements for financial assistance for RE projects
- ~ Evaluation of RE projects financing assistance programmes

Component 4 Demonstration schemes

Outputs

- ~ Biomass based power generation and CHP demonstration programme
- ~ Selection criteria for host demonstration companies
- ~ Suitable project demonstration sites
- ~ Baseline data for three dimensional sites
- ~ Specific demonstration programme implementation requirements
- ~ Installation and implementation of design/plans for first demonstration site
- ~ Financial and procurement assistance arrangements for demonstration scheme

Component 5 Technology development

Outputs

- ~ Assessment of other uses of biomass and biogas resources
- ~ Evaluation of the energy utilization performance of palm oil mills
- ~ Training for palm oil mill plant engineers and operators
- ~ Financial assistance to local equipment manufacturers
- ~ Assessment of capabilities of local steam and power generation equipment
- ~ Training on high efficiency designs and production technologies

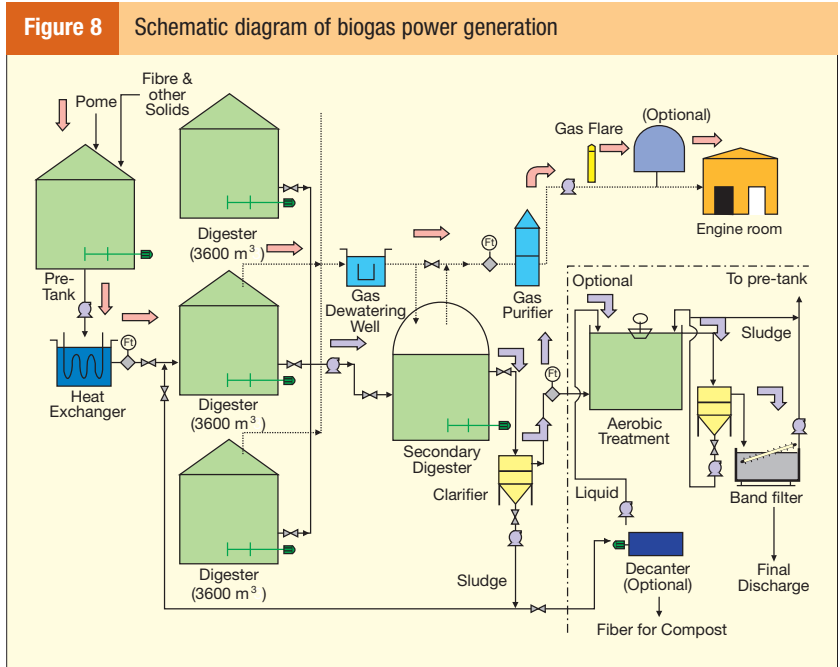
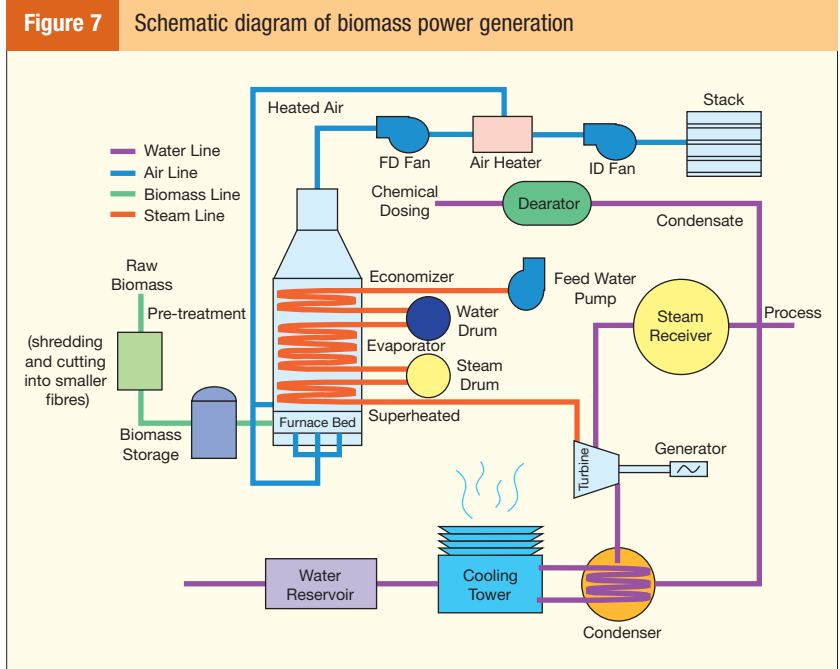
The project has undertaken studies on Biomass Resource Assessment and, based on the findings, the total potential for biomass and biogas from palm oil mill wastes was estimated, in 2005, to be approximately 2,500 MW. Microanalysis on eight selected palm oil mills was carried out in terms of energy utilisation and the potential for improving efficiency of current usage. The mills have also been assessed for the practical feasibility of feeding electricity from excess power generation into the national grid.

Full scale model

A full scale model (FSM) utilizing both biomass and biogas resources was planned as a major outcome of the Biogen project. This was seen as important because it would give a practical demonstration of the technology and processes being utilized and recommended in the project. During 2005, extensive planning occurred for the establishment of the first FSM, but some difficulties were experienced in gaining the requisite level of interest and support. (In attempting to identify suitable candidates for the first full scale demonstration model, similar issues arose to those that were making the industry at large reluctant to adopt CHP, namely: the relatively large scale of investment; a lack of financial depth to meet the equity requirements and an unattractive renewable energy tariff.)

Nevertheless, to facilitate the development of the first FSM, a number of major developments that had been ongoing since the beginning of the project were being brought to a conclusion. Notably, these included the finalizing of the Renewable Energy Power Purchase Agreement (REPPA), and the Renewable Energy Business Facility (REBF), both of which were essential for the contracting of an FSM operator.

In 2006, following a tendering process and evaluation of proposals submitted, instead of a single FSM, two companies were selected: MHES Asia Sdn Bhd to develop a biomass project as the first FSM; and FELDA Palm Industries Sdn Bhd (FPISB) for the biogas project as the second FSM. Schematic diagrams for typical biomass and biogas plants are represented in Figure 7 and 8.



The MHES Asia Biomass Power Plant, located in Bahau, Negeri Sembilan, will have a capacity of 13 MW and will utilize

EFBs as fuel. The plant will sell 10MW of electricity to TNB for 21 years at the agreed REPPA price of between RM0.17/kWh to RM0.21/kWh. The power plant is scheduled for completion by early 2008.

The FPISB biogas project is to be located in Serting Hilir palm oil mill, also in Bahau, Negeri Sembilan, with the objective of utilizing methane-rich POME for power generation. The plant will have a power generation capacity of 500 kW, with plans for expansion after the first few years of operation if agreed by the national utility. The project, still at the planning stage in 2007, is estimated to reduce emissions by the equivalent of 45,000 tonnes of CO₂ per year.

Key achievements

The finalization of the Renewable Energy Power Purchase Agreement (REPPA) pro forma

This is the official document to be used by transacting parties in processing loan

Renewable Energy Power Purchase Agreement (REPPA)

REPPA is the legal document on the selling of electricity by renewable energy project developers and the purchase of electricity by the national utility companies (TNB/SESB). The rights and obligations of both parties cover the commercial and technical aspects governing the project implementation applicable throughout the lifetime of the agreement.

The Biogen project team was instrumental in reviewing the provisions of the agreement, customized for biomass power plants, and negotiating terms with the GoM, banking institutions and private sector stakeholders. Final details of the agreement, relating mainly to tariff, were in process with the FSM participants in 2007.

applications. Through the facilitation and inputs by the Biogen project, this output has been made possible with the close coordination and cooperation of the Government of Malaysia through MEWC, PTM, ST, TNB, and other relevant agencies. The REPPA represents the preparedness for commercialisation of renewable energy power.



Establishment of the Renewable Energy Business Facility (REBF)

In 2005, the Biogen project established the first financing scheme for RE projects. The Renewable Energy Business Facility (REBF) uses funds available from the UNDP/GEF, MESITA and BPMB, provided at 4% per annum for the FSM projects. The REBF paves the way for other funding mechanisms that will be administered through the facility.

Organization of the Biomass One-Stop Centre

The Biomass One-Stop Centre was established through the Biogen project in PTM. It provides services, including consultancy, for biomass utilization projects, information database, technical advisory, services, financing facilitation, and project identification.

Energy audits of selected palm oil mills

Eight mills were audited to assess their energy utilization and the possibility of improving current usage efficiency. These mills are also being assessed for connection to the grid for additional power supply from excess generation.

Different policy studies

These studies have been conducted in support of the government's renewable energy programme. Their value lies in their contribution to modifying relevant laws, making agreements more workable, providing against force majeure, dealing with loss or shortfall of energy, and setting of performance targets.

Tariff negotiations

Power purchase price is negotiated between the utility and the RE developers. As such, the Biogen project team prepared and submitted a proposal to MEWC for a raised renewable energy tariff that would make biomass projects viable. The point at issue is that, to assist the SREP programme, GoM intervention is required to address the feed-in renewable energy tariff in Peninsular Malaysia. RM0.17cents/kWh is set as the benchmark figure for feed-in tariff which will subject to standard industry review. The position in Sabah, for the operation of TSH Bio-Energy cogeneration project, was less problematic as the existing tariff (of about RM0.21/kWh) is compared against the cost of diesel-powered generation.



Adoption of RE in mill operation syllabus

The project team worked with MPOB in identifying key information to be included in the syllabus for Diploma-level mill operation.

Biomass Resource Information System (BRIS)

A web-based interactive system is under its final stage and will be ready by end 2007. It will show an estimated amount of biomass available by most palm oil mills resource mapping, and the availability for power generation at any specified grid intake.

Biomass availability assessment

The Biogen project reported that the total potential for biomass and biogas mill wastes was indicated at 2,600 MW per annum in 2005. Detailed data are to be stored for easy access in the RE database being completed by the Biogen project.

Selection of host companies for the full scale models

The MHES Asia Biomass Power Plant, located in Bahau, Negeri Sembilan, was chosen as the first FSM, and will utilize EFBs as fuel for generating biomass based power. The FPISB was chosen to undertake the second FSM with the objective of utilising methane-rich POME for power generation. The selection process was developed and implemented by the Biogen project.

Workshops and promotional activities

More than 15 seminars and workshops were conducted by the Biogen project in support of the capacity building of various stakeholders and benefitted nearly 1,000 industry professionals.

Institutionalization of the renewable energy programme and organization

PTM was instrumental in the institutionalization of the RE programme. The necessary organizational support was provided by the Biogen project which was able to draw on the various outputs from the five components and provide the government with the required relevant inputs for current and future development.

Palm oil mill biomass power plant

By 2006, 50 palm oil mills, or 12% of all palm oil mills in Malaysia, had indicated their intention of developing plans to implement biomass power generation and cogeneration.



Challenges

1. To assist the government in developing pragmatic approaches in tariff setting, by conducting appropriate follow-through activities.
2. To continue to develop alternative financing mechanisms such as CDM credits, grace period extensions, and loan guarantee coverage, customised to the particular requirements of palm oil mills and CHP.

3. To continue strengthening the network and organisational linkages among the stakeholders, particularly the members of the decision-making committees so that they can respond effectively, innovatively and in a timely fashion to the continuing and changing needs of all the target projects, especially the FSMs.
4. To develop, establish and sustain an effective monitoring and evaluation system for the pipeline of biomass and biogas projects contributing to achievement of the national renewable energy target, especially by providing support for post-Biogen renewable energy projects.
5. To enhance the design and fast-track the establishment of the biomass information database and exchange system through the Biomass One-Stop Centre facilitating decision making and business transactions, especially for such information as: fuel supply availability and pricing; financing mechanisms; technology supply and services; best practices; and lessons learnt.



LESSONS LEARNT

Stakeholder participation

Achieving a significant impact on policy requires consistency with the development aims of government; this was substantially achieved through broad, high-level stakeholders participation in the project design and throughout the stages of implementation.

Institutional focus

Having an established institutional focus in the PTM greatly expedited and helped sustain the project and its viability, and could be seen as setting a useful precedent for similar projects in the future.

Sustainability of renewable energy

Promoting the use of renewable energy is a long-term policy. Renewable energy, as demonstrated by the work of UNDP/GEF in other countries, is a cost effective way of reducing emissions of greenhouse gases, but needs an achievement horizon of decades. Sustainability of this work and the impact achieved largely depend on the government's willingness to put substantial resources behind such efforts on a continuing basis so that progress achieved so far is not squandered. It also requires support from civil society and the public. For similar projects, it is desirable that they should be predicated on the reasonable expectation of substantial government funding to sustain momentum.



Reduce fossil fuel subsidies

Achieving more efficient use of renewable energy is challenging because of the relatively low buy-back tariff and high risk. The practice in Malaysia of substantially subsidizing fossil fuel does not encourage energy players to develop new renewable energy plants and eliminate wastages.

Right formulation of energy price

Fixing a suitable feed-in tariff depends heavily on parameters such as price of fuel supply, choice of technologies and materials, and other associated costs, including legal expenses. All relevant factors must be taken into account and stakeholders need to be consulted in the course of determining the tariff, to ensure the right formulation is achieved.

Suitable fiscal and financial mechanism

Adopting renewable energy technologies and processes is largely dependent on the private sector, and it is therefore crucial that appropriate fiscal and financial incentives are formulated to encourage the implementation of these measures and provide clear linkages to monetary benefits.



Efficient deployment of feedstock

Ensuring security of feedstock supply is important and requires appropriate policy intervention. Also, as biomass sources are mostly organic, it is imperative that feedstock is deployed as quickly and efficiently as possible to prevent degradation of quality. The use of densified feedstock to overcome degradation and for ease of transport is highly encouraged.



Level playing field

The use of conventional Power Purchase Agreement as the basis for achieving an equitable Renewable Energy Power Purchase Agreement (REPPA) is inappropriate since the systems utilize different types of feedstock and technologies. Unlike fossil fuels, renewable energy should command a premium price as it has the overarching objective of preserving the environment and recycling waste.

The needs of continued awareness raising

Although power generation is not new to the palm oil millers, the continuous awareness programme is needed to ensure that the waste recycling will remain relevant despite the fast pace of technology development. Furthermore, policy makers and stakeholders require updated and genuine information in determining the correct mechanism to be placed.

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