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OPPORTUNITIES FOR BIOMASS POWER PLANTS IN SOUTHEAST ASIA REGION

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ABSTRACT

The Kyoto protocol has become a major issue for governments worldwide. Concern over global warming and the effect of pollution caused by the burning of “brown” fuels cannot be neglected.

The promotion of biomass (“green”) energy and more efficient utilization of local sustainable energy resources is part of strategy on fuel diversification in **S**outh **E**ast **A**sia (SEA) countries.

The tropical countries in SEA have a great comparative advantage due to the intensity and regular availability of solar energy, which may be exploited through plant photosynthesis.

For example Malaysia has an annual “green” energy potential equivalent to more that 36 million tones of crude oil, a potential that has to be utilized for energy generation. Especially oil palms, which are abundant in Malaysia, have a great capacity to utilize high light intensities with average water requirement and hence produce large quantities of biomass per hectare

In Thailand, energy production from biomass, and the common desire to use the sustainable fuel sources will all help to increase the use of biomass based fuels for generating electricity and heat. Additionally to utilized renewable energy resources, more than 3 million tons bio-waste are still available as energy resource for “green” electricity generation whose potential is estimated to be at least 88 GWh per year.

In relation to utilization of biomass for power generation, the following shall be highlighted:

- Governments shall strongly promote implementation of biomass waste for “green” energy generation because it would help improve the productive value of the finite energy resources.
- A 15 % saving in fossil fuel consumption will immediately translate into 15 % reduction in emissions into the environment.

- One typical 5 – 10 MW biomass power plant could produce enough energy for up to 1,700 households.
- Modern biomass technologies in particular offer one of the best prospects for generating “green”, decentralized, electricity in the remote rural areas not connected to a national grid.
- The “green” energy generation is not competitive at present market conditions, therefore, subsidies in the form of guaranteed higher tariffs, exemption of import duties and investment tax allowances have to be used to compensate for higher generation cost.

However, there are a number of challenges that inhibit the development of biomass energy. In this regard, formulation of sustainable energy policy and strategies in addressing these challenges is indeed a pre-requisite for the development and promotion of biomass energy.

A techno-economic model has been developed by IMTE to analyze the technical and economic feasibility of specific biomass equipment investments.

PRESENT SITUATION IN SOUTHEAST ASIA

GENERAL

Biomass is an important source of energy in SEA and its use is still increasing. In SEA, energy produces from biomass, mainly from wood and agricultural waste products, represents about 30 - 40% of total energy consumption.

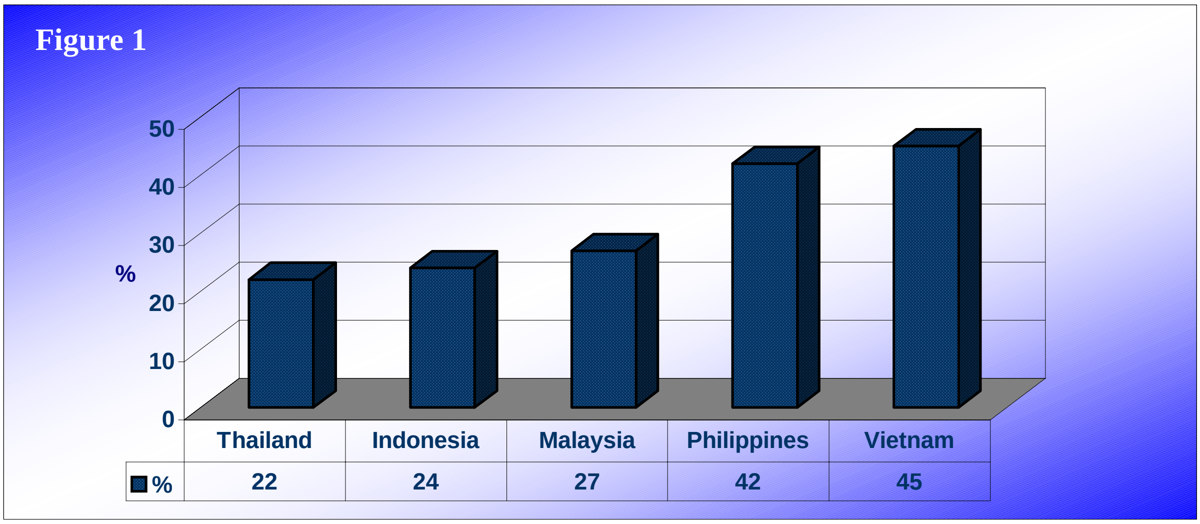
Main applications are in the domestic sector and small-scale industries like palm oil, sugar, rubber and coconut processing, rice parboiling, fish and meat drying, brick making, lime burning, ceramics and pottery producing, distilleries, timber drying, silk and textiles factories and recently more and more in modern systems for combined heat and power generation.

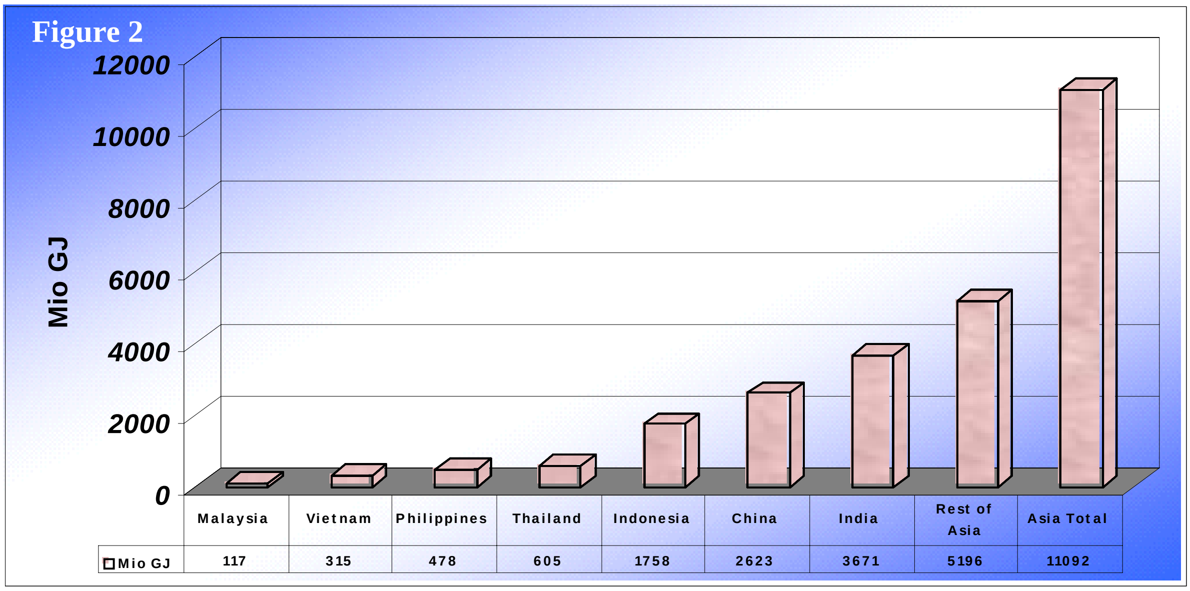
In SEA countries, which enjoy most favorable conditions for growing biomass, most important biomass fuels are wood and residues from coconut, rubber and oil palm trees, sawdust, bagasse as well and husks and straw from rice plants.

However, constraints to optimal use of biomass as main alternative energy source are still to be resolved.

It is recommended that energy policy makers in SEA countries acknowledge the important role and great value of biomass energy and its future potential, so that biomass energy can be integrated in overall country’s energy policy making and planning.

In particular the potential of modern applications for power generation should be given serious consideration as a way of ensuring optimal utilization of each country's biomass resources. Following diagrams show the energy potential of biomass fuels like palm oil and coconut waste, rice husks and straw as a percentage of total primary energy production in selected SEA countries (Figure 1) and biomass energy consumption in selected Asian Countries (Figure 2).



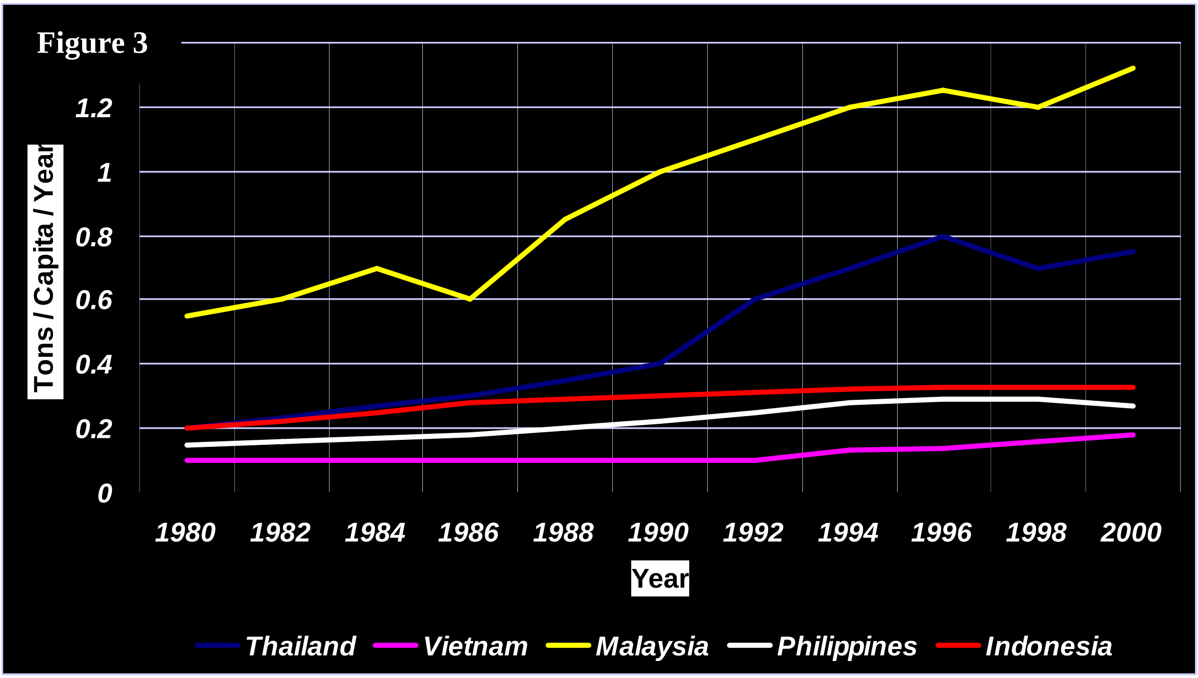


Malaysia's and Thailand’s per capita carbon emissions are relatively high compared to many of its neighbors in SEA.

As shown in the following diagram, Figure 3 Malaysia's per capita carbon emissions have more than doubled (2.3x) and Thailand's per capita carbon emissions have more than tripled (3.5x) since 1980.

The strong emissions reduction in year 1985 and 1997 (Malaysia & Thailand) reflect the energy (1985) and economical (1997) crisis respectively.

On the other side, Malaysia and Thailand also have a higher level of per capita energy use than the majority of neighboring countries.



INDONESIA

In spite that Indonesian Government strongly promotes renewable energy and although that Indonesia has the largest "green energy" potential in the region, the market for biomass based power generation has not picked up until now.

Country wide abundant biomass energy is currently under-utilized for commercial power generation.

Biomass residues are very often discarded or burned where they are produced.

The national energy policy aims to reduce the dependence on oil and gas by developing and using non-oil/gas energy resources.

The diversification policy, especially in agricultural (rural) areas, will take into consideration the most abundant biomass resources as one of major energy sources.

However, the availability of biomass energy sources differs by geographical location. In mountainous areas, fuel wood is predominant while in the lowlands, agricultural waste is the most available biomass energy source.

Presently, the potential investors and project developers are still hesitant to invest in this new power generation technology in Indonesia, mainly due to lack of technology infrastructure, low return on investment and also due to political instability.

The Indonesian market for biomass based power generation is expected to mature only after the technologies are well established in other SEA countries and when the electricity tariffs reach reasonable level and the technology investment costs become substantially lower.

THAILAND

In order to reduce greenhouse gas emissions as well as to increase independency on conventional fuels the Thai government is promoting the use of renewable energies by accelerating the utilization of biomass based power generation technologies in the country.

Since 1992, Small Power Producers (SPP) are allowed to sell power to the Electricity Generating Authority of Thailand (EGAT), up to a maximum of 90 MW each.

Last year, the biomass as fuel for electricity generation has received another boost following a joint agreement by the United Nations and Thai agencies to set up a “one-stop clearing house” giving out information on biomass technology.

The UN Development Programme, the National Energy Policy Office, and the Office of Environmental Policy and Planning are behind the center, which will plug people into commercial financing sources for biomass based power generation projects.

Thanks to abundant biomass resources mainly from the agricultural and forestry sectors, Thailand has a huge potential for power generation based on biomass fuels.

With support from the Thai Government, changes have been unfolding quickly in the past five-six years with the introduction of programs for renewable power generation by SPP and the regulation of power generation sector, which also includes the privatization of power generation sector.

Currently there are more than 30 biomass based (bagasse, woodchips and paddy husk) power generation projects in the country with total capacity of above 250 MW.

PHILIPPINES

The Philippines has abundant supplies of biomass resources, offering huge potential for power generation particularly from agricultural residues as shown in the following table.

	Unit	Rice	Sugar	Wood	Palm Oil
Processing	Mio to	11.3	20.5	1.1	0.4
Residues	Mio to	2.5	6.2	0.5	0.15
Installable Capacity	MW	215	455	53	10

The government initiatives to meet the objective of increasing power generation from indigenous resources, which will have some impact on the market for biomass technologies.

Support for biomass technologies in the country comes in a variety of forms, including fiscal incentives for private sector investments, government programs for renewable energy promotion and support, utility schemes to install renewable capacity, and soft loans managed by national banks and organizations.

New support or opportunities may be available in the future through minimum guaranteed prices for renewable and liberalization of the power generation sector.

The following fiscal incentives are available to encourage investment in infrastructure to enable economic growth, with special concessions for biomass power generation projects:

- Tax duty exemptions on imported capital equipment
- Tax credit on domestic capital equipment
- Income tax holiday of 6 years for biomass projects
- Additional deduction for labor costs
- Deduction of infrastructure expenses from taxable income.

Additionally, the Department of Energy is also investigating the possibilities for guaranteed minimum prices for electricity from non-conventional energy sources, with the aim of making them competitive in terms of price with conventional technologies.

MALAYSIA

Malaysia has over 3.5 million hectares of oil palm plantation capable of producing about 16 million tones of biomass waste annually.

In order to supervise the energy sector more specifically, the Government established the Malaysian Energy Commission (MEC), with effect from 1st May 2001.

Among others, the MEC is responsible for promotion of new renewable sources of energy.

The promotion of renewable energy and more efficient utilization of local energy resources is part of Malaysia National Strategy on Fuel Diversification.

According to MEC Chairman Datuk Mohd Annas Mohd Nor, about 50 to 60 renewable power plants will be set up by 2005 to meet the targeted 5 per cent or 600 - 750 MW of the total estimated national power supply.

Study performed by the Government in year 2000 and 2001 has shown that the renewable sources of energy available in Malaysia have an annual energy potential equivalent to more that 36 million tones of crude oil. This is a huge potential that has to be utilized for energy generation.

The Government is ready to study the cost of power production from biomass sources, to fix the prices so they are different from the prices paid for oil, gas and coal-generated energy.

VIETNAM

In spite of the fact that the country has large energy reserves, Vietnam is a relatively small producer and consumer of energy.

The country’s energy reserves mainly consists of extensive coal deposits, natural gas and oil, considerable hydropower reserves and huge biomass resources.

Biomass fuels, mainly firewood and agricultural residues are the major source of energy used by the vast majority of the rural and semi-urban population.

Ministry of Energy is paying a great attention to the modern energy sector, including biomass base power generation.

Vietnam Institute of Energy proposed that the Government address biomass energy in its policies.

The intention of the Government of Vietnam is to proceed with rural energy planning, including wood and biomass energy utilization, with assistance from the Asia Development Bank.

SINGAPORE

Singapore has very little biomass power generation potential. However Singapore Government plans to buy electricity generated from renewable sources from neighboring countries. Singapore will also setup an environmental academy to promote renewable energy in the SEA region.

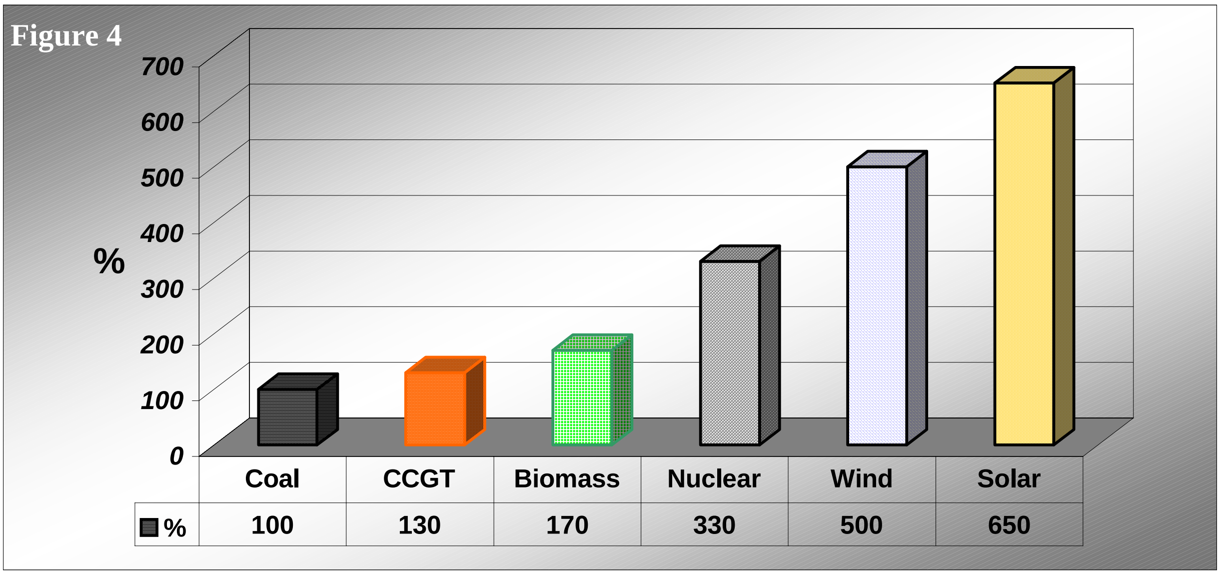
CAMBODIA, LAOS, MYANMAR, BRUNEI

In the above countries, the domestic sector is the main user of biomass fuels; primarily for cooking and heating.

The main user groups are farmers and villagers, but daily wage earners, industrial workers and food vendors in cities all use biomass fuels to some extent. Villagers also use biomass fuels to process agricultural products either for preservation or for conversion into tradable commodities.

PRICE COMPARISON

When the unit (kWh) price generated in coal fired (lignite) power plant averages 100%, than the unit generated in natural gas fired CCGT power plant costs around 130% and unit price in biomass power plant is approximately 170%. The following Diagram (Figure 4) shows comparison between unit prices for different power generation systems.



CASE STUDY
OPPORTUNITY FOR 10 MW BIOMASS FIRED POWER PLANT IN MALAYSIA

BACKGROUND

Malaysia has been an energy exporter for the last 2 decades but its oil reserves are likely to be depleted within a decade and the gas reserves in about 50 years. Most of the coal is imported. There are no nuclear power generation plants nor are there plans for the future.

Until 1999, renewable energy figures did not appear in the National Energy Balance although much biomass in the palm oil industry is available.

But by 1999, both the Prime Minister and the Energy, Communication and Multimedia Minister were publicly stating that renewable had the potential to be a 5th fuel source in the country's energy supply scene.

There is now an attempt to set up major demonstration projects using biomass from palm oil mills.

In the Eighth Malaysia Plan (2001-2005), the government plans to replace the Four Fuel Diversification Policy with a Five Fuel Diversification Policy, which will add renewable energy as a potential source.

Utilizing only 5% of renewable energy could save the country RM 5 billion over 5 years (*The New Straits Times, 29/06/2000*). Therefore, government's concern on renewable energy is beginning.

Government and non-government agencies are already taking proactive actions to coordinate and promote energy generation based on renewable resources such as inventory of renewable sources, identification of suitable technologies, create incentives for appropriate practical application and a better national renewable energy policy to allow more participation from government, non-government and public.

Financial institutions are urged to assist producers of renewable energies such as biomass and biogas to help realize the Government's target of generating about 750MW or 5 per cent of total power generation from new energy sources by the year 2005. Malaysia has a good start since the program kicked off in May last year.

It is estimated that about 16 million tones of waste generated yearly from the palm oil industry was more than enough to fuel small power and cogeneration plants.

To date, the Malaysian Energy Commission has approved and granted licenses to four renewable energy producers.

Tenaga Nasional Berhad (TNB) has signed renewable energy purchase agreements with two producers under the **S**mall **R**enewable **E**nergy **P**rogram (SREP).

The two producers are Bumibiopower Sdn Bhd and TNB's wholly-owned subsidiary, Jana Landfill Sdn Bhd. Both plants are still under construction.

In October 2001 TNB agreed to buy electricity generated by Bumibiopower at 16.7 sen per kWh (kilowatt hour) for 21 years, and from Jana Landfill at 16.5 sen per kWh for 15 years. More licenses would be granted by the end of this year.

To meet the Government's target, between 50 and 60 renewable power plants, costing RM40-RM50 million each, would be set up by 2005.

To attract more players into the renewable energy sector and to compensate those already in the industry, the Government has granted these companies a 70 per cent tax-exemption on their statutory income for five years or a tax allowance of 60 per cent of capital expenditure incurred during the period.

In addition, the companies will also enjoy import duty and sales tax-exemption on machinery and equipment not available locally.

In the Eighth Malaysia Plan, the Government allocated RM500 million for renewable energy activities and RM300 million for energy efficiency activities.

The Government of Malaysia has a strong interest in promoting implementation of renewable energy generation because it would help improve the productive value of the finite energy resources the country has and develop national energy resources and power assets in a more sustainable manner.

In addition to bringing national benefits and savings to individual companies, introduction of renewable energy production would also benefit the environment.

A 10 % saving in fossil fuel consumption will immediately translate into 10 % reduction in emissions into the local and global environment.

BIOMASS RESOURCES

Residues from palm oil mills, rice mills and wood mills as well as landfill gas (methane) are the main types of biomass resources that are considered as potential renewable energy for power generation in Malaysia.

Forest residues and biogas (pig waste) utilization are not significant.

Up till May 2001, there were 352 oil palm mills, 39 palm kernel crushers, 46 refineries and 16 oleo chemical plants in the country. They are producing about 16 million tones wastes of empty fruit bunches with an equivalent energy potential of more than 3 million tones of diesel oil, which represent about 10 % of the total national energy supply (status 2002).

Over the last decade production has increased and continues to grow rapidly and it was expected to increase the oil palm planting from 3.376 million hectares in 2000 to 3.547 million hectares in 2001. This constitutes about 60 percent of the total cultivated area in the country.

Typically palm oil mills consume less than half of their solid waste for energy requirements. The remainder is composted, incinerated, dumped or returned to the plantation.

The empty fruit bunches; shell, fiber and liquid effluent can be used much more efficiently to fuel biomass power plants, which provide the mills' steam and power requirements and substantial surplus electricity to feed to a local or national grid. At the same time, fossil fuel use is reduced and Greenhouse Gas emissions mitigated.

OPPORTUNITY FOR SMALL BIOMASS POWER PLANTS

The concept of marketing biomass energy has a huge potential in Malaysia considering that the country has an abundant supply of agricultural wastes that can be used to generate energy.

One typical biomass power plant could produce enough energy for up to 1,700 households.

Biomass power plants usually are sized between the ranges of 5 MW to 10 MW and are therefore more suitable for small housing areas, preferably those located near estates and plantations.

The proximity to biomass producers, in this case palm oil mills, will enable easier transportation of biomass fuels to the power plant. This would enhance the economic viability of putting such power plants fueled by biomass.

While the population in Malay Peninsula is well served by an extensive grid system, supported by major centralized power plants, the government appears committed to securing better use of indigenous energy sources, rather than imported coal that has been considered for recent IPPs.

A superficial estimate of the potential for biomass generation range above 2000 MW using the discarded dried fruit bunches, biogas and the regular felling of the palm trees themselves.

It is estimated that a total of 42 million tones of Fresh Fruit Bunches (FFB) were produced in Malaysia by end of last decade.

For low-pressure systems with an assumed energy conversion rate of 2.5 kg of palm oil waste material per kWh, potentially over 7,000 GWh could be generated in an overall capacity of over 1,000 MWe.

The introduction of new and more efficient process heat and power generation equipment in existing palm oil mills will take center stage as co-generation is already widely practiced. In addition, for every tone of palm oil produced, 2.5 m3 of waste-water (POME) is generated.

Anaerobic digestion of this wastewater results in a biogas consisting of 60–70 % methane, 30–40 % carbon dioxide and trace amounts of hydrogen sulphide.

At many palm oil mills, this process is only done in order to meet water quality standards for industrial effluent. The gas is flared off. Potentially 1 m^3 of this biogas could produce additional 1 kWh of electrical power.

With the anticipated possible waste shortages in palm oil mills, these biogas resources may offer an alternative.

TYPICAL PROJECT TIME SCHEDULE

Typical project time schedule for substantial completion dates of small (10 MW) biomass fired power plant (first unit) is shown in the following table.

Activity	Lead Time Starting (Month)	Lead Time Ending (Month)	Duration (Months)
Basic engineering & main equipment selection	**0**	**3.5**	**3.5**
Detailed engineering	**2**	**6**	**5**
Main equipment manufacturing & delivery to site	**2**	**15**	**14**
BOP equipment manufacturing & delivery to site	**3**	**12**	**10**
Site construction & erection works	**6**	**15**	**10**
Interconnection to TNB distribution network	**15**	**15**	**1**
Commissioning & testing	**14**	**18**	**5**

The delivery time for following units can be substantially reduced (learn & modularization effect).

TECHNO-ECONOMICAL ASPECTS

Modular design approach offers a great contribution achieve the target of developing a highly standardized, most flexible and economical biomass fired power plant.

Modular design concept breaks the power plant down into main three levels:

Level 1 → Defines the overall system packages like ST, boiler, fuel storage, W/S Cycle, BOP Systems, etc.

Level 2 → Divides the overall systems packages into sub-systems that again can form independent “modules”.

Level 3 → Defines the physical modules for each of the subsystems.

In all levels, a classification with regards to standardization shall be carried out and certain parameters shall be defined as “frozen” or “variable”.

Options should be, whenever possible; in such case they will be defined as separate modules.

With this approach, it is possible to identify the systems and areas which can become highly standard and those for which standardisation is not useful or even not possible due to inherent parameters.

For those systems, prior to the project start, it need to be decided if more alternatives or options shall be considered or if those systems will just be designed on a project specific case by case basis.

The modular approach orientates itself at the rule that standardisation starts from inside. This means the further the design of the plant moves from the heart (generating equipment) to the peripherical systems (e.g. BOP systems).

Modularisation helps the standardisation of products as it can break down a system into subsystems that are relatively independent from the main system.

Such subsystems can be standardized again and can be used as a physical module in conjunction with other systems or processes.

The largest common denominator in such a system could be physical module size or a simple process chain.

In defining practicable and standardised modules for a 10 MW biomass power plant the main target is to transform, wherever possible, complete **systems** into **standard modules**.

By doing so, it will become easier to transform the **modules & submodules** into **power plant modules**.

Thus, a total of eleven modules and approx. 40 submodules have been defined for this type of power plant.

Due to the standard grid system used by the power plant modules, the modules will become easily exchangeable without changing the overall layout, which provides the required flexibility, optimization and standardisation for this type of power plant, **resulting in cost saving and lower electricity tariff for the power consumers.**

Connec-T AG & IMTE AG have developed a modular system for 10 MW biomass fired power plant which is currently under consideration in Malaysia.

COMMERCIAL ASPECTS

PROJECT COST ESTIMATES

The total project cost for the proposed 10 MW biomass power plant is estimated at 10 – 15 Mio US$. This includes the EPC costs, interest during construction and other development and financing cost amounting to 2 – 2.5 Mio US$ (appr. 20 - 25% from EPC cost).

However, the actual project cost may differ from the estimate for one or more of the following main reasons:

- Changes in interest rates and fees
- Variation in exchange rates
- Changes in applicable laws
- Changes in imposition of any taxes
- Project delay beyond the control of the Investor
- Changes in financing draw-down schedule
- Variations in scope of supply
- Events or circumstances not within reasonable control of the Investor.

KEY ASSUMPTIONS

The assumptions for this case study have been provided by IMTE and are based on similar projects in the region.

Generally it should assist the Investor to undertake its own independent analysis and associated due diligence to determine the viability of the Project.

This section summarizes variable operating parameters used to develop financial pro forma parameters and to calculate indicative revenues and expenses of Investor arising from the anticipated commercial agreements.

The variables are separated into the following areas, which are detailed below:

- Capital cost
- Operational cost
- Revenue
- Expense
- Financing
- Taxation
- Economics

Cost Assumptions

Estimated average cost of the project amounts to US$ 12.5 Mio US$. million and a breakdown is summarized as follows:

Capital Cost Breakdown
Turnkey Price (EPC)
Site Preparation
O & M Mobilization
Contingency
Land Costs (appr. 14’000m^2)
Land Conversion Costs
Reimbursed Development Costs
Insurance during Construction
Consultants' and Advisors' Fees
Import Duties and Sales Tax
Financing Fees
Interest during Construction

Operational and other Variables

Operational and other major project variables, which have to be considered, are summarized in the following Table.

Key Assumptions
Gross Power Output
Degradation Factor
Power Plant Availability
Capacity Factor
Expected PPA Tariff
Fixed O & M Escalation
Variable O&M Escalation
PPA Tariff & Capacity Escalation
Fuel Price Escalation
Auxiliary Consumption
Net Power Output
Heat Rate
Operational Life Time (PPA)
Operational Months / Year
Fuel Low Heating Values (LHV)
Fuel Costs
Fixed Operating Costs
Variable Operating Costs
Financing Conditions
Taxation
Other Economic Assumptions
Fixed O & M Escalation
Variable O&M Escalation
PPA Tariff & Capacity Escalation
Fuel Price Escalation

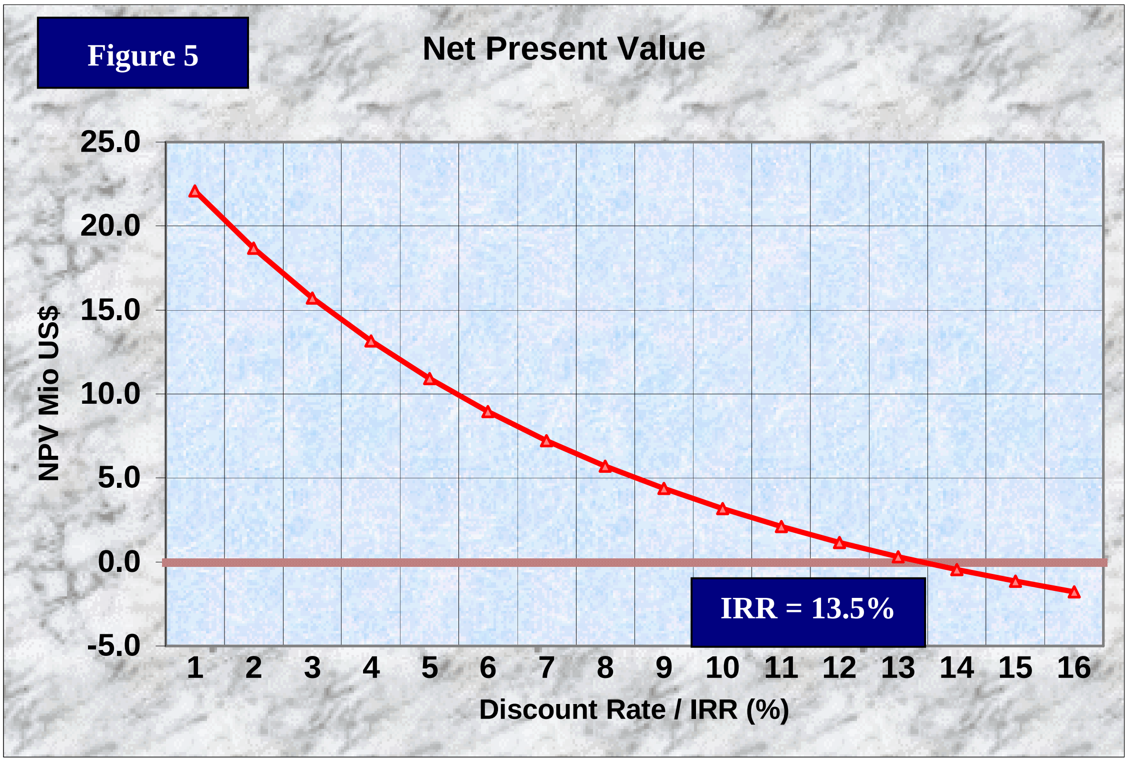
PROJECT NET PRESENT VALUE & IRR

The following assumptions have been made for project NPV & IRR calculation.

- Total investment costs → 12.5 Mio US$
- Net capacity → 10 MW
- Capacity factor → 80 %
- Power Plant Availability → 87.5 5
- PPA period → 21 years
- PPA Tariff → 0.0442 US$/kWh
- Debt repayment period → 12 years
- Developer equity → 25 %
- Interest rate → 6.5 %

- Tax & duties → 0 (Variable for each project and country)
- Construction period → 18 Months

The result is shown in the following diagram (Figure 5).



Project's expected average internal rate of return (IRR) before tax, is the discount rate (DR) which sets the net present value (NPV) of the given cash flows (Figure 6) made at the given time (21 years) zero. IRR is above 13.5% for this case.

Calculated project's IRR represents the average periodic rate of return earned on funds invested in the project (first unit).

Considerably higher IRR is achievable for following power generation units under assumption that the same technology and unit size will be considered.

It shall be emphasized, that above introduced IRR is an average rather than constant rate; the rate of return generated by the project in any one period is not equal to its IRR.

Also under aspect that all applicable taxes and duties *(which have not been considered for this case)*, will be imposed to the project later, it is expected that the project will be profitable for the investor.

Expected project cash flow before tax is shown in Figure 6 considering the following main inputs:

- flow "in" from Operations (Electricity sales and other revenues)
- flow “out” from Operations (Fixed and variable O&M costs, fuel costs and other expenses.)
- flow "out" to Project Financing (Debt repayment and other fees)

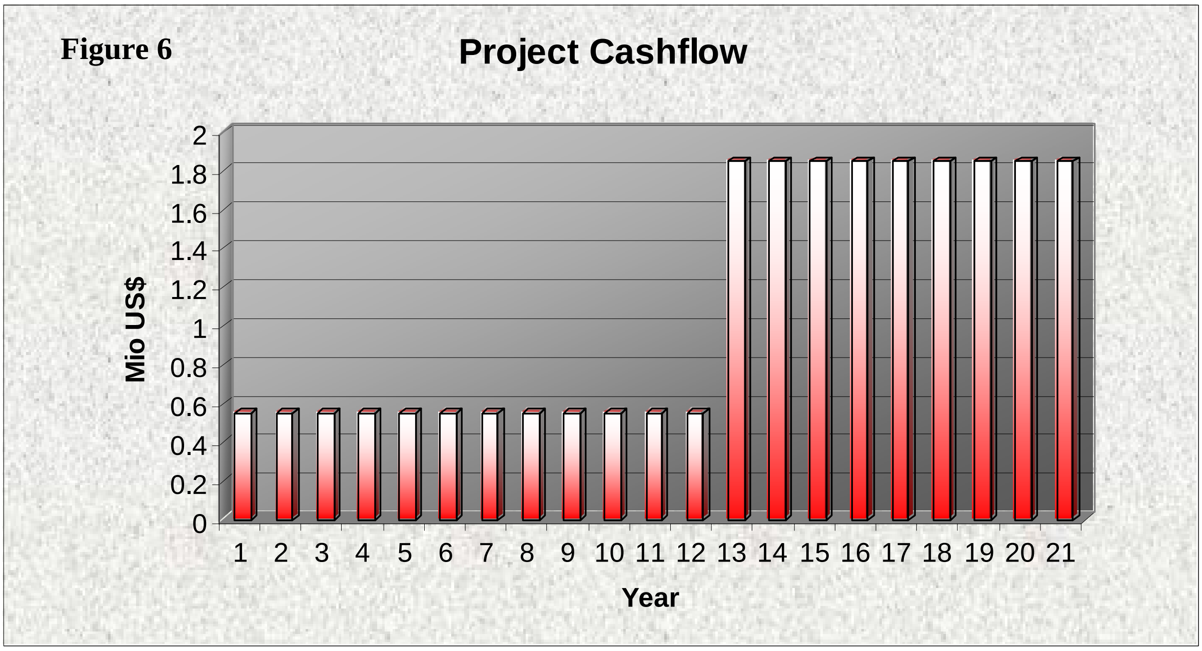


Figure 6

Project Risk Aspects

It is important to review certain major risk factors, which may affect the commercial performance of the Project. The following does not purport to be a complete or exhaustive review of all risks facing the project Investor.

The table below is a summary of relevant risks and mitigating factors associated with the Project.

RISK MATRIX			
Risk	**Risk Factor** 5=Max 0=Min	**Bearer of Risk**	**Mitigating Factors**
Construction Period Risks			
Completion Risk	2	Contractor-Investor	Turnkey contract – liquidated damages
Construction Price Risk	1	Contractor-Investor	Turnkey Contract – Fixed price
Permitting and Approvals	0	Contractor-Investor	To obtain the majority of permits and approvals.

RISK MATRIX			
Risk	**Risk Factor** 5=Max 0=Min	**Bearer of Risk**	**Mitigating Factors**
Operating Risks			
Project Performance	2	Operator-Investor	Contract warrantees-Liquidated damages
Technology	2	Contractor-Investor	Relatively new technology in Malaysia
Market Demand and Price	2	Investor - TNB	Long term PPA required
Energy Dispatch	2	Investor - TNB	Long term PPA with capacity payments preferable
Operating and Maintenance Costs	2	Operator-Investor	Support from major equipment supplier required
Biomass Supply	3	Investor	Long term delivery agreement with palm oil producers (POP) required
Biomass Price	3	Investor	Present price 10 RM / Ton; Long term price agreement with POP required
Equipment Breakdown or Failure	1	Operator-Investor	Critical spare parts must be available on site + proper insurance coverage
Regulatory and Environmental Risks			
Environmental	1	Investor	Environmental Impact Assessment that ensures compliance with all required environmental regulations must be performed. Operator shall regularly monitor the Project’s environmental parameters to ensure compliance.
Emissions	1	Contractor – Investor	The Contract shall provide for guaranteed emission levels.
Waste Disposal	0	Operator - Investor	Shall be considered in project design
Economic and Financial Risk			
Inflation	2	Investor - TNB	PPA
Interest & Exch. Rate	2	Investor	Conservative assumptions & hedging
Force Majeure	3	Investor - TNB - Operator	Subject to terms of PPA and biomass supply agreement

Completion Risk

There is a risk that delays in construction will result in delays in operations and thus increased construction costs and a delay in revenue receipts.

The Contractor shall be liable for liquidated damages.

Construction Price Risk

There is a risk that the construction cost will exceed the projections.

Contract with a fixed price (lump sum turnkey contract) is required.

Permitting and Approvals

There is a risk that the issuance of certain permits and approvals may be delayed or that certain permits and approvals will not be obtained.

The contractor shall be liable to obtain a majority of the permits and approvals required for the construction of the power plant.

Project Performance

There is a risk that the completed power plant will not perform as guaranteed by the contractor.

In the event the contractor does not meet the Guaranteed Net Output and the Guaranteed Net Heat Rate, the contractor shall be liable for liquidated damages.

Technology

In any power plant there is a risk that the technology employed will fail causing additional replacement costs and loss of revenue.

All of the components used in the power plant shall be proven technology supplied by recognized equipment manufacturers with extensive manufacturing experience.

Market Demand and Price

Increased competition as a result of restructuring in the Malaysian power industry may lead to reduced demand and/or prices for power produced by the Project.

In the event of a restructuring of the Malaysian electricity industry, the Investor and TNB shall negotiate in good faith amendments to the PPA to enable full participation by the Investor in the restructured market.

The power plant utilizes local biomass fuel and supplies local distribution network. Thus there is a very high probability that it will be demanded in a pool market system.

Energy Despatch

The Project may be dispatched at a low level thereby reducing revenues available.

The PPA shall be structured with a capacity (to cover all fixed and capital costs) payment and an energy (to cover the biomass fuel and variable operating costs) payment.

Operating and Maintenance Costs

There is a risk that operating and maintenance costs will exceed projections.

The Operator shall be subject to liquidated damages in the event of non-performance for availability, capacity, heat rate and emissions under the O&M Contract.

Biomass Fuel Supply

There is a risk that biomass fuel supply could be impaired, thereby decreasing the output of the Project.

In addition, issues such as the logistic of biomass supply (estimated average 250 – 500 tons/day), the storage, treatment processes to convert it into usable fuel must be taken into consideration.

Biomass Fuel Price

There is a risk that increases in the price of oil palm biomass could increase thereby decreasing the cash flow of the Project.

Major concern is that the biomass waste now has an affordable value but there is no telling how the price tag will look like in a few years.

The price of palm oil biomass waste is now somewhere between 0 and RM10 per tone compared with RM25 paid to generate the same amount of heat from coal.

Equipment Breakdown or Failure

There is a risk that a failure of certain equipment may cause forced outages under the PPA, thereby reducing the cash flow of the Project.

All of the components used in the power plant shall be proven technology supplied by recognized equipment manufacturers with extensive manufacturing experience.

The Investor (operator) shall purchase and maintain a stock of all critical spare parts for the power plant.

In the event of a breakdown, the operator shall use the spare parts onsite to expedite the repairs. The Investor shall maintain certain insurance including industrial all risk and industrial all risk – advance loss of profits policies.

Regulatory and Environmental Risks

The Project is required to comply with environmental regulations governing operation of the power plant, including meeting air, water and noise emission standards. Non-compliance could result in the suspension or cancellation of the License and/or the imposition of fines. The adoption of new laws or regulations, or changes in the interpretation or application of existing laws or regulations could require the Investor to make additional material expenditures on environmental compliance, and Investor's ability to operate the Power Plant in a cost effective manner could be materially adversely affected.

compliance with all material environmental regulations. Pursuant to the O&M contract, the operator shall be required to meet certain guaranteed levels with respect to emissions. In the event the operator does not meet these emission levels, the operator shall be liable for liquidated damages.

Inflation

The Project's revenues may not be sufficiently adjusted to compensate for inflation in operating costs.

The PPA shall provide for escalation of the fixed and variable operating components of the tariff.

Interest Rate

There is a risk that increases in interest rates may adversely affect the cash flows of the Project.

Conservative estimates and assumptions for interest rates should be used in forecasting debt service payments.

Exchange Rates

Certain Project capital and operating costs will be in foreign currencies, whereas the financina and revenues for the Proiect are in local currencv.

Local currency portion to be maximized and other currencies hedged.

Force Majeure

In the event of a force majeure, the Investor may be subject to certain additional costs, which will negatively impact the Project and its cash flow.

Many scenarios are possible, however this shall be covered properly in PPA and other applicable agreements and contracts.

Summary & Conclusions

The renewable, biomass based energy market is growing rapidly worldwide. There are hundreds of biomass-fired steam and electricity generating plants currently operating in the USA. Although their economic feasibility can pose challenge, their technical feasibility is well proven.

However, the further development and future direction of oil palm biomass for power generation will very much depend on the requirements of the economy in terms of reliability and security of energy supply.

In line with the objective of diversifying the sources of energy, the biomass and other renewable energies have been already identified as an alternative source of energy in some SEA countries.

There are a number of challenges that inhibit the development of renewable energy.

Following some aspects related to utilization of biomass for power generation and global environment protection are summarized:

- Biomass includes all kind of wet and dry agricultural by-products, forestry wood waste products and also including residues, and energy crops;
- Biomass has the potential to sustainably provide a major proportion of the primary global energy supply and is therefore an exciting opportunity for the next millennium. It will satisfy many of the roles played by fossil fuels as conversion technologies mature;
- Biomass is a renewable source of energy and its use does not contribute to global warming. In fact, it can reduce the atmospheric levels of carbon dioxide;
- Biomass fuels have negligible sulphur content and therefore do not contribute to sulphur dioxide emissions, which cause acid rain. The combustion of biomass generally produces less ash than coal combustion, and the ash produced can be used as a soil additive on farm land to recycle material such as phosphorous and potassium;
- Biomass is a domestic resource, which is not subject to world price fluctuations or the supply uncertainties of imported fuels. In developing countries in particular, the use of liquid biofuels, such as biodiesel and ethanol, reduces the economic pressures of importing petroleum products;
- An exciting alternative economic model promises a better life everywhere without destroying the earth's natural support systems. The new economy will be not powered by fossil fuels, but by various sources of wind energy, solar energy (where also biomass energy belongs to) and hydrogen;

- Wind power already supplies 8% of Denmark's electricity and 15% of the electricity for Schleswig-Holstein in Germany;

As such, the choice to use oil palm biomass for power generation is not difficult but requires lot of organization and logistic skill.

It is important that the biomass power plant designer and developer shall-

- Work closely with a few number of larger biomass suppliers rather than a large number of small suppliers;
- Be aware that biomass waste don't "travel well," and require special fuel handling systems;
- Know that when purchasing biomass, the moisture content and the calorific value must be accounted for;
- Be careful in accepting resource assessment studies, which promise huge supplies of biomass. There is a big difference between promised gross volumes and what is economically viable to recover and use;
- Locate the new biomass fired power plant near by the biomass source and close to the power distribution network.

Nevertheless, the driving force to use oil palm biomass for power generation is the market, which will clearly have a very important influence on economic viability for sustainable country development in the future.

In order to promote the development of green, biomass, electricity, the following is expected from SEA Governmental Authorities:

- Grant full support for new biomass based power generation projects;
- A forward-looking and committed national power distribution companies management;
- Ensure guaranteed access for electricity generated in biomass fueled power plant to the national power distribution network;
- To streamline and simplify administrative procedures for the installation of biomass fueled power plants;
- Ensure that the calculation of tariffs for connecting biomass fueled power plants to the national grid are fair and non-discriminatory;
- Introduce a bonus system for surplus production;
- Provide clear and concise information to the general public and producers about the environmental and economic costs and benefits of new biomass based power generation technology.

Advanced biomass-based systems have the potential to contribute significantly to the SEA energy supply in the future.

The central goal for development is to create an economically and environmentally sustainable system, based on a fuel-supply infrastructure that will enable investment in modern high-efficiency power-production cycles.

According to calculations performed for this paper, an average oil palm biomass fired 10 MW power plant shall generate positive, before tax, cash flow over the life time period of 21 years. The average debt service ratio is 1.5 and the average time interest earned ratio is 6.0.

Expected average IRR (before tax) is 13.5%.

SPEAKER'S BIOGRAPHICAL SKETCH

Miro R. Susta is graduate of Swiss Federal Institute of Technology in Zurich, ETHZ; Diploma (M.Sc.) degree in Power Plant Mechanical Engineering.

He is a Member of Swiss Engineers and Architects Association (SIA) and Member of American Society of Mechanical Engineers (ASME).

Mr. Susta has more than 28 years of professional experience in power plant design & engineering, field and factory testing, sales and marketing with Sulzer-Brown Boveri Turbomachinery AG, Brown Boveri AG, Motor Columbus Consulting Engineering AG and Asea Brown Boveri AG in Switzerland.

During his professional career, Mr. Susta accumulated a vast knowledge and experience not only in power plant design, engineering, marketing and management, but also in general power business not only in Europe but also in miscellaneous countries in Asia.

In year 1992, Mr. Susta joined Swiss consulting engineering company IMTE AG, which is specialized in thermal power generation consulting engineering activities. Among others, he was involved in Lumut 1303MW CCGT power generation project in Malaysia from year 1993 till 1997 and Sepang 710 MW CCGT.

At he present he is a director of IMTE AG Switzerland and SEA Regional Manager of IMTE AG Ltd. with office in Malaysia.

Currently Mr. Susta is also involved in development of small biomass fired power plants in Malaysia.