ICRA

BACKGROUND PAPER

BIOMASS FOR ELECTRICITY GENERATION IN ASEAN

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Author: Lara Bertarelli, IED
in collaboration with the RE-SSN

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CONTENTS PAGE

1 INTRODUCTION

This report serves as a background paper on biomass for electricity production : the case, potential, experience, challenges and opportunities in the ASEAN region. This report will draw where possible on the European experience and feed into the development of a policy orientation and action plan which will be forwarded for adoption by the Renewable Energy Sub-Sector Network (RE-SSN). This report is a collaborative action between the focal points of the RE-SSN and IED, France and acts as one of the deliverables[1] of a European Union – ASEAN co-financed project titled "Information for the Commercialisation for Renewables in the ASEAN region (ICRA)". For further information on the project itself please refer to the ASEAN Centre for Energy (ACE) website: http://www.aseanenergy.org/icra/index.htm.

The report acts as a self-standing report covering the following topics:

1. The case for biomass energy for electricity production: Why biomass and what is biomass?
2. The potential for biomass energy in the region
3. Status of biomass applications in the region – opportunities for regional knowledge sharing
4. European know-how
5. Case studies
6. Challenges
7. Recommendations

2 WHY BIOMASS FOR ELECTRICITY PRODUCTION?

As populations expand and develop, industrialising economies will require additional and diverse energy sources. Energy forecast models are increasingly shifting towards a diverse energy mix wherein renewables have an increasingly important role to play[2].

Within twenty years renewable energy is expected to provide between 5-10% of the worlds energy needs and maybe 50% by the middle of the century (ref 39). Key among these will be biomass which is available worldwide in significant quantities. According to the RIGES[3] model biomass could expand to produce 18% of electricity requirements during the period 2025-2050 (ref 39) and, according to the "Rapidly Changing World with Stabilising Policies (RCWP)" scenario of the US Environmental Protection Agency, supply 26% and 32% of the world primary energy needs over the same time frame. (ref 24) A study by Shell international quantifies the contribution of biomass energy to about 221 EJ by 2060 with a business-as-usual scenario. (ref 24)

In fact, biomass energy plays an important role in a number of energy models. ***Whatever the model, it is clear that the biomass sector has a potential to grow rapidly in the future as demand for energy and clean fuels increases.***

In the ASEAN region the high cost of imported fuels, the rapid increase in demand for power[4], the need to secure and diversify the mix of primary energy supply coupled with an increasing environmental consciousness and the availability of abundant biomass resources are expected to stimulate the greater utilisation of biomass energy for both on-grid and off-

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[1] Other background papers that have been prepared for the ASEAN region include: (i) Policy aspects; (ii) CDM; and (iii) PV Standard Harmonisation.

[2] In recent years, mounting concerns on the global dependence on fossil fuels have been growing due to climate change and security of supply. Renewables provide promising options for mitigating emissions of GHGs as well as acid rain pre-cursors and as well aspects of security of supply.

[3] The Renewable Intensive Global Energy Scenario model suggested that by 2050 around half the worlds primary energy consumption could be met by biomass. (ref 39)

[4] in Thailand for example demand for electricity is expected to double from 2001 to 2012

grid situations. The possibility to generate carbon credits[5] is also an important factor that is contributing to this gradual shift towards making today biomass energy a reality.

This regional realization came to its climax in the Philippines in June 2004 during the twenty-second ASEAN ministers on energy meeting (22nd AMEM) when the ASEAN Plan of Action for Energy Cooperation (APAEC) for 2004 – 2009 agreed to explore new initiatives such as promoting the use of bioenergy and bio-fuels in the ASEAN region. This meeting endorsed the SOME's proposal to **increase the share of renewable energy in power generation** in the ASEAN region **to at least ten percent over the next six years**. This represents an incremental RE installed capacity of 2000 MW by 2010. It is the RE-SSN's belief that biomass energy can significantly contribute to meeting this objective.

In fact, the region represents the world's top producers of palm oil, sugar, rice, rubber, timber products; starch and coconuts. The range of these activities gives rise to large quantities of calorific by-products that are presently not valorized or otherwise discarded as waste. The effective use of these waste by-products alone are thought to hold much potential for the regions' future electricity production.

To date, Thailand in particular has been active in assessing its resources and establishing a framework to attract investment[6]. As of November 2004 the biomass grid-connected installed capacity amounted to 914 MW and a target for an additional 700 MW by 2010 has been put in place. Thailand today can act as a show case for the rest of the region who is lagging behind. Much is yet to be done to fully commercialise modern biomass energy technologies across the region. The future growth of biomass energy will depend to a large extent on the attractiveness of the institutional and regulatory framework in luring the private sector to invest and in parallel the accessibility of information.

Box 1: ASEAN Energy Policy Priorities:

- The national energy policy in **Indonesia** aims to reduce the dependence on oil & gas by developing energy resources like Renewables (ref 11).
- In **Malaysia** the national energy policy is focused in diversifying its fuel base & protecting the environment – Renewables will act as the fifth National fuel
- The **Philippines** aims to reduce its dependence on imported fuels and reduce emissions
- **Thailand** seeks an alternative to imported fossil fuels for security of supply and reduce greenhouse gases
- **Singapore** addresses ways of promoting energy conservation
- Whilst **Vietnam, Lao** and **Cambodia** are focused on increasing access to electricity in rural areas via renewables.

So why biomass?

- Biomass is a diverse and versatile fuel that can be converted into electricity, gas, heat or liquid fuels and can either be used solely or by co-firing in power stations.
- Biomass is a widely available resource: agro-industrial residues such as bagasse from sugar cane mills, palm oil mill residues, rice husks, sawmill residues, wastewater from these processes etc often have a negative market value or even constitute a disposal problem, making good use of the residues is often attractive[7].
- Biomass is also referred to as a carbon neutral[8] fuel which leads to net CO_2 emission reductions if used to substitute fossil fuels. Biomass feedstocks and fuel derivatives are also typically low in sulfur compared to fossil fuels such as coal and oil.
- Biomass is a local resource that offers the possibility of creating long-term jobs in the local area and strengthen rural infrastructure: employment in terms of cultivation,

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[5] 44 biomass energy projects have been submitted to the Executive Board of the UNFCCC - Kyoto Protocol as of February 2005. Biogas emits about 20 grammes of GHG's per unit compared to 1,008, 796, 650 and 471 grammes per unit, respectively from lignite, coal, diesel, and gas.

[6] SPP in Thailand - NEPO has set aside 2 billion Baht to ensure that SPPs which generate electricity from agro-waste get tariff rates which make their projects viable

[7] In many cases, disposal of the refuse is an expenditure

[8] Sustainable biomass production and its use for energy generation does not lead to net build up of CO2 levels in the atmosphere because of the net effect between CO2 absorbed during the plant growth and CO2 emitted during its combustion/processing

husbandry, harvesting, transport and fuel preparation[9]. Additionally, it is a fuel that with an increased market value and with the right political backing can also act as an important export fuel.

- Biomass appears to be the most important of the renewables in terms of technical and economic feasibility during the next few decades. Biomass energy is viewed today as the future energy source for development and industry. (ref 43)

3 BIOMASS CHARACTERISTICS – WHAT IS BIOMASS?

A brief description for the most important biomass fuels in ASEAN is given in the following sections. It should be noted that when taking into account these resources some may have alternative uses and their availability for power generation may be limited.

3.1 Palm Oil Residues – Empty Fruit Bunches, Shells & Fibre and Waste Water

Most palm-oil mills generate combined heat and power from fibres and shells, making the operations self-efficient. However, the use of palm-oil residues can still be optimised in more energy efficient systems. A palm-oil mill could theoretically supply an excess amount of power that is twice as big as its own consumption.

Empty fruit bunches (EFB) are conveniently collected and available for exploitation in all palm oil mills. At present EFB's are usually burnt causing air pollution or returned to the plantation as mulch.

The process also gives rise to waste-water (POME) and is often discarded in disposal ponds, resulting in the leaching of contaminants that pollute the groundwater and soil, and in the release of methane gas, one of the six greenhouse gases. This effluent could be used for biogas production through anaerobic digestion. Anaerobic digestion of this waste water results in a biogas consisting of 60-70% methane, 30-40% CO2 and trace amounts of hydrogen sulphide. At many palm-oil mills this process is already in place to meet water quality standards for industrial effluent. The gas however is flared off.

Retrofitting existing palm oil mills with new co-generation equipment and biogas systems capturing the methane released from the wastewater ponds are seen as holding a significant commercial opportunity.

> Reference Box 1
>
> For every tonne of oil palm fruit production 43-45% of this will become mill residue in the form of EFB, shell and fibre. The total waste from 1T of FFB will produce about 132kWe.
>
> **Empty Fruit Bunches (EFB) :**
>
> 1 ha = about 25T FFB, of which 5.5T EFB
>
> 1 t of Full Fruit Bunches (FFB) = 46 kWh of power from the EFB
>
> moisture content = 65%
> calorific value = 6,028 KJ/kg
>
> **Fibres and Shells :**
>
> 1 t of Full Fruit Bunches (FFB) = 41 kWh, from fibres
>
> 1 t of Full Fruit Bunches (FFB) = 47 kWh, from shells
>
> Fibre moisture content = 40%
> Fibre calorific value = 9,6 MJ/kg
> Shell moisture content = 25%
> Shell calorific value = 13,4 MJ/kg
>
> **Waste Water (POME)**
>
> For every tonne of palm-oil produced - 2,5m3 of waste-water (POME) is given off
>
> Potentially 1m3 of this gas could produce 1kWh of electrical power.

In the region particular potential is held by Malaysia, Thailand, the Philippines and Indonesia. In 2002, Malaysia and Indonesia accounted for 84% of global palm oil production. Malaysia, the largest producer of palm oil in the world, has around 330 palm oil mills in operation and is currently producing approximately 345,000 tonnes of total residues that are considered to be a waste problem and left to biodegrade and 1,73 million tonnes of Palm Kernal Shell as of 2001 of which about 1,38 million tonnes are used within the oil palm industry already or other

[9] biomass power and co-generation plants will create more operational and maintenance jobs than any of the other renewables per MW of installed capacity. (ref 40). In Europe for example, Biomass is expected to generate 300,000 jobs by 2020.

local industrial processes (brick works and rendering plants) or is considered logistically unaccessible. (ref 6) Malaysia is focusing on the waste products from the palm oil industry as potential biomass feedstock for future power plants.

3.2 Cane Trash and Bagasse from the Sugar Cane Industry

Cane trash and bagasse are produced during the harvesting and milling process of sugar cane which normally lasts between 6 to 7 months.

Cane trash, consisting of sugarcane tops and leaves can potentially be converted into around 1kWh/kg, but is mostly burned in the field due to its bulkiness and its related high cost for collection/transportation.

> Reference Box 2
> **Cane Trash :**
> 1 t of sugarcane = 290kg cane trash
> 1 t cane trash = 345 kWh
> calorific content = 1800 kcal/kg
> moisture content = 49%
> **Bagasse:**
> 1 t of sugarcane = 280kg bagasse
> 1 t of bagasse = 370 – 510 kWh
> calorific value of bagasse = 2200 kcal/kg
> moisture content = 50%

Bagasse is the fibrous residue produced when the juice has been extracted from sugarcane. A portion of the bagasse produced is already used in existing sugar mills to meet the factories own captive electrical and thermal needs. Low pressure - 20 bar - boilers and low efficiency steam turbines are commonly used. Upgrading these to highly efficient, high pressure systems with higher capacities and utilising the excess bagasse can be, commercially speaking, an interesting option. However, it should be highlighted that harvesting of sugar cane is a seasonal activity and to therefore achieve maximum utilization of a potential co-generation plant a system of bagasse storage or use of other biomass fuels or fossil fuels will have to be adopted (ref 36). The use of wood wastes for example in the non-crushing season has created recent interest. Of the world's 1670 sugar mills, more than 800 have greater than 5 Mwe potential export generating capacity and many are situated in countries where electricity is in short supply (ref 44).

Of particular interest in the ASEAN region for bagasse production are Thailand, Vietnam, the Philippines and Indonesia. In Thailand alone the total annual bagasse production amounts to about 21 million tonnes per year – this alone could generate 7407 GWh of electricity per year amounting to about 8,15% of the National electricity demand. In the Philippines and in Indonesia the total annual bagasse production amounts to about 7 million tonnes and 6,5 million tonnes respectively which could potentially generate between 2400 GWh and 3570 GWh per year. A study by the Philippine Sugar Millers Association showed that improvements in existing cogeneration systems can bring about an additional 100 MW of exported power to the grid.

3.3 Rice Husk and Straw from Rice Production

> Reference Box 3
> **Rice straw :**
> 1 t of rice paddy = 290kg rice straw
> 290 kg rice straw = 100 kWh
> calorific content = 2400 kcal/kg
> **Rice husk :**
> 1 t of rice paddy = 220kg rice husk
> 1 t rice husk = 410- 570 kWh
> calorific content = 3000 kcal/kg
> moisture content = 5-12%

Among the residues produced by the rice industry, only rice husk and straw can be used as a fuel. Rice husk, the main by-product from rice milling, accounts for roughly 22% of paddy weight, while rice straw to paddy ratio ranges from 1.0 to 4.3. In estimating rice husk production it should be noted that the type of rice mill used affects its availability as a potential fuel. In the Philippines for example, rice husk can be obtained only from the cono and rubber roll type mills.

In general there is a large excess of rice husk, the disposal of which can impose additional costs on rice millers (the use of land for rice husk disposal / fines for illegal dumping / risk of uncontrolled open burning etc.) – as a result there is a renewed interest in the use of rice husk for power generation, despite some difficulties.

The rice husk can be burned through efficient suspension boilers that then can generate electricity from the resulting steam. The high silica content of rice husk means that the combustion process needs to be carried out in a carefully controlled system since heating the ash above the silica melting point may completely clog the flow of the fuel of the boiler – which combined with the abrasive nature of rice husk, may ultimately destroy it. (ref 1)

The system, in addition to electricity, produces a good quality ash containing a high silica content that can be sold as a high value product to electronics and steel industries. Approximately 30 % of the husk ends up as ash which presently has a retail value of $ 200 per ton (equivalent to $ 40 per ton of rice husk, or $ 8 per ton of rough rice) (Ref: 37). It should be noted that this rising high market value for the ash, due to the high silica content, may lead to a situation wherein the supplier of the raw material - rice husk – may demand royalties on the sale of the ash. In Thailand for example the cost of rice husk is now in the range of 800-900 baht/tonne (15 - 17 Euro /tonne).

All countries within the region hold particular potential for rice husk utilisation – Thailand produces 5 million tonnes of rice husk per year, Vietnam with about 127 mills operating at a capacity of over 10 tonnes/shift produces about 7 million tonnes per year, Indonesia, 14,3 million tonnes of rice husk per year and in Laos and the Philippines about 2 million tonnes per year per country. In 2001 about 18,000 rice mills existed in Laos and the total annual rice husk production amounted to about 0,4 million tonnes per year. Even if 10% of all the available rice husk were made available for power generation in the region this would amount to about 1,5 GW.

3.4 Coconut Husk, Shell and Fronds from Coconut Production

Reference Box 4

Coconuts :

Production: 8000 nuts per ha

One nut = 0.5 kg, of which 60% is considered to be husk
heating value of the husk = 20.05 MJ/kg

Potentially available biomass wastes from the coconut industry include coconut husk, shell and fronds. The residues to crop ratio is 0,12 shell and 0,42 husk. Coconut fronds are derived from the leaves, which are not normally cut, and thus are difficult to estimate. These residues are largely utilized as fuel in the domestic and industrial sectors.

The two biggest producers of coconuts in the world are Indonesia and the Philippines, having about 3.7 million ha and 3.1 million ha respectively. Coconut residues can be significantly used as fuel for captive use and for export to the grid in both these countries. Coconut plantations in the Philippines produce an annual production of nuts ranging from 11,2 billion kg to about 12,2 billion kg. Coconut shell and husk produced annually were about 1,34 billion kg to 1,46 billion kg and 4,7 billion kg to 5,1 billion kg, respectively. (Ref: 30)

3.5 Municipal Waste

Domestic waste generated in cities throughout the world, contain a high proportion of biomass (between 20-30%) that can be trapped and utilized. (Ref: 22) The vast majority of this domestic waste is dumped in landfill sites.

Landfill gas is generated through anaerobic digestion. The amount of gas available from a landfill site depends on the type of waste, moisture content, temperature, acidity of the waste and the design of the site. On a well designed and managed landfill site the gas can be collected from the stored waste and scrubbed and cleaned before feeding into gas pipelines for use by internal combustion engines or gas turbines to generate heat and power. Gas may still be produced up to 50 years after the landfill is sealed.

Reference Box 5

- About 50-200 m3 of gas is produced per tonne of waste dumped
- Gas comprises between 50-60% methane.

The gas

The average municipal solid waste in Malaysia is 0,5 – 0,8 kg/person/day and 1,7 kg/person/day in major cities. Kuala Lumpur, Malaysia is disposed on one waste-to-energy project (refer to the CaseSTudy presented in Annex 4) and Singapore of 4.

3.6 Animal Wastes

There is increasing pressure, especially on large scale operations, to tackle the water pollution and odour problems arising from animal wastes. Anaerobic digesters offer one of the best solutions to these impacts, whilst also generating a valuable fuel "biogas", a potential source of additional income or cost savings. In the Philippines there are an estimated 300 operational biogas units of varying capacity – yet not all produce electricity from their producer gas. One prominent example is the much quoted Maya Farms.

> Reference Box 6
> - A 500 kg dairy cow produces about 35 kg/day manure of which 13% in solids
> - A pig gives about 3,3 kg/day of manure of which 9% solids
> - A hen 0,12 kg/day at 25% solids

There are a wide range of animal wastes that can be used as sources of biomass for energy. The most common sources are manures from pigs, chickens and cattle as these animals are usually reared in confined areas, generating a considerable concentration of waste. Pig waste offers the best technical potential in terms of biogas generation as other animal wastes are mainly used as organic fertilizer and/or as a component in feeds for commercial fisheries.

Thailand is now one of the world's largest chicken-producing countries. Poultry is raised in intensive factory farms with units of 30,000 to 50,000 birds being common. In Thailand within the last decade, large-scale or industrialized pig farming has rapidly increased. It has recently been estimated that about 80 percent of all pig production is now carried out by commercial enterprises.

It should be noted that domestic and municipal sewage from mainly human waste can also be a source of biogas.

> **Thailand**
> Veterinanrian Charin Kajornchaikroon of Than Kaseam Farm is Saraburi Province said they were interested in finding a way of disposing the huge amount of manure generated by the thousandths of pigs on their farm. The Farm invested 12 million baht in its biogas system which will eventually recover itself in 10 years. The biogas technology on the farm which turns pig excrement into biogas was installed with the support of the National Energy Policy Office. The biogas produced helps the farm reduce its monthly electricity bill by 200,000 to100,000 baht. Moreever, it can also use the treated water from the biogas process for its sweet corn and sunflower fields. The farm also gets income from selling dry pig manure as fertilizer.

3.7 Wood Processing & Plywood Industries: cutting, trimmings and sawdust

The potential sources of fuelwood are: logging residues, cutting, trimmings and sawdust from wood processing and plywood industries; and rubber wood or palm tree wood from plantations that are cleared or renewed. Wood residues vary in substance, volume and quality (calorific value) depending on the stage of wood processing. Small branches, stumps, bark, sawdust and coarse residues are the result of logging and primary production processes. Sawmills produce bark, sawdust and coarse residues, while plywood/board manufacturers produce log of board trimmings, cores, bark and sawdust as waste. It has been estimated that logging produces about 40% waste, sawmilling about 50% waste – of which 38% wood and 12% sawdust, and plywood production about 50% waste – of which 45% wood and 5% dust (Ref: 3).

Typically sawmills require 35 to 45 kWh to process 1m^3 of debarked wood, while the waste could

> In **Indonesia** over 400 sawmills are estimated to have a milling capacity between 10,000 and 50,000 m3/year. Seventy have capacities of over 50,000 m3/yr. The future of cogeneration in the wood-based industries in Indonesia will depend on the economic attractiveness of doing so.

generate up to 150 kWh of electric power. It should be noted however, that more of these residues could be used for other, more economically, advantageous purposes (like furniture production).

3.8 Tapioca Production : Wastewater

Cassava is a widely cultivated plant in Thailand (more than 15Mha and 23Mt of fresh roots per year are produced) aiming primarily to the production of tapioca. Currently about 60 tapioca starch factories exist, producing 700,000-922,800 tonnes per year. The main area of exploitation, regarding this cultivation involves the use of the discharged wastewaters in biogas systems. SWI is Thailand's largest processor of cassava root and discharges in excess of 6,000 m3/day highly concentrated, biodegradable wastewater which is ideally suited for biogas generation – the projected biogas yield is expected to replace all of the factory's heavy fuel oil requirements plus generate an excess for electricity generation to offset a substantial percentage of the factory's public-grid supplied electricity.

3.9 Energy crops

These refer to plantations of crops grown and harvested specifically as a source of energy. Production costs are still high but these will come down as plant varieties with higher yields are bred and as efficient harvesting methods are developed. (Ref: 22) The use of energy crops for electricity production is in its early stages and is mostly perceived as a medium to long term solution. These are envisaged to become the main sources of material for modern biomass conversion technologies with degraded and surplus land providing the areas needed (Ref: 39). Shell International envisages that in a business as usual scenario fuel plantations could contribute to 179 EJ by 2060 (Ref: 24).

> In the **Philippines** interest in dedicated energy crops for power generation is limited due to the poor performance of a dendrothermal programme, involving cultivation of dedicated wood crops for power generation, launched in the early 1980s. Of the 16 dendrothermal plants purchased only 2 reached operation.

Careful attention needs to be given to the following potentially contentious aspects: (i) energy crops vs. food crops – ensure that energy crops are not taking the land of what would have otherwise been used for food crops; (ii) specie selection & monocultures – studies have shown that there is much potential in the use of fast growing local and mixed species whilst maintaining high productivity's and at the same time preserving biodiversity and reducing the need for fertilisers; and (iii) sustainability – ensure that the plantations are sustainably managed.

Energy crops can provide a useful energy source both for the export market (although liable to market fluctuations) but more importantly also for the more stable demand of the local market, for example energy crops could act as a main fuel for fixed bed gasifiers in rural settlements in need of an electricity service – such examples are becoming more wide spread in India (Hosahalli, Ungra etc.). These examples have set aside communal land to grow dedicated energy crops which are then harvested, mixed with crop residues and used as feedstock for the small scale gasifiers (Ref: 42).

Today Indonesia, Malaysia and Thailand in the ASEAN region are looking into establishing dedicated plantations but mostly for liquid biofuel production for the transport sector and possibly also for the power sector (substituting diesel used in diesel generators).

4 BIOMASS AVAILABILITY IN ASEAN

The ASEAN region is endowed with biomass resources whether through agro-industrial processes, municipal waste or dedicated energy plantations. The region is home to the world's largest producers of palm oil, sugar, rice, rubber, timber products; starch and coconuts. The range of these activities give rise to large quantities of calorific by-products that are presently not valorized or otherwise discarded as waste. The effective use of these waste by-products alone are thought to hold much potential for the regions' future electricity production. A full resource assessment has not been done across the region and the assumption from one region to the next may differ with regards to resource availability, however as an indication the following table on the potential for biomass generation has been compiled. It should also be noted that some of these figures are national targets and not the effective potential which is higher.

	Paddy Residues	Palm Oil Residues	Wood Residues	Sugar Cane Residues	Coconut Residues	Total
Cambodia						700
Indonesia	450	260	275	360	250	1800
Laos	60			8		68
Malaysia	156	2400	55			2600
Philippines	360	-		540	20	920
Thailand						7000
Vietnam	150	-	5	200	-	400
TOTAL	1500	2700	920	1500	270	13500

Table 1: Realistic Potential for Biomass Power Production in ASEAN (in MW)

The potential for power generation from biomass in the region amounts to about 13,5 GW installed capacity as shown in Table 1 – it should be noted that this figure does not take into account the potential power generation from biogas produced from anaerobic digestion from municipal solid waste, wastewater treatment of palm oil and tapioca industries, sewage treatment or animal farms. In addition the figure does not take into account Lao PDR wherein no data on potential production are yet available. Not withstanding, only about 15% of these readily available and known resources would need to be diverted to the power sector to meet the regional renewable energy target of 2000 MW by 2010.

Data on the biomass resource base in most of the region is either outdated or inexistent - the **Philippines** for example is in need of updating its biomass resource base due to loss of interest in the technology during the 1990's – only more recently is biomass obtaining a renewed interest due to technology improvements and positive experiences in the international arena. In **Cambodia** a detailed resource assessment has recently started via a JICA funded project – this is scheduled to complete at the end of 2005. **In Laos** data collection has recently started. Rice husks and wood residues hold most potential in the country – although a full assessment needs to be conducted.

5 BIOFUEL TO ENERGY : COMMERCIAL THERMOCHEMICAL CONVERSION PROCCESSES

In the ASEAN region the following technological options for power generation appear to be the most promising today and in the near future: (Ref: 3)

- Direct combustion and/or cogeneration of most agro-industrial residues (this includes also co-firing of woody biomass fuels in combination with other fuels like coal)
- Anaerobic digestion of agro-industrial wastewater, manure, sewage or municipal solid wastes
- Fixed bed gasifiers and Biomass Integrated Gasification Combined Cycle for woody biomass

5.1 Combustion / Cogeneration

There are a number of strategies for converting biomass into electricity. The simplest is to burn the biomass in a furnace. This approach, often called direct firing, is the most widespread means of deriving heat and electricity from biomass today. Direct firing has the attraction of simplicity.

Depending on the needs of the factory, a steam-producing plant can generate only heat, power or both heat and power. Combined production of heat and power constitutes cogeneration. Steam is generated by a boiler, which consists of a furnace where combustion takes place and a heat exchanger that transforms water into steam. When only process steam is required low pressure boilers are generally used. When power is needed, higher pressure boilers are required. Steam is then expanded in a steam turbine, which is coupled to an electricity generator. (Ref: 1)

In ASEAN co-generation is practised in three main agricultural industries: sugar, palm oil and rice mills. If appropriate technologies are implemented, cogeneration not only can render these agro-industries self-sufficient in energy but can also help them to earn profit by exporting excess energy to the national grid or to neighbouring industries and/or communities. (Ref:. 9)

Today sugar mills in the region generate an average of 20 kWh of electricity per ton of sugar cane in their older, less efficient steam turbines that operate at a pressure of 18 atmospheres. The conversion rate in the newer mills, built in the 1980s, is about 40 kWh per ton of cane, enough to make them net contributors to the national grid. The typical conversion rate in industrialized countries is 60 to 80 kWh. In Hawaii, with the use of more efficient electricity cogeneration technology that is manufactured in many countries today, net exports of electricity to the grid already reach 100 kWh/ton, while advanced biomass-fueled cogeneration systems undergoing commercial trials worldwide might produce as much as 500 or 600 kWh per ton of cane.

Likewise traditionally designed Palm oil mills burn the fibre and about 50% of its shell in order to produce the electrical and process steam needs of the plant. The boilers in a traditionally designed palm oil mill are normally low pressure, typically 20 bar and feed back pressure steam turbines. They are usually characterised by a very low cycle efficiency for the production of electricity to approximately 3,5%. By raising the boiler pressure and introducing condensing steam turbines with extraction to provide process steam, the use of palm oil residues can be optimised in more energy efficient systems. Using a boiler pressure of 45 bar, medium pressure, with a condensing steam turbine and the same process steam as before, results in a cycle efficiency for electrical production of about 13%. In addition, the boiler can be designed to burn all of the wastes not just the fibre and the shell. At 13% efficiency of 1 tonne of fresh fruit bunch (FFB) will produce about 132 kWh from all the wastes (shell, fibre and empty fruit bunches). A high pressure boiler system, 65 bar, 450°C, will improve efficiency to 25%. (Ref: 39)

Substantial assistance in the ASEAN region has been provided on biomass cogeneration over the past 13 years (1991 to 2004) by the EC-ASEAN COGEN programme (three phases), its aim was to transfer EU technologies in the field of heat and power generation from biomass residues, and in particular, from wood and the agro-industry. Within this programme, assistance was being provided for demonstration projects with up to 15% of the total equipment costs being covered. Among the many attributes of the programme, a valuable website with a wealth of information on the region - http://www.cogen3.net has been developed.

5.1.1 Co-firing with coal

An interim solution which is cheap to implement and provides efficient conversion of biomass into electricity is co-firing. This involves burning biomass with coal in a coal-fired power plant. Up to 15% of biomass can be added to most types of plant, reducing overall carbon dioxide emissions and sulphur emissions (Ref: 22). In the short term this may prove as being the cheapest and most efficient means of exploiting biomass in the region. Examples of this practice are in Austria, Sweden, Finland, Denmark, the Netherlands, the UK and the USA - coal power stations have been successfully co-firing with biomass since the start of the 1990s. (Ref:. 26)

Boilers that use fluidised bed technology are particularly suitable for use with other fuels. Pulverized coal firing, grate-firing and cyclone–fired systems can also be used for co-firing with biomass. The variety of biomass that can be used ranges from wood dust and scrap wood to straw and animal excrements such as chicken litter. Another advantage is that because of the low sulfur content in biomass, it burns with lower SO_2 emissions than coal.

In the ASEAN region, coal is found in Indonesia (19% of generation mix), Thailand, Vietnam (14% of generation mix), Philippines and Malaysia. The RE-SSN has expressed a vivid interest in co-firing however further information is required on exactly under what conditions can co-firing happen and what mix is allowed.

5.2 Gasifiers

A more advanced approach is biomass gasification. Gasification is the process by which solid biomass materials are broken down using heat to produce a combustible gas, commonly known as producer gas. Common feedstocks for combustion include wood, charcoal, rice husks and coconut shells.

Fixed-bed gasification technology is more than a century old. During WWII more than one million gasifiers were in use for operating trucks, buses, taxis, boats, trains etc. in different parts of the world. Interest in fixed bed biomass-gasifier engine systems as an option for decentralised electricity generation, typically in the range of 5 – 500 kW, is growing again, notably in India and China, where fixed bed gasifiers are commercially available. The total installed capacity of fixed bed gasifiers in India is about 35 MW. The gasifiers use agricultural and forest residues. Fixed bed gasifiers have been demonstrated in Indonesia, the Philippines, Thailand and Sri Lanka. (Ref: 21) Large Italian rice mills have traditionally gasified their rice husks and used the gas to drive power units for milling.

The chief technical problems ailing the fixed bed gasifier is tar and other impurities present in the gas – yet with proper wood chip sizing the tar problem is controllable. Engines operating on 100% producer gas are not yet commercially available - but it is technically feasible for both diesel and gasoline-fueled engines. The fixed bed gasifier based system is a promising option for small power generation under 1 MW and one that has already been demonstrated through numerous projects. **This option should be seriously considered for decentralized village or district electrification.**

On a different scale is the Biomass Integrated Gasification Combined Cycle (BIGCC) which is still in its development stage but it promises high efficiency (exceeding 40%) and may offer the best option for future biomass-based generation. (Ref: 22) The first plant was established in Sweden in 1995. At present several BIGCC plants of capacities of up to 75MW are in different stages of construction for demonstration in USA and Europe. (Ref: 21)

The following table provides some European examples of current gasification projects producing electricity:

	Värnamo	**Biocycle**	**Energy Farm**
Location	Sweden	Denmark	Italy
Output (electric)	6 MWe	7,2 Mwe	11,9 MWe
Output (thermal)	9 MW	6,8 MW	
Feedstock	Waste wood	SRF Wood	SRF Wood
Gasifier	Pressurised CFB (Bioflow)	Pressurised fluid bed (REUBAS)	Atmospheric CFB (Lurgi)
Tar removal	Catalytic dolomite cracking	Thermal cracking and dolomite	Water scrubbing
Gas cleaning	Hot gas filter	Hot gas filter	Bag filter

Table 2: European examples of Gasification Projects

5.3 Anaerobic Digestion

Anaerobic digestion giving off biogas is considered commercial in the industrial sector, in the Philippines nine biogas technology manufacturers and suppliers are active. A number of installations are operating successfully, but due to high initial investments, insufficient information on the technology and other concerns, the use of biogas technology is not widespread in the region.

Biogas and landfill gas harness the natural process of anaerobic digestion. This is the decomposition of an organic substance by bacterial action in the absence of air and in warm and wet conditions. Biogas is generated from concentrations of sewage, manure (penned livestock : piggeries, dairies etc.) or wastewater from food industries (tapioca starch mills, POME from palm oil mills, distilleries, breweries etc.). These are usually in the form of slurry comprising mostly water (almost 95%). The slurry is fed into a digester, either continuously or in batches. Digestion takes from about ten days up to several weeks, at a temperature of 35°C. It should be noted that most food industries already have existing wastewater treatment facilities in the form of open ponds – adapting them therefore can be a relative simple process.

Landfill gas arises from waste deposited underground in landfill sites. Biodegradable organic waste decomposes anaerobically to produce a gas that is roughly an even mixture of carbon dioxide and methane. The methane content gives it the potential as a fuel which can then be used to generate electricity. The amount of gas available from a landfill site depends on the type of waste, moisture content, temperature, acidity of the waste and the design of the site. Gas is drawn up from vertical or horizontal wells through a system of pipes. The generating equipment is usually contained within the same area as the extraction plant.

The use of gas turbine cycles have many advantages over steam cycles, notably higher efficiency; lower specific capital cost, especially at small scale; short lead times by virtue of modular construction; lower emissions; higher reliability and simpler operation. (Ref:23 page 49) However it should be noted that gas turbines are usually more sensitive to the fluctuating gas composition and therefore especially in reference to landfill gas may not be the best option.

6 BIOMASS CONVERSION COSTS

Prices will depend on the size and type of fuel handling, process (combustion, anaerobic digestion etc.), equipment sourcing (and whether there are import duties etc.) and waste disposal costs. Costs usually being a sensitive issue are quite challenging to obtain, as an indicative guideline the Cogen programme uses a figure of 1000 USD/kW installed for cogeneration projects within the region.

In Thailand and Malaysia for palm oil mills - all suppliers basically offer the same standardized technology: water tube boilers with a fixed grade and spreader stoker. In most mills, co-generation is in the form of a back-pressure turbine, with the primary function of producing the steam for the steralizers: investment costs per installed kW may vary between USD 800 and USD 1200 for back-up pressure systems. In Indonesia – for palm-oil the required investment is about USD 1000 – 1200 USD/kW. Fully integrated systems utilizing all palm-oil mill waste material may cost anywhere between USD 1200 and 1500 USD/kW installed. Whilst for power generation costs in the sugar industries the required investments range between 600 USD and 800 USD/kW.

In Thailand: For rice mills, development costs may range between USD 1500 and USD 2000 per kW installed for small systems (c. 500 kW) and USD 1400 - 1600 per kW for large systems (c. 2 MW).

Co-firing can offer the cheapest option for introducing biomass into the existing power generation mix. Adapting an existing coal-fired plant has been estimated to cost in the range of 180$/kW and 200$/kW although costs could be higher for some facilities. (Ref: 22)

7 REGIONAL MANUFACTURING CAPACITY

System costs will decrease as further autonomy in system manufacturing are achieved. If biomass is really set to play the role that it is envisaged to play in the region a serious consideration needs to be placed on building of local manufacturing capacity to cover the range of biomass technologies whilst at the same time introducing standards / certification.

Today the local manufacturing capacity in the region of equipment is limited but covers (i) boilers, (ii) anaerobic digesters for household applications and (iii) fixed bed gasifiers (see Table below). Engines usually comprising the most expensive and the most complex component of the system are mostly imported in the region from either Japan, Australia or Europe and are liable in most ASEAN countries to high import taxes.

Much can be done towards building the regional capacity in fuel supply, storage, transportation and logistics - for example the harvesting equipment that maximise the collection of crop waste (palm oil fibre; cane trash, rice straw etc.), improving management techniques for waste distribution in landfill sites, rendering raw biomass fuels into a biofuel (example pelleting).

ICRA identifies that there is a strong need within the region for opportunities for more business to business partnerships for technology transfer and technology adaptation.

Malaysia is working on developing boilers with efficiencies of 60%. They have also developed a palm oil industrial design “package“ which optimises the energy potential. They are also working on a system for pre-preparation of palm oil prior to its combustion.

	Fixed-bed Gasifiers	Boilers	Anaerobic Digesters	Waste to Energy
Indonesia	✓	✓	✓	
Thailand		✓	✓	✓
Philippines	✓		✓	✓
Malaysia		✓	✓	✓
Singapore				✓
Vietnam			✓	
Cambodia			✓	

Table 3: ASEAN Manufacturing know-how

8 BIOMASS ENERGY APPLICATIONS & SPECIFIC BIOMASS POLICIES IN ASEAN

In the past few years, Thailand and Malaysia in particular have become involved in modern applications of biomass energy. These deliver electricity to the grid, utilize the electricity to satisfy the captive power demand or do a combination of both. They are not research or pilot projects – these are actual investment projects to exploit biomass fuels to generate heat, steam and/or electricity for use by industries through more efficient, convenient and modern technologies. The projects are proving to be technically successful and economically profitable. They also prove that biomass energy can be a technically efficient, economically viable and environmentally sustainable fuel option. (Ref: 1)

For further details on policy aspects please refer to the Background Paper on RE Policy Recommendations. The following sections will focus on biomass policies and actions in those ASEAN countries that have adopted a positive political attitude towards biomass in general. For a set of case studies in the region please refer to Annex 4.

8.1 Thailand

Thailand recently launched a road map for installing an additional 710 MW of biomass power generation by 2010. This will mostly be sourced from wastes generated from agro-industrial processes, typically: Rice husk, bagasse from the sugar industry, empty fruit bunches from the Palm Oil industry and cassava from tapioca production.

The national energy policy in Thailand promotes renewables as these address key issues on energy security, reduction on energy imports, and greenhouse gas emission reductions. The promotion of biomass residues in particular is part of this policy, and favours the purchase of power from small power producers (SPP) (with PPA of 21 years), as well as promotes the

Energy Conservation Act 1992 (ENCON) forcing industries to comply under Designated Facility Programmes. Thanks to this SPP programme, today 22 SPPs are involved in the operation of biomass power plants that generate about 914 MW sold to the grid.

In addition to the favourable regulatory framework for biomass power projects to sell excess power to EGAT an ENCON Fund has been put forward as an incentive in a form of subsidy per unit of power generated from renewable energy. (Ref: 25)

Some examples of installations include:

- A.T. Biopower Rice Husk Power Project in Pichit
- Danchang Bio-energy cogneration (DCBC) – up grade and expansion of the existing biomass cogeneration system in the sugar mill facility of Mitr Phol Sugar Corporation (MSPC) in Dan chang, Suphan Buri Province (Ref: 2)
- Anaerobic digester at Sanguan Wongse – the biogas produced is used in the facility itself to dry the wet starch cake to the final dry starch product. The biogas is displacing nearly 8 million litres of fuel oil per year. Excess biogas will be utilized in generators to produce electricity for the facility – in the future excess generation could be sold to the electricity board once a PPA can be negotiated with the local utility. (Ref: 8)
- Two of the SPP projects use rice husk for electricity production - one is a 46 MW power plant using a combination of rice husk and wood waste, with a potential of exporting 36 MW to the grid, the other is a 6 MW plant that will supply EGAT with 5 MW of power.
- A 2,5 MW demonstration plant using rice husk as fuel has been established from the EC-ASEAN COGEN programme at Chia Meng Co. Mill in Chakkaraj Nakorn Ratchasima.

Roi Et Green Project, cogen project, a pilot project of capacity 9.8 MW using rice husk as the feedstock.

8.2 Malaysia

In Malaysia the energy policy promotes renewable energy as the fifth fuel source. The Small Renewable Energy Power Programme - SREP - launched on 11th May 2001 is among the steps being taken by the government to encourage and intensify the utilization of RE in power generation with the target of 5% of total electricity generation by 2006 – in terms of capacity this translates to 600-700 MW installed at the end of the Eight Malaysia Plan period. Included in this strategy are: biomass, biogas, municipal waste etc.; in house biomass cogeneration and R&D on palm diesel. (Ref: 11)

Small power generation plants which utilise RE can apply to sell electricity to the Utility. The maximum capacity of small RE plants designed for the sale of power to the grid must be 10 MW. To date 60 SREP projects have been accepted but only 6 projects have come to fruition due to lack of financial support. To further catalyse the development of the SREP programme the government implemented a national project called the biomass-based power generation and cogeneration in the Malaysian Palm Oil Industry (BioGen) which is in the second year of running – the project aims to maximize the use of the wastes from palm oil mills for power generation.

This strategy involves the implementation of barrier-removal activities, including the implementation. The project will run over 5 years. Activities will include a first phase which will provide technical assistance, and a phase two that will cover the implementation of an innovative loan/grant mechanism that will be worked through the Malaysian banking sector.

In Malaysia, grid access regulations and buy-back power rates have been developed and the first grid-based biomass power plant has been implemented. 15% of palm oil mills have initiated plans to implement biomass power generation and cogeneration (50 palm oil mills) yet work still needs to be done in terms of making buy-back rates more attractive (Ref: 14)

Examples:

- Lafarge cement Bhd – will be substituting a large percentage of the coal used at its two plants with the use of Palm Kernel Shell obtained from the oil palm industry – total of c. 345,000 tonnes will be used. (Ref: 6) The project has been submitted to the CDM.
- TNB Jana Landfill

- TSH-palm oil waste

8.3 Philippines

The DoE launched in August 2002 the Renewable Energy Policy Framework to facilitate the creation of a favourable and sustainable market environment with active private sector participation in the development, utilisation, promotion and commercialisation of RE resources in the country. The DOE has put long-term goals into a policy framework to guide the Philippines in its pursuit of RE development. A primary objective is to double RE-based capacity by 2013. The Philippines aims among other things to expand the contribution of biomass, solar and ocean energy by about 250 MW. (Ref: 31) The use of biomass is expected to triple in the period up to 2025, with a shift away from biomass use for cooking, process heat and mechanical drive, towards a greater use of power generation.

The most important drivers include the government measures such as the BOT scheme which are gradually opening up the power market to a wide range of potential electricity generators, generating incentives for investment in the installation or upgrading of biomass technologies. A bill to liberalise the electricity sector aims at improving access for Independent Power Producers (IPPs).

Support comes in a variety of forms, including fiscal incentives for private sector investments, government programmes for renewable energy promotion and support, utility schemes to install renewable capacity, and soft loans managed by national banks and organizations. Fiscal incentives are available to encourage investment in infrastructure to enable economic growth, with special concessions for renewable energy projects.

Fiscal incentives include:

- tax duty exemptions in imported capital equipment
- tax credit on domestic capital equipment
- income tax holiday of 6 years for biomass projects
- additional deduction for labour costs, and
- deduction of infrastructure expenses from taxable income.

<u>Applications:</u>

The largest rice husk large-scale power plant is a 40 MW grid-connected plant developed by Cypress Energy. Scheduled for construction in Bulacan, the plant will use rice husk from a radius of 80 km. Other plans include that of the Philippine National Oil Company Energy Research Development Center (PNOC-ERDC), which has already completed detailed feasibility studies for the installation of two communal rice husk fuelled plants in Cabanatuan and Aurora, Isabela, each with a capacity of 2 MW. (Ref: 38)

Examples:

- Maya Farms, a large meat processing plant in the Philippines, pioneered the adoption of large use of biogas technology in the industrial sector. Their experience on the technology included the utilization of biogas for heating and power generation.
- Biogas Yaptenco Farm
- NFA Iloilo rice hull-fired Steam power plant (1987). The NFA Iloilo project started commercial operation in 1987 yet ended in 1990 - operation was stopped due to the damage to the 13,2 kV switchgear, which served as the tapping point between the NFA and the electric co-operative.
- 30 MW Talisay Project (April 2004) using bagasse. The surplus power will be sold to the utility - power plant will be completed in August 2006.
- 50 MW Victorias Milling Company- bagasse-fired cogeneration project – not yet installed
- PNOC 22kW Pilot Power Plant (1992) - aims to showcase the technical and economic viability of the steam engine in rice mills vis-à-vis the present energy system commonly used eg diesel engines or electric motors.
- DOST-ITDI 75kW (1994) Gasifier Pilot Plant - testing the operation of a 75kW gasifier pilot plant donated by Japan.

8.4 Indonesia

In Indonesia, renewables have a clear political support – the Electricity Act No. 20 passed in 2002 clearly states that renewables should be a priority. The government has set a biomass target of 5% growth in capacity per year up to 2008 and 3% up to 2020.

The Ministry of Mines and Energy published the tariff for purchase of electricity under the Small-Scale Renewable Energy Power programme which aims to ensure the availability of electricity and to provide business opportunities for small-scale power investors. The utility is obliged to purchase electricity generated from renewables with capacity less than 1 MW and developed by small scale industries and cooperatives. No subsidies are available at present for such projects, yet a tax holiday framework is under discussion by the MoE and Ministry of Finance. There are no specific soft loans for the development of renewable energy, but there is a Government scheme that provides some budget (soft loan) for small scale industries and cooperatives to develop a business including renewable energy projects. Biomass technologies are liable to tax duties.

Within this framework 13 biomass power projects have been identified in the sugar sector with an aggregated electricity potential of 82 MW and 1 palm oil mill with 3 MW capacity. (Ref: 1) The Asian Development Bank (ADB) is also helping to evaluate the potential for using waste from Indonesia's palm oil mills as a source of renewable and commercially viable clean energy, through a technical assistance (TA) grant package. (Ref: 41).

Present hurdles are that the PPA is set for one year only and is limited to 1 MW. Although the process for license application in simple since the utility is obligated to purchase it, in practice the contract needs to be approved by the shareholder meeting which is only scheduled once a year.

Examples:

- Plywood manufacturing company PT Siak Raya Timber – the company reduced their environmental impact by replacing the diesel engines by a new energy plant fuelled by wood residues – generating 5,55 MW of electricity for captive use. Contracts have been signed with European equipment suppliers. The total investment cost (excluding civil and structural works is 5,6 Million USD and based on the present diesel consumption and price, the annual savings in diesel purchase will be more than US 1,7 Million USD. The expected pay-back period is around 3 years after commissioning. (Ref: 12)
- plans to install a municipal solid waste power generation project of 50 MW in Jakarta, are at a preliminary stage.
- rice husk cogeneration
- Palm Oil - 3,5 MW
- Biogas Electricity Generation Cakung, Jakarta from animal dung with capacity of 35 kW
- Wastewood gasification Inhutani- South Kalimantan with capacity 40-100 kW

8.5 Vietnam

A decree for RETS is being drafted at present. The objective of the 10 year Renewable Energy Action Plan (REAP) is to set the policy framework for the development of renewable energy for socio-economic development in off-grid areas (80,2% of the population reside in rural areas) and enhancement of electricity supply to the grid. The Renewable Action Plan, prepared by EVN for WB lending, however is not a legal document and there is no obligation to adopt it.

The Government encourages investment in renewable electricity development to supply electricity to rural consumers through private or public companies, cooperatives or other entities. Yet utility tariffs are low as subsidised hence the present framework is not attractive for private investment.

The Master Plan on Power Development for Vietnam for the period 2000 - 2010 with consideration to 2020 has been approved by the Government, biomass electricity generation is projected to about 200-400 MWe. This capacity is to be connected to the grid and supplied to rural areas.

Examples:

- Cogeneration system for demonstration of 50 kW installed in a food processing plant with Australian aid - using rice husks and supplemented with coffee husks and sawdust (Ref: 13). The system was installed around the beginning of the year 2000.
- COGEN 3 in Vietnam, EC-ASEAN Cogen Programme Phase 3.
- Biogas Programme funded by the Netherlands Gov. The project stated in Feb. 2003 and will be completed in January 2006.

8.6 Singapore

Singapore a highly urbanised country has a limited potential for renewable energy technologies especially with regards to Biomass. To date 4 grid-connected waste-to-energy plants have been implemented and sell their generated power to the utility.

- 4 Grid-connected Waste-to-Energy plants:
  - Ulu Pandan Incineration Plant - 16 MW;
  - Tuas Incineration Plant - 46 MW;
  - Senoko Incineration Plant - 54 MW ;
  - Tuas South Incineration Plant - 132 MW.
- 2 Off-grid biomass cogen plants:
  - ECO Industrial Environmental Engineering Pte Ltd (ECO-IEE) biomass-fired cogen plant - 0.53 MW
  - Bee Joo Industries Pte Ltd biomass-fitred cogen plant - 1.0 MW

8.7 The role of the CDM in Biomass projects

The Clean Development Mechansim (CDM) of the Kyoto Protocol can provide that additional financial incentive for a project to go ahead towards implementation. The CDM therefore can act as an important element to the commercialization of biomass technologies in the region. For further information on CDM activities in the region please refer to the ICRA Background Paper on the CDM also available for download on the ACE ICRA website.

As of today up to 44 biomass projects have been submitted to the Executive Board of the Kyoto protocol to seek carbon emission certificates - this represents 53% of all projects submitted to the CDM. Thirteen of these are in Asia and are listed in the table below:

No°	Project Title	Country
1	Bumibiopower Biomass Power Plant Project	MALAYSIA
2	Kunak Bio Energy Project	MALAYSIA
3	Bio-diesel Fuel Production Project in Indonesia	INDONESIA
4	Krubong Melaka LFG(Landfill Gas) Collection & Enegy Recovery CDM Project	MALAYSIA
5	PNOC Exploration Corporation Payatas Landfill Gas to Energy Project in the Philippines	PHILIPPINES
6	Jaroensompong Corporation Rachathewa Landfill Gas to Energy Project	THAILAND
7	Anding Landfill Gas Recovery and Utilisation Project	CHINA
8	5 biomass gasifier based power plants totalling around 2 MW	INDIA
9	18 MW Biomass Power Project in Tamilnadu, India	INDIA
10	Biomass in Rajasthan - Electricity generation from mustard crop residues	INDIA
11	Shree Renuka Sugars Bagasse Cogeneration	INDIA
12	9 biomass gasifier based power plants totalling 2.25 MW	INDIA

13	Clarion 12 MW (Gross) Renewable Sources Biomass Power Project	INDIA

Table 3: Asian CDM projects submitted for Validation

All the project descriptions can be downloaded from the UNFCCC website and can act as a useful information base – including technical description, equipment used, costs and risks. Malaysia, Philippines, Thailand and Indonesia in the ASEAN region show particular expertise in such CDM procedures.

9 REGIONAL COOPERATION

The region has more or less similar conditions in renewable energy development particularly on biomass for electricity generation.

To date detailed information exchanges within the region are very limited and usually instigated via irregular projects such as this, formal information exchange channels within the region have been identified as being of true added value to the region by the RE-SSN focal points. The renewable energy database is a good virtual start for an information hub yet an effective and "human interface" communicating on the regions needs and building on the work carried out by the Cogen 3 programme is also to be set in place.

Aspects on:

- understanding the resource base
- technologies – pros and cons, experiences of use in the region and where to source equipment
- policy and regulatory frameworks (tariff setting)
- policy instruments - fiscal incentives etc
- success stories – what made it a success?
- regional technical know-how – what is locally manufactured? Who are the main stakeholders in the region etc.
- other socio-economic issues would be beneficial to the region

The need for a "one-stop-shop" where potential renewable energy developers can obtain sufficient information as well as competent advisory services in matters related to the choice of technology, legal issues, preparation of agreements/contracts, financing, CDM etc in the region would prove extremely beneficial. This "one-stop-shop" could act as a centre point between the ASEAN and Europe – and monitoring global trends in developments of biomass technologies.

The table below illustrates the knowledge available within the region that can be shared. The following Annex's aim to act as starting point for future information sharing activities. Annex 1 provides a list of information hubs in the region and also internationally, Annex 2 provides a list of biomass companies working in the region, Annex 4 provides a set of regional case studies and Annex 6 provides an extremely informative data matrix for each of the ASEAN countries.

	Paddy Residues	Palm Oil Residues	Wood Residues	Sugar Cane Residues	Coconut Residues	Municipal Waste	Biogas
Vietnam	✓						✓
Thailand	✓	✓	✓	✓		✓	✓
Indonesia	✓	✓	✓	✓			✓
Malaysia	✓	✓	✓			✓	
Singapore			✓			✓	
Philippines	✓			✓	✓		✓

Table 4: Regional Experience on Modern Forms of Biomass Energy Technologies

10 CHALLENGES IN ASEAN

Significant opportunities exist in the region to broaden the market for modern biomass energy technologies yet a set of challenges are to be addressed by a range of stakeholders.

Institutional Framework

1. Need for strong policies and regulatory and institutional frameworks encouraging biomass electricity production.
2. Requirement of supportive programmes with the right amount of incentives
3. Little experience with large-scale renewable energy systems that sell surplus power to the grid under a firm contract.
4. Designing appropriate power purchase agreements for a long enough duration to provide assurance to the project developer. Payment for the energy produced by the biomass plant should be higher than for a conventional plant because of the higher investment, higher fuel collection costs and the higher risk involved. Allowances should be specified for offsetting pollution.

Financial Attractiveness

5. Commercial banks have a low awareness of biomass technologies. Their risk perception of privately initiated renewable projects with high and long term financing (10-15 years) is commonly not available for non-traditional power projects.
6. The fiscal framework often favours conventional energy projects - tax policies, import duties etc. may have to be revised if biomass energy is to take a priority track.

Technical

7. Limited understanding of the availability of biomass resources and the security of biomass fuel supply coupled with an overall lack of data.
8. Limited know-how of fuel supply, storage, transportation and logistics.
9. Limited local capacity in terms of equipment manufacturing and service maintenance.

Information Channels

10. Requirement for capacity building, information and support to potential developers and owners of agro-industrial processes
11. Marketing information on biomass opportunities
12. Few show cases to use as real illustrations of a project at work. Limited information dissemination and communication channels. Limited regional study tour opportunities.
13. Ad-hoc cooperaton opportunities between developers/researchers, manufacturers and potential users
14. Limited opportunities for business to business partnerships and study tours.

11 BIOMASS EVOLVEMENTS IN THE EUROPEAN UNION

Biomass has been identified as offering a large potential resource in the EU[10] and various schemes have been implemented at EU, national and regional levels to make bioenergy competitive. One of the main energy policy targets of the EU is to double the share of the Renewable Energy Sources (RES) in gross inland consumption, from 5.4 % in 1997 up to 12.0% by 2010. Various legislative actions have been undertaken in order to facilitate this target the most important of which are:

- to promote the electricity generation from renewable energy sources by increasing the production from 14.0 % in 1997 up to 21,0 % by 2010 for EU 25 corresponding to 22.1% for EU 15 (Directive 2001/77/EC).
- to promote the use of biofuels for transport applications by replacing diesel and petrol up to 2% by 2005 and 5.75% by 2010 (Directive 2003/30 EC) with the accompanying detaxation of biofuels (modification of the taxation of energy products and electricity directive 2003/96/EC)

[10] In addition it is estimated that Europe-wide, over 300,000 jobs could be created from biomass fuel production by 2020 (EC Altener study).

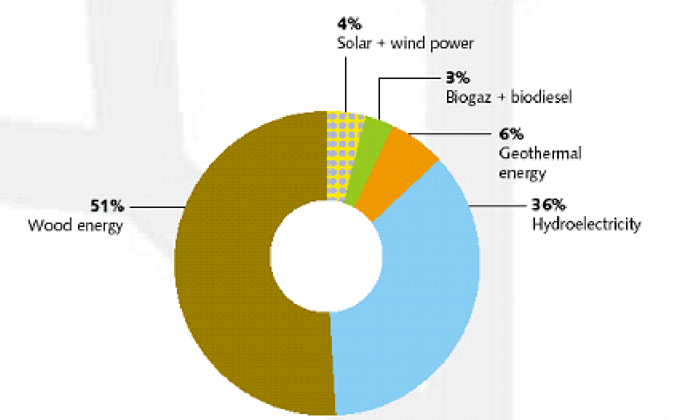
- to double the share of cogeneration from 10% to 18% of total electricity generation by 2010. The EU CHP/cogeneration directive was approved in February 2004 by the European Parliament.

The recent official EU communication on “The share of renewable energy in the EU” (COM(2004) 366 final) concluded that further efforts – in particular in the biomass sector – are needed in order to achieve the EU RES policy objectives. To meet this goal, intensified use will be made of biomass, both for heating purposes and for power generation. Timber and forestry residues are available in ample quantities, but the required investment costs are a barrier to the broad-based use of this energy source.

In 2001, total biomass production for energy purposes was 56 Mtoe (see figure below for the share of biomass in total EU RE energy mix). To achieve the RES 12% target 74 Mtoe more from biomass is needed by 2010. This additional production can only be achieved in the short term with strong and targeted measures and actions in all three sectors (electricity, heat, and biofuels for transport) and a better coordination of EU policies.

Each of these sectors has to contribute the following indicative additional amounts of biomass energy: electricity 32 Mtoe, heat 24 Mtoe, and biofuels 18 Mtoe. This would lead to a total biomass accumulated energy production of 130 Mtoe in 2010. To ensure the achievement of this objective a Community Biomass Action Plan is in the process of development.

The biogas sector has been developing constantly in most of the countries of the European Union. During 2002, European biogas production increased by 10% compared to 2001 – yet for lack of economically profitable outlets, approximately half of the biogas produced in Europe is simply burned off in stacks. (Ref: 15) The UK is European leader in terms of production, then Germany and France.



1 - *Part des différentes filières renouvelables dans la production d'énergie primaire de l'Union européenne* *Share of the different renewable energy sectors in European Union primary energy production* - EurObserv'ER 2003

The European Union biogas installation capacity amounts to 4190 to 4390 units. The biggest biogas deposit in Europe in terms on number of units is that of urban sewage plants. These are principally valorized in the form of cogeneration. In Sweden these plants provide the main source of biogas that is used as a fuel or injected into the public natural gas network. (Ref: 15). The second largest producer and users of biogas are farms. The biogas produced and trapped at waste storage dumps (approximately 450 installation across Europe) provide useful sources of electricity that are injected into the power grids. More recently in Denmark the developments of municipal waste methanisation units are being put in place, a total of 120 installations to date, these represent collective co-digestion units (joint treatment of liquid manure, agro-industrial waste etc) (Ref: 15). This new wave of investments in biogas systems throughout Europe are a response to better purchasing tariffs.

Wood fuels have been traditionally used in the geographic regions where they've been produced. Nonetheless, over the last few years it's been possible to observe that real international exchange networks are being set up, notably from the Baltic states to the Scandinavian countries. Italy has also become an importer. Dutch, Belgian and Swedish power stations are currently buying enormous quantities of pellets and other conditioned biomass products to add to the fuels of their conventional power stations and in this way meet their national CO_2 targets. This has produced a gigantic market for several million tonnes of biomass per year. In fact 70% of industrial generation plants could be converted for biomass without investment and without loss of performance. (Ref: 27)

An estimate for the **Netherlands** showed that around 60% of the renewable energies required if the country is to meet its 2010 carbon emission target will have to be obtained by biomass. A major role is planned for the co-firing of biomass power in power stations. (Ref: 26). The motivation for the emergence of these projects is basically economic, although legislation has also played its part. High costs for waste disposal, high taxes on fossil fuels, and legal provisions have accelerated the development of biomass co-combustion.

About 6% of **Denmark's** total energy consumption is covered by biomass energy, representing 75% of the country's renewable energy production. Denmark is an agricultural country that generates large amounts of straw and animal wastes which are increasingly being used as sources of energy. Straw is efficiently pressed and used in on-farm heating systems and increasingly purchased by utilities for power generation. Though only 12% of the country is forested, 70% of all wood residues is being used for energy purposes. The majority of these residues are chipped in situ using mobile equipment. Municipal solid waste is also increasingly being used for energy. Households separate organic from non-organic waste. The organic waste is used in biogas digester plants which generate heat and electricity from biogas. (Ref: 12)

For a set of case studies in the European Union please refer to Annex 5.

12 CONCLUSIONS

The ASEAN region is endowed with a significant potential for biomass energy – typically in the short term from :

1. Agro-industrial wastes
2. Animal and human wastes

In the longer term, energy crops can provide an interesting energy resource both to satisfy the local market and also potentially as a valuable export fuel. However, careful attention here needs to be placed on the contentious aspects of: (i) energy vs. food crops; (ii) impacts of specie selection & monocultures and (iii) sustainability.

Technical applications for the production of electricity from these resources will continue to be combustion/co-generation, anaerobic digestion, fixed-bed gasification for small-scale applications and in the longer term BIGCC technology. Co-firing of biomass fuels with fossil fuels – like coal - is also perceived as an interesting application that needs more attention. Coal power stations are found in Indonesia (19% of generation mix), Thailand, Vietnam (14% of generation mix), Philippines and Malaysia.

In the past few years, several countries in the region have become involved in modern applications of biomass energy – a few show cases can be seen in Thailand, Malaysia, Indonesia, Singapore, the Philippines, Vietnam. These deliver electricity to the grid, utilize the electricity to satisfy the captive power demand or do a combination of both. They are not research or pilot projects – these are actual investment projects to exploit biomass fuels to generate heat, steam and/or electricity for use by industries through more efficient, convenient and modern technologies. The projects are proving to be technically successful and economically profitable – made more attractive also by financing tools like the CDM. They also prove that biomass energy can be a technically efficient, economically viable and environmentally sustainable fuel option.

The main catalyst for project implementation in the region simply boils down to whether the country provides an attractive environment for a project developer to do business in. This is largely illustrated by the successful case of Thailand, that should act as a show case for the rest of the region.

Establishing an attractive business environment depends on (i) the contractual framework for selling electricity to the utility or directly to clients in a form of a mini-grid – which includes the conditions, system sizing, tariff and duration of the contract, (ii) the simplicity, transparency and duration of procedural aspects, (iii) fiscal incentives and equipment import constraints and (iii) access to information. Thailand and the Philippines, have the greatest installed power thanks to a framework in which developers can function in. Indonesia has the framework yet is limited by two main aspects : (i) the duration of the PPA contract is only one year and (ii) the system size is limited to 1MW maximum. Whilst in Malaysia, implementation is lagging as the tariffs are not interesting enough for investments to take place. Laos and Cambodia, would have to revise their import tax duties (set at about 50%) if they decide to fast track biomass implementation.

Given the right conditions therefore biomass energy can have an important role in the region towards the provision of a secure, reliable, versatile, local and clean energy source well into the future and can go a long way to meeting the regional objectives of the target additional renewable energy installed capacity of 2000 MW by 2010.

The role of the European Union in the ASEAN region is envisaged through mainly cooperation activities in two prevailing aspects:

1. <u>Business to business technology transfer and technology adaptation:</u>
   - Technology developments
   - Fuel Storage techniques and transporting aspects (including pelleting)
   - Workshops / study tours / conferences drawing in expertise
   - Cooperation with European biomass knowledge and network nodes : AEBIOM; ITEBE, BEES, EUBIA
   - Capacity building and consultancy services
2. <u>Lessons learned through policy & implementation frameworks</u>
   - Watchdog on implementation strategies and policy incentives

13 POLICY ORIENTATION RECOMMENDATIONS

In response to the findings of the biomass background paper the following nine policy orientations for regional and national adoption are called upon :

1: In the short term maximising efficiency in existing agro-industries, tapping into animal wastes and landfill gas

2: In the medium to long-term identify the potential for sustainable energy crops without impinging on biodiversity and review the opportunity for biomass co-firing with biomass

<u>At the national level:</u>

3 : Biomass resource assessment and strategy for development and implementation

4 : Fine tune institutional and policy frameworks so as to create a sound business environment allowing a wide range of electricity producers in the market (grid and off-grid):

> **4.1 :** A fast track system for providing PPA for developers (SPP / IPP) of modern renewable energy projects to be implemented,
>
> **4.2 :** a clear process of registering for concessions, operating contracts, licenses etc
>
> **4.3 :** flexibility on the system size
>
> **4.4 :** Incentives for investments in upgrading biomass technologies for power generation both off-grid and on-grid
>
> **4.5 :** Attractive tariffs
>
> **4.6 :** Long PPA with utility obligations
>
> **4.7 :** Tax exemptions / grace periods / tax holiday etc.

5 : Clear Information dissemination channels to potential project developers

<u>At the regional level:</u>

6 : the RE-SSN should capitalise on the knowledge and experiences already available in the region. There is scope for a good interchange of knowledge and experiences at all levels. There is a scope for a regional strategy and a lobbying house.

7 : Assess the in-region competence and local manufacturing facilities

8 : Mobilize information on opportunities through the CDM and international collaboration

9 : Establishing a coordinated regional strategy for information dissemination, capacity building (study-tours) policy and implementation

ANNEX 1: INFORMATION HUBS FOR BIOMASS

Cambodia	o Cambodian Research Centre for Development o www.smecambodia.org
Indonesia	o Indonesia Renewable Energy Society o Ministry Of Energy And Mineral Resources o Agency for Assessment and Application of Technology
Lao PDR	o www.resdalao.org.la
Malaysia	o Biogen, PTM o Renewable Electric Plant Information System (REPIS)
Philippines	o Department of Energy,: http://www.doe.gov.ph/ o UP Solar Laboratory o WWF-Philippines o Renewable Association of the Philippines (REAP), o Philippines Association of Small-scale Hydropower (PASSHYDRO) o Philippine Renewable Energy Association (PHILREA) o Don Severino Agricultural Colleges for Biogas "Biogas Technology Extension Program in Key Livestock Areas"
Singapore	o Waste-to-Energy Incineration Plants o National Environment Agency: http://www.nea.gov.sg / http://app.nea.gov.sg/cms/htdocs/category_sub.asp?cid=75 o Energy Market Authority: http://www.ema.gov.sg o ECO-IEE: http://www.eco.com.sg/bus_hazardous_prod&service.asp#wte o Bee Joo Industries: http://www.ecowise.com.sg/news/sgx_060104.html
Thailand	o One-stop Biomass Clearing House o Cogen 3 o Biogas Advisory Unit o DEDE, Bureau of Energy Study, Research and Development o NEPO, Naqtional Energy Policy Office o King Mongkut's Institute of Technology Thonburi o National Science and Technology Development Agency o Electricity Generation Authority of Thailand o Songkla University o ECCT – Energy Conservation Centre Thailand o Biogas Technology Centre (BTC) Chiangmai Univeristy
Vietnam	o Institute of Energy. o Hanoi University of Technology. o Cantho University. o Hanoi Architecture University. o Research Center for Energy and Environment (NGO). o VACVINA (NGO). o Energy Team (NGO)
Regional:	o EC-ASEAN COGEN Programme o Regional Wood Energy Development Programme in Asia (RWEDP)
European	o European case studies available on : http://www.managenergy.net/cgi-bin/esearch/csearch.pl o European Biomass Energy Association: http://www.ecop.ucl.ac.be/aebiom/main.html. AEBIOM, European Biomass Association, is a group of national biomass associations with membership open

	to representatives of the European Union, Central and Eastern Europe o http://www.novator.se/ : Homepage of magazine Bioenergi and related information products. Photo archive, complete articles, facts and statistics, links to bioenergy and environmental companies in Sweden and more. o http://www.britishbiogen.co.uk/ : British Biogen - Trade Association of the UK Bioenergy Industry o http://www.cogen.org/index.htm : Cogen Europe - The European Association for the Promotion of Cogeneration o http://www.videncenter.dk/uk/index.htm : The Centre for Biomass Technology promotes the utilization of wood, straw and other biofuels for energy purposes as alternatives to traditional fuels such as coal, oil and natural
International	o GASIFIER INVENTORIES with list of manufacturers and installations: http://www.gasifiers.org/ o FOR MORE INFORMATION ABOUT BIOENERGY, visit the IEA site :www.aboutbioenergy.info o Netowork on Pyrolysis http://www.pyne.co.uk/ o http://www.ieabioenergy.com/ : IEA Bioenergy. IEA Bioenergy is an organisation set up in 1978 by the International Energy Agency (IEA) with the aim of improving cooperation and information exchange between countries that have national programmes in bioenergy research, development and deployment. o http://www.bioenergyinternational.com/ : A new media product o http://www.itebe.org/accueil_portail_itebe/default.html : ITEBE - Bioenergy Portal o http://www.bioenergy-world.com : an international bioenergy exhibition & conference to be held in the context of a leading European Agricultural exhibition “Fiera agricola” in 2006 in Italyt

ANNEX 2: BIOMASS COMPANIES WORKING IN THE REGION

Waste solutions, Ltd	New Zealand	Designer of waste tot energy plant – biogas . Referance: Thailand – Sanuguan Wongse Industries
Clean Energy Development Company Ltd	Thailand	Specilizing in biogas projects (CleanThai)
CleanThai	Thailand	Provided SEED funding for a technical site evaluation
Korat Waste to Energy	Thailand	KWTE was established in response to the SWI project – to carry out the design, construction and operation of the new waste to energy plant – KWTE acts as the operator of the system and sells the biogas and electricity at discounted rate to the SWI.
Esmil International BV/CSM	Dutch	Biogas systems in Thailand for agro-industries
Siamtec	Thailand	Biogas systems in Thailand
Bangkok Industrial Boiler Company Ltd.	Thailand	
German Thai Boiler Engineering Company Ltd	Thailand	
HANSA International Co Ltd	Thailand	
KB Boiler	Thailand	
Rolls Royce International	Thailand	
Bronzeoak	UK	Bronzeoak develops, finances and owns renewable energy projects and is currently working on sustainable developments in the UK, the Philippines, Indonesia, Malaysia and Central America.
Institute of Technogy Center	Laos	Working on R&D on power generation using rice husk (160kW)

ANNEX 3: THE BIOENERGY CHAIN

Biomass feedstocks are converted to fuel which are directly or later processed to generate bioenergy :

SOLID biomass feedstock	**fuel produced**	**fuel generation technology**	**bioenergy output**
wood, paper pulp	Logs, wood chips, pellets, saw dust, briquettes	Direct combustion (pile, stoker, suspension, fluidised bed boilers) Cofiring Gasification	Heat Electricity Steam Mechanical movement
rice husks, nut shelves, straw, etc	crop residues		
wood	charcoal		
peat	peat briquettes		
municipal and industrial waste	solid recovery fuels		
LIQUID biomass feedstock	**fuel produced**	**fuel generation technology**	**bioenergy output**
sugar cane, sweet sorghum, cassava, sugar beet, potatoes, wheat, corn, wood	alcohols : ethanol, methanol	Extraction/Esterification Pyrolysis Hydrolysis/Fermentation Distillation	Transport Heat Electricity
vegetable oils (sunflower, groundnut, soybean, rape seed), nut oils (oil palms, coconut), recycled cooking oils	biodiesel		
ethanol and cellulose	gel fuel		
wood	pyrolysis oil		
GASEOUS biomass feedstock	**fuel produced**	**fuel generation technology**	**bioenergy output**
landfill, wet wastes, sewage treatment	biogas	Anaerobic digestion	Electricity Transport Cooking Heating
solid biomass feedstocks	producer gas		
solid biomass feedstocks	biohydrogen		

ANNEX 4: ASEAN Modern Biomass Energy Case Studies

Korat Cassava Waste to Energy (Ref: 28)	**Thailand**

Sanguan Wongse Industries (SWI) is one of the Thailand's largest producers of cassava(tapioca) starch, accounting for about 12% if Thailand's national total of 1,8 to 2,0 million tonnes per annum. SWI is based on Korat about 250 km northest of Bangkok.

The design, construction and operation of the waste to energy plant is taken care of Korat Waste to Energy (KWTE) who then sells the biogas and electrixity at a discounted rate to the SWI.

This project represents one of the largest waste to energy projects in the world – delivering biogas with a nominal capacity of 120,000m3 per day (33 MW of thermal energy) to fuel the factory's starch dryers with the surplus gas being used for electricity generation – 3,15 MW power plant.

The design of the waste to energy plant is based on Waste Solutions Ltd Covered In Ground Anaerobic Reactor (CIGAR) which consists of a constructed in-ground lagoon that has been covered by a plastic membrane. The biogas that collects under the membrane is removed by a compressor that pumps it through a pipeline to the gas burners and the electricity generators. A significant aspects of the CIGAR process is its low capital and operating costs, which makes the technology very applicable to a wide range of opportunities, particularly in developing countries.

The construction of the KWTE biogas plant was completed in April 2003 at a total cost of USD 1,4 million. The construction of the power plant was completed in March 2004 and in operation since April 2004. The total biogas production from the CIGAR digester amounts to 80,000 m3 per day.

The plant in its current configuration replaces already all of the factory's heavy fuel oil consumption and 62% of its electrical energy needs. Overall now the factory is over 86% energy-independent. The system is sized so as to allow for SWI's growth in starch production to 750 tonnes of cassava per day compared to today's 550 tonnes per day

Besides the obvious economic and environmental benefits, the plant produces the following benefits:

- land recovery – the old treatment system that comprised of over 200 hectares of lagoons and channels can now be brought back into agriculture production
- process water recovery – the treated water can be reused for irrigation or be further treated as an insutrial water source
- biomass recovery – the biomass recovered from the CIGAR is high in nutrient content and does not contain harmful organisms – it can be used as a fertilizer, stock food supplement or as as soil conditioner

The success of this project has lead to intense interest from the agricultural processing industry in Thailand and abroad. Two new plants based on CIGAR concept has set a new standard for affordable and environmentally sustainable treatment of solid and liquid wastes from agriculturally based processing industries.

Two new plants based on CIGAR technology are currently under construction in Thailand. One of these will treat the wastewater from an ethanol distillery in central Thailand. Further projects based on CIGAR technology are in preparation in Thailand, Indonesia, China and Malaysia.

First Grid Connected Biomass based Power Generation Project from Landfill Gas	**Malaysia**

Landfill Gas (LFG) Power Generation at Air Hitam Sanitary Landfill, Puchong is the first grid connected Renewable Energy project in the country. This LFG project has a capacity of 2 MW and it has the status of Small Renewable Energy Programme (SREP) project, where it will gain the SREP benefits such as tax exemptions etc. This project is owned by Jana Landfill Sdn Bhd (JLSB), a wholly-owned subsidiary of TNB Energy Services Sdn Bhd and Worldwide

Landfill Sdn Bhd as the landfill site operator. The project construction has been completed in November 2003. This project has secured the RE Tariff from TNB of RM 0.165 per kilowatt-hour. The total investment cost for this project is about RM 9.8 millions, of which the equipment cost amounts to about RM 9 millions. The funding agency for this project is Bumiputra Commerce Berhad Bank. By proportion, the investment cost for this project to produce 1 MW of power is RM 4.9 millions. The feasibility study of this project was sponsored by Malaysian Electricity Supply Industry Trust Account (MESITA), Tenaga Nasional Berhad (TNB) and UK Government Foreign and Commonwealths Office.

The power plant has 2 gas engines rated at the capacity of 1048 kW. The Austrian made gas engine is a reciprocating type. Besides the gas engines, the gas generator also comprises of a set of gas extraction system. This system is directly connected to the pipe from the gas field or well. The system functions as the fuel pre-treatment system of the biogas such as filtration, heating and cooling of the gas. This is to ensure the quality of biogas before entering the gas engine. The interconnection point of TNB substation with the gas power generator is located only 30 meters from the site. The overhead cable is used for connecting 415V generating voltage from the plant to the 11kV transmission voltage at the substation with the transformer rating at 1250 kVA. The operation hours for the first phase of this LFG power plant is anticipated at 8000 hours per year, with the availability factor of 90%. The operation mode of this power plant is as a base load power plant. Among the benefits gained from this project are the reduction in odour level to the surrounding area and mitigation of green house gasses emission. These benefits are also shared by the surrounding community, whereby previously they have to face the higher level of odour problem everyday. The concession period for this power plant is 15 years. JLSB extracted biogas from the wells, which were built at the landfill site. Each well can produce biogas for 20 years.

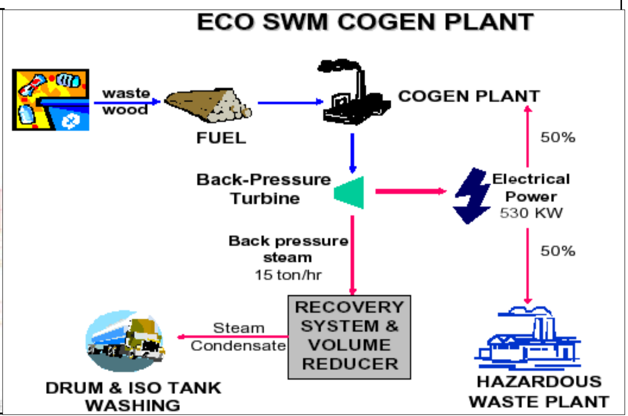
Characteristics of the Biogas Captured	
Fuel Composition	More than 55% are methane gas
Moisture Level of the Biogas	Maximum at 80% moisture level
Temperature	24^0C
Calorific Value	5.32 kWh / m^3
Biogas Production Rate	$40m^3$ / hr
Biogas Feeding System	Direct extraction from gas field.
Monitored emission	NOx < 500 mg / m^3

ECO-IEE Biomass-fired Cogeneration Plant.	**Singapore**

ECO group of company is a one-stop waste management solution provider. It offers efficient and safe waste management through comprehensive waste minimisation, recovery and disposal. Being a major waste management company in Singapore, ECO's recycling facility receives wood wastes such as pallets, packing material, boxes, formwork, and sawdust from the industries. The wood waste-fired power plant consists of a boiler supplying steam to a turbo-generator producing 0.53 MW for the recycling plant as well as 15 tonnes of steam per hour for the downstream waste treatment process.

Characteristics of the Biogas Captured	
Location:	ECO Special Waste Management Pte Ltd (ECO-SWM) 23, Tuas View Circuit, Singapore 637768
Operating since (month/yr):	January 2004.
Who is involved:	ECO Industrial Environmental Engineering Pte Ltd (ECO-IEE) and EC-ASEAN COGEN Programme.
Installed Capacity:	0.53 MW.

Biomass feedstocks used:	Wood Waste.
Grid or off-grid?	Off-grid.
Capacity sold to the grid?	Not applicable.
At what tariff?	Not applicable.
Cost: Investment	1.8 million Euro.
Cost: O&M	Not available.
Cost: Feedstock	Not available.
Funding: (sources of funding)	ECO-IEE and EC-ASEAN COGEN Programme.
What are targets and aims: (To whom and who gets the benefits)	ECO-IEE
Achievements: (Major outcomes of the project)	Uses wood waste that cannot be recycled to produce electricity and steam for hazardous waste treatment processes. Alleviates solid waste disposal problem in Singapore. Improves energy efficiency through cogeneration technology.
Lessons learnt: (Key success factors and recommendations, conclusions for further actions.)	Key Success Factors/ Recommendations for Biomass-fired Cogen Plant Availability of biomass, Technological and financial incentives, Cogeneration technology to maximise energy efficiency, and Direct use of electricity and steam for downstream processes. Conclusion Integration of biomass-fired cogen plant with internal process is important.
Further information: (Contact information, website link for full information.)	ECO Industrial Environmental Engineering Pte Ltd 40 Tuas West Road, Singapore 638389 Col (Ret) Chua Tiong Guan DID: 65-6862-5333, Fax: 65-6862-0133, Email: chua@eco.com.sg



Biomass Gasification Electricity Generation	**Cambodia**
The process which converts biomass material into gaseous component, the system consist of three major unit gasification unit, purification unit and energy converter unit. The system is grid connected. The main objective of the project is to increase the community productive activities and therefore increase income levels in Tamei Village.	
Location:	Anlong Tamei village, Bannan District, Battambang Province.
Operating since:	January 2005
Who is involved:	Community/SME Cambodia
Installed Capacity:	14 kW
Feedstock:	Leucaena
Capacity sold to the grid?	7kW
At what tariff?	R 1,200 /kWh
At what tariff?	R 1,200 /kWh
Funding:	CIDA
Lessons learnt:	The villagers still hesitate as they can not believe that Leucaena can be used to generate electricity.
Further information:	www..smecambodia.org



ANNEX 5 – EUROPEAN CASE STUDIES AND BIOENERGY INFORMATION BASE

A series of documents produced on the European biomass market, technologies, legislation, etc. are available from the ICRA website. These include the following:

Title	Author
Wood Energy Barometer 2004	EurObserv'ER
Bioenergy's role in the EU energy market 03/08/04 • Bio-energy's role : A view of developments until 2020 • Improving the public perception of Bioenergy in the EU • Biomass availability in Europe • Important actors in the Biomass sector in Europe	
Biogas Barometer 2004 02/08/04	EurObserv'ER
Stationary Applications of Liquid Biofuels PTA contract NNE5-PTA-2002-006 16/07/04	5th Framework Programme
Biofuels Barometer 2004	EurObserv'ER
The future for biomass pyrolysis and gasification: status, opportunities and policies for Europe Altener contract 4.1030/S/01-009/2001	A. Bridgwater
Wood Energy Barometer 2003	EurObserv'ER
Progress in Biomass Gasification: An Overview	K.Maniatis European Commission
An Assessment of the Possibilities for Transfer of European Biomass Gasification Technology to China	A. Bridgwater A.Beenackers K .Sipila Y.Zhenhong W.Chuangzhi S.Li
Biomass co-firing: An efficient way to reduce greenhouse gas emissions	EUBIONET Altener Programme
Best Practice Projects Yearbook 1997-2000	

SELECTED MODERN BIOMASS ENERGY EUROPEAN CASE STUDIES

BIOVALE LANDFILL SITE	FRANCE

- installed capacity 6,2 MW
- 8 MW thermal could be available yet there are no clients for this
- 5 year repayment period – total investment 41,3 MF (~6,2 million Euro)
- area: 80 hectares – of which 25 are presently used
- total waste collection 450,000 tonnes/year household wastes
- life time : 20 years
- system installed since 2000

- realized by Elyo
- PPA – 15 years duration – contract signed in 1999 – average price 0,29 Euro/kWh – with an index linking on an annual basis
- 7 engines – Waukesha L 7042 GLD medium-speed (1000rtm) – each of 995 kW - more expensive yet more tolerant to the fluctuations in biogas composition. Designed as a modular system – as the system will vary in size in time.
- Overall efficiency of the engines 33,2%.
- The biogas is firstly passed through a filter (via condensation) system – this gas contains on average 40 to 45% methane, 4-5% oxygen, 25% nitrogen, 25-30% carbon gas, and traces of HCL, H2S etc. The gas is pressurised and passed through a heat exchanger where its temperature is brought to 25°C – then through a second exchanger where its temperature is brought at 5°C where it then passes through a separator to remove the two thirds of water and half of the pollutants.
- Within the first 8 months of operation the availability of gas was 75-85% instead of the predicted 95-98% due to a drainage problem.
- In France the investment is profitable if the system produces more than 3500-4000 NM3/h of biogas whilst unprofitable if below 1500nm3/hour.
- The main bottlenecks in this type of development in France is that establishing a PPA is still problematic – an improved institutional framework is urgently needed – says ELYO.

Ely Power Station – Straw Burning Power Station	**UK**

At 38MW, installed capacity, Ely Power station is the largest straw burning power station in the world generating over 270GWh each year. The plant was developed by EPR in partnership with Cinergy Global Power. EPR has 70% ownership.

Ely has a wide ranging planning permission and has successfully burned oil seed rape and miscanthus in addition to its usual fuel of cereal straw. The 200,000 tonnes p.a. fuel demand of the plant is supplied by Ely's sister company, Anglian Straw.

The plant is highly efficient, generating steam at 540°C and 92 bar. Noted for its high reliability Ely achieves one of the highest load factors of any renewable energy plant.

In June 2004 EPR took over the operation and maintenance of the plant from the plant constructor FLS Miljo. Control of operations will allow EPR to burn a wider range of fuels opening up the potential for reducing fuel costs and increasing security of supply. In addition, the in-house experience of our operations team in scheduling maintenance effectively will further increase output and reduce costs.

Ely Straw Burning Power Station in Cambridgeshire became fully operational in September 2000. It is the first modern, and the world's largest, straw fired power station. This 36MW facility consumes around 200,000 tonnes of straw and generates sufficient electricity every year to satisfy the needs of 80,000 dwellings. The plant is also capable of burning a range of other baled energy crops, such as miscanthus, and can use mixtures of up to 10 % natural gas.

The facility has created about 50 long term jobs. Long-term contracts are in place for the sale of the plant's entire output. Ely is a partnership formed between Energy Power Resources Ltd and Cinergy Global Power.

Source: http://www.eprl.co.uk/assets/ely/detail.html

Characteristics of the Project	
Project Company	EPR Ely Power Limited
Project Subsidiaries	EPR Ely Limited; Anglian Straw Limited; Anglian Ash Limited
Capacity	38MW
Fuel	Straw (200 kt/yr). Also capable of burning a

	range of other biofuels and up to 10% natural gas. Fuel procured by wholly owned subsidiary Anglian Straw
Technology Employed	Vibrating grate with conventional steam cycle
Date of Commission	December 2000
Number of Employees	34
Project cost	£60 million
Sale of Output Energy	NFFO Contract until 28th August 2013
Sale of Non-Energy Output Items	Ash sold for civil engineering use and agricultural fertilizer
Plant Procurement	The plant was built by FLS Miljo
Operation and Maintenance	Directly employed management and staff

Sewage treatment works – Biogas	**UK**

Sludge is not an attractive substance, but when it can be turned into a renewable source of energy that leaves clean water behind, its value is clear. At the Minworth sewage-treatment works in Britain, Severn Trent Plc — an environmental services company and a leading provider of water, waste and utility services — is doing just that.

The Severn Trent plc sewage treatment works at Minworth, West Midlands, is 100% self-sufficient in electricity and exports 12 % surplus to the national electricity grid. The works is the largest inland treatment works in Europe, serving 1.3 million people as well as businesses in the Midlands. During a £90 million upgrade in 2001, 47 acres of biological filter beds were replaced with an activated sludge process. Minworth's floating roof digesters use anaerobic digestion to process more than 4,000 litres of sludge a day, producing heat which is used to heat its own digesters and 75,000 cubic meters of sewage gas, mostly methane. The methane produced during the breakdown of the sludge is compressed to remove any water and excess moisture and to increase the pressure of the gas, which is then piped to the combined heat and power plant. The methane is then pumped into five gas engines, capable of producing 1.5 MW of energy each, where it is burnt to generate electricity. The waste heat from the engines is used to heat the digesters. The system is flexible and when more energy is needed, the amount of sludge going into the system can be increased to meet demand. Severn Trent saves money by not buying electricity made from fossil fuels from the national grid and earns money by selling its excess electricity production. The plant also returns effluent to the River Tame, meeting the very stringent quality standards set by the British Environment Agency.

Largest chicken litter fuelled Biogas	**UK**

Thetford, at 38.5MW, is the largest chicken litter fuelled plant in the world and is Europe's largest biomass fuelled electricity generator. The plant was developed by the Group which retains 51% ownership. The plant is located at the centre of England's poultry producing region and consumes 420,000 tonnes of litter each year. The litter sourcing is managed by a dedicated EPR team. Thetford has successfully trialled the burning of feathers and other agricultural residues. High quality fertilizer is produced at the plant that is marketed through a group wholly owned subsidiary, Fibrophos. The plant was designed to benefit from the experience gained at the two earlier plants at Eye and Glanford. At its heart is an extremely reliable and robust chain grate, spreader stoker combustion system. Steam conditions are 450°C and 65 bar. EPR operates and maintains the plant. Power output from the plant is sold under an NFFO contract that expires in 2013. The plant is located off Mundford Road, Thetford, Norfolk.

Characteristics of the Project	
Project Company	Fibrothetford Limited
Project Subsidiaries	

Capacity	38.5MW
Fuel	Poultry Litter | 420,000 tonnes/yr
Technology Employed	Conventional moving grate boiler and steam cycle
Date of Commission	June 1999
Number of Employees	35
Project cost	£65 million
Sale of Output Energy	NFFO until 2013
Sale of Non-Energy Output Items	Ash sold to Fibrophos, a wholly-owned subsidiary of Fibrowatt Group
Plant Procurement	Designed and built by Taylor Woodrow Management and Engineering (TAYMEL). The equipment suppliers include Ansaldo Energia SpA for the turbine, Foster Wheeler Ltd of Canada for the boiler, Detroit Stoker Inc. for the grate system and Birtley Engineering plc for the fuel handling system
Operation and Maintenance	Directly employed management and staff

A list of case studies in Europe that can be downloaded at the following website (http://www.managenergy.net/cgi-bin/esearch/csearch.pl) follows:

1	Biogas - biofuels for urban vehicles in Linköping, Sweden
2	Biogas as a source of renewable energy in Thessalonica, Greece
3	Biogas powered vehicles in Lille, France
4	Biogas for transport sector in Chambéry, France
5	Biogas utilisation in CHP plant in Herning, Denmark
6	Biogas generation by landfill site in Vienne, France
7	Vehicles running on biogas in Stockholm, Sweden
8	Heat and Power generation using biogas in Besancon, France
9	Preparation of a pilot biogas CHP plant integrated with a wood-chip fired DHP system, Poland
10	Biogas utilisation in co-generation unit in Aalborg, Denmark
11	Biogas from urban waste produced in Bilbao, Spain
12	Biogas production plant in Brecht, Belgium
13	A complex of a landfill gas installation, a biogas plant and an upgrading plant in Tilburg, the Netherands
14	Energy saving measures at waste water treatment plant, Romania
15	Energy, water, sewerage - Europe's largest lagooning station in Rochefort, France
16	Research on the Landfill Gas Utilization Possibility on Municipal Solid Waste Landfill Suhodol for Electricity and Heat Energy Recovery, Bulgaria
17	Biomass CHP plant in Växjö, Sweden
18	Implementation of Gasification plant in Armagh, Northern Ireland, UK
19	100% locally renewable energy in the Western harbour of Malmö in Sweden, Sweden
20	Biomass wood - The largest biomass fired power plant in Austria is in Lienz
21	Biomass CHP plant in Borås, Sweden
22	Promotion of conversion to biomass CHP in Poland
23	Biomass - forest residues power plant in Mortágua, Portugal

24	Pre-feasibility study of a waste wood district cogeneration in Sambuca industrial park as an area resources recovery project in the middle of Chianti hills, Italy
25	Successful Biomass Implementation in Ireland
26	Successful introduction of small scale biomass in the region of Bavaria, Germany
27	Biomass sawdust heating demonstration project in Tasca, Romania
28	Good Practice Case Study: SIDA DemoEast programme in Estonia. Supply, delivery and installation of wood pellet burning equipment
29	Straw for heating in Lubañ, Poland
30	The first 100 % Biomass fired CHP plant in Finland
31	Wood-chip-fired interconnected heating system in Feldkirch, Austria
32	Såtenergi AB - 4 MW Straw heating plant, Sweden
33	Wood Burners at the Living Rainforest, UK
34	Regional implementation of small scale biomass in Upper Austria
35	Wood Fired Heating Plant in Slovak Republic
36	Biomass - Wood heating plant in Autun, France
37	Biomass pilot installation in school hostel in Frankfurt am main, Germany
38	Good Practice Case Study: GreenHeat, United Kingdom
39	Vörå municipality in Finland - A forerunner in biomass heating
40	Reducing Greenhouse Gas Emissions through the Use of Biomass Energy in Northwest Slovakia
41	Wood fuelled urban heating in Dole, France
42	Biomass plant and district heating system rehabilitation project in Ignalina, Lithuania
43	Oxfordshire Boiler Replacement Scheme, UK
44	Basse-Normandie collective purchase of wood boilers - France
45	Comfortable use of wood pellets in one-family houses in Jämtland County, Sweden
46	Biomass straw fired boiler plant in Przechlewo, Poland
47	Biomass wood - forest residues heating plant in Kê pice
48	Straw fuelled heating plant in Nakskov, Denmark
49	Nearby heating in the county of Kronoberg, Sweden
50	Good Practice Case Study: Utilization of biomass from municipal green areas for heating purposes: Pilot Joint Implementation project in Poland
51	Optimization of the combustion process at Vattenfall Värme, Uppsala district heating plant in Sweden

ANNEX 6: DATA MATRIX

SINGAPORE				
No°	**Theme**	**Category**	**Question:**	**Answer:**
2	general	1. Socio-economic	**Agriculture accounts for how much of GDP?**	<1%.
5	general	1. Socio-economic	**% rural population**	0%.
8	general	2. Energy Scene	**overall electrification rate (national)**	100%.
14	general	2. Energy Scene	**electrification rate (rural only)**	Not applicable.
18	general	2. Energy Scene	**Off-grid electrification target - If any**	Not applicable.
19	general	2. Energy Scene	**Utility Name**	List of Retailers (http://www.ema.gov.sg/Electricity/retailer_list.php) Keppel Electric Pte Ltd, SembCorp Power Pte Ltd, Tuas Power Pte Ltd, Senoko Energy Supply Pte Ltd, Seraya Energy Pte Ltd, and Island Power Supply Pte Ltd.
20	biomass	1. Resource Availability	**Are there coal-fired power stations?**	No. (Most use natural gas as main fuel and diesel as back-up)
21	biomass	1. Resource Availability	**What is the contribution of coal-fired power stations over the total generation mix?**	0%.
24	RETS	3. RE Support	**Renewable Energy Technology Policy**	Yes.
25	RETS	3. RE Support	**Renewable Energy Targets**	50,000 square metres of solar collector area by 2012.
34	policy	4. Energy Policy Environment	**Liberlized Energy Market (yes/no)**	Yes.
36	policy	4. Energy Policy Environment	**Is there an off-grid electrification strategy?(yes/no - explain)**	No, 0% rural population.
38	policy	4. Energy Policy Environment	**Is it possible to sell electricity generated by an IPP/SPP to the utility? (please describe is their a minimum / maximum?)**	Yes. Amount of electricity that can be sold is determined by the liberalised electricity market.
39	policy	4. Energy Policy Environment	**Is the utility obliged to purchase the electricity generated by the IPP/SPP?**	No information is available.
40	policy	4. Energy Policy Environment	**And if so, what are are the tariffs that the utility has to pay to purchase the power form the IPP/SPP?**	No information is available.
41	policy	4. Energy Policy Environment	**Are there any particular incentives for IPP's that generate power from renewables?**	No.
42	policy	4. Energy Policy Environment	**What are the tariff rates that the utility charges?**	Low tension Tariffs by SP Services Ltd Residential: 16.73¢/kWh. Details are available at http://services.spservices.sg/cs_services_elec_latest-rates_frameset.asp?ID=
43	policy	4. Energy Policy Environment	**Usual length of contract/ concession:**	Varies with contract between retailers and contestable customers.
44	policy	4. Energy Policy Environment	**Is it legally possible for an IPP/SPP to distribute power to its own set of clients (mini-grid) - if so please desribe:**	Yes. The only IPP currently is SembCorp Cogen Pte Ltd that produces electricity and steam from natural gas-fired cogeneration plant. SembCorp Cogen sells electricity through a retailer in the liberalised electricity market subjected to market rules.
45	policy	4. Energy Policy Environment	**What are the regulatory frameworks set in place for renewables and rural**	Not applicable.

			electrification?	
46	policy	4. Energy Policy Environment	**Clarity of policy - how easy is it for an IPP to generate power and sell it to the utility - is it a complicated process?**	SembCorp Cogen sells its power through its linked company (retailer), SembCorp Power Pte Ltd.
63	policy	7. Financing	**Are there any subsidies for renewables or for rural electrification? (please describe)**	Not applicable.
64	policy	7. Financing	**Any fiscal incentives (duty exemptions, tax holidays, no interest loans) - please describe:**	Innovation for Environmental Sustainability Fund Grants for innovative projects up to 50% of project qualifying costs. Details are available at http://app.nea.gov.sg/cms/htdocs/category_sub.asp?cid=42
65	policy	7. Financing	**Availability of soft loans? Please describe:**	Not available.
67	policy	7. Financing	**Has there been much foreign investment in setting up IPP's?**	SembCorp Cogen (IPP): started as a joint venture between SemCorp Utilities Pte Ltd (a local company) with Tractebel. Currently 100% owned by SembCorp Utilities.
68	policy	7. Financing	**Which specific instruments help with investment - what are the drivers?**	Economic feasibility.
72	biomass	1. Resource Availability	**Abundant Biomass Resources for Energy Exploitation**	No.
73	biomass	1. Resource Availability	**National Biomass Resource / Market Assessment**	Almost all biomass not recovered for recycling is burned at waste-to-energy incineration plants to generate electricity.
75	biomass	1. Resource Availability	**Total Biomass Theoretical potential :**	Very limited - organic waste in municipal waste (food waste, paper/cardboard, wood/timber and horticultural waste) was 1.49 mil tonnes in 2003)
76	biomass	1. Resource Availability	**Palm Oil Residue Potential :**	No palm oil residue.
77	biomass	1. Resource Availability	**Paddy residues Potential :**	No paddy residues.
78	biomass	1. Resource Availability	**Sugar cane residue Potential :**	No sugar cane residue.
79	biomass	1. Resource Availability	**Wood residue Potential :**	Almost all wood waste not recovered for recycling is burned at waste-to-energy incineration plants to generate electricity.
80	biomass	1. Resource Availability	**Municipal Solid Waste :**	Most incinerable municipal wastes are already burned to generate electricity at the four waste-to-energy incineration plants.
81	biomass	1. Resource Availability	**Other crop residue potential (specify) :**	Very limited crop residue.
82	biomass	1. Resource Availability	**Dedicated Energy Crop Plantation Potential:**	Limited land for agriculture.
83	biomass	1. Resource Availability	**Animal wastes potential:**	Limited land for livestocks.
84	biomass	1. Resource Availability	**What are the competing markets for residues listed above:**	Very limited crop residue available for market competition.
85	biomass	2. Policy	**What is the bioenergy perception for both grid and off-grid opportunities?**	Biomass in municipal wastes are already burned to generate electricity at the four waste-to-energy incineration plants.
86	biomass	2. Policy	**Is there a Political Interest in Modern Biomass technologies for power generation? (please describe)**	None.
87	biomass	2. Policy	**Policies relevant to Biomass specifically**	None.
88	biomass	2. Policy	**If there a Specific Biomass programme: (please describe)**	None.
89	biomass	2. Policy	**Is there a Specific biomass target:**	None.

90	biomass	2. Policy	**Any specific Biomass government funds : (please specify)**	None.
91	biomass	2. Policy	**Are there any national standards in place for biomass equipment?**	None.
92	biomass	3. Economics	**Costs for different technologies and feedstocks (Fuel costs + capital costs + O&M)**	Please refer to case study.
94	biomass	3. Economics	**Is imported biomass equipment liable to tax duties? (please describe)**	Yes. Goods and Services Tax at 5%.
95	biomass	3. Economics	**Access to financing (commercial and soft loans - national and foreign) for biomass projects?**	Yes.
96		3. Economics	**Number of SPP/IPP dealing with biomass already: please provide as much info of these including technologies used, installed capacity etc.**	None.
99	biomass	3. Economics	**How in your view can biomass become an attractive business investment environment?**	Limited potential due to very few agricultural activities.
100	biomass	4. Installed Capacity / experience	**Present biomass uses: (please also provide information on existing biomass uses for power generation)**	Recovered horticultural waste is recycled as compost. Recovered wood waste is recycled into compressed wood for making crates and furniture. Recovered paper waste is exported for recycling into recycled paper. Recovered food waste is recycled into animal feed. Biomass (horticultural waste, wood waste, paper waste, food waste) not recovered is sent to waste-to-energy incineration plants to generate electricity. Some wood waste/ horticultural waste are used to generate electricity and steam in two biomass-fired cogeneration plants.
101	biomass	4. Installed Capacity / experience	**Biomass Installed Capacity (MW):**	Waste-to-Energy Incineration Plants: 248 MW Biomass-fired Cogen Plants: 1.53 MW
102	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	4 Grid-connected Waste-to-Energy plants: Ulu Pandan Incineration Plant; Tuas Incineration Plant; Senoko Incineration Plant; Tuas South Incineration Plant. 2 Off-grid biomass cogen plants: ECO Industrial Environmental Engineering Pte Ltd (ECO-IEE) biomass-fired cogen plant and Bee Joo Industries Pte Ltd biomass-fitred cogen plant.
103	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	0.53 MW ECO-IEE biomass-fired cogen plant (off-grid) using wood waste as fuel.
104	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	1.0 MW Bee Joo Industries biomass-fired cogen plant (off-grid) using wood waste as fuel.
105	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	-
106	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	-
107	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	-
108	biomass	5. National know-how	**Are there examples of Off-grid biomass installations providing power to local mini-grids? (please describe)**	No. ECO-IEE and Bee Joo Industries biomass-fired cogen plants generate power for internal process use.
110	biomass	4. Installed Capacity / experience	**Biomass lessons learned (+ve and -ve): (please describe)**	

111	biomass	5. National know-how	**In-country Biomass References: (please list main references)**	Waste-to-Energy Incineration Plants National Environment Agency: http://app.nea.gov.sg/cms/htdocs/category_sub.asp?cid=75 Biomass-fired Cogen Plants ECO-IEE: http://www.eco.com.sg/bus_hazardous_prod&service.asp#wte Bee Joo Industries: http://www.ecowise.com.sg/news/sgx_060104.html
112	biomass	5. National know-how	**Manufacturing capacity for biomass for power generation (including biogas systems): (please describe)**	Waste-to-Energy Incineration Plants Ulu Pandan IP: 16 MW, Tuas IP: 46 MW, Senoko IP: 54 MW, and Tuas South IP: 132 MW. Biomass-fired Cogen Plants ECO-IEE: 0.53 MW, and Bee Joo Industries: 1.0 MW.
113	biomass	5. National know-how	**R&D experience**	None.
114	biomass	5. National know-how	**R&D main institutions responsible**	None.
115	biomass	5. National know-how	**Biomass networks / Information clearing houses**	None.
116	biomass	5. National know-how	**Main National Actors (associations, etc.)**	Energy Market Authority: http://www.ema.gov.sg National Environment Agency: http://www.nea.gov.sg
117	biomass	5. National know-how	**Information Links**	As provided individually above.
118	biomass	6. Challanges	**Main Challenges, causes for failure : technical, socio-economic, policy etc. implementation**	Main challenge: Limited land for agriculture.
119	biomass	7. Recommendations	**National recommendation and Way forward**	Monitor global trend in developments of biomass-fired technologies and economic feasibility.
120	biomass	8. Regional dimension	**Level of regional dialogue on biomass and info. exchange**	Ministry of Environment and Water Resources http://www.mewr.gov.sg
121	biomass	8. Regional dimension	**In your view how can the region work together in this aspect - opportunities for regional cooperation?**	Exchange of technological know-how and experience.
122	biomass	8. Regional dimension	**Are there any opportunities in your veiw for Regional Trade – fuel (philippines – briquettes)/ technologies / know-how ?**	Possible import of renewable biomass for cogen plants if economically feasible.
125	biomass	9. European dimension	**What expertise from Europe are you seeking, if any?**	Exchange of technological know-how and experience.

CAMBODIA				
No°	**Theme**	**Category**	**Question:**	**Answer:**
2	general	1. Socio-economic	**Agriculture accounts for how much of GDP?**	N/A
5	general	1. Socio-economic	**% rural population**	85%
8	general	2. Energy Scene	**overall electrification rate (national)**	55kwh/capita
14	general	2. Energy Scene	**electrification rate (rural only)**	8,60%
18	general	2. Energy Scene	**Off-grid electrification target - If any**	N/A
19	general	2. Energy Scene	**Utility Name**	N/A
20	biomass	1. Resource Availability	**Are there coal-fired power stations?**	No
21	biomass	1. Resource Availability	**What is the contribution of coal-fired power stations over the total generation mix?**	
24	RETS	3. RE Support	**Renewable Energy Technology Policy**	Draft
25	RETS	3. RE Support	**Renewable Energy Targets**	100,000 HH will have access to electricity from RETS including 12000 SHS
34	policy	4. Energy Policy Environment	**Liberlized Energy Market (yes/no)**	Yes
36	policy	4. Energy Policy Environment	**Is there an off-grid electrification strategy?(yes/no - explain)**	Yes
38	policy	4. Energy Policy Environment	**Is it possible to sell electricity generated by an IPP/SPP to the utility? (please describe is their a minimum / maximum?)**	Yes, not limit
39	policy	4. Energy Policy Environment	**Is the utility obliged to purchase the electricity generated by the IPP/SPP?**	No
40	policy	4. Energy Policy Environment	**And if so, what are are the tariffs that the utility has to pay to purchase the power form the IPP/SPP?**	According to the license from EAC
41	policy	4. Energy Policy Environment	**Are there any particular incentives for IPP's that generate power from renewables?**	Not yet have, in the future will have
42	policy	4. Energy Policy Environment	**What are the tariff rates that the utility charges?**	9-80 US Cent/kWh
43	policy	4. Energy Policy Environment	**Usual length of contract/ concession:**	N/A
44	policy	4. Energy Policy Environment	**Is it legally possible for an IPP/SPP to distribute power to its own set of clients (mini-grid) - if so please desribe:**	N/A
45	policy	4. Energy Policy Environment	**What are the regulatory frameworks set in place for renewables and rural electrification?**	
46	policy	4. Energy Policy Environment	**Clarity of policy - how easy is it for an IPP to generate power and sell it to the utility - is it a complicated process?**	
63	policy	7. Financing	**Are there any subsidies for renewables or for rural electrification? (please describe)**	Will have from the REF
64	policy	7. Financing	**Any fiscal incentives (duty exemptions, tax holidays, no interest loans) - please describe:**	incentive for investor - is being drafted at the present

65	policy	7. Financing	**Availability of soft loans? Please describe:**	
67	policy	7. Financing	**Has there been much foreign investment in setting up IPP's?**	N/A
68	policy	7. Financing	**Which specific instruments help with investment - what are the drivers?**	N/A
72	biomass	1. Resource Availability	**Abundant Biomass Resources for Energy Exploitation**	Yes
73	biomass	1. Resource Availability	**National Biomass Resource / Market Assessment**	just startted in data collection
75	biomass	1. Resource Availability	**Total Biomass Theoretical potential :**	N/A
76	biomass	1. Resource Availability	**Palm Oil Residue Potential :**	Yes
77	biomass	1. Resource Availability	**Paddy residues Potential :**	Yes
78	biomass	1. Resource Availability	**Sugar cane residue Potential :**	Yes
79	biomass	1. Resource Availability	**Wood residue Potential :**	Yes
80	biomass	1. Resource Availability	**Municipal Solid Waste :**	Yes
81	biomass	1. Resource Availability	**Other crop residue potential (specify) :**	Yes/ cashewnut, coconut..
82	biomass	1. Resource Availability	**Dedicated Energy Crop Plantation Potential:**	N/A
83	biomass	1. Resource Availability	**Animal wastes potential:**	Yes
84	biomass	1. Resource Availability	**What are the competing markets for residues listed above:**	Rice husk
85	biomass	2. Policy	**What is the bioenergy perception for both grid and off-grid opportunities?**	Yes
86	biomass	2. Policy	**Is there a Political Interest in Modern Biomass technologies for power generation? (please describe)**	Yes
87	biomass	2. Policy	**Policies relevant to Biomass specifically**	Draft
88	biomass	2. Policy	**If there a Specific Biomass programme: (please describe)**	
89	biomass	2. Policy	**Is there a Specific biomass target:**	
90	biomass	2. Policy	**Any specific Biomass government funds : (please specify)**	
91	biomass	2. Policy	**Are there any national standards in place for biomass equipment?**	N/A
92	biomass	3. Economics	**Costs for different technologies and feedstocks (Fuel costs + capital costs + O&M)**	N/A
94	biomass	3. Economics	**Is imported biomass equipment liable to tax duties? (please describe)**	Specific only
95	biomass	3. Economics	**Access to financing (commercial and soft loans - national and foreign) for biomass projects?**	No
96		3. Economics	**Number of SPP/IPP dealing with biomass already: please provide as much info of these including technologies used, installed capacity etc.**	Not now,but in future will have

99	biomass	3. Economics	**How in your view can biomass become an attractive business investment environment?**	Incentive
100	biomass	4. Installed Capacity / experience	**Present biomass uses: (please also provide information on existing biomass uses for power generation)**	Very small, Along Tamei Village, Battambang Province
101	biomass	4. Installed Capacity / experience	**Biomass Installed Capacity (MW):**	N/A
102	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	Very small, Along Tamei Village, Battambang Province
108	biomass	5. National know-how	**Are there examples of Off-grid biomass installations providing power to local mini-grids? (please describe)**	
110	biomass	4. Installed Capacity / experience	**Biomass lessons learned (+ve and -ve): (please describe)**	
111	biomass	5. National know-how	**In-country Biomass References: (please list main references)**	
112	biomass	5. National know-how	**Manufacturing capacity for biomass for power generation (including biogas systems): (please describe)**	NEDO project, PV-biogas (50kWp+70kW)
113	biomass	5. National know-how	**R&D experience**	Incorlaboration with NEDO for the research project
114	biomass	5. National know-how	**R&D main institutions responsible**	MIME/NEDO
115	biomass	5. National know-how	**Biomass networks / Information clearing houses**	No
116	biomass	5. National know-how	**Main National Actors (associations, etc.)**	SME
117	biomass	5. National know-how	**Information Links**	Cambodian Research Centre for Development
118	biomass	6. Challanges	**Main Challenges, causes for failure : technical, socio-economic, policy etc. implementation**	
119	biomass	7. Recommendations	**National recommendation and Way forward**	
120	biomass	8. Regional dimension	**Level of regional dialogue on biomass and info. exchange**	Yes
121	biomass	8. Regional dimension	**In your view how can the region work together in this aspect - opportunities for regional cooperation?**	Exchange information/technology/experiences
122	biomass	8. Regional dimension	**Are there any opportunities in your veiw for Regional Trade – fuel (philippines – briquettes)/ technologies / know-how ?**	
123	biomass	9. European dimension	**What expertise from Europe are you seeking, if any?**	Any

INDONESIA				
No°	**Theme**	**Category**	**Questions:**	**Answers:**
2	general	1. Socio-economic	**Agriculture accounts for how much of GDP?**	17,30%
5	general	1. Socio-economic	**% rural population**	70%
8	general	2. Energy Scene	**overall electrification rate (national)**	50%
14	general	2. Energy Scene	**electrification rate (rural only)**	32%
18	general	2. Energy Scene	**Off-grid electrification target - If any**	No specific target for the off-grid, but the off-grid is directed for isolated and remote area
19	general	2. Energy Scene	**Utility Name**	PLN
20	general	2. Energy Scene	**Are there coal-fired power stations?**	Yes,
21	general	2. Energy Scene	**What is the contribution of coal-fired power stations over the total generation mix?**	4,790 MW or 18.99%
24	RETS	3. RE Support	**Renewable Energy Technology Policy**	To develop technologies that fit with our available resources, for example technologies on biodiesel, gasification
25	RETS	3. RE Support	**Renewable Energy Targets**	5% minimum by 2020
34	policy	4. Energy Policy Environment	**Liberlized Energy Market (yes/no)**	Not yet, it will be started probably around 2007
36	policy	4. Energy Policy Environment	**Is there an off-grid electrification strategy?(yes/no - explain)**	Yes, the strategy is to develop the off-grid for isolated and remoted area
38	policy	4. Energy Policy Environment	**Is it possible to sell electricity generated by an IPP/SPP to the utility? (please describe is their a minimum / maximum?)**	Yes, based on the PPA
39	policy	4. Energy Policy Environment	**Is the utility obliged to purchase the electricity generated by the IPP/SPP?**	for less than 1MW -
40	policy	4. Energy Policy Environment	**And if so, what are are the tariffs that the utility has to pay to purchase the power form the IPP/SPP?**	Based on the contract, tariffs may vary each other
41	policy	4. Energy Policy Environment	**Are there any particular incentives for IPP's that generate power from renewables?**	Yes, for the capacity less than 1 MW and developed by by small scale industries and cooperatives, the utility is obligated to purchase it
42	policy	4. Energy Policy Environment	**What are the tariff rates that the utility charges?**	6 or 7 Usc/KWh
43	policy	4. Energy Policy Environment	**Usual length of contract/ concession:**	1 year
44	policy	4. Energy Policy Environment	**Is it legally possible for an IPP/SPP to distribute power to its own set of clients (mini-grid) - if so please desribe:**	for less than 1MW -
45	policy	4. Energy Policy Environment	**What are the regulatory frameworks set in place for renewables and rural electrification?**	We have set the target that in 2020, 90% of rural would be electrified. We had Electricity Act No. 20 Year 2002 which clearly stated that renewable energy should be the priority (if possible) for the area to develop electricity generator

46	policy	4. Energy Policy Environment	**Clarity of policy - how easy is it for an IPP to generate power and sell it to the utility - is it a complicated process?**	For the capacity less than 1 MW, the process in simple since the utility is obligated to purchase it, however in practices, the contract should be approved by the shareholder meeting which only scheduled once a year
63	policy	7. Financing	**Are there any subsidies for renewables or for rural electrification? (please describe)**	No
64	policy	7. Financing	**Any fiscal incentives (duty exemptions, tax holidays, no interest loans) - please describe:**	under discussion under moE and Mof finance for tax holiday
65	policy	7. Financing	**Availability of soft loans? Please describe:**	We don't have yet any specific soft loans for the renewable energy development, but we have scheme that the government provide some budget (soft loan) for small scale industries and cooperatives to develop tha bussinesses including renewable energy projects
67	policy	7. Financing	**Has there been much foreign investment in setting up IPP's?**	Yes, for large capacities
68	policy	7. Financing	**Which specific instruments help with investment - what are the drivers?**	I think soft loans and multiyears contract are the most important drivers
72	biomass	1. Resource Availability	**Abundant Biomass Resources for Energy Exploitation**	from waste - 2349
73	biomass	1. Resource Availability	**National Biomass Resource / Market Assessment**	A world bank/ESMAP study estimated the market potnetial of power generation from biomass residues at around 1800 MW
75	biomass	1. Resource Availability	**Total Biomass Theoretical potential :**	1800 MW
76	biomass	1. Resource Availability	**Palm Oil Residue Potential :**	2255 GWH/yr
77	biomass	1. Resource Availability	**Paddy residues Potential :**	3926 GWh/yr
78	biomass	1. Resource Availability	**Sugar cane residue Potential :**	3173 GWh/yr. Total of 56 sugar mills in operation
79	biomass	1. Resource Availability	**Wood residue Potential :**	2424 gwh/yr
80	biomass	1. Resource Availability	**Municipal Solid Waste :**	plans to install a municipal solid waste power generation project of 50 MW in Jakarta, are at a preliminary stage.
81	biomass	1. Resource Availability	**Other crop residue potential (specify) :**	coconut - 2201 GWh/yr
82	biomass	1. Resource Availability	**Dedicated Energy Crop Plantation Potential:**	No, but recently we are developind Jatropha Oil as a dedicated plantation for biodiesel
83	biomass	1. Resource Availability	**Animal wastes potential:**	hundreds of units have been installed for rural communities using animal dung.
84	biomass	1. Resource Availability	**What are the competing markets for residues listed above:**	
85	biomass	2. Policy	**What is the bioenergy perception for both grid and off-grid opportunities?**	Bioenergy/biomass is the only one that has a promising futurre application. Not as solar or wind, biomass can managed and planned
86	biomass	2. Policy	**Is there a Political Interest in Modern Biomass technologies for power generation? (please describe)**	Yes, the government has set the target (road map) until 2020
87	biomass	2. Policy	**Policies relevant to Biomass specifically**	promting green energy policy with fiscal and tax incentives

88	biomass	2. Policy	**If there a Specific Biomass programme: (please describe)**	yes
89	biomass	2. Policy	**Is there a Specific biomass target:**	yes : 5% growth in capacity per year up to 2008 and 3% up to 2020
90	biomass	2. Policy	**Any specific Biomass government funds : (please specify)**	No
91	biomass	2. Policy	**Are there any national standards in place for biomass equipment?**	yes
92	biomass	3. Economics	**Costs for different technologies and feedstocks (Fuel costs + capital costs + O&M)**	Not available
94	biomass	3. Economics	**Is imported biomass equipment liable to tax duties? (please describe)**	Yes, it follows the tariffs that defined by Ministry of Finance
95	biomass	3. Economics	**Access to financing (commercial and soft loans - national and foreign) for biomass projects?**	Because the contract (if the electricity will be sold to the utility) is one year, so the bank considers that the project is not bankable. It is difficult to find the soft loan and commercial as well
96	biomass	3. Economics	**Number of SPP/IPP dealing with biomass already: please provide as much info of these including technologies used, installed capacity etc.**	Not available, but we will have some SPP dealing with biomass in the framework of CDM. One example is the one used empty fruit brunces of palm oil as I presented in Kuala Lumpur. Another is the use of bagasse sugarcane, in Sumatera
99	biomass	3. Economics	**How in your view can biomass become an attractive business investment environment?**	There should be more government incentives, for example the current incentive that the utility should purchase the electricity produced from renewables is only available for the capacity less than 1 MW. On the other hand, at such small scale the developer is not interested. The other is that the contract of PPA should be multiyears
100	biomass	4. Installed Capacity / experience	**Present biomass uses: (please also provide information on existing biomass uses for power generation)**	share of biomass in the total energy consumption is approxiamtely 35-40%
101	biomass	4. Installed Capacity / experience	**Biomass Installed Capacity (MW):**	302 MW, all of which are developed by industries and your for their own needs
102	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	cogen projects - 5,5 MW waste-wood powdr plant at T Siak Raya Timber in Pekanbaru, Sumatra
103	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	rice hush cogeneration
104	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	Palm Oil - 3,5 MW
105	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	possibilty to purchase less than 1MW
106	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	Biogas Electricity Generation Cakung, Jakarta from animal dunk with capacity of 35 kW
107	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	Wastewood gasification Inhutani- South Kalimantan with capacity 40-100 kW
108	biomass	5. National know-how	**Are there examples of Off-grid biomass installations providing power to local mini-grids? (please describe)**	No
110	biomass	4. Installed Capacity / experience	**Biomass lessons learned (+ve and -ve): (please describe)**	Indonesia is a country that has abundant resources of biomass and it is spreaded out of the country, but much of the biomass utilization in still in very conventional methods such as fuel wood. It is important that to improve the welfare,

				therefore, biomass should be directed as a modern energy
111	biomass	5. National know-how	**In-country Biomass References: (please list main references)**	World Bank biomass projects under RESPP - but project cancelled
112	biomass	5. National know-how	**Manufacturing capacity for biomass for power generation (including biogas systems): (please describe)**	gasifiers up to 100 kW - costs provided based on this. Manufacturers of boilers, gasifiers and biogas systems. Companies that can design boilers etc.
113	biomass	5. National know-how	**R&D experience**	We had various experiences in developing biomass as fuel such as biogas, biodiesel, gasification, carbonization. However, as far as I kow we had only one example to use biomass for electricity that is rice-husk as I presented
114	biomass	5. National know-how	**R&D main institutions responsible**	ministry of energy and mineral resources. Agency for Assessment and Application of Technology
115	biomass	5. National know-how	**Biomass networks / Information clearing houses**	Association of sugarmillers, association of palm oil millers, association of plywood industries, MEMR-DGEED, BPPT, CIFOR, MOF,
116	biomass	5. National know-how	**Main National Actors (associations, etc.)**	Indonesia Renewable Energy Society,
117	biomass	5. National know-how	**Information Links**	
118	biomass	6. Challanges	**Main Challenges, causes for failure : technical, socio-economic, policy etc. implementation**	Tha main challenge is technical and economic issues, since most of biomass is used in conventional ways and the current practice for electricity is not attracting
119	biomass	7. Recommendations	**National recommendation and Way forward**	To set the programmes and activities to reach the target of electrificity generated from biomass
120	biomass	8. Regional dimension	**Level of regional dialogue on biomass and info. exchange**	Facilitated by ACE and also APEC, mainly on middle level
121	biomass	8. Regional dimension	**In your view how can the region work together in this aspect - opportunities for regional cooperation?**	The region has more or less a similar condition in renewable energy development particularly on biomass for electricity generation. Therefore, information exchange on biomass including technologies, policy, incentives, success stories and other socio economic issues would be benefecial to the region
122	biomass	8. Regional dimension	**Are there any opportunities in your veiw for Regional Trade – fuel (philippines – briquettes)/ technologies / know-how ?**	Yes, they are.
123	biomass	9. European dimension	**What expertise from Europe are you seeking, if any?**	
124	biomass	9. European dimension	**European Added Value on technical know-how**	
125	biomass	9. European dimension	**What expertise from Europe are you seeking, if any?**	The success in developing biomass as one of significant energy resources in Europe particularly on gasification technologies

LAOS				
No°	**Theme**	**Category**	**Question:**	**Answer:**
2	general	1. Socio-economic	**Agriculture accounts for how much of GDP?**	48%
5	general	1. Socio-economic	**% rural population**	80%
8	general	2. Energy Scene	**overall electrification rate (national)**	43%
14	general	2. Energy Scene	**electrification rate (rural only)**	
18	general	2. Energy Scene	**Off-grid electrification target - If any**	2005 - 45% access 2010 - 70% access and 2020 - 90% access (target include on-grid)
19	general	2. Energy Scene	**Utility Name**	Elecricity Department of Laos (EDL)
20	biomass	1. Resource Availability	**Are there coal-fired power stations?**	No, only hydro/small hydro palnts
21	biomass	1. Resource Availability	**What is the contribution of coal-fired power stations over the total generation mix?**	None
24	RETS	3. RE Support	**Renewable Energy Technology Policy**	None
25	RETS	3. RE Support	**Renewable Energy Targets**	no target for RE
34	policy	4. Energy Policy Environment	**Liberlized Energy Market (yes/no)**	2 existing IPP project - 210 & 150 MW
36	policy	4. Energy Policy Environment	**Is there an off-grid electrification strategy?(yes/no - explain)**	No
38	policy	4. Energy Policy Environment	**Is it possible to sell electricity generated by an IPP/SPP to the utility? (please describe is their a minimum / maximum?)**	Yes
39	policy	4. Energy Policy Environment	**Is the utility obliged to purchase the electricity generated by the IPP/SPP?**	Subject to discussion
40	policy	4. Energy Policy Environment	**And if so, what are are the tariffs that the utility has to pay to purchase the power form the IPP/SPP?**	As per contract (Depend on project-stability of technologies)
41	policy	4. Energy Policy Environment	**Are there any particular incentives for IPP's that generate power from renewables?**	No
42	policy	4. Energy Policy Environment	**What are the tariff rates that the utility charges?**	Refer q.17
43	policy	4. Energy Policy Environment	**Usual length of contract/ concession:**	for hydrp projject is 25-30 years
44	policy	4. Energy Policy Environment	**Is it legally possible for an IPP/SPP to distribute power to its own set of clients (mini-grid) - if so please desribe:**	No national policy yet
45	policy	4. Energy Policy Environment	**What are the regulatory frameworks set in place for renewables and rural electrification?**	Not yet only rural electrification study by World Bank
46	policy	4. Energy Policy Environment	**Clarity of policy - how easy is it for an IPP to generate power and sell it to the utility - is it a complicated process?**	Not yet
63	policy	7. Financing	**Are there any subsidies for renewables or for rural electrification? (please describe)**	Income tax/fee exemption only for government program

			describe)	
64	policy	7. Financing	**Any fiscal incentives (duty exemptions, tax holidays, no interest loans) - please describe:**	tax exemption for imports
65	policy	7. Financing	**Availability of soft loans? Please describe:**	By World Bank at 2%
67	policy	7. Financing	**Has there been much foreign investment in setting up IPP's?**	Only for large hyros-Korea/Thailand
68	policy	7. Financing	**Which specific instruments help with investment - what are the drivers?**	Lao National Committee for Energy
72	biomass	1. Resource Availability	**Abundant Biomass Resources for Energy Exploitation**	sawdust; rice husk; rice straw; agricultural residues
73	biomass	1. Resource Availability	**National Biomass Resource / Market Assessment**	
75	biomass	1. Resource Availability	**Total Biomass Theoretical potential :**	
76	biomass	1. Resource Availability	**Palm Oil Residue Potential :**	None
77	biomass	1. Resource Availability	**Paddy residues Potential :**	Rice product in year 2003-2,375,100 tonne
78	biomass	1. Resource Availability	**Sugar cane residue Potential :**	Sugar cane product in year 2003 - 308,417 tonne
79	biomass	1. Resource Availability	**Wood residue Potential :**	
80	biomass	1. Resource Availability	**Municipal Solid Waste :**	170 ton/day
81	biomass	1. Resource Availability	**Other crop residue potential (specify) :**	None
82	biomass	1. Resource Availability	**Dedicated Energy Crop Plantation Potential:**	None
83	biomass	1. Resource Availability	**Animal wastes potential:**	
84	biomass	1. Resource Availability	**What are the competing markets for residues listed above:**	None
85	biomass	2. Policy	**What is the bioenergy perception for both grid and off-grid opportunities?**	
86	biomass	2. Policy	**Is there a Political Interest in Modern Biomass technologies for power generation? (please describe)**	Yes
87	biomass	2. Policy	**Policies relevant to Biomass specifically**	Supportingpolicy
88	biomass	2. Policy	**If there a Specific Biomass programme: (please describe)**	no
89	biomass	2. Policy	**Is there a Specific biomass target:**	no
90	biomass	2. Policy	**Any specific Biomass government funds : (please specify)**	no
91	biomass	2. Policy	**Are there any national standards in place for biomass equipment?**	no
92	biomass	3. Economics	**Costs for different technologies and feedstocks (Fuel costs + capital costs + O&M)**	no
94	biomass	3. Economics	**Is imported biomass equipment liable to tax duties? (please describe)**	maybe-free of tax

95	biomass	3. Economics	**Access to financing (commercial and soft loans - national and foreign) for biomass projects?**	Yes, by foreign investor
96		3. Economics	**Number of SPP/IPP dealing with biomass already: please provide as much info of these including technologies used, installed capacity etc.**	None
99	biomass	3. Economics	**How in your view can biomass become an attractive business investment environment?**	Good for environment/sell the CER
100	biomass	4. Installed Capacity / experience	**Present biomass uses: (please also provide information on existing biomass uses for power generation)**	A company produced saw dust, burn them and produced charcoal
101	biomass	4. Installed Capacity / experience	**Biomass Installed Capacity (MW):**	No
102	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	None
103	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	None
104	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	None
105	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	None
106	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	None
107	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	None
108	biomass	5. National know-how	**Are there examples of Off-grid biomass installations providing power to local mini-grids? (please describe)**	None
110	biomass	4. Installed Capacity / experience	**Biomass lessons learned (+ve and -ve): (please describe)**	
111	biomass	5. National know-how	**In-country Biomass References: (please list main references)**	resdalao.org.la / wood energy info analysis in Asia - EC-FAO
112	biomass	5. National know-how	**Manufacturing capacity for biomass for power generation (including biogas systems): (please describe)**	None
113	biomass	5. National know-how	**R&D experience**	Ins. Of Technogy Center is doing R&D on power generation using rice husk (160kW)
114	biomass	5. National know-how	**R&D main institutions responsible**	Science and Technology Agency (STA)
115	biomass	5. National know-how	**Biomass networks / Information clearing houses**	Cogen 3
116	biomass	5. National know-how	**Main National Actors (associations, etc.)**	EDL
117	biomass	5. National know-how	**Information Links**	www.resdalao.org.la (not much info.though)
118	biomass	6. Challanges	**Main Challenges, causes for failure : technical, socio-economic, policy etc. implementation**	want to know more about biomass / lack of info / lack of info on technology / no real understanding about the real resource base / national technical know-how / update data and more info.
119	biomass	7. Recommendations	**National recommendation and Way forward**	90% electrification by 2020
120	biomass	8. Regional dimension	**Level of regional dialogue on biomass and info. exchange**	Low
121	biomass	8. Regional dimension	**In your view how can the region work together in this aspect - opportunities for regional cooperation?**	Through Cogen 3

			for regional cooperation?	
122	biomass	8. Regional dimension	**Are there any opportunities in your veiw for Regional Trade – fuel (philippines – briquettes)/ technologies / know-how ?**	Low potential
123	biomass	9. European dimension	**What expertise from Europe are you seeking, if any?**	Master plan

VIETNAM				
No°	**Theme**	**Category**	**Question:**	**Answer:**
2	general	1. Socio-economic	**Agriculture accounts for how much of GDP?**	
5	general	1. Socio-economic	**% rural population**	80,20%
8	general	2. Energy Scene	**overall electrification rate (national)**	
14	general	2. Energy Scene	**electrification rate (rural only)**	
18	general	2. Energy Scene	**Off-grid electrification target - If any**	
19	general	2. Energy Scene	**Utility Name**	EVN
20	biomass	1. Resource Availability	**Are there coal-fired power stations?**	Yes
21	biomass	1. Resource Availability	**What is the contribution of coal-fired power stations over the total generation mix?**	13,60%
24	RETS	3. RE Support	**Renewable Energy Technology Policy**	no endoresements today - RETS only mentioned in master plan in terms of rural electrification. A decree for RETS is being drafted at present. Renewable Energy Action Plan (REAP): the objective of REAP is to supply renewable electricity for socio-economic development in off-grid areas and enhancement of electricity supply to the grid.
25	RETS	3. RE Support	**Renewable Energy Targets**	no target
34	policy	4. Energy Policy Environment	**Liberlized Energy Market (yes/no)**	no - utility single buyer
36	policy	4. Energy Policy Environment	**Is there an off-grid electrification strategy?(yes/no - explain)**	yes - rural energy policy
38	policy	4. Energy Policy Environment	**Is it possible to sell electricity generated by an IPP/SPP to the utility? (please describe is their a minimum / maximum?)**	the Government encourages investment in renewable electricity development to supply electricity to rural consumers through private or public companies, cooperatives or other entities.
39	policy	4. Energy Policy Environment	**Is the utility obliged to purchase the electricity generated by the IPP/SPP?**	
40	policy	4. Energy Policy Environment	**And if so, what are are the tariffs that the utility has to pay to purchase the power form the IPP/SPP?**	
41	policy	4. Energy Policy Environment	**Are there any particular incentives for IPP's that generate power from renewables?**	
42	policy	4. Energy Policy Environment	**What are the tariff rates that the utility charges?**	low - subsidized - not attractive for private investors
43	policy	4. Energy Policy Environment	**Usual length of contract/ concession:**	
44	policy	4. Energy Policy Environment	**Is it legally possible for an IPP/SPP to distribute power to its own set of clients (mini-grid) - if so please desribe:**	yes - not very specified but based on a case by case - based on negotiation
45	policy	4. Energy Policy Environment	**What are the regulatory frameworks set in place for renewables and rural electrification?**	money from budget to rural electrification and local government
46	policy	4. Energy Policy Environment	**Clarity of policy - how easy is it for an IPP to generate power and sell it to the utility - is it a complicated process?**	
63	policy	7. Financing	**Are there any subsidies for renewables or for rural electrification? (please describe)**	into construction for rural electrification in medium voltage distribution network

64	policy	7. Financing	**Any fiscal incentives (duty exemptions, tax holidays, no interest loans) - please describe:**	for particular projects - BP PV project tax exemption. Tax holiday but dependent on the actual project. The gov(t can provide up to 50% of the project costs.
65	policy	7. Financing	**Availability of soft loans? Please describe:**	
67	policy	7. Financing	**Has there been much foreign investment in setting up IPP's?**	
68	policy	7. Financing	**Which specific instruments help with investment - what are the drivers?**	Renewable Action Plan - prepared by EVN draft for WB for lending - not a legal document not an obligation. By 2010 about 1 million HH's will not be connected to the grid - so reneables to provide access to these 1 million HH.
72	biomass	1. Resource Availability	**Abundant Biomass Resources for Energy Exploitation**	
73	biomass	1. Resource Availability	**National Biomass Resource / Market Assessment**	
75	biomass	1. Resource Availability	**Total Biomass Theoretical potential :**	
76	biomass	1. Resource Availability	**Palm Oil Residue Potential :**	
77	biomass	1. Resource Availability	**Paddy residues Potential :**	there are 127 rice milling operations with a capacity of over 10t/shift scattered around vientam. Each mill with a capacity more than 5 tonnes per hour culd support a rice husk fired power plant of 500 kW capacity or greater and could aggregate as much as 70 MW - 150 MW.
78	biomass	1. Resource Availability	**Sugar cane residue Potential :**	between 150 - 200 MW - this is a significant potential capacity as sugar cane is processed during the dry season whenpower shortages occur due to the reduced generation from hydropower plants. around 40 sugarmills in vietnam use combined head/power systems for capitve power. There are no sales to the grid. Around 50% of the bagasse is dumped as waste, leaving a large potential underutilized.
79	biomass	1. Resource Availability	**Wood residue Potential :**	5 MW
80	biomass	1. Resource Availability	**Municipal Solid Waste :**	30 to 50 MW
81	biomass	1. Resource Availability	**Other crop residue potential (specify) :**	
82	biomass	1. Resource Availability	**Dedicated Energy Crop Plantation Potential:**	
83	biomass	1. Resource Availability	**Animal wastes potential:**	
84	biomass	1. Resource Availability	**What are the competing markets for residues listed above:**	
85	biomass	2. Policy	**What is the bioenergy perception for both grid and off-grid opportunities?**	
86	biomass	2. Policy	**Is there a Political Interest in Modern Biomass technologies for power generation? (please describe)**	
87	biomass	2. Policy	**Policies relevant to Biomass specifically**	
88	biomass	2. Policy	**If there a Specific Biomass programme: (please describe)**	Master Plan on Power Development for Vietnam for the period 2000 -2010 with consideration to 2020 has been approved by the Government in which biomass electricity generation is projected at about 200-400 MWe. This capacity is to be

				connected to the grid and supplied to rural areas.
89	biomass	2. Policy	**Is there a Specific biomass target:**	
90	biomass	2. Policy	**Any specific Biomass government funds : (please specify)**	
91	biomass	2. Policy	**Are there any national standards in place for biomass equipment?**	
92	biomass	3. Economics	**Costs for different technologies and feedstocks (Fuel costs + capital costs + O&M)**	
94	biomass	3. Economics	**Is imported biomass equipment liable to tax duties? (please describe)**	
95	biomass	3. Economics	**Access to financing (commercial and soft loans - national and foreign) for biomass projects?**	
96		3. Economics	**Number of SPP/IPP dealing with biomass already: please provide as much info of these including technologies used, installed capacity etc.**	
99	biomass	3. Economics	**How in your view can biomass become an attractive business investment environment?**	
100	biomass	4. Installed Capacity / experience	**Present biomass uses: (please also provide information on existing biomass uses for power generation)**	
101	biomass	4. Installed Capacity / experience	**Biomass Installed Capacity (MW):**	
102	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	one ricemill has been equipped with a 50kW Cogen system under an Australia / Malaysian technical cooperation. The system was installed around the beginning of the year 2000.
103	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	
104	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	
105	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	
106	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	
107	biomass	4. Installed Capacity / experience	**Please list biomass to power project examples (grid and off-grid projects)***	
108	biomass	5. National know-how	**Are there examples of Off-grid biomass installations providing power to local mini-grids? (please describe)**	
110	biomass	4. Installed Capacity / experience	**Biomass lessons learned (+ve and -ve): (please describe)**	
111	biomass	5. National know-how	**In-country Biomass References: (please list main references)**	(1) RE.Program, 52 C, coordinated by MET, carried out in the period 1985-1995. (2) COGEN 3 in Vietnam, EC-ASEAN Cogen Programme Phase 3. (3) Biogas Programme is funded by the Netherlands Gov. The project stated in Feb. 2003 and will be completed in Jan. 2006. (4)Ministerial level research “Assessment of feasibility of biomass use and other RE at industrial scale in Vietnam” carrying out in the period 2002-2004. (5) The theme: “Research on assessment of feasibility for power generation using rice husks” has

				been being carried out in the period 2003-2004 . (6) The project "Dissemination of biomass ICS at provincial level"
112	biomass	5. National know-how	**Manufacturing capacity for biomass for power generation (including biogas systems): (please describe)**	
113	biomass	5. National know-how	**R&D experience**	
114	biomass	5. National know-how	**R&D main institutions responsible**	
115	biomass	5. National know-how	**Biomass networks / Information clearing houses**	
116	biomass	5. National know-how	**Main National Actors (associations, etc.)**	Institute of Energy. Hanoi University of Technology. Cantho University. Hanoi Architecture University. Research Center for Energy and Environment (NGO). VACVINA (NGO). Energy Team (NGO)
117	biomass	5. National know-how	**Information Links**	
118	biomass	6. Challanges	**Main Challenges, causes for failure : technical, socio-economic, policy etc. implementation**	Insufficient awareness on biomass technologies; lack of strong policy and regulatory framework for encouraging biomass electricity production. Lack of reliable data. No available large commercial enterprises supplying biomass technologies and services. Lack of enthusiasm. Lack of financing. Cost of biomass conversion technologies still high.
119	biomass	7. Recommendations	**National recommendation and Way forward**	
120	biomass	8. Regional dimension	**Level of regional dialogue on biomass and info. exchange**	
121	biomass	8. Regional dimension	**In your view how can the region work together in this aspect - opportunities for regional cooperation?**	
122	biomass	8. Regional dimension	**Are there any opportunities in your veiw for Regional Trade – fuel (philippines – briquettes)/ technologies / know-how ?**	
123	biomass	9. European dimension	**What expertise from Europe are you seeking, if any?**	

ANNEX 7: BIBLIOGRAPHY

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