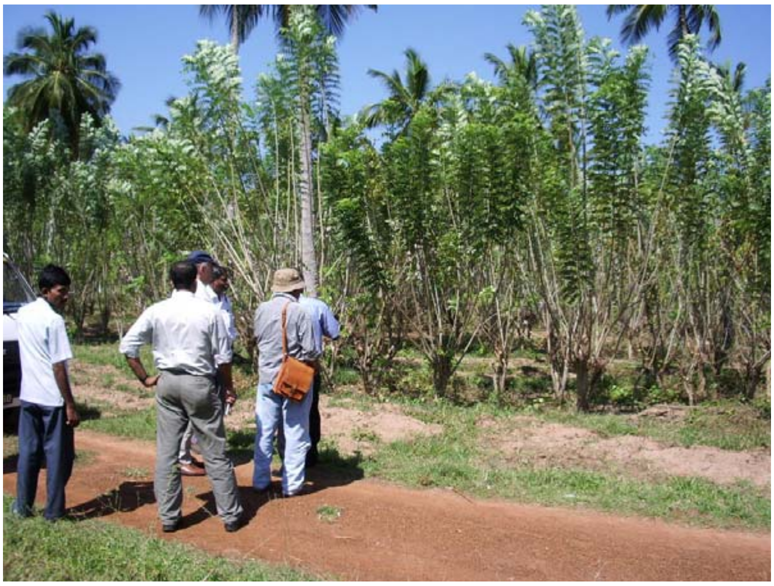
INTERNATIONAL CONFERENCE ON ISSUES FOR SUSTAINABLE USE OF BIOMASS RESOURCES FOR ENERGY

PROCEEDINGS



COLOMBO, SRI LANKA AUGUST 2005

FORWARD

These are the proceedings for a three-day conference that was held in August 2005 in Colombo, Sri Lanka on the theme of "Issues for Sustainable Use of Biomass Resources for Energy"

The Conference was an integral part of a project funded by the European Commission under its Asia Pro-Eco Programme. The project is a combined effort of four partners:

- The The Natural Resources Institute, University of Greenwich (NRI), UK
- The Bio Energy Association of Sri Lanka (BEASL)
- The Energy and Resources Institute (TERI), India
- Comitato Termotecnico Italiano (CTI), Italy

The partners would like to express their thanks and appreciation to the EC for their support in carrying out this conference and the associated activities and to the Government of Sri Lanka for their co-operation and support – in particular the Ministry of Science and Technology, which has been closely involved in the development of biomass-energy systems.

Natural Resources Institute

Natural Resources Institute, UK

Bio-energy Association, Sri Lanka

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The Energy and Resources Institute, India

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Comitato Termotecnico Italiano, Italy

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Introduction

During the period August 15th to 19th 2005 an international conference was held on the theme of "Issues for Sustainable Use of Biomass Resources for Energy". The venue was the Hotel Trans Asia, Colombo Sri Lanka.

The conference had been organised as an integral part of the project "The way forward for the use of wood and agricultural waste for energy production in SE Asia". This project is being funded through the EC as part of their Asia Pro Eco Programme. The partners involved in the implementation of the project and hence the conference comprised: -

- The Natural Resources Institute, University of Greenwich (NRI), UK
- The Bio Energy Association of Sri Lanka (BEASL)
- The Energy and Resources Institute (TERI), India
- Comitato Termotecnico Italiano (CTI), Italy

The objective of the conference was to review progress being made within the region and the lessons that have already been learnt on the use of wood and agricultural waste for energy production and to define what should be the future strategy for increasing the proportion of energy produced from these materials. The conference was targeted at researchers, energy policy makers, farm groups and private companies involved in sustainable energy production from wood fuel and agricultural waste working in the region and involved either in the growing side or in the conversion process. Following on from the conference a series of working group meetings has been planned together with additional data collection and linked studies to culminate in the production of a series of manuals and guides to the technology.

Background

Wood is a critical component of the total energy balance of many countries within Asia, being close to 70% of the total national demand for Sri Lanka and Bangladesh and 30% for India. It is relatively recently that national energy policies have seriously accepted that fuelwood-based energy production can provide an economically viable alternative to expensive oil imports as well as providing a useful source of income to farmers and commercial growers. Sri Lanka has already embarked on a field testing programme of the production capabilities of short-term rotation crops in a range of sites under an EU funded research programme "Sustainable Supply of Fuelwood to meet Sri Lanka's Energy Needs". This project was funded under DG1B as part of the Tropical Forest Budget Line (B7-6201). Additional studies have been conducted by the Coconut Research Institute, who are interested in a more efficient use of the coconut plantation sites through under-planting with fast growing leguminous tree species both for the production of energy crops and for green manure.

The objective of the project of which the conference is part, is to make use of the Sri Lanka experience as a central plank and to bring together other researchers and workers from neighbouring countries to exchange their observations on such issues as: -

- The production levels and economics of fast-growing trees for biomass production
- Lessons learnt in developing this activity by farmers groups and out growers
- The social and developmental issues arising from the encouragement of energy plantations as a livelihood activity
- The utilisation of waste agricultural material for energy production, practical and economic factors.
- Suitable low-medium volume conversion technologies – lessons learnt and conclusions reached on overall efficiency rates and economics of this approach.
- Current land tenure and lease arrangements for land identified as suitable for plantations,
- Land use maps that show the current and potential suitability for fuel wood plantations within *chena land*, abandoned tea estates, grass land or other derelict land.
- Participation with communities in developing strategies that are appropriate for fuel wood production in these areas, and which they endorse as their own.
- Current national and regional policies on alternative energy development
- The opportunities for regional co-operation and for linkages between public and private sectors.
- Knowledge gaps and the way forward.

The overall objective being to promote the use of alternative energy production schemes within the region.

As part of the outputs of the project, a web site has been established: -

http://www.bioenergysrilanka.com/dendro_2005/index.html

These proceedings along with the outputs of the Working Groups will be placed on this web site.

The conference was organised into four sessions covering the following areas:

Session 1 – Energy Strategy and the Role of Renewables
Session 2 – The Technology of Dendro-power and Fuel Production
Session 3 – The Economics of Dendro-power
Session 4 – Future Strategies and Development Activities

The conference together with the inaugural session took place over three full days and was followed by a one day field visit made to the north of Colombo, organised to show the participants some of the work that has been carried out with the growing of short-rotation coppice crops and the operation of small and medium size gasifiers.

On the final day (Friday), participants met to consider some of the outputs of the conference and to initiate a process of regular meetings of working groups. These groups are intended to take forward some of the issues and to develop a range of documentation that will assist energy planners and practitioners, at all levels in the energy sector, in South Asia.

MONDAY 15TH AUGUST   INAUGURAL SESSION

Agenda

9.00 -9.30	Registration
9.30 -9.40	Welcome Address – Mr Parakrama Jayasinghe, President BEASL and lighting the lamp ceremony
9.40- 10.00	Introduction to the Conference Theme, Mr Trevor Abell, NRI
10.00- 10.10	Address by the European Union – Roshan Lyman, EC Delegation Colombo.
	Morning Break
10.30 – 11.00	Address by the Chief Guest, Hon. Susil Premajayantha, Minister of Power and Energy.
11.00 – 11.20	Address by the Hon, Anura Priyadharshana, Minister of Plantation Industries
11.20 – 11.50	Video presentation on role of biomass energy in Sri Lanka
11.50 – 12.20	Policy Initiatives in prioritising bio-energy for socio-economic development in Sri Lanka – Mr Michael Warnakulasooiya, Chairman of the Energy Conservation Fund.
12.20 -12.30	Vote of Thanks
	Lunch Break

The first set of introductory presentations provided the participants with the work and role of BEASL and the theme and objectives of the conference. **Mr Jaysinghe** in opening the meeting oversaw the Lighting of the Lamp ceremony which, he explained, represented the attainment of knowledge and enlightenment and the dispelling of ignorance and darkness.

The background to the development of the conference and the project of which the conference is part was described by **Mr Abell** of NRI. He noted that with the price of oil currently reaching $66 per barrel the timing of the conference was opportune as there is a critical need for all counties within the region to reduce their dependence on imported fossil fuel.

Mr Roshan Lyman, representing Mr Walter Wilton, the Charge d'Affairs of the Delegation of the EU to Sri Lanka outlined the role and interest that the EU has played in the energy sector. The EU is currently active in supporting trade related assistance to business and has a particular focus on the issues raised by the Tsunami in terms of development assistance. It regards the energy sector as an extremely important element in the development programme and was particularly happy to support this current conference and project under the Asia Pro Eco Programme.

The address by the **Chief Guest, the Hon. Susil Premajayantha, the Minister of Power and Energy** provided an overview of the current power situation in the country. He informed the meeting of the diminishing role of hydro power in the energy balance of the country with just 35% now coming from that source. The role of hydro has reduced as the ultimate ceiling to hydro potential is reached but expansion of this sector is being promoted as much as possible through the issue of licences for mini-hydro schemes, 200 of which had been issued to date. In recent years the effect of a continuing drought has severely strained the system.

He indicated that the average sale price is Rs 7.70 per KWh this represents a financial loss of Rs 3.30/KWh and consequently is leading to a financial crisis within the CEB.

70% of the country's population now have access to the grid and the Government has plans to expand the country's thermal power capacity with a heavy reliance on imported coal. The Minister was able to announce that a recent decision has now been made to accept *Gliricidia sepium*, the main energy plantation species being used as a short-rotation crop (SRC) in the country, as the 4th national estate crop (following tea, rubber and coconut). This decision is part of the policy to see dendro-power take on a greater role in the energy balance of the nation with an intended in-country capacity of 100 MW by 2008.

The address of the Hon. Minister of Plantations was presented by **The Secretary Mr Abywickrema**, the Minister unfortunately being unable to attend at the last minute.

The address outlined that fact the country has no fossil fuel resources and in 2003 fuel imports totalled Rs 23 billion or 47% of the revenue. The need for another domestic-based energy source is clearly appreciated as the proportion of energy being supplied from hydro-based resources diminishes. The potential value of all the renewables – solar, wind and biomass is accepted and the particular importance of wood-based energy linked to short-rotation. *Gliricidia* is now accepted as a viable energy crop with production in the range of 25-30 tonnes/ha and the ability to provide a useful source of green manure and hence reduce the imports of nitrogen-based fertiliser. The announcement that it is to be recognised as an official estate crop, illustrates its importance. The role of the Coconut Development Board in the past promotion of *Gliricidia* was recognised and it is seen to have a continuing role in this aspect since it operates an extensive extension service and is fully capable of expanding the planting of this crop

Following a break for refreshments, the meeting was shown the video "Growing our own Fertility and Fuel". This had been commissioned by BEASL and provides a clear presentation of the role of biomass in the energy balance in the country and the multiple benefits for farmers growing a leguminous tree crop such as *Gliricidia*.

Following the showing of the video, Mr Jayasinghe, called on **Mr Michael Warnakulasooriya**, Chairman of the Energy Conservation Fund, to outline key aspects of the formulation of national policy in terms of energy and social-economic development.

Mr Warnakulasooiya stated that policy formulation efforts targeting renewable energy development had been attempted previously with limited success. Even with the strong possibility to link socio-economic development with energy, a supportive policy framework is yet to be realized. In 1997 an energy policy was developed which focused on the development of indigenous resources and had a heavy bias towards biomass energy.

In the latest energy policy, which is still in a draft stage; issues such as energy security at the national level as well as at the individual level are addressed. A diversified energy resource base has been identified as the path towards gaining energy security. The role played by indigenous energy resources in gaining strategic independence is also recognized, whilst appreciating the environmental concerns of operating energy systems.

Stemming from the budget speech of 2004, an initiative to afford special treatment to biomass energy was taken by the Ministry of Power & Energy, culminating with the appointment of an Inter Ministerial Working Committee (IMWC) to draw up an action plan to develop biomass-based electricity generation to a much larger scale.

The committee has identified several important differences between biomass energy and other renewables. Most important features of biomass energy are: the ability for it to involve large numbers of rural people in both the supply and demand sides; and the ability for biomass to store energy and at the same time provide positive environmental characteristics.

The committee identified three issues which can be resolved by developing biomass energy in a mass scale.

(a) energy security
(b) access to energy
(c) lack of purchasing power by a segment of people

An extremely polarized distribution of economic growth between poorest and the richest segments of the country during the last two decades has been identified as a serious issue which can be addressed directly through establishing energy links between urban load centres and rural supply bases.

Grid connected power generation has been identified as the catalyst. Several policy measures and an attractive incentive package were proposed for the first 50 MW of capacity developed by the pioneering entrepreneurs. It is argued that this development could help to break the vicious cycle of poverty, due to the promotion of a steady market for at least one agricultural output which has the ability to sustain a sizable rural population..

Main features of the policy recommendations are as follows.

- Set firm Renewable Energy targets and devise strategies for these to be achieved;
- Elevate fuel-wood farming to a national industrial plantation level;
- Establish a firm regulatory regime to ensure a fair deal to all stakeholders;
- Establish an apex body to develop Renewable Energy;
- Establish an expeditious land allocation mechanism;
- Create a development fund;
- Offer a two tier tariff of Rs.8.50/KWh initially and Rs.7.00/KWh after 7 years for biomass power plants.

Following this presentation, **Mr Jaysinghe** offered a vote of thanks to all the attendees and especially the honoured guests. He expressed the hope that it had set the scene for those participants from outside the country This marked the end of the inaugural session and the meeting was closed for the lunch break, which in turn would be followed by the commencement of the main technical sessions.

MONDAY PM - COMMENCEMENT OF THE TECHNICAL SESSIONS

Technical Session 1 - Energy Strategy and the Role of Renewables

Chairman for the first session – Mr T.M. Abell (NRI). Mr Abell welcomed the participants to the commencement of the main part of the conference and outlined the programme. He indicated that due to the number of presentations, strict control by the Chairmen for each session would be needed to ensure that that the programme does not over-run.

European Renewable Energy Policy and opportunities provided by the CDM.
Part 1 – EU Renewable Energy Policies.
Professor Giovanni Riva of Comitato Termotecnico Italiano (CTI).

This paper is the first half of a combined paper dealing with the development of energy policy, and technology within the EU and linkages to the CDM. The second half of the paper was covered in Technical Session 3.

Dr Riva outlined the actual and projected levels of energy within the EU-15. In 2000 this was of the order of 60.8 EJ and is expected to increase to 69.4 in 2020 and to 72.0 by 2030. Current level of renewable energy is 3.7 EJ of which biomass is about one-third. The level of renewable energy is expected to almost double by 2030. Current EU directives want to see overall renewable electricity equating to 22% of total generation by 2010, but there is a wide range of actual and projected targets for member states with respect to the proportion of electricity coming from renewable resources, with Austria having a target of 80% and Belgium less than 5%. Cost of production of bio-mass derived energy compared to traditional approaches is the main concern and direct support measures are being applied. Countries can either adopt measures to support the supply side: feed-in tariffs, bidding systems; or measures that support the demand side – quota obligations or green certificates. For example Austria is currently paying a biomass incentive of € cents 10.2-16.0 /KWh, France has a standard rate of €cents 4.9 and a premium rate of 6.0/KWh. In the United Kingdom, a green certificate system is applied where non- compliance power producers (i.e. not meeting a minimum figure for their total production to come from renewable sources) have to buy certificates at a current price of €cents 4.5/KWh. Dr Riva draw attention to the need for some standardisation over the different fuels. There is a wide range in the intrinsic properties of wood pellets c.f. logs for example. Internal trading of biomass fuels within the EU has been growing and reached 1 Mtoe in 2004.

On the growing side, the EC is promoting the planting of energy crops through a € 45/ha grant. A limit of 1.5 million ha has currently been set; but in 2004, the first year of application, the total was only around 300,000 ha, with France taking the lead with some 129,000 ha planted within its own borders. Dr Riva outlined some of the other measures that are applied to support tree farming.

In his presentation, Dr Riva provided examples of recent incentives being taken in Germany and the Walloon Region of Belgium for the promotion of renewable energy. In Germany major revisions were made to the feed-in tariffs paid for biomass-derived electricity with an innovative approach where the tariffs vary in accordance to the generation costs of the units. In Belgium, the Green Certification approach has been used with the unit being linked to the amount of carbon dioxide avoided (1 GC =456 kg of CO_2 avoided).

He concluded that from the viewpoint of Sri Lanka and the South Asia region it was necessary to: -

- To study the different pricing mechanisms for biomass electricity and see if some revaluation is required.
- Re-examine the legislation and regulations that can favour a correct utilisation of biomass.
- Increase the average size for the installed power of new units being commissioned (>10 MWe) to take advantage of the greater efficiencies of larger units
- Improve the general understanding of the benefits of such interventions as industrial co-generation and off-grid village power schemes.

Following some clarification of the points made by Dr Riva concerning the level of support provided by the EC, the Chairman called on the next speaker, Dr Deias from the Italian Region of Lombardia to outline some of the support measures that the region has been making to develop biomass energy as an effective component to the total energy supply.

Renewable Energy in the Lombardia Region of Italy

Dr A. Deias, Dr G. Boccasile,
Agro-environmental Policy Board of Lombardia Region - Agricultural Department

Dr Boccasile explained that Lombardia is one of the most important and advanced regions of Italy. It is known world wide because of its industry. The Region falls under the authority of the Lombardia Regional Council based in Milan. Its activities, both in the industry and services sectors, are characterized by companies of significance at a European scale. Due to economic social and institutional importance Lombardia has significant weight in Italy, demonstrated by the presence in all the programmes conducted at national level..

The Region is implementing several programs according to a Master Plan for the use of Renewable Energy Sources and Energy Saving measures linked to European, National and Regional directives. The Lombardia Region (Agro-environmental Policy Board of Lombardia Region - Agricultural Department) has relevant dedicated cooperation agreements with the Ministry of Environment.

The Region is promoting sustainability at a local level as part of a policy to activate sustainable energy use and generation in the Rural Communities. It is also looking for reduction of Green House Gas (GHG) emissions in the transport sector. So far, three Combined Heat and Power (CHP) biomass plants and one district heating system are operating and five further plants are under construction. A total of 5,000 hectares are grown under short-rotation coppice (SRC) techniques, with the emphasis being on the use of poplar. Three biogas plants in rural areas have been constructed and a further 27 are under construction. Wood gasification is in the feasibility stage.

Dr Boccasile outlined that intensive mechanical cultivation and harvesting systems used for poplar in order to minimise labour costs. The maximum production from the poplar was around 25 odt/year and growers are provided with an establishment grant of €700/ha, on the basis that the crop is retained for at least 15 years.

Following Dr Boccasile's presentation there was discussion on the costs of production of both wood and operation of the biomass power units and the overall importance of labour costs in the final cost of electricity. Within the European environment, the cost of labour is a critical component and hence *the high priority given to mechanisation in the establishment and harvesting of SRC. In order to provide the perspective from the South Asia region, the Chairman called on Dr Kishore of The Energy and Resources Institute of India (TERI) to provide a synopsis of his paper "Renewable Energy and the development of dendro- power in India and South Asia"*

Renewable Energy and the development of dendro power in India and S Asia

VVN Kishore and P Raman,
The Energy and Resources Institute of India (TERI)

Concerns such as energy security, the widening gap between supply and demand for electricity and high prices of imported oil have been driving several developing countries to search for renewable energy solutions. In India, a Commission for Additional Sources of Energy (CASE) had been formed in 1981. The Department of Non-conventional Energy (DNES) was subsequently formed in the Ministry of Power, in 1982, with biogas as the main programme component. An independent Ministry of Non-conventional Energy Sources (MNES) was created in 1992. The MNES has made very serious attempts to promote power from renewable energy. The main thrust so far has been towards the expansion of wind power, bagasse co-generation, biomass power and power from waste. Recently, programmes such as the Village Energy Security Program (VESP) and the Remote Village Electrification programme (RVE) have been launched to address the issue of energy access to some 18,000 remote villages. Photovoltaic systems, micro-hydro plants and biomass gasifier systems are considered as promising technology options. Both capital subsidies and soft loans are being offered as promotional incentives. Bagasse co-generation, biomass power and biomass gasifier-based systems can together be classified as dendro- power.

The combined potential for renewable energy has been estimated at 82,000 MW for India excluding solar power of which 16,000 MW is represented by biomass (current installation is less that 300 MW). Dr Kishore indicated the problems in getting accurate figures on the amount of waste land that could be used for energy plantations, however based on individual state figures it could be as high as 93 million ha.

He indicated that there is a growing interest in tree farming in India, as more farmers become dispirited with the low process paid for food crops. Figures suggest that the cost of wood production averages \$23/tonne with an IRR >20%. This costing needs to be compared to that for coal which is in the range of \$40-75/tonne. Even allowing for the better calorific value of coal, wood could still prove to be a more economic option. He indicated that taking the cost of landed coal to be \$44/tonne, the cost of power production would equate to Indian Rp 2.95/KWh. However taking account of transmission losses, the cost to the consumer would be Rp 4.54/KWh. He therefore suggested that there should be a note of caution by the Government of Sri Lanka when assuming that a coal-powered plant will be a cheaper option for the consumer.

Dr Kishore noted that the barriers facing the expansion of bio-energy in India were not from limits in the existing technology or in the techniques for growing energy plantations; the main barriers seemed to relate to: inadequate access for developers to finance to promote the setting up of small decentralised power units together with the overall lack of a clear and consistent policy in the promotion of the different types of renewable energy. He noted that there needs to be clearer thinking on the levels of subsidies and state-level support that should be targeted on the renewable energy sector and at the same time better direction on defining the extent that each technology should be allowed to develop. The same area of wasteland seems to be targeted to develop wind farms, biomass plantations, *Jatropha* cultivation etc. and no clear guidelines exist for apportioning the available land for specific projects. There are too many official clearances required for setting up projects, subsidies are re-introduced where market growth seems to be happening and are not required; subsidies are provided for unproven/untested/under-tested products and in general there is little spirit of public-private partnership. He argued that it thus seems paramount that platforms should be established at different levels to promote dialogue amongst such bodies as energy consumers, entrepreneurs, government agencies for promoting renewable energy development in an organised way.

The Chairman took some questions before the coffee break. There was discussion from the floor on the differences between Europe and India/Sri Lanka in terms of the extent of research inputs and the level of support for the sector. It was pointed out by Dr Kishore that within India, agriculture is becoming more and more unprofitable and farmers are searching for ways to change their livelihoods. The development of energy plantations and bio-fuel could be one viable alternative to growing food crops if the level of government subsidies and support is set at the right level.

For the next Session, the Chairman was Mr M Warnakulasoosriya. He introduced the next speaker Mr Tara Nath Bhattarai from Nepal who would outline some of the energy strategies being followed by the Nepali Government.

Renewable Energy Development Strategies and Solid Biomass Fuels in Nepal

Tara Nath Bhattarai
Institute of Engineering, Tribhuban University, Kathmandu
(Formerly with the FAO Regional Wood Energy Development Project)

Three energy sources, namely traditional, commercial and alternative sources, contributed 87.4%, 12% and 0.4% respectively, in total primary energy supply in fiscal year 2002-03 in Nepal. Hydropower, although a renewable source, has been classified under commercial energy together with the petroleum fuels and coal. All other renewable sources such as biogas, solar and wind power including micro-hydropower have been put under a common classification "Alternative Energy Technology". This classification system could mislead people with the false notion that electricity generated through large- and medium-size hydropower plants should not be classified as renewable energy. Out of the traditional sources, fuel wood alone contributed as much as 77.9% share in total primary energy consumption, followed by animal dung 5.7% and agricultural residues (crop harvesting and processing residues) 3.8%. The share of petroleum products, electricity and coal was 8.9%, 1.6% and 1.6%, respectively.

Mr Bhattarai explained that as much as 84.5% of the energy was consumed in the residential sector and over 90% of it was contributed by traditional biomass fuels. The transport sector, although a major consumer of the imported petroleum fuels, its share in total energy consumption was still small at 3.7%. The industry and commercial sectors consumed 3.0% and 1.1%, respectively and consumed both commercial and traditional energy. The agriculture sector consumed very little energy (about 0.8%), only for running the irrigation systems.

He suggested that the current energy consumption and supply mix by sectors and end uses in Nepal could be treated as a typical case for all least developed countries in Asia. Energy demands have been mostly from the residential sector, for meeting the cooking and space heating energy needs, and most of it has been met from traditional biomass energy.

However, this on-the-ground reality has not been fully considered during energy planning and resource allocation for development in the energy sector. The current investment priority in the energy sector has been for the development of large- and medium-size hydropower plants, even if the total contribution of this sub-sector in energy supply has been less than 2%. Besides, management of the petroleum fuel and coal import and distribution in the public sector has become a big burden to the national economy, from both financing of the import as well as balancing of the foreign exchange reserve point of views. With 9% share in total primary energy supply this sub-sector already consumes over 40% of the hard earned foreign currency for the import of commercial fuels.

Mr Bhattarai stated that after endorsement of the importance for promoting and developing renewable energy technology (RET) in Nepal in the Perspective Energy Plan for Nepal (PEPN) 1995, a separate agency called Alternative Energy Promotion Centre (AEPC) was established in 1996, for coordinating the activities of RETs development from the central level. But so far, even after the establishment of the AEPC, there has not been a sole agency responsible for overall coordination of energy development in the country. The task is divided between various ministries according to their sector specific mandates and jurisdictions. Energy supply management may or may not be included in their sector specific mandate. Among the important ones, the Ministry of Water Resources is responsible for large- and medium- size hydropower development; the Ministry of Commerce and Supplies for importation and distribution of petroleum fuels and coal; the Ministry of Forests and Soil Conservation for the management of woodfuel supply sources; and the Ministry of Science and technology for coordinating the activities of RETs promotion and development. Although residues of crops and animals also contributed significantly to primary energy supply in the country, the concerned ministry -Ministry of Agriculture - has so far no direct role in the management of residues for energy.

Recently, RETs promotion has been given greater encouragement with subsidies being developed for a range of operating scales. Subsidy seems to be desirable during the initial phase of new technology promotion and demonstration, in order to motivate rural people for their participation. Currently, different donor assisted projects and programmes have been generous in taking over the additional costs of new technology adoption by providing subsidies under different alternative energy promotion schemes. But questions will need to be raised about the long-term effectiveness and feasibility of such schemes without any future subsidies

The only visible component that has been included under AEPC activities in the bio-energy sub-sector has been Improved Cooking Stove (ICS) development and dissemination. Considering the size of population that depend currently on fuelwood for energy, and the target of ICS installation under ongoing AEPC assisted projects or programmes, there seems to be further scope for improvement in biomass fuel combustion technology, for promoting biomass briquetting, charcoal making, and gasification technologies.

There followed some comments from the floor regarding the fact that donor-funded projects tended to concentrate on issues related to food security. In doing so there is a tendency to forget that cooked food is required and not enough attention is paid to the need for improved access to affordable energy. There was some comment that these key issues are perhaps neglected as a consequence of the lack of female representation in such fora and planning teams. The Chairman then called on the next speaker Sorawit Nunt-Jaruwong from Thailand to describe the key points from his paper dealing with the renewable energy policy in his country.

Thailand Renewable Energy Policy - The Potential for Electricity from Dendro-power

Sorawit Nunt-Jaruwong
Department of Alternative Energy Development and Efficiency, Bangkok, Thailand

The author noted that the Royal Thai Government has declared the objective to increase the level of renewable energy utilisation from a level of just 0.5% at present, to a figure of 8%, (approximately 6,600 KToe), by the year 2011. In reaching this target for renewable energy, biomass-based energy is expected to provide a share in excess of 60%, reflecting the fact that Thailand is a country highly dependent on the agricultural sector and hence has access to large amounts of waste agricultural material. The other sources of renewable energy are expected to be biogas, wind, municipal waste, mini-hydropower, solar power as well as bio-fuel energies. Currently, Thailand depends substantially on imported crude oil this amounted to $10.7 billion in 2004 representing 6.5% of the GDP.

In order to achieve the 8% goal, the government is encouraging the power generating sector to produce some 1,900 MW from renewable sources. Independent Power Producers (IPPs) are required to adhere to the Renewable Portfolio Standard (RPS), which has been introduced to accelerate renewable energy utilization. Under this standard, power producers that wish to sell power to the Electricity Generating Authority of Thailand must produce 5% of their installed energy generating capacity from renewable sources.

Since Thailand is an agricultural country, the sustained development of biomass in the country can definitely reduce fuel consumption as well as improve the stability of the electricity supply. Agricultural residues, such as bagasse and palm fibre have been used as energy sources in the co-generation plants. However, expected improvements in the efficiency of operation of these plants will also ensure greater heat output and improved electricity levels.

Biomass represents significant energy generating potential. Such production is particularly appropriate for businesses which have access to a regular supply of agricultural products, such as United Power Generation Co.'s planned biomass project in Nakon Ratchasima province to be fuelled by wood from a reforestation site. Thailand has an installed biomass electricity capacity of about 670 MW, with sale to the grid of 246 MW. The Energy for Environment Foundation has estimated that the nation has potential to generate an additional 1,400 MW, for a total potential of approximately 2,000 MW. The same source has indicated that Thailand's installed biogas systems generate approximately 20 MW of power, with an estimated total generating potential of 278 MW.

Under a programme of cooperation with the British Government, a feasibility study on the development of a dendro-thermal project was carried out in North-east Thailand. A bubbling fluidized bed boiler and condensing steam turbine were adapted in this project to generate 8 MW electricity. Currently the project is still at the planning stage and implementation of this project is awaited.

There followed discussion on the level of financial support for farmers growing biomass crops and interest in the bio-fuel crop Jatropha. It would seem that yields had been poor and there is an insufficient return for farmers. In Cambodia, results have been more positive for this crop and this will be described in a later paper.

Questions were raised on the level of importance of rice husks as a source of agricultural waste that is used for power production. The speaker said that this material has become a favoured source of energy and commands prices of Bhat 200-800/tonne ($5-20/tonne).

The Chairman then called upon the last speaker of the day – Dr Rajkumar of the Institute for Renewable Energy Development Authority of India to tell the meeting something on the issue of funding renewable energy in India.

Funding renewable energy programmes in India
Dr Rajkumar, Indian Renewable Energy Development Agency Ltd. (IREDA), India

Dr Rajkumar outlined the problems facing the country with the explosion in the level of energy demand. The country is very dependent on fossil fuels much of which has to be imported with the exception of low-quality coal. The Ministry of Non-Conventional Energy Sources (MNES) has been implementing a comprehensive programme for the development of renewables. Estimates have put the potential for grid-connected renewable energy as high as 80,000 MW; however only 6,000 MW has so far been developed. The renewable energy power generation capacity presently constitutes 5% of the total installed capacity in the country; the national target for 2012 is to raise this proportion to 10%.

IREDA was incorporated as a Public Limited Government Company in 1987 under MNES with the following objectives: -

- To operate a revolving fund for the development and deployment of new and renewable sources of energy

- To give financial support to specific projects and schemes for generating electricity and /or energy through new and renewable sources and conserving energy through energy efficiency.

The country is thought to be producing 400 million tonnes of agricultural waste every year and the estimated potential for power generation through biomass is around 19,500 MW of which 3,500 MW would be represented by co-generation in sugar industries. In terms of biomass power generation, IREDA has provided support to 38 projects with an installed capacity of 239 MW. For co-generation projects, 35 projects have been supported with an installed capacity of 461 MW.

Fiscal incentives are provided by both Central government and some State Governments in terms of tax holidays. IREDA is currently providing loans at 11% interest rate for biomass co-generation projects and 10.5% for biomass power projects. The repayment period is set at 10 years plus a three year grace period. For both types of project the maximum loan equates to 70% of the total project cost. For biomass power projects, the generating capacity need to be between 1.0 -7.5 MW in order to qualify.

A question was raised on the success of the investments made to date and the level of repayment. This was reported to be good. There was a further question related to the issues and concerns facing this type of development. Dr Rajkumar indicated that many of the technologies being put forward are not fully tested and there is insufficient knowledge concerning the minimum economic size of installations. He also noted that there are concerns over the estimates used regarding the extent of biomass resource; there is a perception in IREDA that many of these figures are very rough estimates.

This presentation completed the programme for the first day and also concluded the first Technical Session. The meeting was closed at around 6 pm.

End of Technical Session 1

DAY 2 TUESDAY 16TH AUGUST

Technical Session 2 – The Technology of Dendro-power and Fuel Production

The Chairman for the start of this second session was Dr Kishore. He welcomed participants to the start of the second day and to the new session which would focus on the engineering and technical aspects of using biomass as source of energy. He then called on the first speaker, Mr Alec Hollingdale from the Natural Resources Institute to start the session with a review of his paper looking at recent developments in Europe and how they might be utilised within the South Asia region.

Recent advances in biomass energy technology in Europe and applications for South Asia.
Alec Hollingdale, NRI Associate

Mr Hollingdale summarised some of the options available dependent on the size of the operation: -

Power 100kW

- Steam engine
- Small scale gasification with an internal combustion (IC) engine
- Pyrolysis with an IC engine
- Indirectly fired gas turbine (under development)
- Fuel substitution using biodiesel and ethanol
- Stirling engine

In this size range he considers that the best choice would be with the small gasifier linked to the IC engine. Recent developments with the Stirling engine however make this one alternative to watch. - Stirling engine systems have been the subject of some impressive development work over the past 5-10 years by the Danish Technical University in association with Bios Energiesysteme GMBH, Austria. This has resulted in trial operation of a 35KW power output system for over 7,000 hours. Also a pilot plant with a 75 KWe Stirling engine has been put into operation in autumn 2003 and has been operated for more than 2,000 hours .

2MW

- Steam turbine
- Updraft gasifier with IC engine
- Organic Rankine Cycle

In this size group, the updraft gasifier linked to the IC engine is currently the best option. An economic analysis of these systems at 2MW concluded that the price of electricity generated by the steam boiler/steam turbine and updraft gasifier/ IC engine systems is similar. The steam technology is well established with little scope for cost reduction and process improvement. Gasifier power systems using fixed bed updraft gasifier technology were selected as they have more potential for improvement, particularly in terms of capital cost and efficiency

>2 MW

- Steam boilers linked to steam turbines
- Gasifiers lined to gas turbines

As size increases a more advanced combustion gasifier technology is appropriate and fluid bed systems are utilised for systems over 5MW. Any choice of biomass fuelled power plant will depend upon the scale of operation and the feedstock characteristics. Information on the COGEN3 website that is to be retained until 2006 is a useful information resource for European equipment with examples of demonstration projects.

The following table was presented from the paper which provides an overview of the capacity and efficiency of different biomass power systems.

Typical capacity/efficiency/resource data for biomass power systems

System	**Power kW***	**Energy efficiency %**	**Biomass dm tonnes/yr ** **	**Comments**
Small down draft gasifier/IC engine	10	15	74	High operation & maintenance, and/or low availability, low cost
Large down draft gasifier/IC engine	100	25	442	High operation & maintenance, and/or low availability, low cost
Stirling Engine	35	20	177	Potential good availability, under development, high cost
Steam Engine	100	6	1840	Good reliability, high cost
Indirect-fired gas turbine	200	20	1104	Not available commercially
Pyrolysis/IC engine	300	28	1183	Under development
Rankine Organic Cycle	1000	18	6133	Commercial
Updraft gasifier/IC engine	2000	28	7886	Commercial
Fixed grate or fluid bed boiler/steam turbine	2000	18	12270	Commercial
Fluid bed (BIG/CC) – dedicated biomass	8,000 +	28	29710	Demonstrated
Fluid bed gasifier - co-fired	10,000+	35	31500	Commercial

Notes

* Indicative of range for application

** Assumes: availability at 70%, fuel net calorific value 20 MJ/kg

There was some discussion on the benefits of co-firing of coal-based plants. This perhaps has particular relevance for Sri Lanka as the country considers expansion of their power resource on the basis of a coal-fired unit. Earlier trials in Europe had given inconclusive evidence about the impact on ash formation, in-plant depositions, etc. and also there was a general reluctance from the power generators to go in this direction since it created additional operational problems. However the attraction of this approach was that it gives high conversion efficiency at around 35% through benefiting from the use of advanced high pressure steam turbine technology in these stations. However in UK, for example, there had been little financial incentive until the introduction of

Renewable Obligations Certificates (ROCs). With this and other such schemes the use of wood became financially attractive and power generating companies became serious about trials and the commissioning of co-firing. Mr Hollingdale noted that one of the longest running schemes for biomass co-firing is the Lahti, Finland CHP plant which is rated for outputs of 216 MW electricity and 240 MW heat. Standard fuelling is a mixture of gas and coal-fired, but locally available bio fuels and refuse fuels substitute about 15% of the fossil fuels burned in the main boiler,

Mr Hollingdale outlined the fact that when making comparisons between Europe and S.Asia in the applications of biomass energy technology, we need to recognise that there are key differences in terms of appropriate policy, engineering infrastructure, social and historical background and general economy. In many respects there are influences favouring the use of biomass in S.Asia due to, amongst other things: high existing levels of biomass use for energy, existence of traditional plantation industries, relatively low labour charges, lack of fossil fuel resources and a need to minimize trade balance, etc.

He suggested that any technology that may be proposed for conversion of biomass to energy will need to show high availability, moderate cost and efficient use of biomass. Energy efficiency in existing systems needs continuing attention.

There was some discussion concerning the development of the Stirling engine and its potential role. Mr Hollingdale indicated that they have the potential for good conversion efficiency and can be used in small-scale CHP applications Current costs per unit are high, but with an expected modest manufacturing run of moderate sized units, unit price will become more competitive. The Chairman then called on the next speaker Mr Trevor Abell also from the Natural Resources Institute to present his paper dealing with forestry and biomass production.

Forestry and Biomass Production. Lessons from the Temperate Regions and the Tropics
T.M. Abell, Natural Resources Institute (UK)

Mr Abell initially referred to the driving forces for the expansion of the use of biomass energy within Europe. This comes from the overall target of achieving 12% of energy consumption from renewable resources by 2010 and for the linked target of electricity production to be 22% dependent on renewable resources by the same year. The target for biomass-derived energy is 135 Mtoe for 2010. Each country has it own way of providing financial support to tree growers and financial restrictions to power producers that do not use an adequate amount of renewable material in their overall energy production. In the UK the driving force on the power producers comes from the use of Renewable Obligation Certificates (ROCs). Power producers have the choice of either meeting the commitment or purchasing ROCs at a current rate of €45/MWh. At the same time farmers turning to energy plantations can get financial support which amounts to about half the cost of establishment.

SRC in Europe has been dominated by species of willow and poplar though other species such as chestnut and Eucalypts have also been used. There has also been a growing interest in the *Miscanthus*, a fast growing grass with growth characteristics like the tropical elephant grass with yields in the range of 12-20 odt/ha. Establishment and harvesting of all biomass crops is inevitably highly mechanised and for willow and poplar reliant on the use of vegetative propagation. At present, in much of Europe, short rotation forestry is still at the experimental stage or early pilot stage. In Sweden, however, developments are more advanced and the area under this type of management is in excess of 15,000 ha, moreover there are plans to increase this to 30,000 ha by 2010 and in the medium-long term to see this increased to 200,000 ha plus. Planting of SRC crops initially took-off in the mid 1990s in Sweden when the income from growing cereals was low and there were good financial incentives from the EU to grow willow. Later however, some of the incentives were removed as a reaction to there being too great an area under the Set Aside programme and consequently many farmers pulled out of the industry. Austria claims several thousands of hectares of energy poplar; and many experimental plantations have been established in Germany. *Robinia* is being planted in Italy by Regional Management Agencies, who are keeping an eye on poplar and eucalyptus as potential species groups. Austria in particular has been extremely successful in its approach to efficient use of biomass and indeed in its overall use of renewable energy. In 2002, the share of renewable energy was 23%, of which half is from biomass and the other half from hydro power. A large market for wood pellets and an effective distribution system has developed using waste wood and sawdust products as the resource for the pellets. Many householders are now regularly using wood pellets for home heating.

In the USA, the development of SRC has been slow to take off, with poplar planting concentrated along the Pacific NW coast. In Hawaii there have however been extensive trials by the Bioenergy Development Corporation with good results using *Eucalyptus saligna, E. grandis* and *Albizia falcataria.*

The Philippines is one country that appreciated early on the potential of dendro-power and embarked on a large scale plantation programme in the 1980s based on *Leucaena leucocephalla*. Unfortunately the programme was not a success, due to poor planning with respect to species and site selection and insufficient attention to the practical problems of moving the harvested material to the power plants. Brazil has been active in the use of wood for energy with a concentration on the use of Eucalypts.

Reference was made to the use of energy crops in Australia and New Zealand. Here most of the emphasis is on the use of waste material from regular timber plantations rather than special planting for SRC. Development in Australia has been constrained by the restriction of any financial support for plantations grown specifically for energy. Renewable Energy Certificates are not eligible for crops specifically grown for energy; such material should be from waste material that would be deemed unacceptable for other uses.

In Asia and Africa there has been a strong focus on the development of farm forestry and agroforestry systems, energy crops are grown alongside food crops or livestock production areas. Species used for this type of management are often multi-purpose, coppice easily and often nitrogen-fixing. A few examples that can be given also include *Leucaena leucocephalla* along with *Prosopis species, Calliandra calothyrsus, Azadirachta indica, Cassia siamea, Sesbania sesban. Gliricidia sepium, Albizia lebbeck, Acacia spp and Tamarindus indica.*

In terms of future developments, Mr Abell considered that it would be necessary to take greater advantage of tree breeding programmes and micro-propagation techniques including the use of GM technology. It was also considered that there needed to be a better integration of biomass –energy processes/products (wood coppice, straw, woody grasses, bio-diesel, bio-fuels etc) so that the right product(s) are being developed for each site and that there is overall a greater integration between the power producers and biomass growers in order to maximise production efficiency.

There followed some discussion on the levels of production that could be expected from each site and reference was made to following table:-

Product	**Yield M3/ha**	**Yield Tonnes/ha/an**	**Initial Crop Density Stems/ha**
Temperate – SRC Willow/poplar	20-50	8-20	10-20,000
Temperate timber regime	8-15	3-5	1,000- 2,500

Tropical SRC	50 – 80	20-35	10,000 -20,000
Tropical timber –pine	10-20	4 – 8	1,000 – 1,500
Tropical timber – Eucalypts, Acacia	12-60	5 – 25	850- 1,500

Following the presentation there was some discussion on the extent of planting in Scandinavia and the fact that Finland and Sweden have been active in this field. Mr Abell agreed that although reference had been made to Swedish development in the paper, greater attention should perhaps be given to the considerable activity that there has been in this part of Europe. Dr Kishore commented that one useful outcome would be to derive a set of acceptable figures for productivity of plantation. He felt there was a tendency for the production figures to be exaggerated and not relate to average on-farm conditions.

It was confirmed in discussion that the policy in Australia to preclude SRC from ROCs has been a serious constraint to development of farm forestry geared to energy.

The Chairman then called on the next speaker, Dr Gunathilaka of the Coconut Development Board to outline the paper prepared in part by himself in co-operation with other colleagues.

Biomass Production in Sri Lanka and Possibilities for Agro-Forestry Intervention

Dr. H.A.J. Gunathilaka -*Coconut Research Institute (CRI)*,
Dr. T.S.G.Peris - *CRI*, P.G. Joseph - Ministry of Science & Technology and Harsha Wickremasinghe- *Energy Conservation Fund*

Dr Gunathilaka summarised the findings of a research project that was carried out over a period of five years commencing in 1998 on Sustainable Supply of fuel wood to meet Sri Lanka's energy needs by four institutions, jointly by the Ministry of Science and Technology, Natural Resources Institute of the University of Greenwich, U.K., Department of Forestry, Coconut Research Institute (CRI) and the Land Use Policy Planning Division. The project had the two short term objectives.

1. To demonstrate the technical feasibility of short-rotation fuel wood plantations, particularly on degraded lands, as sources of energy for Sri Lanka and
2. Enhance institutional capacity in Sri Lanka in the knowledge of fuel wood as a source of energy.

The project set out to determine, the growth and performance for well known fuelwood species using a range of spacings and different harvesting techniques. Although overall some 14 species were included, the emphasis was placed on the key species of *Gliricidia sepium, Acacia auriculiformis* and *Leucaena leucocephala*. A split-plot design was adopted for the plantation trials to provide replications of species, spacing and harvesting regimes. The interventions for establishment were envisaged to be three species (as above) two spacings, (S1:1m x 2m and S2:1m x 1m) and two harvesting regimes (H1:annual coppicing roughly at a height of 1m and H2:continuous harvesting-removing branch materials as it reached a base diameter of 25mm , cutting at a height above 1.5m on the main stem)

The results on the growth and yield were compared with the similar trials performed under coconut at the CRI. Both *Gliricidia* and *Acacia* performed well in a wide range of sites over *Leucaena*. However, *Gliricidia* was the best in many locations due to high wood yield, high rate of leaf decomposition, tolerance to frequent harvesting, less mortality, easy establishment with sticks, easy handling due to appropriate size of branching and multiple use (e.g. feeding for cattle etc).

Comparing the two espacements; planting *Gliricidia* at 1m x 1m (10,000 trees/ha) appeared to be preferable to 1 x 2 m spacing (5,000/ha). Planting at the closer espacement led to an expected improvement in the suppression of weeds in the initial years of establishment together with the development of straighter shoots. However where the tree crop is being grown as a pure crop at the close espacement and not in combination with an overstorey of coconut, then for ease of harvesting a gap of 4m is required for every 12 rows of trees. This leads to an effective density of 5,625 trees per hectare.

Considering the two harvesting regimes tested, annual cropping (cutting of all branches at the same time) at a height of 1m produced the highest yield in the long run. Trials in many locations together with the demonstration areas at CRI suggested that a harvesting interval of eight months could be adopted to optimise leaf and wood yield particularly from *Gliricidia.*

In terms of energy production, wood yield is of course the most important concern. A mean wood yield of 24.0 metric tonne per ha (at 20% moisture level) was obtained from *Gliricidia* in additional to a foliage yield of 24.0 metric tonne per ha (fresh weight basis). At the third year after planting, *Gliricidia* was able to demonstrate a positive cash flow and by the fifth year, *Gliricidia* inter-cropped with coconut generated Rs. 35,400 per year as net profit.

Parallel studies conducted at the CRI (in the two locations of Pallama and Rathmalagara) showed that inter-cultivation of *Gliricidia* within coconut improved the micro climate i.e. there was a reduction of soil temperature coupled with an improvement in soil moisture compared to a pure crop of coconut. Considering the issue of soil fertility, the nutrition of coconut palms was increased by its association with *Gliricidia* especially with respect to nitrogen. With the exception of Potassium, other plant nutrients such as P, Ca and Mg levels were also improved as a result of the inter-cropping. The deep root system of *Gliricidia* appears to have the effect of mining nutrients from the deeper soil layers to and returning them to the upper layers through the process of pruning and decomposition of the foliage.

Assessment of the real economic value of *Gliricidia* cultivation requires further extensive study. Fuelwood generates additional income through the generation of power and energy, but additional benefits and income are possible through the silvi-pastoral systems where the foliage is used to supplement cattle feed. Such an integrated system generates milk, compost for farming and the generation of bio-gas. Based on present market values, this system has the potential to generate over Rs.220,000 per ha/year.

Based on the impressive results of the trials, two demonstration facilities to convert fuelwood into heat and electricity were established by the Ministry of Science and Technology. These demonstration units have resulted in the encouragement of many farmers taking up fuelwood.

The Government of Sri Lanka has taken the following steps to promote the growing and utilization of fuelwood:

- An Inter Ministerial Working Committee was established to identify the issues to be addressed to promote the growing and utilization biomass fuels. This Committee has submitted its final report. The Government is in the process of implementing the recommendations of this committee.

- The Ministry of plantation Industries has decided to support and promote fuelwood crops by including *Gliricidia* as the fourth major plantation crop under the ministry.
- The Coconut Cultivation Board has decided to give a subsidy of Rs.7,500 per ha for inter-planting *Gliricidia* in coconut lands.
- Further, the Coconut Development Authority has initiated action to support the use of SRC wood as a fuel for the desiccated coconut industry.

Following the presentation of the main results of the trial, there were questions and discussion on the extent of coconut cultivation in the country, the levels of production of both coconut and Gliricidia and the level of income for the farmers. It was noted that currently there are some 440,000 ha of land under coconut cultivation in the country. Local farmers and workers are paid Rp1/kg at the Coconut Research Institute for the collection of fuelwood which is currently being sold on to Haycarb. This company has been paying Rp2/kg at the factory gate for partially dried material (20%). The level of interest at these rates has been very high and farmers are able to make a marked addition to their income with production levels of 10-20 tonnes/ha for close planted material. However to date most of the collection is coming from mature hedges rather than well managed fuelwood plantations specifically planted for the purpose. In terms of additional benefit of Gliricidia, figures were presented on the savings in the use of fertiliser by incorporating green leaves from the Gliricidia into the root system of coconut palms equating to some Rp35,000/ha

There then followed a break for coffee

The chairman for the next session was Prof Priyantha Wijetunga who called on the next speaker Mr L.P.Jayasinghe of BEASL to outline the successes and constraints facing the development of biomass energy in the country

The Biomass Energy Sector In Sri Lanka - Successes & Constraints
L P Jayasinghe, President, Bio Energy Association of Sri Lanka

Traditional biomass accounts for nearly 52% of the primary energy supplied in Sri Lanka. Nearly 76% of the population still depend on fuel wood and other forms of biomass for their household cooking. Mr Jayasinghe stated that in his paper he was able to note the welcome change in perception of the importance of the use of wood as an industrial source of energy. The sharp rise in the price of imported fossil fuels is acting as an incentive for more industrialists and entrepreneurs to view biomass is an entirely different light. The other significant event has been the introduction of manufacture of Medium Density Fibre Board. This industry has led to a welcome expansion of the market for large quantities of wood, making use of what was formerly regarded as waste. Thus even those industries which were using fuel wood are being forced to look for alternatives as the means of reducing their consumption.

Several initiatives have led to gasifiers being manufactured and used within Sri Lanka. The first dendro-power plant of capacity 1.0 MW is already connected to the national grid. As a parallel activity, the pioneering work done by the Coconut Research Institute of Sri Lanka, on the plantation and collection of valuable data on the yields, propagation methods and other benefits of the selected SRC species, such as *Gliricidia sepium* has promoted the expansion of the fuel wood resource.

The biomass availability in MT per year is indicated below:

Type	MT / Year	%
Rice Husk available from commercial mills	179,149	6.2
Biomass from Coconut Plantations available for industrial use	1,062,385	37
Sugar bagasse	283,604	8.3
Bio degradable garbage	786,840	27.4
Saw dust	52,298	1.8
Off cuts from timber mills	47,938	1.7
Biomass from home gardens Such as Gliricidia	505,880	17.6
Total	2,873,880	100

It has been noted that the consumption of fuelwood for generation of electricity using currently available technologies, and equipment, whilst meeting all environmental and other conditions is about 1.2 –1.5 kg/KWh . Calculations on the national potential for dendro power in Sri Lanka by BEASL have estimated this to be in excess of 4,000 MW annually generating over 24,000 GWh. This is nearly 4 times the total hydropower potential in this country. The conclusion may therefore be drawn that the dendro potential in the country is adequate to meet our electrical energy demand for many decades.

The cost of creating this resource, if the land is made available is estimated in the table below.

Year	**CEB Projection of Annual Energy GWH**	**Proposed Replacement % GWH**		**Land Requirement Additional Ha**	**Incremental Cost of Establishment Rs Millions**	**F.E.Savings from fossil fuel imports Rs Millions**
2005	6967	2 %	139.34	6500	65	**1,463**
2006	8342	10%	834.2	35540	356	**8,759**
2008	9892	20%	1978.4	50,550	506	**20,773**
2010	11505	50%	5752.5	176,630	1,767	**60,401**

However getting biomass recognised as a viable energy source has been a major battle and few were willing to consider it as a viable option in the earlier years. A clear national policy on the use of indigenous renewable sources of energy is an urgent need. The indications are that such a policy is now emerging.

In subsequent discussion, it was noted that a decision on the tariff payable is being awaited from the CEB. For on-grid power generation a subsidy is paid, however no such subsidy applies for off-grid situations. It was noted that when considering the role of dendro- power in terms of national needs that in the NE of the country, the terrain is relatively flat and there is no opportunity to develop hydro as a viable energy source. It is therefore strongly advocated that dendro- power ought to take on a major role in this area.

The Chairman welcomed the next set of speakers. The next two papers were to be presented from energy practitioners in Cambodia. In the first presentation by Mr Leuk Dan and Sam Bona, the conference will hear of the work being carried out by an NGO - SME Cambodia- in setting up a village dendro-power unit. In the second presentation, the subject will focus on the growing interest and potential for bio-fuel.

Farming Wood fuel for Sustainable Energy In Rural Area in Cambodia - A Case Study

Leuk Dan and Sam Bona, SME Cambodia

The authors covered the main aspects of their paper which provided the results of a case study in Cambodia where a programme of planting *Leucaena* has been implemented as part of a rural development programme. The presentation was split between the two subjects of establishment and management of the energy resource and secondly the operation of the gasifier. Mr Sam Bona provided an overview of the nursery and planting techniques used. The tree is being used in a variety of ways including hedgerow planting, alley cropping, fence-line planting and as a farm-based plantation. Growth is rapid and harvesting commences within 12-18 months of transplanting, cutting normally being carried out at waist-height. The tree is being used for green fodder, land amelioration as well as an energy crop.

Branch biomass production ranged between 3.1-5.1 t/ha, oven dried. The total above ground biomass (including stem, foliage and fruits) reached about 10 t/ha, within the first year. The branch production expected over the next year will likely reach well over 10 t/ha (oven dry basis).

In the second part of the presentation, Mr Leuk Dana provided an assessment of the energy production work. Using biomass gasification technology, 1.2 to 1.5 kg of wood (with moisture content of less than 20%) is required to produce 1 KWh of electricity. One ton of wood therefore can be converted into about 714 kWh of electricity. Presently, in Cambodia, the price of *Leucaena* fuel wood (dry) is around $25 USD per ton. The fuel costs for operating a biomass gasification, village electrification system in Cambodia is therefore only 0.035 US $ per kWh. A reasonably efficient diesel generator set consumes about 0.3 litre of diesel fuel to produce 1 kWh of electricity. In practice, for rural electrification in Cambodia, the consumption will be higher than this because of the use of old and inefficient equipment. Presently in Cambodia, the price of diesel fuel is about 0.66 US$ per litre (retail price on 24 July 2005). Therefore, the fuel costs for operating a diesel generator set for village electrification in Cambodia are 0.20 US$ per KWh and hence the fuel costs for operating a biomass gasification, village electrification system are 6 times lower than the fuel costs for operating a diesel generator set. The cost of the initial investment and maintenance of a biomass gasifier is however somewhat higher than for a diesel generator set.

A development project was run in a village in Battambang Province comprising more than 200 households and with no alternative electricity supply system. Services are currently being supplied to 75 households on a non-subsidized, sustainable basis since February 2005. Customers are charged on a per KWh rate, based on metered individual customer consumption. Rates charged for the electricity consumed are established such that all system operation and maintenance expenditures plus equipment replacement costs are included. The tariff of $0.30 per KWh is 1/2 to 1/3 of the tariffs currently charged in nearby rural communities, and similar to the rate charged by the government owned electricity provider in the provincial capital ($0.25 per KWh). The system also provides 20 streetlights on the main road through the village at no extra charge to the members.

It was noted that a monitoring exercise had indicated that some villagers have already utilized the new opportunity provided by the availability of electricity to establish new businesses or to extending their business hours to night time hours.

Some questions were raised with respect to the level of additional income that farmers can expect from the growing of Leucaena. A figure of $200-300/ha/yr was indicated as being the sort of figure one could expect. In discussion it was noted that SME Cambodia has also been looking at the use of agricultural residues such as rice husks, peanut and cashew nut shells as a source of energy. A question was asked on the total power being provided by the gasifier. It was noted that the unit is providing up to 9KW and is currently providing 80 connections of just 100 W each, this is just adequate to provide the operation of a TV and a light.The Chairman then called on Dr Andrew Williamson, to present key aspects from his paper dealing with the development of bio-fuel in Cambodia.

Biofuel: A Sustainable Solution for Cambodia?

Andrew Williamson, Cambodian Research Centre for Development (CRCD)

Cambodia has few conventional energy sources available within the country, and even fewer currently exploitable. Wood accounts for more than 80% of total national energy consumption and fuelwood is by far the main source of energy available to the general population, but plays an even greater role for the poor and rural people

It was noted that Cambodia has the highest electricity costs of any ASEAN country which puts business at a distinct disadvantage. Rural electricity supply is highly dependent on Rural Electricity Enterprises (REE). These operate small diesel-powered mini-grids to sell power to an estimated 60,000 customers. The REEs are usually small locally-owned businesses which consist of a diesel engine and generator with low voltage distribution lines which service anywhere from 30 to 2000 local households and businesses. The average tariff charged by REEs is estimated at US$0.53/kWh . An estimated 8000 battery charging businesses provide services to households and businesses, and the effective tariff is often over US$1.00/kWh .

After providing this background on the rural energy scene in the country, Dr Williamson then turned to a consideration of liquid biofuel. He explained that it can be categorised as :

- **Straight Vegetable Oils** (SVO) - possibly the simplest form of biofuel is pure vegetable oil, such as the oil from peanuts, olives or sesame seeds.
- **Biodiesel** – this is a product that is made through the 'trans-esterification of suitable biological oils and can be used in almost any type of diesel engine without modification, and has a long shelf life.
- **Ethanol** – this can be produced from a wide range of biomass (plant) material using a relatively complex chemical process. Generally the ethanol is mixed with gasoline, in varying concentrations, although cars are now produced for sale in some countries that can run on pure ethanol.

Comparison of the Properties of Diesel Fuel and Jatropha Oil

Parameter	Diesel Fuel	Jatropha Oil
Energy content (MJ/kg)	42.6 - 45.0	39.6 - 41.8
Spec. weight (15/40 °C)	0.84 - 0.85	0.91 - 0.92
Solidifying point (°C)	-14.0	2.0
Flash point (°C)	80	110 - 240
Cetane value	47.8	51.0
Sulphur (%)	1.0 - 1.2	0.13

Dr Williamson outlined some of the properties of bio fuels and the opportunities that he considered that they represented particularly for Cambodia, a country facing extremely high imported fuel costs and no fossil reserves. In summary he considered that the main points arising from his paper that will need to be followed up are: -

a) The potential costs and benefits outlined in the paper need to be investigated and quantified in order to ensure that the energy source is commercialised appropriately for Cambodia;
b) The outcomes of the analysis of costs and benefits should be used to assess current policy for any potential barriers or opportunities for appropriate policy support;
c) One particular area of government policy that should be considered with respect to biofuel is taxation with the aim of maximising the net benefits to the whole economy; and
d) Appropriate biofuel quality standards, awareness and enforcement should be developed as early as possible.

Following the presentation, a question was raised concerning the levels of yield that could be expected. It was indicated that on the soils that are likely to be available for the crop i.e. poor, sandy soils a yield of 2.5 t/ha is expected. In discussion it was suggested that yields in Africa might only be 400 kg/ha. A question was raised concerning the cost of coal, this was thought to be as high as $85/tonne excluding taxes.

The meeting then adjourned for lunch.

End of Technical Session 2

Technical Session 3 – The Economics of Dendro-power

Following the lunch break, the meeting was chaired by Mr Parakrama Jayasinghe.

The Chairman welcomed participants back and announced that this would now be the start of the next Technical Session covering the Economics of Dendro Power. The next set of papers would be looking in particular at the opportunities presented from carbon trading and in particular the Clean Development Mechanism (CDM) of the United Nations Convention on Climate Change (UNFCCC) as a means of making dendro power an economically attractive option over and above the known savings from the use of expensive oil-based products.

European Renewable Energy Policies and the Opportunities provided by the CDM.
Part II – Opportunities provided by the CDM
Ms Eng. Mauro Alberti, Comitato Termotecnico Italiano (CTI)

The presenter explained that mechanisms exist that allow those countries that had signed the Kyoto Protocol to off-set some of their excessive carbon outputs through support to carbon-saving projects within the developing world. Joint Implementation (JI) allows countries to claim credit for emission reduction that arise from investment in other industrialised countries which result in the transfer of emission reduction units between countries. The CDM allows for the establishment of emission reduction projects that assist developing countries in achieving sustainable development and to generate certified emission reduction for use by investing countries or companies.

The EU has established its own trading scheme (The European Trading Scheme or ETS) which is based on the policy that creating a price for carbon through the establishment of a liquid market for emission reductions provides the best method for member states to meet their Kyoto obligations. Carbon credits recognised by the CDM are accepted as contributing to targets within Europe. However the EU Directive indicates that until 2008, credits from land use change or forestry sinks will be excluded. In addition to individual companies – EU member states are also seeking to utilise credits from the CDM as much as possible themselves and collectively intend to procure 500-600 million tonnes of CO_2 credits for the period 2008-12. Most projects tend to be in the range of 0.5-1.0 million tonnes, so there is projected to be a great demand for good bankable projects. The Netherlands, Austria, Italy, Portugal and Spain were noted as being particularly ambitious in this respect.

Examples were provided for Austria and Italy. The former has set a maximum of 50% of its commitment to come from CDM/JI programmes with a budget of €288 million allocated for 2003-2012. An example was provided for the Alwar Power Company making use of waste residue from a mustard crop. Italy has signed an agreement to contribute $7 million to the World Bank's Community Development Carbon Fund (CDCF) and to set up an Italian Carbon Fund .

In concluding his presentation, Mauro Alberti indicated that there is a need to:-

- Understand the CDM rules on additionality and the possible replication of projects
- Need to appreciate the costs of different reduction options (biomass v improvement of energy efficiency v waste recovery etc)
- Need to forge links with European countries and with carbon credit markets and develop a portfolio of possible projects for EU support and as much as possible promote the signing of MoUs. Analysis suggests that already in Sri Lanka 19 projects are currently being prepared for proposal as CDM fundable and are at different stages of completion.

Following the presentation there was discussion on the market-value of the CER. It was noted that prices under the EU ETS have been very variable reaching € 12-14 in early 2004 and then between € 7-10 in late 2004. However during 2005 the levels have dramatically increased reaching €20 in June 2005. During the discussion it was also noted that no clear rules for Afforestation/Reforestation projects exist yet under the Kyoto Protocol framework. The presenters and the participants agreed that discussions at UNFCCC (United Nations Framework Convention on Climate Change) on this topic must be given particular attention to understand opportunities for projects in S. Asia

The Chairman called on the next speaker to continue the theme of carbon trading.

Accessing Environmental Funding From European Markets C.Pooley, Campbell Carr, UK

For Sri Lankan energy generators or tree planters to gain access to European consumers for the environmental benefit that they produce, there must be an internationally recognised quality registration infrastructure in place. The United Nations Framework Convention on Climate Change (UNFCCC) Clean Development Mechanism (CDM) will be one such framework for conveying certified carbon reductions. However, there are other frameworks already in place that are of generic design and capable of transporting a range of products designed for different market sectors.

Such systems are a form of attribute tracking – essentially used for three purposes, support, target and disclosure. Support is a function of government policy and can take a number of forms including subsidies, tax concessions or licence obligations. It is a direct means of stimulating the development of particular technologies or fuel sources and is intended to place renewable and low carbon technologies in a competitive position against conventional fossil fuels. Targets are associated with national or international policy and certificates can be used both to provide proof of compliance and to avoid double counting.

Since 1999 a group of European countries have been collaborating to develop a mechanism to support trading in renewable energy certificates. The Renewable Energy Certificate Scheme (RECS) is a voluntary arrangement that now involves most of the EU-15 Member States as well as a number of non-member states. In 2002 trading in RECS began, initially through a 'test phase'. Such was the success of the 'test phase' in demonstrating a demand side for the market that full operation followed shortly after. The scheme now has over 100 active trading accounts and continues to grow.

The precise systems and procedures involved in verification and monitoring are slightly different in every country. The RECS 'test phase' demonstrated that a harmonised standard is essential for generating the trust and confidence of the trading parties that make up a market, and proved that such a standard can accommodate national differences. In order to develop this quality standard in the transportation mechanism, the Association of Issuing Bodies (AIB) was founded. Members of the AIB are registry operators, providing the monitoring and communication systems to facilitate the market. The Association is voluntary, although endorsed by governments and energy regulators.

With the onset of guarantees of origin, the Association has broadened its scope to European Energy Certificate System (EECS) schemes. As a secure transportation network, the nature of the certificate being transported does not change the operation of the system. A number of governments recognised this along with the similarity between guarantees of origin (GO) for renewable energy sources and RECS certificates. They decided that with a proven infrastructure already in place, it would be cost-effective to operate the legislative GO system within the same environment as the voluntary RECS system. As a consequence, the number of certificates entering the system is increasing rapidly (already in excess of 80 million). This in turn will bring down the charges to users as system operators achieve economies of scale. So too will the planned developments into other certificate types including CHP, landfill permits, bio fuels and potentially voluntary carbon credits,

Recently the South Africans were very interested to establish a framework system that replicated, and potentially integrated with, the European standard, the longer-term intention being to become accredited into that standard to enable full trading into the European market. A similar approach might also be one route for Sri Lanka. Mr Pooley mentioned the recent development of the USA-Australia-Japan Pact which had been international news. The scheme is expected to a voluntary based system and is likely to be similar to the European RECS.

For smaller projects, which tends to be the norm within the renewable energy sector, it is essential to bundle projects together to make the complete package more acceptable to the buyers and at the same time reduce costs on individual projects

Questions following the presentation dealt with the value that such certificates and the volume being traded. Current figures indicate that around 80 million have been issued and some 50 million have been redeemed. International transfer has reached 40 million. In January 2005, the value of the Renewable Obligation Certificates (ROCs) in the UK system had reached around 60 Euro/MWh and was little changed by July 2005. The Italian Certificati Verdi (GRTN) had values of €96 and 116/MWh for the same periods.

Establishing an Internationally Recognised Certificate System - The Practitioner's View
Ed Everson Green Certificate Company

A system of green certification developed during the 1990s as a way of taxing the energy sector that was dependent on fossil fuels and providing some sort of incentive to power producers willing to make use of renewable sources of power (including nuclear). It quickly became apparent that each country had different standards and that in many instances these differences were significant. In some instances the differences were procedural; in others the differences were fundamental to the value of the Certificates. In 2002, the Association of Issuing Bodies was formed with its objectives including assisting in the harmonisation of standards and the promotion of Certificate based mechanisms in general.

Within the scope of environmental benefits, Certificates can be used for a number of purposes. They can be used to provide evidence for production, as in EECS (the European Energy Certificate System), and for greenhouse gas reduction, as in the UNFCCC (United Nations Framework Convention on Climate Change) sponsored CDM (Clean Development Mechanism).

Recognising the problems with these interactions, the AIB has been working with Issuing Bodies in Europe for a number of years, seeking to implement common standards for issuing, transfers and reporting of Certificate details. To a large extent it has been successful, although there remain a number of as yet unresolved issues still to be addressed.

The AIB has documented a universal PRO (Principles and Rules of Operation) that applies to all its members. This document enshrines the principle of Uniqueness. It is this principle, when applied to Certificates that ensures that double counting cannot occur. A Certificate is produced once and relates to a specific set of evidence, conferring a specific set of evidential attributes that can be traded and redeemed as appropriate to the market.

Within Europe there are a number of independent Issuing Bodies operating within a range of markets. For example, Observ’ER acts as Issuing Body for EECS within France and Oeko-Institut undertakes this role in Germany. Similarly there are many Issuing Bodies operating under mandate. Within the

Netherlands the Issuing Body function is managed by the Transmission System Operator, TenneT, through its CertiQ subsidiary. This is the case for many of the European nations. Some have chosen to appoint the market regulator as Issuing Body, such as Ofgem for the ROC system in the UK. This case can however raise concerns that there is no-one to regulate the regulator. GCC was appointed by the RECS participants within the domains of the UK and the Republic of Ireland to act as Issuing Body for these domains.

GCC's experience as an Issuing Body has confirmed time and time again that the principle requirement is confidence. Without this confidence the commodities evidenced by Certificates are little more than worthless.

Certificates can be both a robust and flexible means by which to implement a mechanism to evidence activities that might be eligible for activity-based support through both the obligatory and voluntary markets. When carefully specified and properly managed, Certificate-based support mechanisms can be cost effective to implement and operate.

It is possible to implement a robust Certificate management system with very little initial development by utilising off-the shelf registry products and configuring them for local requirements. The procedural documentation and management processes required to operate an Issuing Body can be specified to reflect other recognised infrastructures, removing the requirement to start from a blank canvas.

By recognising the value of Certificate-based evidentiary mechanisms early on it is possible to utilise the same infrastructure to support a variety of trading, compliance and monitoring activities. Establishing the standards at the beginning and enabling the voluntary sector to integrate their requirements on the same infrastructure can remove the possibility of double counting and provide participants, regulators and government with a mechanism in which they can have confidence.

Mr Everson provided the participants with an example derived from the setting up of a hydro scheme in Guatemala. He outlined the various audits and monitoring that was required centring on engineering, environmental and commercial aspects of the project.

Following the presentation there was discussion on the financial aspects of getting certification. Mr Everson indicated that the costs are generally in the range of €0.07-0.25/MWh . A charge structure of €0.07/MWh for issuing certificates and €0.03/MWh for redemption would be a reasonable average.. The cost for verification where this is required would be close to €1,200/day

The Chairman then called on the last speaker of the day Md. Danesh Miah to tell us something of developments in Bangladesh and the opportunities and interest in CDM.

Biomass energy promotion in Clean Development Mechanism (CDM) perspective in Bangladesh
Presented by Md. Danesh Miah

Biomass energy sources currently supply some 70% of the country's primary energy supply, though the country does have appreciable gas reserves. Bangladesh has just over 4,000 MW of which 94% is thermal, mostly using natural gas. In earlier times, fuelwood was regarded as a free resource and this together with the heavy demand for agricultural land has led to extensive deforestation rates. Bangladesh is now reported to have the lowest fuelwood consumption per capita in the world.

An area of around 1.14 million ha of government forest land has been totally degraded and the annual deforestation rate is put at 3.3%. In terms of total land use for the country the area of medium to good quality forest has fallen from 20.5% in 1992 to 9.25% in 1999. Current population is 141 million and is projected to reach 220 million by 2030 and 280 million by 2050. Biomass demands have been modelled in accordance with a range of conditions. The baseline scenario makes the assumption that no extension of the forest land is attempted, only the *status quo* is maintained, replanting forest that is harvested in the same year. Under the medium growth scenario, the area of plantations increases by 1% per year. In the third scenario, the area of plantations is allowed to grow extensively so that the level of industrial roundwood production doubles by 2050 and the amount of wood fuel increases from 150,000 m^3 in 2000 to 1.08 million m^3 by 2050.

Scenarios	**Round wood '000m3**				**Woodfuel '000 m3**			
	2000	**2010**	**2020**	**2050**	**2000**	**2010**	**2030**	**2050**
I	477	512	540	492	151	669	415	590
II	477	512	611	703	151	678	495	823
III	477	512	762	930	151	698	657	1082

The presenter outlined the positive advantages of the CDM in promoting forestry development but considered that the most important constraints to Bangladesh actively participating in the CDM relates to poor capacity and experience in dealing with such projects. He cited inadequate baseline information, leakage and poor monitoring as principal concerns together with inadequate yields. In order to overcome some of these deficiencies, he recommended such measures as investment in better seed sources, tightening of the silvicultural and management procedures in order to move towards high productivity, short rotation crops.

In terms of land availability for expansion of forest planting, reference was made to the degraded forest land under government control which could be brought back into maximum production. In addition, homestead forests are thought to be a major option since they already provide 70% of all the wood consumed and 90% of the fuelwood, even though the greater proportion is regarded as being degraded.

Secure land tenure coupled with simplified agreements between farmers and utilities for fuel supply is needed along with the recognition that forestry should be treated as an agricultural crop. He considered it important that SRC is promoted to avoid long rotation periods that detracts from farmer interest in forestry. It was noted that the government produced a National Forest Policy in 1994 and a National Energy Policy in 1995 which both address the issue of woodfuel. Tree cover is planned to be increased by 20% by 2015.

Following the presentation there was some discussion on the proper mechanism to establish baseline information and the sort of information that would be needed. It was noted that Campbell Carr had been operating in Bangladesh and some assistance was being given to promote capacity to develop CDM proposals. Their involvement came through funds provided by the World Bank and the ADB.

The Chairman noted that this was the final paper of the day and that all participants would be welcomed back later in the evening for the official dinner.

DAY 3 WEDNESDAY AUGUST 17TH

Continuation of Technical Session 3

Mr Abell took over the Chairmanship for the morning session and welcomed all participants back for the final day of the main conference. He took the opportunity to explain the itinerary for the field trip planned for the following day. He explained that in the period up to the coffee break we would continue with two further presentation on the them of the economics of dendro power before moving on to the last session dealing with future Strategies and Development Activities.

Financing Small Scale Energy Development in Sri Lanka Jayantha Nagendran, Senior Vice President (Project Management), DFCC Bank

Capacity development of power is lagging behind demand (8% per annum) and expected that grid will reach 80% of the population by 2010

The Sri Lanka Renewable Energy Program is assisted by a World Bank credit line and Global Environment Facility (GEF) grant for two investment projects, the recently completed Energy Services Delivery (ESD) Project (1997 – 2002) and the ongoing Renewable Energy for Rural Economic Development (RERED) Project (2002-2007). This is served by a $75 million credit from IDA and $ 8 million grant from GEF.

An Administrative Unit (AU) set up within DFCC Bank, a private blue chip development bank, functions as the implementing agency on behalf of the Government of Sri Lanka. The AU administers the IDA credit line to refinance sub-loans made by participating credit institutions (PCIs) to investment projects (referred to as subprojects) that are owned and operated by private sector corporations, village community based organisations and individuals. The AU also administers the GEF grant funds available for co-financing off-grid subprojects, preparing off-grid community based subprojects, developing new applications and technical assistance to address numerous market development activities

The PCIs are private sector institutions comprising development banks, commercial banks, leasing companies and micro-finance institutions that participate in the program by fulfilling defined eligibility criteria. Registered finance companies are expected to become eligible to participate shortly.

The IDA credit line is channelled through the Central Bank of Sri Lanka (CBSL) to PCIs to refinance sub-loans disbursed to investment projects set up by sub-borrowers. Refinance is limited to 80% of the sub-loan disbursed, and is provided at a floating rate of interest equal to the 6-month Average Weighted Deposit Rate, a market based benchmark. PCIs provide the balance 20% from their own resources, and negotiate with the sub-borrower the interest rate on the sub-loans as well as the other terms and conditions such as the extent of loan financing (gearing ratio), tenure, grace period, collateral etc. The lending program is on commercial terms, with the PCI making its own creditworthiness assessment and negotiating the terms of the sub-loan.

By March 2005, 87 MW of mini hydro and 1 MW of dendro power capacity had been added to the grid through 32 projects, while off-grid community owned village hydro schemes and stand-alone solar home systems provided electricity to 3,961 and 65,864 homes respectively.

The program supports the provision of on- and off-grid electricity services and socio-economic development in rural areas through: (i) hydro, solar PV, wind and biomass renewable energy technologies; (ii) credit financing through private participating credit institutions; (iii) output based grant mechanisms for off-grid systems; (iv) technical assistance for promoting productive applications of off-grid electricity; and (v) technical assistance for promoting energy efficiency, developing carbon trading mechanisms and integrating renewables into government policy.

A multi-stakeholder approach was adopted in overcoming financial, institutional and market barriers and in developing a vibrant industry of renewable energy suppliers, developers, consultants, NGOs, community based organisations and industry associations, while promoting commercial financing to this sector through banks, leasing companies and micro finance institutions. The growing renewable energy industry in Sri Lanka presently comprises more than 200 organisations with over 2,000 people commercially involved in grid-connected, off-grid community and household based renewable energy systems.

Co-financing grants are a form of capital subsidy and are available to off-grid subprojects provided they fulfil defined criteria, such as conformity with technical specifications, transparent procurement procedures and environmental safeguards. The ESD Project introduced a standardised Small Power Purchase Agreement (SPPA) and a Small Power Purchase Tariff (SPPT) mechanism for renewable resource based independent power producers selling energy to the state owned utility, the Ceylon Electricity Board.

The first biomass project, with a capacity of 1MW, was commissioned in late 2004 and was financed by a PCI operating under the RERED Project. The lessons learnt from this project are expected to pilot more dendro-power projects, subject to the introduction of a more equitable power purchase tariff. The present tariff paid by the Ceylon Electricity Board has no capacity component, and is inadequate for sustainable operations of biomass projects.

There followed some discussion on the level of development of the renewable energy sector. Mr Jayantha Nagendran indicated that the sector has indeed progressed well on commercial lines with over 40 mini hydro companies backed by about 20 active developers, 11 registered solar companies, 22 registered village hydro developers and 12 village hydro equipment suppliers as compared to 1 mini hydro developer, 4 fledgling solar PV companies and 2 village hydro developers at the start of the program in mid-1997. At village level, there are now more than 90 functioning electricity consumer societies that own and operate off-grid micro hydro schemes that meet ESD and RERED technical standards.
There was some discussion on the level of commercial financing now attracted to this sector. He indicated that banks are now competing for business in some sectors such as mini hydros. In addition active industry associations include the Grid Connected Small Power Developers Association (commercial mini hydro developers), Bio Energy Association of Sri Lanka (dendro power developers), Federation of Electricity Consumer Societies (representing owner-operators of off-grid village hydro schemes) and the Solar Industries Association (solar home system suppliers and consumer loan providers) have all been formed, which augers well for the future.

The Chairman then called on the next speaker, Ms Claire Coote of the Natural Resources Institute to outline her paper on the economics of forest plantations and farm planting.

The Economics of Forest Plantations and On-farm Planting as a Rural Income-generating Activity
HC Coote, Natural Resources Institute

Ms Coote first outlined the differences between the UK and Sri Lanka. The driving force for adoption of renewable energy options is the need to reduce carbon emissions and the desire to support rural areas with the decline in the role of agriculture. In Sri Lanka the driving force comes from the need to reduce the cost of fuel imports and the desire to improve rural livelihoods. The United Kingdom has slowly woken up to the need for it to diversify its electricity generation base away from fossil fuels and into renewable energies. Although many areas of the world are well ahead in their use of biomass as an energy crop the UK is catching up. The policy environment and concomitant assistance is becoming much more supportive to energy crop growers. The UK now has around 1,500 ha of SRC coppice under cultivation. Currently UK government has a scheme to underwrite the establishment of short rotation coppice. Under the Energy Crops Scheme, grants are given for establishment of short coppice rotation species and to aid the establishment of producer groups for short rotation coppice. Applicants have to demonstrate that they have or will have an energy end-use for the crops. This can be a biomass power station or a community energy scheme using heat or combined heat and power (CHP) technology. In spite of this grant, which covers approximately 50% of the establishment costs, there was a slow start to uptake under the scheme. Disadvantages of SRC include the high cost of establishment and the three to five year development time.

Sri Lanka has a long history of producing fuelwood as an energy crop and this expertise is recognised. In order to promote the growing of Gliricidia and other preferred SRC, more information needs to be put together on the costs of production including the opportunity costs of labour. The following table was presented which provides a guide to the value of SRC in terms of employment creation. The table is derived from data collected by FAO.

Bio-energy employment from selected studies (Latin America, SE Asia, particularly Thailand)

Person years/PJ*	**Intensive production, farmers**	**Intensive inter-cropping**	**Large scale “energy forestry”**
Establishment	112	71	34
Weeding	338	196	59
Harvesting	248	251	85
Transport	70	71	51
Chipping	13	13	13
Administration	19	19	11
Total	799	620	252

* employment per unit of energy in person years

The presenter indicated that it is important to ask the question, “Why would farmers want to grow trees?” Low input tree crops may be used as a way of keeping land in productive use. Tree growing may also be adopted where lack of access to capital prevents farmers from adopting more capital intensive crops. Trees may also be grown to diversity farm production, to provide products and income in the period between the main harvests and to help even out demand for labour. In some countries in the past, the expansion of the growing of trees as field cash crops has caused concern, particularly in India, because it was felt that land was being diverted from production of essential food. The decision to grow trees also depends on land tenure and security of tenure. Leasing, sharecropping and other forms of tenancy have been assumed to inhibit tree growing. It has been said in Sri Lanka that the lack of long-term tenancy agreements with the Forestry Department have been a deterrent to expanding this type of farming practice. In other countries the main deterrent is usually linked to inadequate markets or access to credit of financial support.

It was noted that where credit is easily available there is a danger of farmers planting trees for the short term returns from cash payments, rather than from long-term investment in trees; this could lead to distortions in land use. In addition, the comments that have been made in earlier papers with respect to the use of scrub land for large-scale planting should only be promoted after some assessment has been made of the alternative uses of such land for example livestock grazing. In those areas where grazing is a popular activity, conflict between graziers and tree-farmers is an issue that needs to be at least considered.

Following this presentation, which marked the end of the Session 3 there was some discussion on the issues raised by the papers on the Economics of Dendro power. Participants agreed that the issue of carbon trading provided an exciting and potentially attractive means to enhance the importance of SRC in terms of national planning. In terms of individual farmers however, its value had still to be proven. Clearly there is a great need for guidance on the whole carbon and CDM issue and one of the outputs of this project must be to define what this form of intervention can make to the overall economics of SRC. The value of SRC as a means of providing alternative employment opportunities is a further aspect that needs to be promoted. Within the Sri Lanka context the use of SRC as a means of making better use of under-utilised scrub land has been discussed , though has been pointed out in the last paper, there is a need for better information on the opportunity cost of labour and the labour requirements for this type of development.

The Chairman, Mr Abell then adjourned the conference for a 20 minute break for coffee.

End of Session 3

Session 4 Future Strategies and Development Activities

After reconvening he indicated that the conference was now moving into the final session area dealing with future strategies and development activities. He called on the first speaker Mr B.A. Jayananda from the Department of Lands who was to introduce the paper that had been prepared by Dr Ridgway of NRI with substantial inputs from the Department of Lands and Mr P. Silva. However for this presentation, Mr Jayananda was able to present some tables not provided in the main paper.

Land availability and suitability for biomass production in Sri Lanka

Mr B.A. Jayananda, Department of Lands.
Dr R.Ridgway NRI and Mr P.Silva

There is no shortage of land in Sri Lanka that is suitable and could be used for growing fuelwood trees. There is however uncertainty about what land is available now, with sufficient security of land use rights to encourage this land use. There are a number of reasons for this uncertainty about the land. First, it is a constant challenge to revise land legislation to keep pace with the rapid changes taking place in land use. By default what is happening is that existing legislation is being updated in piecemeal fashion, bypassing the need for its systematic overhaul and rationalisation. Secondly, there is a multiplicity of government and parastatal institutions in the country authorised to implement the land legislation but, with overlapping and sometimes ill-defined missions, they often have inadequate means for its enforcement. Thirdly, there is the lack of good and modern record keeping, with maps, on the land tenure and administration of each parcel of used land in the country. Such records must form the objective basis for sustainable land tenure and land use. Fourthly, there is an unknown number of people and agencies willing to be involved in growing fuelwood trees, but they need to be identified and given the necessary support. Fifthly, with nearly 80 percent of the country still under some form of state control, Sri Lanka's land, its management and its uses remain subject to significant government intervention.

The main paper focuses on two of these aspects of land and land management. They are, first, the availability of land records, land legislation and maps that will be of use in assessing land availability for fuelwood, and, secondly, the availability of new 'recruits' to the envisaged significant programme of expansion of the sector. Statistical land data are carefully recorded by many agencies, but the information they provide would benefit from updated mapping and correlation. In particular, currently unmapped parcels of state land that contain unregularised encroachments will reduce the apparent total area of legally available land that appears in the land records. Land policies and legislation are adequate, if disentangled, to support the growing of fuelwood trees and provide the legal basis for increasing the size of areas under this land use, but they need to be rationalised.

Mr Jayanda kindly presented aspects of the paper written by Dr Ridgeway and Mr Silva which provides an overview of the status of land and land availability in the country and the areas that might be available for energy plantations. However he was able to bring to the meeting additional sets of statistics derived from his own researches to add to the overall picture. This data provided regional breakdowns of the either land that was under utilised or had been alienated

It was noted that the State owns 82% of the land within the country
In terms of land that is most relevant for plantation development we have: -

- Category 1 Unutilised State-owned land
- Category 2 Alienated State-owned land, comprising major settlement schemes
- Category 3 Open Forest

In terms of total area he indicated that the relevant figures are: -

- Category 1 114, 093
- Category 2 54,213
- Category 3 471,593

Mr Jayanda indicated that the Category 3 land was particularly relevant for expansion of SRC
He further outlined the agro-climatic regions of the country, which would be another factor that would need to be taken into account in considering SRC programmes.

Wet zone	– 1700-3300 mm
Intermediate Zone	– 1100 -2400 mm
Dry zone	- 650 - 1100 mm

Detailed agro-climatic maps have been prepared which would assist in the process of site selection.

Following the presentation clarification was requested regarding the most realistic assessment of the area of land available. It was confirmed that the figure of 470,000 ha for the Category 3 land would be the best starting point. Figures as high as 1.6 million ha have been quoted for under used scrub, but the question of ownership and approval for change of use might not be automatically forthcoming. However, it would seem that a shortage of land for SRC would not be a serious constraint for Sri Lanka.

The Chairman then called on Asoka Abeygunawardana who had been so active in the overall organisation of the conference to give an overview of his own paper which deals with the role of NGOs in the energy sector. Mr Abeygunawardana represents the Energy Forum and is an active member of BEASL.

The role of community organizations and the NGO sector in the energy sector
Asoka Abeygunawardana, Energy Forum of Sri Lanka

The NGOs and the community based organisations (CBOs) play a vital role in the energy sector in Sri Lanka mainly in the areas of incorporating social and environmental concerns in electricity generation planning and in providing energy services to the off-grid communities.

The presenter indicated that he wanted to examine the role played by the key energy sector NGOs, Micro financing institutions and CBOs in creating a better environment for the promotion of renewable and rural technologies in Sri Lanka. Civil society organisations have initiated a lobbying process to give due recognition to the renewable energy technologies in long-term electricity generation expansion planning. As a result of the lobbying process of the NGOs, the Government of Sri Lanka has now realized the role that can be played by dendro- power to fill the gaps in the current imported fossil fuel dominated electricity generation expansion plan of the Ceylon Electricity Board. The NGOs have been expressing their concern over the proposed development of the first coal-powered generation plant in the country in terms of CO_2 production and the economics of importing coal from Australia.

On the other hand, in the absence of any government authority to look after the energy requirements for the off-grid population in Sri Lanka, the civil society organizations have become the backbone of the off-grid energy sector. The NGOs and CBOs, during the last 15 years, have contributed to the off-grid energy sector by mobilising the community and organising the end users, by conducting Research and Development, providing micro-financing and by monitoring the after sale services. As a result the off-grid energy technologies have now provided energy services to about 80,000 off-grid households in Sri Lanka. These energy technologies include Solar PV systems, village hydro systems, bio-gas units, small wind generators and village dendro-power systems. However the NGOs have an uphill task ahead as they still have to reach 1.5 million off-grid households in Sri Lanka.

BEASL has been actively promoting the role of dendro power citing the possibility that it could provide as much as 50% of the power needs of the country by 2010 and at the same time generate another Rs 90,000 each for 60,000 farming families based on the need to plant up a further 175,000 ha of plantations. The Energy Forum has conducted a feasibility analysis of out-grower schemes for short rotation coppice (SRC) and providing capacity building for communities/groups looking for micro-financing packages to get grid connection. In his presentation, Mr Abeygunawardana drew attention to a study that was made in Badulla District on the economics of farm forestry. Farmers were found to have an average of approximately 1 ha of land with 2,000 trees providing an income of Rs16-24,000 ($160- 240/ha). It was considered possible to plant a further 3,000 trees in the same area and realise an income of Rs 40-60,000 ($400-600/ha).

Cost comparisons between different forms of renewable energy had provided the following installation costs per Kw:-

Micro-hydro	$2,000
Dendro	$3,500
Bio-gas	$3,500
Wind	$6,000
Solar PV	$10,000

Some figures were presented for a small off-grid village gasifier being operated from *Gliricidia* sticks collected from those villagers that wanted to take a stake in the project. Average electricity bill for households linked to the system was found to be Rs 500 ($5) per month, this was partly off-set by an income of a little over Rs100/month from the sale of wood to the installation.

Some discussion followed on the role of the Energy Forum with the Energy Services Delivery Project (ESDP) funded by the World Bank which ran successfully from 1997-2002. This project has been followed on by the Renewable Energy for Rural Economic Development Project (RERED). The latest project is funded by a US$75 million line of credit from the International Development Association (IDA) of the World Bank and a US$8 million grant from the GEF. Loans for individual investments (sub-projects) are disbursed through Participating Credit Institutions (PCI), which make their own independent credit assessments and at the same time ensure that sub-projects are financially viable, environmentally sound, meet required engineering standards and are economically justifiable. The executing agency of the RERED Project is the Administrative Unit (AU) set up within DFCC Bank.

This project has been set up to provide off-grid energy technologies to 100,000 households, however even this target will only address the needs of 7-10% of the off-grid households.

Following the end of the presentation, the Chairman asked if there were any points from the floor. A question was raised on how interested communities appear to be on the use of dendro- power. Mr Abeygunawardana suggested that in practice communities are not so much interested in the source of electricity as long as it is available, reliable and at an acceptable price. Clarification was sought on the capacity of the village scheme that had been referred to in the presentation. It was clarified that a mini grid had been established with a circumference of 9 km and a wood collecting area of radius 2 km. Total requirements was 25kW and the unit requires 60 kg of wood per hour. Dr Kishore outlined some of his experiences in Orissa where a similar scheme was set up in a very remote area. The project led to a major saving in kerosene use and it was found best to establish a fuelwood contribution per household rather that cash, which is never available from these communities.

Speakers from Cambodia indicated that when choosing which village to locate such schemes it has been found that the operation of a successful credit union is necessary. Where the schemes have been operating, it has been found that the economics are such that there has to be some use for electricity during the daylight hours. The main customer has become the battery chargers during the day and this has greatly improved the economics of the programme.

The Chairman then closed the meeting for the lunch break

Following the return to the final session of the conference, the Chair was taken over by Mr D B J Ranatunga. The Chairman welcomed participants back to the meeting and introduced the next speaker Dr Sunil Jayasekara of the Tea Research Institute of Sri Lanka. He would be providing some insights into the use that the tea estates are making of dendro power and how he views the future.

Free Bio Energy, Fertility, and Soil / Water Conservation in Tea Plantations

Dr Sunil Jayasekara[1] and Dr A Anandacoomaraswamy[2]
Tea Research Institute of Sri Lanka, St Coombs, Talawakelle, Sri Lanka.
(1 - Chairman, Tea Research Board; 2 – Deputy Director (Research), Tea Research Institute)

Dr Jayasekara first provided some background information on the importance of the tea industry to Sri Lanka. It is the main export based plantation crop in the country and earns about 20 percent of the foreign exchange (Rs 74,897 million or US$ 740 million in 2004). The industry provides direct employment for some 600,000 people on a total of 188,000 hectares of tea land (three workers per hectare). The estate sector with lands of more than 250 ha contributes 50% of the total, smallholdings provide the remaining 50%.

The tea industry is heavily dependent on energy sources for its manufacturing process. The energy cost is about 30% of the total cost of production at the factory level. The fertiliser component of the total cost of production of tea is about 15% with nitrogen representing about 50% of the fertiliser cost.

Tea plantations require regular input of fertilisers as 20 to 50 harvestable young shoots (bud and two leaves) are being plucked from each tea bush at 5-7 day intervals throughout the year. It was noted that about 8 young shoots are required to produce one cup of tea (2.5 g of made tea for a cup of tea). Due to mining of soil for nutrients, fertility status of many tea lands have declined during the last 140 years of tea cultivation in Sri Lanka resulting in low yield levels and about 10% of abandoned tea lands

Energy Consumption in Tea Processing

Process	**Energy (kWh kg Made Tea^{-1})**	
	Mid/High Elevation	**Low Elevation**
Withering	0.46	0.46
Rolling	0.20	0.10
Drying	0.07	0.07
Sorting & Packing	0.09	0.07
Ancillaries	0.12	0.05
Total	0.94	0.75

The thermal energy consumption for withering and drying was presented in the next table

Thermal Energy Consumption in Tea Processing

Process	**Energy (MJ kg Made Tea^{-1})**			
	Mid/High Elevation		**Low Elevation**	
	Actual	Lowest Calculated limit	Actual	Lowest Calculated limit
Withering	9.0	5.6	9.0	5.6
Drying	13.0	10.6	13.7	11.2
Total	22.0	16.2	22.7	16.8

From the above tables, the speaker concluded that the total energy requirement to produce one kg of made black tea is about 25 MJ (0.7-1.0 kWh of electricity and 1.4 - 2.0 kg of dry fire wood). Often the main energy sources are imported and expensive petroleum fuels together with wood from over-mature rubber trees. Total electricity requirement for all tea factories would be equivalent to a generation from a 35 MW power plant - compared to the present installed capacity of 2,172 MW in Sri Lanka

The following sources of fuel wood from within tea plantations were mentioned:

- Fuel wood from diversified tea lands either from fuel wood coupes or social forestry
- High and medium shade trees
- Up-rooted tea

In 2002, the area under tea was 180,000 ha. This area includes marginal tea lands with lower stocking of productive bushes. Assuming 10% of the total tea area is marginal and not suitable for tea cultivation, such areas could be profitably used for raising fuel wood. About 50% of the marginal lands could be used for fuel wood for processing tea and the rest could be used for raising fuel wood for domestic use. Some of the other tea producing countries had planned their tea plantations with integrated fuel wood area within their estates to minimize the transport cost.

It was noted that almost all the tea estates in Sri Lanka have excellent conditions for growing fuel wood. Dr Jayasekara indicated that there are numerous species suitable for fuel wood. i.e. Eucalypts and *Acacia species; Casuarina; Paulownia; Gliricidia; Erythrina; Calliandra; Leuceana; Grevillea; Albizzia* and *Hakea*

One litre of diesel oil is equivalent to 3.5 kg of firewood. Fuel wood trees such as *Gliricidia* and *Erythrina lithosperma* (Dadaps) also supply leaves which serve as an organic matter input to the tea plantations Further, 150 kg of fresh leaves of these plants will be equivalent to 4 kg of urea. When added to the soil, these leaves will release nitrogen very slowly. The leaves also act as a mulch and protect the soil from erosion and weed growth.

Regular replacement of both medium and high shade trees in the remaining 150,000 ha will provide 1.5 million m^3 of fuel wood on an annual basis.

Nitrogen Requirement:

The total tea production at present in Sri Lanka is about 300 million kg. The efficiency of N utilization by mature tea is about 33%. Therefore, the total N requirement assuming a replacement ratio (yield/nitrogen) of 10 is about 30 million kg of nitrogen. The main nitrogen source for mature tea is urea. 65million kg of urea has to be imported to sustain the above yield. The medium shade trees such as Dadaps and *Gliricidia* could supply about 1.0 tonnes of green leaves annually. Assuming 150kg of fresh leaves supply 4 kg of urea, 1.0 tones of leaves will supply 25 kg of urea. Therefore, from 180,000 ha of tea it is theoretically possible to obtain 4.5million kg of urea, an appreciable proportion of the amount required; but apart from green manure trees, other high shade trees will also supply nitrogen but at a slower rate.

Following the presentation there was a question from the floor regarding the proportion of estates making using of Gliricidia. In the mid and low country, it is considered to be the preferred shade species; however in the drier up-country areas, Calliandra and Eucalypts are more popular.

The Chairman then called on Dr Kishore and Mr Raman from TERI to give their paper concerning the role of SMES and entrepreneurs in the energy sector in India

The role of SMEs and the entrepreneurs in the energy sector.

P Raman and VVN Kishore.
The Energy and Resources Institute, New Delhi (TERI)

This presentation covered the role in India of the small and medium sized industries and their impact on the use of energy. The Small Industries Development Organisation (SIDO) was set up in 1954. The Government of India has created a Ministry of Small Scale Industries and Agro-Rural Industries (SSI & ARI) in October, 1999. In September 2001, it was bifurcated into two separate Ministries – the Ministry of Small Scale Industries and the Ministry of Agro-Rural Industries.

In December 1999, a Millennium Mission was introduced to give a boost to the SSIs. The main features of the Mission were : -

- Creating a sound policy environment to cope up with the challenges of globalisation

- Additional resources, technology and modern management policies
- Make the SSI sector internationally competitive
- Simplification of complex rules and regulations
- Create an appropriate fiscal environment
- Rationalisation of taxes and tariffs
- Rationalisation of subsidy to make them compatible

In August, 2000 the Government came out with a comprehensive policy to overcome the issues and problems faced by the small scale industries:

1. Raising the exemption for excise duty limit to improve the competitiveness of small scale sector.
2. Providing a credit linked capital subsidy of 12 per cent against loans for technology improvements
3. Conducting the third census of small scale industries by the Ministry of SSI & ARI after a gap of 12 years. .
4. Raising the limit of investment in Industry related service and business enterprise.
5. Continuation of the ongoing scheme of granting Rs. 75,000 to each small scale enterprise for obtaining ISO 9000 certification.
6. SSI associations encouraged to develop and operate testing laboratories. One time capital grant of 50 per cent will be given on reimbursement basis to such associations after detailed examination of each case.
7. Raising the limit for composite loans from Rs. 10 lakh to Rs. 25 lakh.
8. Constitution of a group under the Cabinet Secretary to suggest/recommend streamlining of inspection and repeal of redundant laws and regulations applicable to the sector.
9. Increasing the coverage of ongoing Integrated Infrastructure Development (IID) scheme to progressively cover all areas in the country with 50 per cent reservation for rural areas and 50 per cent of plots will be earmarked for tiny sector.
10. Raising the family income eligibility limit of Rs. 24,000 to Rs. 40,000 per annum.

Details were provided relating to the growing importance of small scale industries (SSIs) in the Indian economy. By 2002, almost 11 million SSIs were believed to be in operation of which 723,000 were classed as unregistered. The total sector is providing as much as $17.8 billion in export earnings up from $6.1 billion ten years previously.

Problems facing the sector include access to finance. Only 15% of such companies are able to attract commercial financing due to high interest rates imposed due to an assumed risk factor.
The following measures are proposed to improve SMEs :

- Comprehensive SME legislation (to create security and recovery of dues)
- Credit information related to SMEs
- Credit guarantee and cooperation
- Secondary market instrument for SMEs
- Risk management techniques

The Micro Credit Scheme (MCS) was introduced by the Small Scale Industries Development Bank of India (SIDBI) in 1994. The scheme provided soft loans through well managed NGOs and up to 1999, SIDBI disbursed Rs.307 million through the MCSs.

Training and development of the entrepreneurs is one of the key elements for the development of the SSIs. In India, the Ministry of Small Scale Industries has two important schemes (i) Entrepreneurship Development Institution (EDI) and (ii) National Entrepreneurship Development Board (NEDB).

In India, SSI is defined by the investment made in the plant and machinery; but in other countries in the region, the size of the unit and number of employees are considered to define the SMEs. In most countries in the region, SMEs are defined by the number of workers –

- Very small unit – up to 19 workers
- Small unit – 20 to 100 workers
- Medium size enterprise – 100 to 500 workers
- Large enterprise – 500 and above

Energy Consumption in SMEs

Small and Medium Scale Enterprises depends on either conventional fuel like wood or commercial fuel like diesel, furnace oil, LPG, etc. Costs of these fuels are increasing consistently. Over the past eight years, diesel price has increased by four times. Increase in energy costs changes the entire economic scenario and it becomes a question of survival for those industries which are energy intensive. We have noted that the energy intensive industries are switching over to use modern biomass technology like gasification.

A summary was provided of those industries that are beginning to make use of biogas or could be persuaded to change from fossil fuel in order to improve their current energy costs. The adoption of biomass gasification technology is leading to major cost savings since 3.5 kg. of biomass (at a total cost of INR 7.00) is used to replace 1 litre of diesel (costing INR 32.00), which indicates a scope of savings of INR 25.00 per litre of diesel used in the industry.

Mr Raman indicated that biomass energy options are seen as difficult to operate by SMEs and they need to be convinced of the effectiveness of a good service network for the gasifiers

The Chairman then adjourned the meeting for the Coffee Break On return; the Chairman introduced Mr Conrado Heruela from the FAO office in Bangkok. He has been closely involved with the recently completed Regional Wood Energy Development Programme (RWEDP) which had supported energy development in throughout South and South East Asia.

Energy for heating – Lessons learnt from the RWEDP programme. Conrado Heruela, FAO

This presentation was based on observations from the long running Regional Wood Energy Development Programme which was conducted in 16 Asian countries. Although the main theme of this conference has been directed towards the use of biomass for electricity production, the importance of wood and biomass for thermal applications should not be overlooked. The presenter also drew attention to the lack of adequate information on the availability of bio-fuels; they tend to be the invisible fuel. He also highlighted the problem of weak national capacities of forestry services and energy agencies for the management of wood fuel supply.

We are still faced with the problem of unsafe cooking facilities and indoor pollution arising from inadequate ventilation. He indicated some of the common misconceptions facing the use of wood energy:-

- Only used by rural household
- Wood use drops following urbanisation
- Wood fuel is a major cause of deforestation

Instead the situation is such that wood and other biomass energy is used by all sectors of society and in some form continues to be used heavily by urban populations. Biomass should be seen as a modern energy source.

There are gaps in fully understanding of the wood energy sector in terms of its role and the full statistics of its importance. In many countries the wood market operates in a semi-illegal state, there is a need to legitimise these markets and ensure that they operate in the most efficient manner. Mr Heruela indicated that guidelines are needed on aspects relating to wood fuel and its management in order to ensure that its importance is properly considered in regional planning. Such planning need to take account of the real demand, the opportunities for improving the use of a diminishing resource and to better promote new end uses. He further high-lighted the opportunities that will be arising from the CDM, assistance is going to be required for regional planners to take proper account of these opportunities and how the importance of wood fuel could change because of this new funding resource.
The Chairman thanked Mr Heruela for his interesting presentation; reference was made to the wood energy database that was developed by the project as well as the substantial library of documents and reference material, some of which can be downloaded from the web. The Chairman then called on the final speaker, Mr Leelaratne if the National Engineering Research and Development Centre located just outside Colombo. This Centre has been active in developing improved stoves and gasifiers.

Some Recent Technological Advancements in the Efficient Use of Biomass as an Energy Source in Sri Lanka

By MW Leelaratne, National Engineering Research and Development Centre of Sri Lanka

It was noted that even in the present day, biomass dominates the energy supply with 50 % share for Sri Lanka and on the world stage biomass is by far the largest supplier of primary energy supply in terms of renewables. It was further noted that although biomass has been an important source of primary energy, it has not been produced in an organized manner specifically for the purpose providing as an energy source, it tends to be seen as a bi-product. The main industries which use biomass as their main energy source in the country are tea, brick & tile manufacture, rubber – smoking/drying of sheet rubber and crape rubber- , tobacco curing, paddy par-boiling and the operation of lime kilns. The following table was presented to show the consumption by sector/industry in recent years.

Fuel wood consumption by sector – Units '000tonne*

Sector/Industry	**2002**		**2003**	
	'000 tonne	**%**	**'000 Tonne**	**%**
Agro industry				
Tea	620	5.6	610	5.4
Rubber	91	0.8	92	0.8
Coconut	82	0.7	120	1.1
Manufacturing				
Brick	890	8.1	950	8.4
Tile	630	5.7	630	5.6
Lime	260	2.4	280	2.5
Commercial				
Bakeries, hotels & eating houses	470	4.3	430	3.8
Household				
Cooking	8000	72.4	8200	72.5
Total	**11,043**		**11,312**	

* - estimates only

Source: Sri Lanka Energy Balance – 2003, ECF – unpublished data

A lot of work has been directed towards the improvement of cook stoves based on the traditional materials of clay and pottery but with improved designs to improve the conversion efficiency. NERDC has developed a wood gas stove which demonstrates a major improvement in operational efficiency. The wood gas stove is operated by filling the inner chamber (combustion chamber) with dried wood pieces and then firing from top. Small amounts of kerosene may be used for initialising the flame. Perforations ensure that air is taken from the base and the sides of the stove. As the layers below the flame are heated up, the wood tends to initially emit volatiles and the process of gasification commences, with fuel being consumed from the top downwards. It has been found that the combustion efficiency improves with this type of product heat losses and wastage is further reduced. The system has achieved consistent overall efficiencies up to 35% when compared with less than 8% in traditional 3-stone cook stove and can be made more effective by the use of a forced draught operated by a small (battery-operated) fan.

Mr Leelaratne described some of the work that has been directed to the tea industry. This industry uses large quantities of wood and overall has made little move towards improving the drying technology. Traditional systems consumes approximately 2.4 kg of fuel wood to produce 1 kg of made tea and at present day prices the cost of fuel wood is Rs. 9.50 per kg of made tea.. A new process consists of a screw feeder for feeding the wood chips on to a specially designed fire grate, which facilitates the spreading of wood chips for easy burning. Hot air temperature is continually recorded and is used to control the speed of the screw feeder motor through a variable speed drive. Tests have indicated that the efficiency using this equipment is around 75% up from 40% with the traditional driers.

Specific fuel wood consumption and costs with different types

Fuel wood type	**Specific fuel wood consumption - kg /kg MT**	**Specific energy cost – Rs./kg/MT**	**Percent fuel wood savings - %**
Wood logs (Present system)	2.42	9.46	Existing system
Standard wood chips (Improved system)	1.28	5.52	47%
Gliricidia pieces (Improved system)	1.30	3.25	47%

The estimated economic benefits accruable through the improved system are as follows.

With standard wood logs - specific fuel wood cost = Rs. 9.46/kg MT
With wood chips – specific fuel wood cost = Rs. 5.52/kgMT

Reduction in fuel cost = Rs. 3.94 kg/MT

In conclusion, Mr Leelartne stated that

- Biomass will continue to be the major primary energy source in Sri Lanka for the foreseeable future.
- Sustainable use of biomass for energy is vital for maintaining this trend
- Biomass energy is environmentally friendly
- Efficient biomass energy technologies play an important role in promoting dendro power
- Dendro power can contribute immensely for energy non-dependence

In follow-up discussion, the question was raised as to what these savings meant in terms of national statistics. Mr Leelartne indicated that there are about 600 tea factories in the country and the number of hot air furnaces available in these factories is about 1250.

He suggested that the present annual fuel wood consumption in the industry is 610,000 tonne
The predicted fuel wood consumption with the improved system would reduce the consumption to some 323,000 tonne, a saving of 287,000 tonnes. In current fuel wood prices this would equate to around $11 million. Further questions were asked regarding the difference between the forced and natural draft wood gas burner. Both are considered to have an overall efficiency of 35%; however the forced draft leading to quicker cooking times. The fan operates from torch batteries.
Following further discussion, the formal part of the conference was closed.

Mr Abell was asked to outline the rest of the programme. He stated that tomorrow the intention was for all those participants who so wished, to make a field visit that has been organised to show some of the developments in Sri Lanka with respect to the growing of Gliricidia and its use in a small community-sized gasifier and separately at a large commercial installation. Mr Abell explained that following the field visit, on Friday there would be meeting of the working groups to take forwards some of the issues that have arisen from the meeting. He reminded participants that the purpose of this conference was not just the meeting itself, but rather that it was to act as a starting point for the development of technical notes and guidelines that could come out from the project as a direct contribution to the debate on the use of wood and agricultural waste as real and effective component of the renewable energy equation.

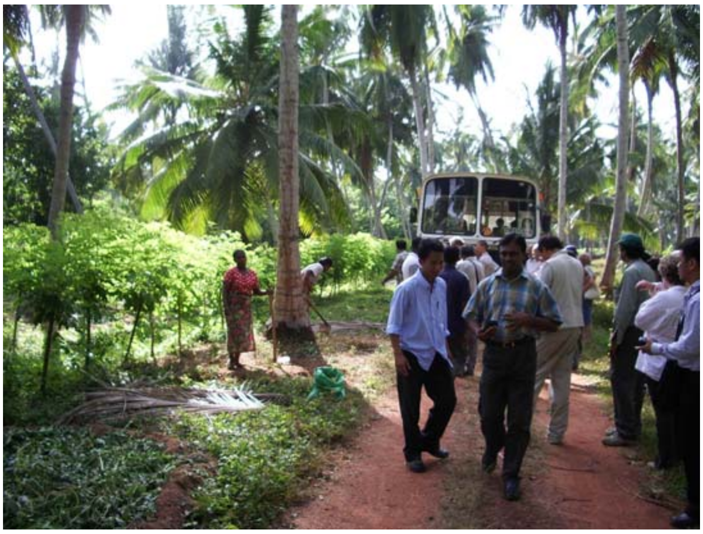
For the moment, Mr Abell expressed his thanks to all the participants for contributing to the conference and hoped they would continue to support the working groups. Special thanks were given to BEASL and the Energy Forum for the organisation of the event.- in particular Mr Asoka Abeygunawarna, Mr L. Jayasinghe and Mr P. Joseph.

DAY 4 THURSDAY 18TH AUGUST

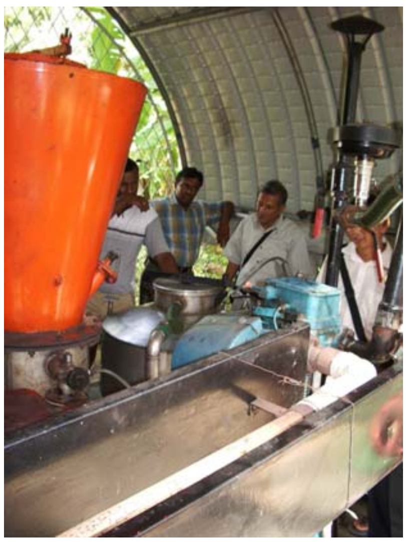
INTERNATIONAL CONFERENCE ON ISSUES FOR SUSTAINABLE USE OF BIOMASS RESOURCES FOR ENERGY

FIELD VISIT

The field visit was made to the Chilaw area to the north of Colombo. The first location to be visited was the trial area established by the Coconut Research Institute (CRI). This institute has been experimenting with the use of nitrogen-fixing trees as a means of reducing dependence on expensive inorganic fertiliser and finding a suitable agroforestry tree that will support the development of coconut and improve the financial balance of the farm enterprise. *Gliricidia* has been found to provide the best results and details of the production levels were provided in the paper presented by Dr H.A.J. Gunathilaka "Biomass Production in Sri Lanka and the possibilities for Agro-forestry intervention."



Dr Gunathilaka was at hand to show the participants some of the trials and the performance of the crop. Since CRI does not have an internal requirement for *Gliricidia* wood themselves, most of the material coming from the site is being sold on to the Haycarb Corporation (the unit was visited later in the day) at Rs 2/kg. Production levels of around 20 tonnes/ha (20% moisture level) can be achieved, with a cutting cycle as short as 8 months. Leaves from the coppiced material are incorporated into the upper soil around established coconut trees and this has been found to avoid the need for any additional nitrogen fertiliser. Foliage production of close to 24 tonnes/ha (green weight) has been recorded.



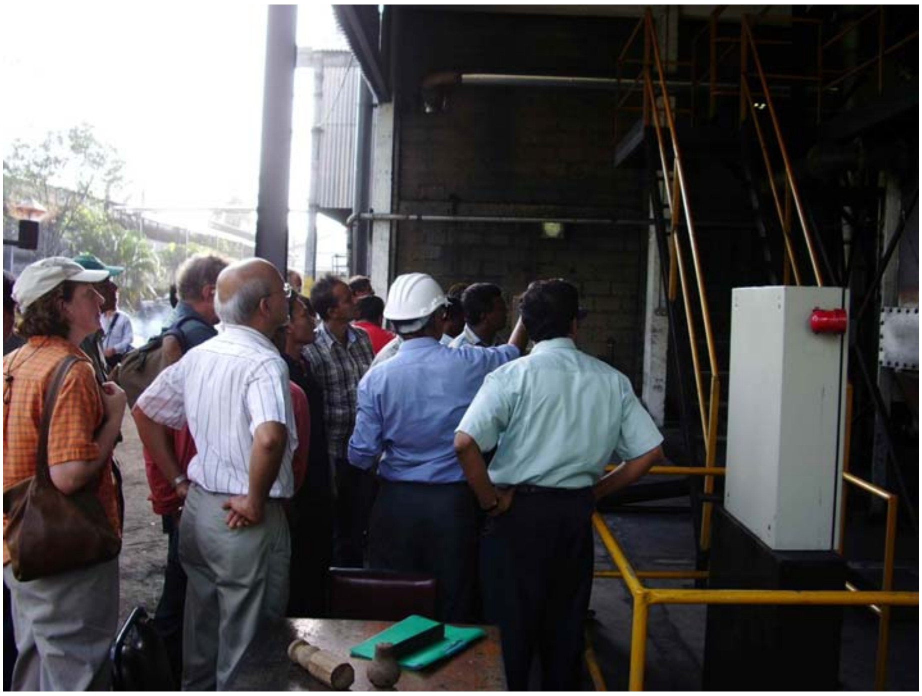
The participants then moved on to a private coconut estate at Kakkapalliya, owned and managed by Dr Ray Wijewardene, an active member of BEASL. Here the *Gliricidia* is also being actively grown, though the crops are more recently established than those at CRI. An Indian-manufactured gasifier linked to an internal combustion engine was demonstrated to the participants. The unit is rated as 3.5 KWe and provides sufficient electric power to operate the estate water pumps and electric lights for the office and housing. The estate also makes particular use of the foliage from the tree to provide green manure.

Following lunch, taken close to the sea, the group moved on to the final stop at the Haycarb plant at Madampe, where the installation was explained by our host – Mr L.P. Jayasinghe, President of BEASL.

The plant is involved with the conversion of coconut husk into activated charcoal for the export market and for the production of coconut-based compost made from compressed coir dust. At this plant chopped *Gliricidia* is being used to fuel a series of large downdraft gasifiers. The producer gas has replaced the use of oil as a fuel and provides the heat needed to dry the coir dust. The gasifiers

were added as retrofits to the factory and have been found to pay back the initial investment in just one year. The unit is rated as 2 MWth.

Following this visit the group returned to Colombo arriving around 7 pm.



DAY 5 FRIDAY 19TH AUGUST

FIRST MEETING OF THE WORKING GROUPS

A first meeting of the potential working groups was held on the 19th of August following the end of the formal part of the Energy Conference. The following groups were recognised:-

1. **Renewable Energy Policy Development and National Planning Needs**
   - balance of renewable v fossil fuels
   - land availability and land suitability
   - role of the CDM
   - renewable energy tariffs compared to non-renewable energy

   Members

   Tara N. Bhattarai - Nepal
   Nishantha Nanayakkaya- Sri Lanka
   M. Rajkumar - India
   G. Riva - Italy
   Jim Sandom – Finlays Sri Lanka
   N. R. Singh - India
   A. N. Abeygunawardana - Sri Lanka
   V. V. N. Kishore - India
   Md. Danesh Miah - Bangladesh
   M. Alberti – Italy

   Additional proposed other names for the group- Mr. M. Warnakulasooriya, Mr. Jayananda, Dr. Batagoda

2. **Bio-energy as an alternative income source for small-scale farmers and estate crops**
   - economics of SRC linked into the farming calendar
   - extension and support structures needed
   - organisation of harvesting and transportation of material
   - micro-finance
   - land leasing

3. **Growth and Development of SRC**
   - focus on the research needs for SRC development in the region
   - exchange of planting material
   - silviculture and management of SRC and biomass crops.
   - development of practical planting and management guides

Members for Combined **Group 2 and 3**

1. Jayantha Gunathilaka
2. Tony Knowles
3. P. M. Gunawardana
4. L.A. Siriwardana
5. G. N. Ratnayake

6. Arjuna Hulugalle
7. Abey Ekanayake
8. Claire Coote
9. Trevor Abell

Proposed - Prof. Hemanthi Ranasinghe

4. **Technical Aspects of small-medium scale power and heat generation from biomass**

- review of the most promising technologies and current constraints
- support needed by national governments
- tariff setting
- grid connectivity issues

Members
1. P. Raman
2. P. G. Joseph
3. Capt Nalaka Gunesinhe
4. Priyantha S. Dissanayake
5. W. P. M. Padmalal
6. Sorawit Nunt Jaruwong
7. Syvang Xayyavong
8. Sanjaya Mande
9. L. P. Jayasinghe

Proposed - Mr. Leelaratne – NEDRC
- Mr A.C. Hollingdale, NRI.

The object of the first meeting was to identify some of the main issues that will need to be addressed as part of the future discussions of the groups.

Notes on the First Meeting by each Working Group

Working Group 1

1. Avoided cost model is applied in Sri Lanka for determining the tariff for renewable energy sources. Hence there is no level playing field for renewables. To have an encouraging policy in place following activities were proposed.
    - establish one central place to provide energy sector information. (Energy Information Centre)
    - Compile reports on case studies - Haycarb, Walapone, CDA & Off-grid schemes
    - Develop a check list to gather information from the South Asia region (by 15th Sept - CTI)
    - Develop an Index for compiling the report (by 15th Sept - BEASL)
    - Collect information regarding energy policies and how those evolved in the recent past
    - Compare the policies in the region
    - Present specific recommendations to the SL Government

2. **Land availability and suitability**

   A detail study is necessary to estimate the land available for energy plantations. The government structure and agrarian extension officers can be used to gather such information. It is necessary to recommend a policy for land use as there may be disputes while getting LOIs for power plants. It is also necessary to develop a program for the announced 4th crop.

3. **CDM**

   As CDM process seems to be remote it is necessary to collect updated information relating to it. A study on nature of the approved CDM projects and why certain projects failed to qualify is important for potential future applicants. As CDM is a complex process it is important to explore the role of the government in project formulation.

Working Group 2 & 3

<u>**For the first meeting, Groups 2 and 3 were combined.**</u>

The members of the discussion groups identified the following key points that should be taken forward:-

1. **Overall Objective of Biomass Energy Development**: There are two aspects – replacement of fossil fuels on economic and environmental grounds and secondly, the promotion of energy crops as an alternative income generation activity for rural communities. It was agreed that for Sri Lanka, we should be promoting both lines.

2. **Key Constraints to the development of energy crops:**

i. **Land.** We had heard that unused unalienated state land is available in relatively small amounts – 114,000 ha but that there are substantial areas that could be possibly available in those areas currently referred to as open forest land under the control of the Forest Department. (470,000 ha). Although in practice it is considered highly unlikely that there would be a land shortage for use under fast growing plantations; it does seem that the land situation is not straight forward and that there are considerable bureaucratic restrictions and delays for interested parties (both the community and the entrepreneur) to obtain land. One weakness is the current lack of completeness of base line maps and an operational database of land use and unused land parcels. The group discussed the fact that in locating land for possible investment in energy crop development, thought needed to be given to the practicalities of the site with respect to local demand for power, adequate water supplies, availability of labour and overall interest in developing alternative income-generating activities. As part of these activities, Working Group 2 (and indeed 1) would need to further develop the report prepared by Dr Ridgway *et al* and ensure that a complete picture on land availability is prepared. At the same time, the groups will need to provide some guidance on the approximate number of hectares of land available in other key countries within the region, in order to develop a credible energy scenario over the next 10-15 years

ii. **Finance**. It is clearly difficult to access micro-finance; although some excellent progress has been made by DFCC in this respect especially with microhydel and solar systems. The donor community might need to think of co-funding support to communities facing particular problems (i.e. tsunami- affected) in order to provide a catalyst for future development. The Working Group will need to identify suitable financing packages based on current regional experience and taking some of the lessons from Europe with respect to central government support.

iii. **Tariff Structure:** this is regarded as currently a very serious restriction to the successful take-off the sector. At current levels, there is unlikely to be any major investment in the establishment of power processing until the promised tariff increases are put into effect.

Tree Farming

The group considered that networks with respect to the management and silviculture of STC are inadequate. There needs to be follow-on from the RWEDP to ensure that workers in the region are better able to interchange information on aspects of species, provenance and even vegetative material (within the restrictions of good phyto-sanitary practice). Any such networks will need to be independent of Pro Eco support or from any other project interventions.

There was considered to be too much reliance on a single species – especially with respect to Sri Lanka, where *Glyricidia* was being promoted almost to the total exclusion of everything else. Although in the particular farming system represented by the growing of coconut as an over-storey with *Glyricidia* as an alley crop, the system is clearly successful and well suited. It was however realised, that multi-purpose SRC should not always be the first choice. Some estates and developers will clearly only be interested in maximum calories/ha and this objective might not be best served by *Glyricidia.*

Social Aspects

A series of key questions/issues were identified that would need to be addressed in the coming months: -

What is the real demand for this type of activity from the viewpoint of farmers groups and communities? This will be partly answered by a clear analysis of the financial and economic models that need to be prepared for SRC and other forestry interventions. The Coconut Research Institute had prepared some analyses of various management options. This work needs to be extended both for other options within Sri Lanka but also for a wider analysis within the region. In undertaking this sort of analysis, it was considered essential that other comparable livelihood options should be examined, in order to provide a degree of comparison. Discussion during the plenary indicated the importance of getting a full economic analysis so that all aspects affecting the environment are included in the analysis and that decisions are not made purely on the basis of cash flow.

An analogous question was raised with respect to land owners. Is the change of land use to SRC clearly sensible? The level of investment in terms of time and money to establish SRC might not provide the same degree of financial gain to large-scale land owners than it might to villagers and communities each responsible for a small area.

The need for a balance in the development of the sector between the private and public/community sectors was highlighted. The growth of energy production within any locality needs to fit in with an integrated assessment of local development needs – especially if we are dealing with off-grid electricity production.

A final point was made that the expansion of the simple technologies that have been shown to work in Sri Lanka and other countries, provides the real opportunity for rural self-reliance in power. To some extent this should be regarded as a highly desirable goal without any active persuasion. However, in some quarters it will be necessary to ensure that communities are fully aware of what adequate electricity supplies means in terms of local development. Part of the outputs from this project will therefore need to be popularisation of the self-sufficiency of energy at a local level and the development of linked income-generating activities.

Working Group No.4
Technical Aspects of Small/Medium Scale Power & Heat Generation from Biomass

Grid-Connected Generation

- The 1 MW Biomass based power plant already commissioned in Sri Lanka did not deploy the Best Available Technology (BAT). All future plants should try to deploy the BAT – working steam pressure should be in the range of 65-80 bars.
- Sugar factories also should deploy the BAT. The feasibility of integrating SRC Energy plantations with sugar cultivation and utilizing biomass from the SRC plantations during off-season should be examined.
- In Thailand many large power plants operating on rice husks are in operation. These have performed very satisfactorily. The working Group should consider further examples of where agricultural waste has been used.

Off-Grid Connections

- Presently in Sri Lanka, 3.5 to 35 kWe systems are operated in the off-grid mode. These deploy solid-wood gasification with Spark-Ignited IC engine systems to drive synchronous generators. Their performance has been thoroughly satisfactory, but prolonged operation is essential to make any conclusive judgment.
- Indian experience has proved that standard 2-cylinder diesel engines could be easily modified to operate with spark-ignition on 100% wood gas.
- Strict compliance with acceptable standards such as the IEE Wiring Regulations is essential in respect of household wiring. As far as the electricity distribution network, a compromise may be reached taking into account safety and costs into account. EU standards may serve as a guide line.
- Use of standard spark-ignited IC engines with biogas may also be considered for off-grid rural electrification.

The Working Group will need to further examine these examples and summarise the lessons learnt.

Industrial Heat Energy
Appreciable lessons have been learnt, which need to be documented: -

- Many systems utilizing biomass gasifiers coupled to furnaces and boilers have been successfully implemented in Sri Lanka. These have replaced furnace oil, diesel or LPG fuels, thus saving valuable foreign exchange and CO2 emission levels. In addition, energy from fuelwood is much cheaper and these conversions have resulted in appreciable energy cost reductions. These installations use coppice fuelwood, mostly *Gliricidia* as the fuel source. Conversions from petroleum fuels to biomass fuels should be extended to many other industrial heat generation applications.
- A few installations utilizing solid fuelwood have now switched to coppice fuelwood, supplied from *Gliricidia* cultivations in home gardens.
- The improved combustion system developed by NERD Centre in Sri Lanka has been identified for wide applications in many industries. It is noted that further improvements to this system, particularly in the reduction of excess air, should be considered.
- In the tea sector in Sri Lanka, the use of refuse tea (amounting to around 3% of the out put) as a fuel substitute should be considered. This would prevent the sale of such refuse tea as good tea in illicit market. A properly regulated refuse tea feed arrangement with the improved system developed by NERD Centre would be sufficient for this purpose.
- Many Desiccated Coconut factories in Sri Lanka use either furnace oil or coconut shell as fuel in steam boilers. *Gliricidia* coppice fuelwood grown in coconut plantations could be used as a

substitute if suitable boilers and / or chipping machines and feed mechanisms arte installed. This is a good opportunity to implement the recent Government decision in Sri Lanka to establish *Gliricidia* as the 4th plantation crop in the country.

- Other agro and industrial waste such as saw dust, coconut husk, bamboo tops etc. could be used as fuel in suitable boilers, furnaces or gasifiers.
- In order to make biofuels as an alternative to petroleum fuels, it is essential the suitable pre-processing such as drying, briquetting, palletizing and packaging should be carried out. Care should be taken to dry the material prior to packaging in bags to prevent decaying from fungal attacks.
- Ceramic industry in India has successfully converted many installations to operate on wood fuel instead of petroleum fuels. Other countries, particularly Sri Lanka could follow this example.
- Suitable moisture measuring instruments should be developed and marketed.
- The draft emission standard prepared by the CEA (Central Environmental Authority) should be formally adopted to prevent scrupulous officials demanding conformity to arbitrary standards.

Co-Generation and Absorption Refrigeration Applications

- Industries such as Tea, Sugar, Palm Oil are suitable for co-generation applications.
- Biomass fuel based steam generation with absorption refrigeration systems could be deployed for cold stores, ice manufacture or for other refrigeration needs.
- Co-generation of the proposed coal-based generator needs further examination and costings provided to the government in the form of a policy paper.

Household and Restaurant Needs

- The Wood Gas Stove developed by NERD Centre has been accepted by many households. However, non-availability of suitable ready-made fuel packets has impeded its application. The Coconut Cultivation Board may be directed to implement a suitable system to market a suitable fuel packet from *Gliricidia* cuttings. It is observed that as LPG prices are steadily climbing, households would be prepared to pay a comparatively high price for fuelwood if suitable packets are made available.
- Attention should be focused on cooking fuel needs of restaurants, bakeries etc.

Transport Fuel Needs

- Bio Ethanol, Biodiesel based on *Jatropha* or other suitable oil seeds and compressed methane from anaerobic digestion may be considered as suitable bio fuels for transport applications. It was noted that important developments had been reported at the conference from Cambodia in this respect. The Working Group will need to summarise costings and technical constraints on this technology and provide key policy directives.

Future Developments

- Sterling Engines and Micro Turbines operating on bio fuels could meet some of the modern energy needs. The Working Group will need to look further at these and other developments and ensure that the key points and concrete recommendations are made to interested parties.

Grid Connectivity Issues

- It was observed that unlike hydro power and wind power, biomass based electricity generation systems are to a large extent flexible in respect of location and size of power generation facility. Hence the usual restrictions imposed by utilities to absorb energy from "Embedded Generators" by the national electricity grid would not be applicable. By incorporating dedicated medium voltage lines to cluster many medium sized power plants to grid substations would be an alternative.

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