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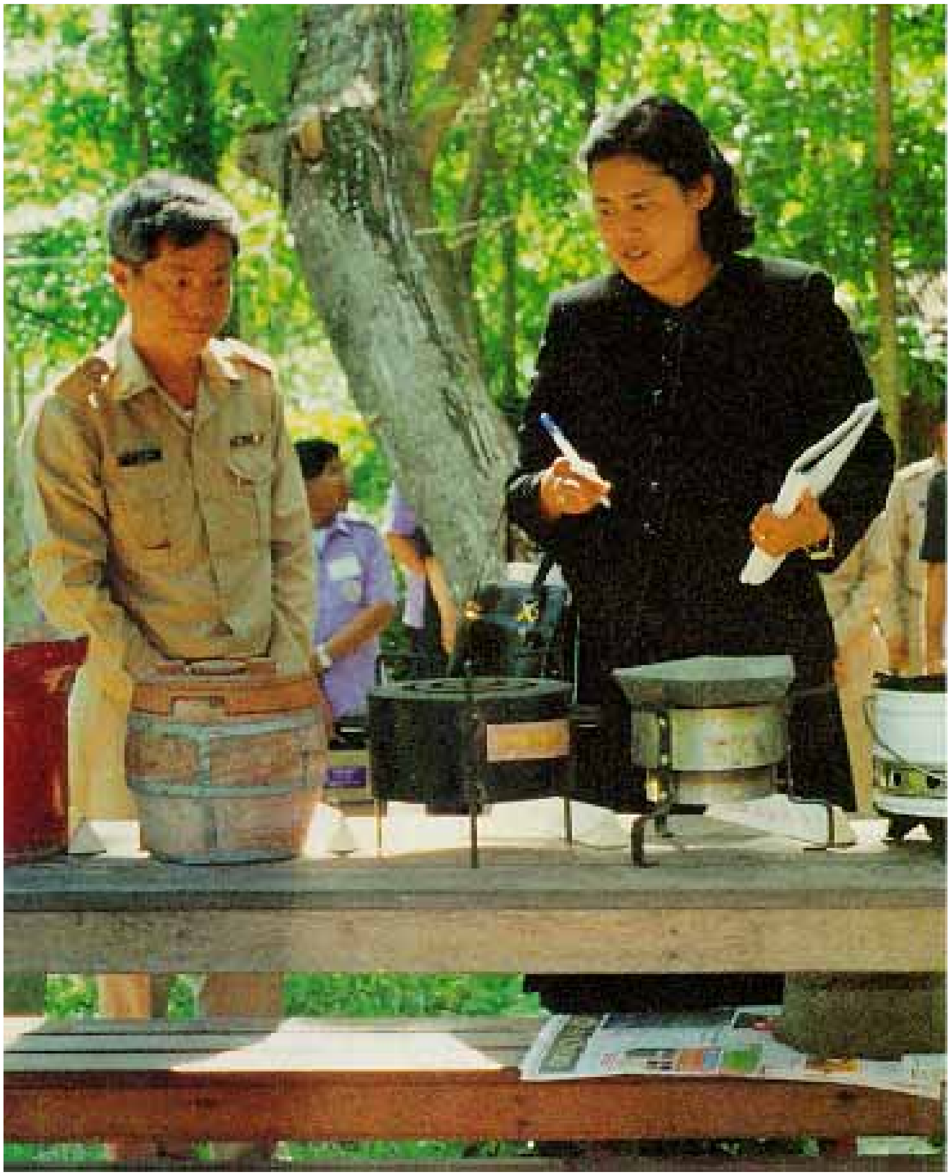

Modern Wood Energy

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Programme Address

Regional Wood Energy Development Programme in Asia (GCP/RAS/154/NET)
FAO Regional Office for Asia and the Pacific
Maliwan Mansion, Phra Atit Road
Bangkok 10200, Thailand

Fax: +66-2-280 0760
Phone: +66-2-280 2760
E-mail: rwedp@ksc.net.th

Dr. W. Hulscher	Chief Technical Adviser
Auke Koopmans	Wood Energy Conservation
Conrado Heruela	Wood Energy Planning
Tara Bhattarai	Wood Energy Resources
Harry Oosterveen	APO/Information Systems

Programme Focal Points

Bangladesh:	Chief Conservator of Forests, Forest Dept., Min. of Environment and Forest; Member (S+T), BCSIR
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Indonesia:	DG of Electricity and Energy Development; Director, Bureau of Planning, Min. of Forestry
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Malaysia:	DG, Forest Research Institute DG, Economic Planning Unit, Prime Minister's Dept.
Maldives:	Dep. Director, Agricultural Services, Min. of Fisheries and Agriculture
Myanmar:	DG, Forest Dept.; DG, Energy Planning Dept., Min. of Energy
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Thailand:	DG, Royal Forest Dept.; DG, Dept. of Energy Development and Promotion
Vietnam:	Director, Forest Sciences Institute Deputy Director, Institute of Energy, Min. of Energy

Editorial

What is considered traditional by one person is sometimes thought of as modern by an other. This most certainly applies to fuels. These days, energy from wood and other biomass is considered a relatively new and modern option in the industrialised world, supported by government policies aiming at environmental management and based on advanced industrial technologies. In parts of Asia the same can be observed, but still the use of woodfuels is largely looked on as a traditional practice. What actually matters is not the labels modern or traditional, but whether or not the woodfuels serve the users in a way that is efficient, clean, convenient and reliable, and at the same time are economically and environmentally sound. Today, all these requirements can be met in the industrial, domestic and utility sectors, whether for generating heat or power, or a combination of both. Let it be clear that 'modern' need not be associated only with electricity generation in large-scale power plants.

Many mature technical options are available to use woodfuels in a modern way, including fuel preparations from residue materials. These technologies are not necessarily more expensive than any traditional method of wasteful, dirty, cumbersome and unreliable usage of woodfuels, or other fuel for that matter, if evaluated on a life-cycle basis. Methods have to be developed further on how to promote the rational use of energy, including wood energy. Modern options deserve a wider recognition amongst decision makers in Asia, and information needs to be disseminated to potential users.

Some promising technologies for utilising wood and biomass fuels are still at the stage of research and development. They should not be promoted as long as they are immature. However, national R&D institutions can do extremely useful work by further developing and adapting the options to conditions prevailing in the region. After all, we know that wood will remain a major fuel in Asia for many more decades to come.

This issue of Wood Energy News can only draw the attention of its readers to some modern options, and indicate some relevant issues such as environmental impacts for the consideration of decisionmakers. Specific information on modern options for wood energy is available from a wide variety of sources, some of which are identified herein.

Front page: H.R.H. Princess Maha Chakri Sirindhorn shows a keen interest in modern woodfuel stoves, demonstrated by the Royal Forest Department of Thailand.

Modern Wood Energy Technologies

Auke Koopmans

Introduction

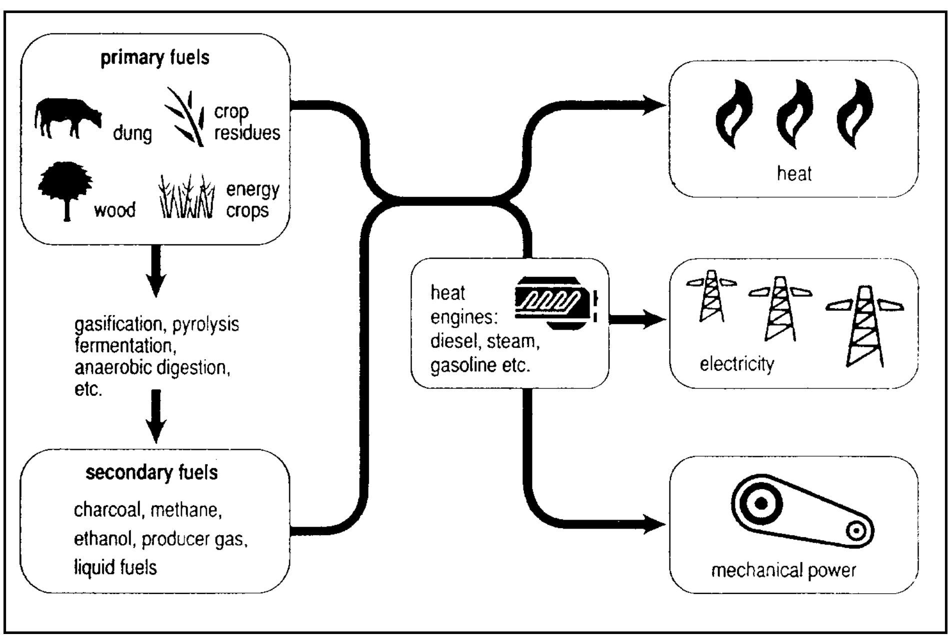
Biomass energy, including wood, has been and still is an important source of energy for all types of applications. This situation is expected to remain for the foreseeable future. Important reasons for this phenomenon are that biomass energy is available almost everywhere on earth, it is relatively cheap, it is virtually inexhaustible, it is renewable and, when used properly, is environmentally friendly. Rough estimates of the amount of biomass grown annually show that, in terms of energy content, the amount is equivalent to about 2,890 Exajoules (10^{18}). Annual biomass production is therefore about 8 times the total annual world energy consumption, estimated at about 359 EJ, from all sources combined (EREC, 1995).

Although biomass appears to represent a very large source of energy, it has to be noted that a large part is not available. This is caused by various factors, noteably, being inaccessible, being expensive in comparison to other sources of energy, having competing uses, etc. In the latter context often the 5 F's are quoted e.g. biomass can be used as Food/Fodder, Fibre, Feedstock, Fertilizer as well as Fuel. All factors combined create a situation whereby only approximately 270 EJ out of the total amount can be considered as a potential sustainable supply of biomass energy at competitive prices (Hall et al, 1992). This amount would be equivalent to over 70% of the total amount of energy consumed on a worldwide basis in 1990.

However, judging from official statistics, the share of biomass energy in the overall amount of primary energy consumed on a worldwide basis is much lower, therefore leaving scope for a more intensive use of biomass as a source of energy. The World Energy Council quotes a figure of approximately 12% as being the share of biomass in the total amount of primary energy used on a worldwide basis (WEC, 1994). Even though data for regions and individual countries show considerably higher amounts (South Asia about 50%, Latin America 30%, Nepal 95%, Myanmar 80%, Bangladesh 65%), it can safely be assumed that in most cases these data are an understatement of the importance of biomass energy.

Biomass used as a source of energy consists not only of woodfuels such as trees, twigs, etc, originating from forests, agricultural lands, homesteads, waste lands, etc. but also consists of agricultural, forestry and other wood residues, crops grown specifically as a source of energy purpose (grasses, trees, etc.), aquatic weeds (water hyacinth, etc.), and others.

An important property of biomass is its versatility e.g. it can be burnt directly to provide heat, it can be converted to electricity, to liquid or gaseous fuels, it can be stored, etc. In many respects it can be compared to fossil fuels. However, the energy content of biomass, ranging from about 17–20 GJ/ton dry is low in comparison with fossil fuels such as coal (23–33 GJ/ton depending on quality) and 38–40 GJ/ton for liquid fossil fuels. Another common property of biomass is that it is often moist if not outright wet, has in general a low weight to volume ratio and is often scattered over large areas. Consequently, the costs of collecting and transporting it can be quite high while the need for processing (drying, crushing, compacting, etc.) adds to the problems. The lower energy density of biomass as well as its moisture content and the need for processing therefore does play a significant role in cost evaluations. Being versatile results in it being used for many varied applications. Such applications can be loosely divided into "traditional" and "modern". The Regional Wood Energy Development Programme considers that the (modern applications) basically cover clean, convenient, efficient, reliable, economically and environmentally sound applications which are or can be used to substitute conventional sources of energy such as coal, oil and gaseous fuels. Some examples are heat and electric power generation from biomass, liquid fuels from biomass such as ethanol, methanol, biodiesel, etc., gaseous fuels from biomass like gasification, biogas, etc. Incidentally, most of these modern applications are relatively large scale.



Options for biomass fuels (from: UNEP, 1991)

Traditional biomass energy systems, by implication, will then, broadly speaking, mainly be confined to applications which do not fulfil the conditions given above. These traditional applications are often relatively small scale and are frequently, but not always, traded in a non-monetized informal local economy. The use of fuelwood for cooking and space heating as well as for small scale industrial use (brick burning, lime burning, food processing, etc.) as is common in many countries in the developing world, are some typical examples of traditional biomass energy applications.

However, it has to be noted that such a division into “modern” and “traditional” is arbitrary. Small scale CHP/Cogeneration applications replacing conventional sources of energy, are both “traditional” and “modern” applications. In terms of scale they would be placed in the traditional category but in terms of their energy and substitution potential they would be considered modern. Biomass energy has in the past also been used for large scale applications including the combination of power and heat through steam engines with waste steam being used for drying purposes and plant oil has been used in the past as fuel for diesel engines, etc. Both are ranked here as “modern”. However, the reason for ranking them “modern” is that in most cases such applications are now reappearing on the energy scene in an upgraded form and are considered to have an important role in energy planning. Many of these once traditional applications almost disappeared as other fuels which were considered to be more convenient became available. This shift to fuels which were considered to be more convenient and often also more modern or progressive, resulted in technological development in the field of biomass energy sources coming almost to a standstill.

The situation started to change in the seventies and eighties after the “oil shocks”, when many people became concerned with energy dependence. Besides the concerns about high cost and dependence, there were other factors which had, and still have, an influence on this shift even though these concerns were often not directly shared by the endusers such as industries nor by energy planners. These concerns consist basically of the environmental aspects and in some countries the overproduction of food crops coupled with the need for foodsecurity and employment. The change has resulted in biomass again being increasingly used for various purposes several countries. A few examples:

- Electricity production based on biomass, mainly in the form of co-generation in the pulp- and paper industry, has in the United States increased by a factor of 36 (from 250 MWe to about 9,000 MWe) over a period of about 10 years (WEC, 1994);
- In Austria, biomass in the form of wood chips, has become an important source of fuel for district heating. During the last 10 years primary energy consumption from biomass increased from about 2–3% to 10% (WEC, 1994) and this is expected to increase to about 25% of the total primary energy consumption by the year 2000 (Howes, 1992);
- Combined Heat and Power systems based on sources of biomass energy such as straw are making inroads into district heating systems in the North European countries;
- Charcoal production for use as a substitute for fossil based coal in pig-iron and steel production in Brazil currently amounts to about 7 million tons per year (WEC, 1994);
- Sugar cane bagasse based electricity production accounts for about 10% of electricity production on the island state of Mauritius (WEC, 1994);
- Alcohol production as a substitute for fossil based liquid fuels has risen by a factor of 20 over a 12 year period in Brazil (WEC, 1994);
- In the United States, mainly in the grain growing areas in the Mid-west, about 13 million cubic meters of corn and other starch crops are converted each year into about 3.8 billion litres of ethanol (DOE-NREL, 1995);

Table 1: Use of renewable sources of energy by regions

Region	"New" Renewable Energy	Modern Biomass	Traditional Biomass	Large Hydro	Renewable Energy Total	Total Energy MTOE	Renewables as Perc. of Region	Renewables as Perc. of Global
North America	12	19	38	127	196	2,157	9.1%	2.2%
Latin America	3	46	125	80	254	577	44.0%	2.9%
Western Europe	10	10	20	99	139	1,462	9.5%	1.6%
Central/East Europe/CIS	5	10	30	55	100	1,739	5.8%	1.1%
Mid East and Africa	2	5	162	14	183	583	31.4%	2.1%
Southeast Asia and Pacific	9	23	351	70	453	1,843	24.6%	5.1%
South Asia	2	8	204	20	234	446	52.5%	2.7%
Total	**43**	**121**	**930**	**465**	**1,559**	**8,807**	**17.7%**	**17.7%**

Note: “New” Renewable Energy includes solar, wind, geothermal, wave and ocean energy as well as micro-hydro power
Source: Adapted from “New Renewable Energy Resources: A Guide to the Future”, World Energy Council, 1994

- The conversion of dung into biogas is common in India (approximately 2 million digesters), China (about 5 million digesters) and Nepal, etc. However, these applications are mainly in the form of small scale applications used as a substitute for other sources of energy.

Most examples indicate that biomass energy is used as a substitute for fossil based fuel or conventional sources of energy. However, with regard to biogas the impact on fossil energy use is not known, as biogas in many cases replaces other biomass energy sources. Besides, it has to be noted that not all biogas plants are in working condition. Studies in India have shown that only about 50% of the plants are still operational. However, with the newer biogas plants survival rates are higher and figures of about 80% are now quoted (Tomar, 1995). In some European countries, notably Denmark and the Netherlands, relatively large scale biogas plants have been introduced. The reason for this has been because farmers faced problems in disposing of cattle dung in an environmentally acceptable manner.

Mechanical collection of fuelwood in Sweden

However, in comparison to traditional biomass, the share of modern biomass is still low, especially given the fact that the statistics on traditional biomass often understate its importance. This is shown in table 1 which provides a brief overview of the use of renewable energy sources including “traditional” and “modern” biomass energy in terms of their 1990 share in the total amount of primary energy consumed on a worldwide basis.

It is clear that the share of “traditional” biomass is still 7–8 times higher than that of “modern” biomass and that the latter still has a long way to go before it becomes a real competitor to the traditional applications of biomass energy. At present, as was shown in most of the examples mentioned earlier, there are several “modern” biomass energy technologies which have been proven on a commercial scale and can possibly be widely used. Other technologies are being introduced on a pilot scale while still others are under development. The following gives a brief overview of some of these “modern” biomass energy technologies and applications.

Harvesting and shredding the wood

Biomass Conversion Technologies

Emphasis will be placed here on some of the more “modern” biomass energy technologies, applications and conversion processes. However, it should be noted that due to space limitations only a few of these can be touched upon, and then only briefly.

Biomass energy technologies can be roughly divided into three main groups e.g. direct combustion processes, thermochemical processes and biochemical processes. The first process is in principle directly concerned with primary fuels e.g. the fuels are used as they are found or after some form of processing such as size reduction, drying, compaction through briquetting, carbonization, etc. The latter two are basically processes in which the primary fuel is converted into a secondary fuel. In thermochemical and biochemical conversion processes the biomass is converted from a solid form into either a gas or a liquid through pyrolysis, gasification or catalytic liquefaction or through fermentation and other related processes such as hydrolysis with acids or enzymes, etc.

Direct Combustion of Biomass to Generate Electricity and/or Heat

Using biomass to generate electricity and heat has been widely practised in the past. At present it is making a comeback in many industrial applications. This can range from simple systems such as stoves, furnaces and boilers to more advanced systems like fluidized bed combustion technology, etc. However, often an intermediate step is involved e.g feedstock preparation such as drying, sizing, grading, compaction, etc. as this will improve the combustion process as well as its control. The heat generated during combustion can be used directly in production processes but it can also be used to generate steam. The steam is normally used to drive a turbine to generate electricity. These are in principle straightforward conversion processes and equipment is commercially available in various sizes and capacities.

However, straight-forwarded conversion of thermal energy into mechanical or electric power results in considerable losses and it is physically impossible to raise the ratio of thermal to mechanical power above 60% (the so-called Carnot Limit). In practice conversion ratios are considerably lower than the maximum. Modern thermal power stations (200–600 MW) operating at high pressures (as high as 240 bar) and high steam temperatures (> 500ºC) and using seawater as a coolant can have an efficiency of about 45%. However, if the low temperature waste heat can be used productively, for instance in district heating systems which are common in the cooler European countries or for drying or heating purposes, much higher overall efficiencies can be obtained. Combined Heat and Power (CHP) systems are not limited to thermal power stations but can be and are used in many different configurations such as for instance internal combustion engines with the heat of the exhaust gases or coolant systems used for productive purposes. Related to CHP are co-generation systems which basically make use of the principle of simultaneously generating heat and electricity. As a rule of thumb it can be assumed that CHP and co-generation systems save about 30% of the fuel when compared with two separate systems (see “Co-generation in Wood and Agro Industries” also in this newssletter).

Thermochemical Processes

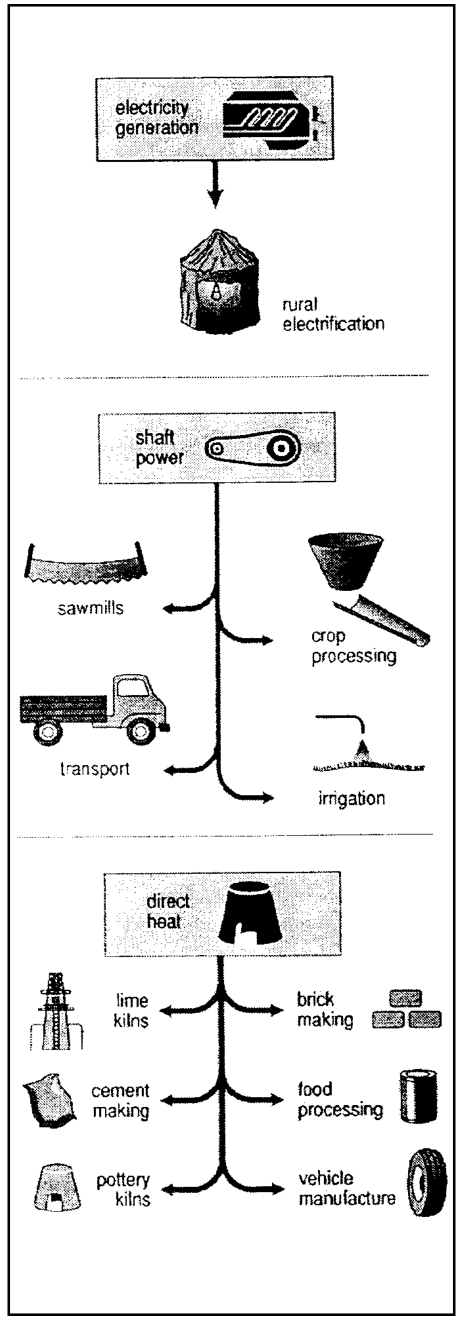
Pyrolysis is the basic thermochemical process to convert biomass into more valuable or more convenient products (to be used as fuels or for other uses). The products formed are normally a gas, an oil-like liquid, and a char. The distribution of these products is dependent on the feedstock, temperature and pressure of reaction, the time spent in the reaction zone and the heating rate. High-temperature pyrolysis (1000ºC) maximizes the production of gas (gasification) while lower temperature pyrolysis processes (< 600ºC) have been used for centuries for the production of charcoal. Another approach to produce liquid fuels and chemicals from biomass is direct catalytic liquefaction.

Because of the interest in relatively simple biomass conversion technologies to produce low or high heating value gases and liquid fuels, pyrolysis has recently received a great deal of attention. Extensive research into new processes of biomass pyrolysis with low residence time in the reaction zone and high heating rates (flash pyrolysis) is being carried out world-wide. Some of these projects have reached the demonstration stage, but few if any have yet been fully commercialized.

Gasification

Gasification is an established technology, the first commercial applications of which date back to 1830. During World War II, biomass gasification systems appeared all over the world. Almost one million gasifier-powered vehicles using wood or charcoal helped keep basic transport systems running. After the war, most of the systems were abandoned.

However, the energy “crises” of the seventies rekindled interest in biomass gasification systems. The technology was perceived as a relatively cheap indigenous alternative, for small-scale industrial and utility power generation in developing countries, that were hard hit



Use of producer gas (from: UNEP 1991)

by high petroleum prices but had sufficient, sustainable biomass resources. Extensive demonstration programmes were started by donor and national governments in various countries including the Philippines, Indonesia, India, China, Brazil, etc. UNDP and the World Bank subsequently carried out a wide-ranging review of these programmes, and came to the conclusion that commercially proven power and heat gasifiers were available to run on biomass fuels such as charcoal, wood, coconut shells and rice husks. However, it was also concluded that at time the economics of biomass gasification were in many cases marginal for most areas, with the viability of heat gasifiers being better than that of power gasifiers.

Sawdust waiting for further processing

Other more complex gasification systems such as high-pressure oxygen gasification, indirectly heated gasifier systems, etc. often in combination with high-efficiency power conversion systems such as for instance biomass-integrated gasifier steam-injected gas turbines (BIG/STIG) or integrated biomass gasifier combined cycle plant (IGCC), are at present under development. They show considerable promise and are expected to be able to compete with conventional coal, nuclear and hydroelectric power in both industrialized and developing countries.

Biochemical Processes

These processes make use of the biochemistry of the raw materials, and the metabolic action of microbial organisms, to produce gaseous and liquid fuels. Examples are biogas, ethanol, methanol, etc.

Ethanol

Ethanol fermentation from carbohydrates is probably one of the oldest processes known to man. Today, it is widely regarded as an important potential alternative source of liquid fuels for the transport sector. Raw materials for the production of ethanol from fermentation can be divided into three main groups based on the type of carbohydrate prevalent, saccharine materials, starchy materials and cellulosic materials. The choice of raw material for ethanol fermentation is critical, as feedstock costs typically make up 55–80% of the final alcohol selling price.

Saccharine materials, with sugars available in fermentable form, require the least extensive preparation, but are generally the most expensive to obtain. Starch-bearing materials are often cheaper, but require processing to solubilize and convert the starch to fermentable sugars. Cellulosic materials such as wood are the most readily available raw material, but the process runs on a semi-continuous basis with recovery and recycling of the yeast. This permits the use of high yeast concentrations which enables a reduction in fermentation times. There are several patented processes such as for instance the “Biostil” process and the Melle-Boinot process in which the yeast is recycled.

During ethanol fermentation considerable quantities of carbon dioxide are produced, which can be easily recovered, compressed and used as an additive in the beverage and food industries.The yeast and other insoluble components of the fermented feedstock are removed from the fermentation stills as stillage (also known as slops or vinasse). When starch is used as a feedstock, the stillage has a high protein content, and can be sold as a livestock feed after evaporation and drying. In the USA, the economic viability of the industrial ethanol fermentation industry is determined to a large extent by the market value of this dried distiller’s grains and solids.

The stillage from sugar fermentation is of lower value, and also constitutes a major waste problem. This is basically caused by the large amount of water used in the system which results in an effluent load of about 10–15 litres of effluent per litre of ethanol produced. In fact a molasses based distillery producing 60,000 litres ethanol per day may have a pollution load equal to a city of one million inhabitants.

Concluding Remarks

From the above, one could conclude that the outlook for biomass energy as a “modern” source of energy is positive. However, it should be noted that we have addressed mainly the technical aspects. In order to come to a definite and informed conclusion, other factors should also be taken into account. For instance, the use of biomass energy as a source of energy can provide employment. Electricity generation based on biomass grown as an energy crop is generally assumed to provide a net gain of 1–3 jobs per MW_e when compared with conventional energy sources with most jobs generated in rural areas. Other factors consist of, but are not limited to, the economic aspects, the technical maturity of the application, the sustainability of biomass supplies, the lead time required from plan to actual operation (often relatively short for biomass energy based power generation systems), employment generation (often high), etc. Only when all the pros and cons have been considered can a definite conclusion about a particular application be made. It should also be noted that at present a great deal of development activities are being undertaken in this field of "modern" biomass energy applications and advances are being made. Situations change and applications, which at present may be judged as risky or not advisable, may soon become attractive.

Biomass energy and the Environment

Biomass energy has, when seen from the environmental point of view, several advantages over conventional sources of energy (fossil fuels) but at the same time it also has some disadvantages.These can be broadly divided into global and local effects. On a global basis the use of biomass energy can help to mitigate the global warming effect. Biomass, when used as fuel does release carbon dioxide just like fossil fuels; however, when new trees are planted for those which are used as fuel, the new growth takes up more or less the same amount of carbon dioxide with the result that biomass energy, when used in a sustainable manner, is in principle CO_2 neutral, unlike fossil based fuels. In addition, replacing fossil fuels by biomass energy can help to reduce sulphur dioxide emissions which may cause acid rain as well as other environmentally harmful emissions. Waste materials which otherwise might result in pollution can be used in an environmentally friendly way e.g. use of municipal solid waste for energy (direct combustion for power generation, etc.), use of landfill gas, biogas production from sewage sludge, etc.

This is not to say that biomass energy has only positive aspects. Biomass, when used in an unsustainable manner can lead to loss of ground cover (deforestation, etc.) which in its turn can result in soil erosion, desertification, silting up of rivers, floods, etc. and possibly even to climate changes and loss of genetic resources. Biomass, when grown as a source of energy, can result in land use competition (agricultural land used for growing of trees, etc.), or competition for food and fodder crops (grain used for ethanol production, etc.) and therefore may result in reduced food and fodder availability. The production of biomass for energy may be water and fertilizer intensive and create in that way competition with food crops. The use of agricultural residues as energy instead of organic fertilizer can reduce the soil nutrient level. Converting biomass into energy can cause pollution (stillage from ethanol production, etc.), the use of residues as energy can result in health problems, particularly when used in badly ventilated areas, which are common in kitchens and small industries, etc.

It is difficult to quantify the positive and negative aspects of the use of biomass as a source of energy not least because of a lack of information on and/or monitoring of the overall positive and negative impacts. In spite of this, it should not prevent us from using biomass as a source of energy as long as the environmental aspects are taken into account when deciding upon the use of a particular fuel in a particular situation.

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Biofuels: Motivations for Their Use

M.A. Trossero

"Asia's thirst for power is to be unquenchable." This short sentence from the Financial Times Survey of 26 September 1995 provides a clear view of the present energy situation in many Asian countries; and it looks that this situation will remain such for many years to come. This means that extra sources of energy will be needed to meet the growing energy demand of different economic sectors. This means new fuels in a decade to be dominated by high economic growth, development and also growing environmental concerns.

Although fossil fuels and hydropower are the predominant sources of energy to foster economic development, other sources of energy, particularly those which are environmentally friendly, and even more so if locally available, need to play an important role too. The rational and proper development of these new sources of energy will require the application and adjustment of national policies, laws and financial mechanisms and regulations.

Several technical solutions exist for producing liquid fuels from agricultural and forest biomass. These fuels are commonly denominated biofuels. Some of these biofuels can substitute liquid fuels such as gasoline and diesel used for engines.

Bio-diesel derived from vegetable oil can substitute diesel oil either totally or partially and ETBE (ethyl tertiary butyl ether) can be produced from ethanol derived from agriculture and forest biomass. ETBE is an octane enhancer for producing reformulated gasolines. ETBE substitutes MTBE in unleaded gasolines.

The use of these novel technologies will depend to a large extent on numerous factors, especially international oil prices, national energy policies and specific local conditions. However, new technologies are being developed in several R & D institutes in the USA, Austria, France, Italy, United Kingdom and Germany in order to reduce their production costs.

Many policy aims can be achieved by adopting the massive use of biofuels:

- Reduction of quantity of imported oil;
- Utilization of locally available sources of energy;
- Answer to environmental concern at the local and regional level through reduction of unbalanced CO_2, utilization of marginal lands for plantations (trees and crops) for energy purposes, reduction of wastes, etc.;
- Creation of new jobs and income for rural populations.

A general description of the technical, economic and environmental aspects of the use of bio-diesel follows.

Bio-diesel

For a long time there has been an interest in the development and utilization of pure or mixed vegetable and animal oils as fuels for internal combustion engines. For various reasons, many of these initiatives failed. However, *transesterified* vegetable and animal oils, commonly denominated *bio-diesel* or *methyl esters* correspond to a product with physico-chemical properties and performances similar to those of diesel derived from fossil oils. The main R & D activities have concentrated on soy bean (in USA) and rape seed (in Europe). For instance, rape seed oil methyl ester (RME) is being widely promoted by the Italian company Novamont, which has established demonstration units in several European countries.

In Europe the use of bio-diesel is an answer to surpluses of agricultural production, but high production costs remain the main constraint to its wider utilization. Special subsidies for bio-diesel production and tariffs to discourage the use of fossil fuels are the main tools to promote the use of bio-diesel. In some other countries such as Brazil, Mali and Thailand, other local vegetable oils are used such as babaçu, palm oil and curcas oil.

For instance, since 1992 in Mali, with the assistance of GTZ (German Agency for Technical Cooperation), tests have been carried out on different types of engines, bio-diesels and technologies for their production. The engines are being driven successfully with curcas oil. Mali, as well as many Asian countries, has large stocks of jatropha (*Jatropha curcas L.*), a shrub-like plant that is grown as a protective hedge around gardens and farming plots. Jatropha has wide environmental tolerance and can be cultivated in arid and semi-arid lands with relatively rapid growth, easy propagation and a variety of uses. Brazil and India are among the countries which have a considerable production of jatropha. Jatropha's seeds yield up to 50 percent of their weight of oil known as *curcas* oil which, once *transesterified* can constitute an excellent fuel for diesel engines.

Unfortunately the production of bio-diesel is not perceived as economically feasible due to the high costs of operation involved in its utilization. However, under specific conditions - relatively good productivity, waste land availability, and low labour cost - curcas oil can represent a good alternative to liquid fuel. Thailand and India have started tests in this field which indicate that jatropha can be considered a good raw material not only for oil but also for medicines, pesticides and soap production (black soap). The potential benefits for local communities can be large, especially for those located in areas where access to conventional sources of energy is not always possible or affordable.

M.A. Trossero is Senior Forestry Officer (Wood Energy) awith FAO in Rome.

Cogeneration in Wood and Agro Industries

Michael Pennington, Ludovic Lacrosse, Alan Dale Gonzales and Yves Schenkel

Wood and agro-industries produce large quantities of residues that can be used for energy. Technologies for energy conversion of these residues have been successfully utilized all around the world.

Cogeneration

Depending on the needs of the factory, a steam-producing plant will produce heat only, power only or both heat and power. Combined production of heat and power constitutes cogeneration. The principal of steam production remains almost the same in all cases. The differences come from the next step, i.e. the way steam is used.

The most conventional objective of using steam is to send it directly to heat exchangers which themselves are part of the process (evaporators, dryers, hot presses, etc.). If power only or both heat and power are needed, the steam can be sent to a turbine.

There are two main types of steam turbines: condensing and back pressure. The use of one or the other will mostly depend on the heat-to-power demand ratio of the factory.

Condensing turbines are preferably used when:
- power only is required;
- there is an excess of process steam;
- two separate boilers for heat and for power are used because of an excess of residues.

Non condensing or back pressure turbines are more appropriate when:
- there is a need for both heat and power; such a process requires large quantities of steam;
- supplementary power requirements can be supplied by other sources (utilities, stand-by gensets, etc.).

The steam enters the turbine at a rather high pressure, and leaves it at a lower pressure; this is sometimes negative in the case of condensing turbines. If intermediate pressure steam in needed, an extraction turbine can be used.

From an energy point of view, cogeneration is much more attractive than power generation only. The global efficiency of cogeneration systems can reach 85% and even higher, as opposed to about 30–35% in the case of electricity production only.

Combined production of heat and power has always been widely applied in agro-industries such as sugar mills and palm oil mills. As the trend in wood industries is towards integrated wood complexes, cogeneration plants are being implemented increasingly in this sector.

The application of cogeneration in the three above-mentioned sectors (sugar, palm oil and wood) will be addressed further in the following sections.

Sugar Mills

Almost all sugar mills throughout the world currently use their main residues, i.e. bagasse, to cover their needs for heat and power (figure 1). Most of these mills are self-sufficient in energy despite the fact that their equipment is very often outdated and inefficient.

The use of bagasse could be optimized by replacing the old low pressure systems. This configuration would allow the sugar millers to sell their excess power back to the grid. The technical potential for ASEAN is estimated at 8600 GWh annual generating capacity with an exportable excess of 6800 GWh.

Palm Oil Mills

The palm oil industry is one of the agro-industrial sectors which produce the highest quantities of residues. Indeed, 70% of fresh fruit bunches are turned into wastes such as empty bunches, fibers, shells, and liquid effluent (figure 2 and 3).

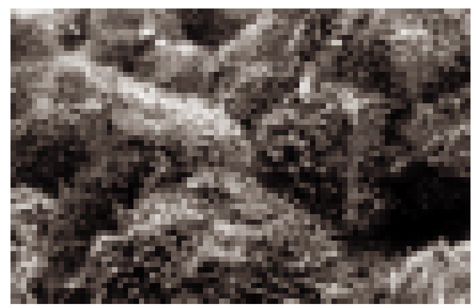


Figure 2: Palm oil fruit bunches

Most palm oil mills cogenerate heat and power from fibers and shells allowing them to be energy self-sufficient. However, the use of palm oil residues could still be optimized. The use of fibers alone could be sufficient to cover the energy needs of a mill. Shells could then be saved for other higher added

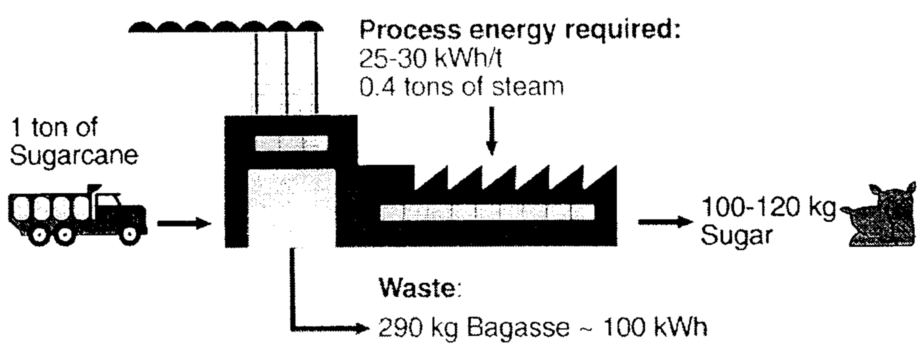


Figure 1: Requirements and products of a sugar mill

The authors work with the EC-ASEAN COGEN Programme, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand

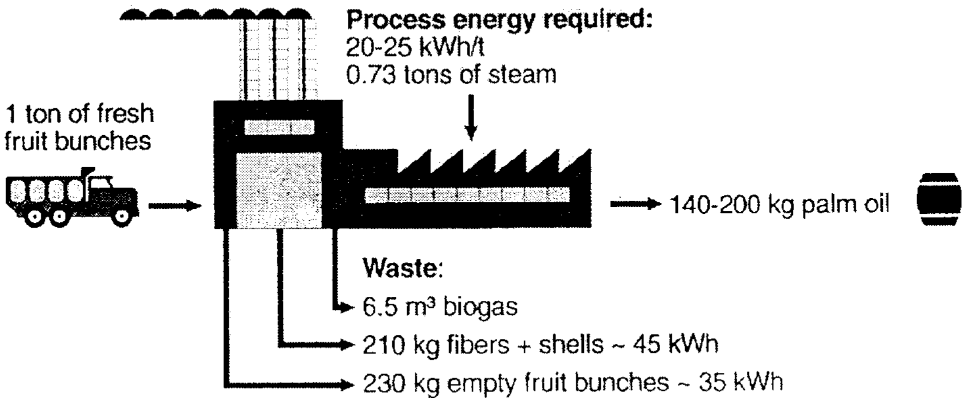


Figure 3: Requirements and products of a palm oil mill

value purposes, like charcoal and activated carbon production. Other residues like empty bunches and palm oil mill effluents also contain a large quantity of energy that is unused most of the time.

Wood Industries

Each wood industry produces vast quantities of residues. More than 50% of the raw wood input is converted into waste in most instances. The majority of the sawmills in ASEAN use diesel gensets or are grid-connected for their electricity requirements. Only in a few cases do sawmills use wastewood for timber drying purposes. There is scope for cogeneration if the sawmill is also equipped with kiln drying facilities.

The plywood industry has large power and heat requirements (see figure 5). To supply their energy needs, many of the plywood industries depend on diesel gensets and bunker oil. Only the biggest and most modernized of the plywood companies use wastewood to cogenerate heat and power.

Integrated wood complexes are large energy consumers. Power is used for running all machinery, while process heat is required for kiln drying and hot pressing. These wood complexes represent ideal cases for the application of cogeneration. The payback period for the investment in cogeneration equipment for such cases is generally shorter than 3 years.

Environmental Issues

As an energy source, biomass conversion can have positive and negative effects on the environment. Specifically, the use of biomass residues as fuel for heat and power generation reduces the environmental hazards associated with the disposal of these residues which are otherwise traditionally considered as wastes. On the other hand, if biomass conversion is not properly implemented (through the use of appropriate biomass conversion equipment and procedures), it may give rise to various negative impacts on the environment.

Biomass energy conversion does not necessarily contribute to CO_2 proliferation, provided that biomass producing lands (agricultural fields, forests, palm trees plantations, etc.) are restored when biomass is exploited. Another important advantage of biomass fuels is that generally they do not contain sulphur. Sulphur dioxide production is thus avoided. But biomass conversion is not always environmentally friendly, especially if the combustion is not complete.

Noxious gases such as CO or CH_4 may be produced if the appropriate biomass energy conversion equipment is not installed or correctly operated.

The use of a well designed (especially regarding the fuel) and a well maintained furnace, combined with sound management of combustion operation, are the key factors in producing energy from biomass in an efficient way while simultaneously respecting the environment.

EC-ASEAN COGEN

The EC-ASEAN COGEN programme is an economic cooperation programme between the European Commission (EC) and the Association of South East Asian Nations (ASEAN). The programme is coordinated by the Asian Institute of Technology in Bangkok, Thailand. Its aim is to accelerate the implementation of proven technologies generating heat and/or power from wood and agro-industrial residues through partnerships bertween European and Southeast Asian companies.

One activity of the programme is to set up demonstration plants. Three such wood industry projects are in operation now, in Sarawak and Pahang, Malaysia, and in Chonburi, Thailand (figure 5, next page).

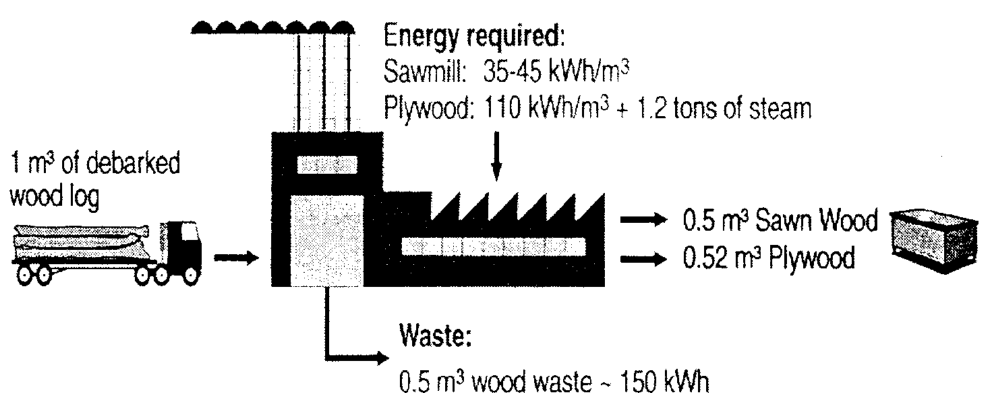


Figure 4: Requirements and products of a wood industry

Figure 5: Wood industry in Chonburi, Thailand; a demonstration project of the COGEN programme

Briquetting of Wood and Agro Residues

P.D. Grover

During the processing of wood, substantial quantities of wood residues, including sawdust, are generated. In addition, most developing countries produce huge quantities of agro-residues, which are used inefficiently causing extensive environmental pollution. In India alone, about 260 million tonnes per year of agro residues are generated out of which about 100 millions tonnes remain unutilized. The total production of mill residues consists of rice husk, coffee husk, coir pith, jute sticks, bagasse, groundnut shells, mustard stalk and cotton stalk. A large part of these residues is neither used nor needed for other purposes such as soil conditioning.

Apart from the problems of their transportation, storage and handling, the direct burning of loose biomass in conventional grates is associated with very low thermal efficiency and wide scale air pollution. The conversion efficiencies are as low as 40% with particulate emissions in the flue gases in excess of 3000 mg/Nm^3, whereas the permissible limits in most countries are 150–300 mg/Nm^3.

About 90 percent of the world's rice is produced in South and Southeast Asia. This crop alone generates 90 million tonnes/year of rice husk. This is extensively used as loose fuel in industrial furnaces. In addition to extensive air pollution, its burning also generates 40% high carbon ash. A typical example, is the case of Ludhiana (Panjab) where about 800 tonnes of rice husk ash high in carbon are generated everyday by burning 2,000 tonnes of husk. As a result of this industrial activity the air pollution became so acute and widespread that the Government of Punjab (India) was forced to ban the burning of loose biomass in the state from 1st April 95.

Wood and agro-residues can be compacted to improve the handling characteristics of loose biomass and provide clean combustion. This technology can help to expand the clean use of biomass for energy use for those industries that are dependent on wood, coal and lignite and can also help to improve the fuel situation in the cooking sector.

Compared to the density of common wood (0.5–0.7 g/cm^3), briquettes can

Prof. Dr. P.D. Grover is from the Indian Institute of Technology, New Delhi—110016 (India)

be produced with a density of 1.2 to 1.4 g/cm^3 from loose biomass with a bulk density of 0.1 to 0.2 g/cm^3. Accordingly, the savings of diesel oil during the transportation of residues or wood are substantial: a 10 tonnes truck can take 3–4 times more weight of briquette than loose biomass fuel.

Technologies

There are numerous technologies for briquetting of biomass. These are classified as:

Direct briquetting with binders

These are relatively low pressure machines but need special binders like ligno-sulphonates. In production process about 4 to 8 percent binder is mixed with the biomass.

Direct briquetting without binders

These high pressure machines are either revolving screw type, reciprocating ram type or piston type. The screw press provides the briquettes with a central hole which facilitates their combustion and their outer surface being partially carbonised gains water repellant properties and thus improves storability.

Bio-coals

These are compacted charcoals made from wood waste and low ash agro-residues. These are produced by two distinct technological routes:

- First briquetting by the technology mentioned in II above, followed by their slow carbonisation in kilns.
- First carbonisation in kilns, drums, inclined hearth carbonisers and, most expensively, in rotary kilns followed by briquetting of char with binders (starch/clay etc.) into different sizes and shapes (example see figure 1).

Screw press briquetting technology

This technology was invented and developed in Japan in 1945. As of April 1969 there were 638 plants in Japan engaged in manufacturing sawdust briquettes known as "Ogalite", amounting to a production of 0.81 million tonnes per year. Recently a number of plants in Europe and a few in South East Asia have been constructed. All these units are being operated using sawdust. When these machines were operated using other agro-residues like rice husk, numerous problems were encountered. With a view to re-establishing the confidence of the entrepreneurs amongst the developing nations of South and South East Asia in this eco-friendly technology, a large scale project was initiated by the Dutch Government and contracted to the University of Twente and the Indian Institute of Technology, Delhi. Extensive tests carried out in Delhi on a 400 kg/hr Shimada machine resulted in solving the problems of excessive wear of screws and power consumption. By preheating the dry and crushed agro-residues to 90º and applying a controlled tungsten carbide hardfacing on the screws, improved machine performance was a consistently obtained.

While working on the most abrasive type of biomass, namely rice husk, the life of the screw was increased from 15–20 minutes to 33 hours with 25% increase in production rate. 15.5 tonnes of briquettes were produced before the screw was taken out for hardfacing.

A reduction in power consumption from 70 to 55 kWh for rice husk and 30 kWh for coffee husk was noticed. Production rate for coffee husk was 600 kg/hr from a rated output of 400 kg/hr, an increase of 50%. The cost of screw maintenance, which was prohibitive without preheating, was brought down to Rs 30 (US$ 1.0) per tonne from Rs. 150 per tonne.

This latest development of preheating the feed has given productivity and maintenance results comparable to those being obtained in Europe for sawdust and the technology has now become economical for adaptation. Steps have been initiated to install a few of these plants in India.

Small screw presses

Smaller machines of capacity 60–100 Kg/hr and up are also being manufactured in many Asian countries. These are much cheaper but the specific power consumption and wear rates of these machines are higher. The typical prices are : India UN$ 5000 (100 Kg/hr) and Myanmar $ 2000 (60 Kg/hr). These machines can be operated successfully provided the entrepreneurs have access to good workshop facilities for maintenance and the cost of inputs, local raw materials, labour and power are cheap. They can meet local demand provided the cost of alternative fuels like wood and coal are higher than the cost of briquettes. In many situations, the cost of briquettes may not be able to compete with the local price of wood. Therefore, a proper survey should be carried out before adopting these machines. Since these briquettes are an excellent replacement for woodfuel, they can help conserve the nation's forests and generate employment activities.

Figure 1: Manual briquetting press from Vietnam

Ram press briquettes

As already mentioned, the briquettes produced by this technology are solids with inferior combustion characteristics compared to briquettes with a concentric hole. While these can be burnt satisfactorily in large furnaces, their use in small furnaces (i.e grate approximately less than 900 cm^2) has not proved to be very efficient and they have been the subject of many complaints when used in cookstoves. Thus these briquettes are usually sold at a lower sale price than of that screw pressed briquettes, provided the latter are also available at the same time. Further, these briquettes cannot be converted to charcoal.

Briquetting—Carbonisation

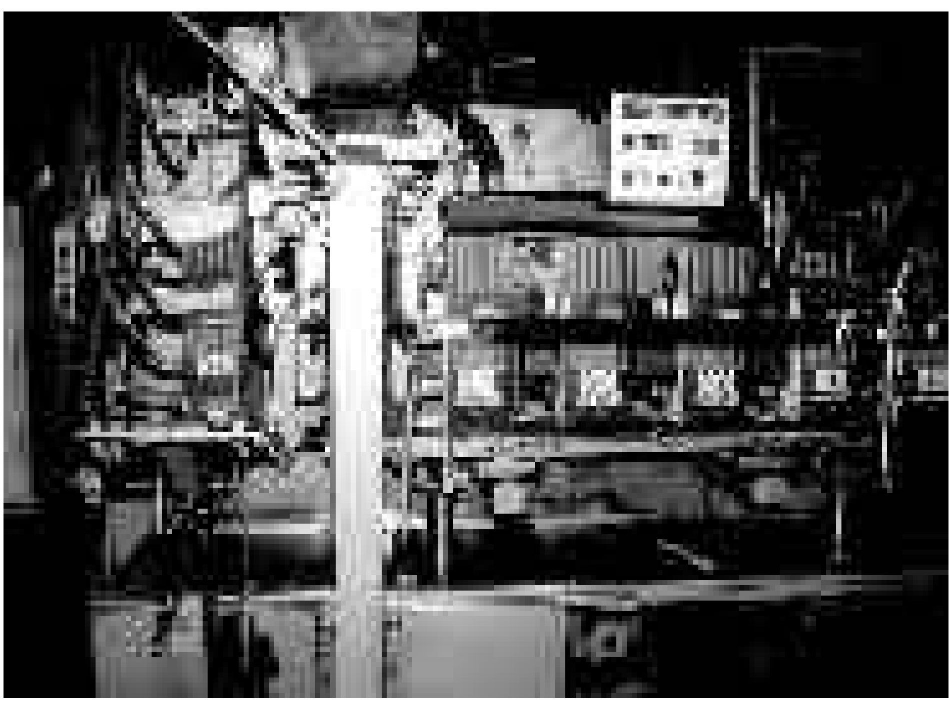
Charcoal briquettes produced by this technology are excellent and find ready demand in developed countries. These are much denser than wood charcoal with good handling strengths. Apparent densities of 0.8 to 0.9 have been reported compared to densities of 0.3-0.6 for wood charcoal. These find applications in food stalls and hotels for roasted food and also in metallurgical and electro thermal industries. However, the cost of production is much higher than conventional charcoal and yields during carbonisation vary from 25–40 percent.

Carbonisation—Briquetting

Wood waste and low ash agro-residues can be carbonised at any scale in various types of kiln. The char obtained is crushed and mixed with moistened binder and inert materials like lime as an energy extender and then briquetted into either pillow shape or cylindrical or beehive briquettes. Briquettes are either formed by different machines or done manually. If production is small scale they are then sun dried, and if industrial scale, the gases produced from the carboniser are burnt and the hot gases are used for drying.

The advantages of these technologies are:

- Highly economical at any scale of operation from 200 kg/day to 25 tonnes/day.
- Use of any wood/agricultural residues and products can replace fuelwood and wood charcoal.
- Provide smokeless domestic fuel easily ignitable with sustained uniform combustion.
- Small capital investments for rural based units.
- Local potter's clay can be used as binder.
- Relevant process for sugarmills. Excess bagasse can be carbonised and briquetted using molasses and press mud as binders and fillers respectively, and the product can be stored and used as boiler fuel during the non operating periods of the mills.



Charcoal briquettes from Sweden

Networking in Briquetting

RWEDP has noticed a strong interest in briquetting in many RWEDP member countries. Overall, there seems to be a need for exchange of information and experiences. Organizations involved in research, development, testing, production or applications with respect to briquetting are invited to express their interest to RWEDP.

Small scale unit

A rural family with 4 charring drums and two hand moulds costing about US$ 300 and using manual labour can produce 100–200 Kg of briquettes from 270 to 540 Kg of biomass respectively. With the sale price of briquettes at 0.15$ per kg in semi urban areas, an income of $15–30 per day can be generated. Because of its excellent economics, its tendency to generate rural employment and above all because it provides environmentally clean fuel from sustainable residues, replacing fire wood, it is highly appropriate and recommended for wide scale dissemination.

Conclusion

Briquetting of wood and agro-residues is a highly relevant technology for the utilisation of wastes. The products obtained can be transported economically and burnt clean both for the industrial and domestic sectors. Being eco-friendly with high social relevance and having the potential to contribute forest conservation, it should be adopted on a wide scale. In fact, this is a technology that can be said to create wealth from waste.

Biomass Research in The Netherlands

J. Van Doorn

In The Netherlands, as elsewhere, concern about global warming caused by carbon dioxide emissions has increased steadily. It is recognized that the emissions related to energy production from coal, natural gas and oil can only be lowered by comprehensive changes in the energy sector. Activities to stimulate energy conservation both in the domestic and industrial sectors are being taken or planned. Furthermore, the use of renewables, like wind, solar and biomass energy to replace fossil fuels is also contributing to a reduction in global carbon dioxide emissions.

In the mid-term, the largest contribution from renewable energy is expected to be from bio-energy. Although the Netherlands is a densily populated country with a relatively small forest area, energy from biomass could replace 5-10% of the present energy sources. Two routes are considered. The first one is to grow and harvest biomass on agricultural lands. Because of overproduction of food crops in the European Union Countries, financial incentives have been introduced to persuade land owners to set land aside. This set-aside land can be used for production of biomass for energy, such as fast growing trees (willow, poplar), oil crops (rape seed) and grassy crops (miscanthus). At present the major drawback is the high cost of producing biomass. It is expected that improving plant material and harvesting techniques will lower the costs considerably.

The second route, which receives most attention in The Netherlands, is the use of biogenic waste materials. Large amounts of waste wood, by-products from agricultural activities, green waste from domestic sources and manure are available at relatively low costs. It has been estimated that 50-100 PJ of bio-waste could be used for energy purposes annually (the total annual energy consumption is about 2700 PJ).

At ECN several reviews have been carried out to gain a better insight in the availability of these bio-waste streams. At the same time, the chemical and physical composition of the various materials is determined in order to evaluate the possibilities for energy production. The most important research activity aims to develop methodologies and techniques for converting biomass into a fuel. An often neglected aspect of large-scale biomass use concerns the complete chain, including the supply of biomass, logistics, conversion technology itself and the application of the solid residues from the process.

The most appropriate technologies for converting biomass into energy carriers are combustion and gasification. For gasification at a larger scale (> 1-5 MW_{el}), circulating fluidised bed gasification is considered the most promising technology for production of electricity, because of its high efficiency and low gas cleaning costs. At a smaller scale, moving bed gasification coupled with an internal combustion engine might be more appropriate. Tests at ECN with such a moving bed (downdraft) gasifier proved that willow wood obtained from an energy plantation is a superb fuel. A 350 kW_{th} circulating fluidised bed gasifier is under construction at ECN. With these two installations problems concerning the gasification behaviour of different forms of biomass and the quality of the fuel gas or solid residues can be solved. The findings will support the implementation of commercial size installations. Concentration on characterization and standardization of fuels could limit the risks of operating commercial gasifiers. These are particularly favoured by manufacturers because they allow the use of a wide variety of fuels. Close contacts between research institutes, such as ECN, and the potential suppliers of biomass and the users of the installation should be stimulated.

J. van Doorn works with Netherlands Energy Research Foundation, ECN, Unit ECN Renewable Energy in The Netherlands

ENERGIA Network and Newsletter

The Energy, Environment and Women Newsletter (ENERGIA) is a new publication to be distributed to field projects, organisations or individuals interested in and/or working with energy and environmental activities as related to women and gender. It is a first step towards promoting networking activities, initially sponsored by an informal group of Northern women, with the idea of recruiting other members, especially from the South, at Beijing and beyond.

The network is designed to share information about improved methods of planning and strengthening of all kinds of energy and environmental activities as related to women and gender and to report on on-going or planned initiatives of potential interest to its members.

The newsletter is intended as a vehicle for the communication of all sorts of information in the area of gender and energy, and its emphasis will be on case studies and other inputs direct from the field, with a high degree of Southern participation, through the publication of short articles (1000–3500 words) about on-going and planned initiatives.

Please address any enquiries or contributions to:
ENERGIA Newsletter
Energy, Environment and Women Network
c/o TOOL
Sarphatistraat 650
1018 AV Amsterdam
The Netherlands

ENVIRONMENT
ENERGY

Publications Review

Stove Images: A document on traditional and improved stoves

This publication aims at improving the household conditions as well as the protection of the environment in Third World Countries. It presents a collection of traditional and improved technologies in the household energy sector and describes these technologies in their comprehensive and complicated framework. Particular emphasis is put on the systematical documentation of the above-mentioned technologies, their visualization and the sensitization of all people concerned including producers, extension workers, project managers as well as decision makers.

The publication is divided into three parts. Part one contains a collection of articles on special topics in relation with these technologies. The authors are experts from different countries. Part two is the technical sector and the main part of the publication which contains 112 data sheets .presenting about 250 photos of traditional and improved stove technologies from 41 countries in Africa, Asia and Latin America accompanied by technical drawings and short descriptions . Part three contains a bibliography of 270 selected titles from 76 countries as well as a directory containing about 510 addresses of organisations, institutions, projects and experts from 100 countries.

This publication was financed by the European Union and prepared by SfE, GmbH, edited by Beatrix Westhoff and Dorsi Gehrmann (221 pages, availability limited)

Report Regional Advisory Committee Meeting

This report is a result of the RWEDP Regional Advisory Committee meeting which was held in Bangkok from the 31 January to the 4 February 1995. RWEDP organized this meeting to seek policy advise from its member countries on the cooperative programme to be undertaken under this regional project. In particular, the meeting aimed at the following:

- to provide broad strategic advise on the direction of the project and work plans;
- to provide advice on priorities for action at the regional level;
- to contribute to the development and adoption of improved wood energy policies, plans and strategies in member countries.

The meeting was attended by 28 high-level officials from both the forestry and energy agencies of the 15 existing member countries of the regional project. Many of these officials are involved in policy deliberations and/or decision-making in their respective countries. During the meeting the draft work plan was approved and some new suggestions were added.

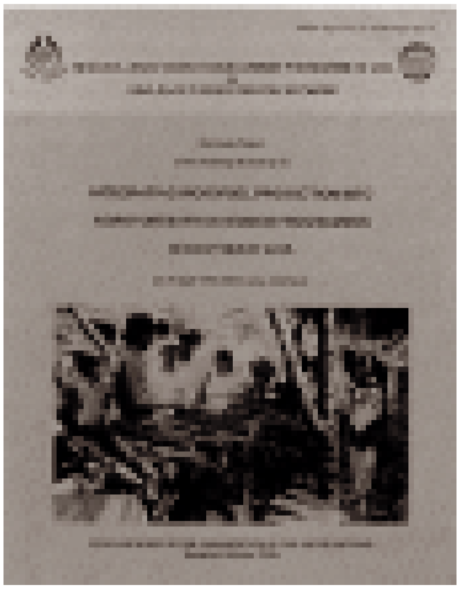
This report describes the organization and conduct of the meeting, summarizes the presentations and discussions held and, finally, presents the main conclusions and recommendations which were given by the committee concerned.

The report is available from the RWEDP secretariat. See also Wood Energy Newws Vol.10 No.1.

Integrating Woodfuel Production into Agroforestry Extension Programmes in Southeast Asia

This report summarizes the training workshop on integrating woodfuel production into agroforestry extension programmes, which was held on West Java in April 1995. Woodfuel is one of the major products from trees in Asia and similarly in other parts of the world and its production is a major economic activity in rural areas of most member countries of RWEDP and APAN. However, it still seems as if the importance of woodfuel and its relevance for forestry is sometimes better appreciated by the agricultural sector than by the forestry sector. This brings us straight to the subject of this training workshop: integrating woodfuel production in agroforestry extension programmes, as a joint effort of the Regional Wood Energy Development Programme (RWEDP) and the Asia-Pacific Agroforestry Network (APAN). The workshop was the first one of two sub-regional workshops on Woodfuel in Agroforestry, funded by RWEDP.

This report, which contains the training workshop sessions, starts with some background information on the organiz-



ing institutions, the participants, the training workshop objectives and the training process itself. In the first session of the training workshop, emphasis was laid on the importance of woodfuel in energy utilization and forest resources in member countries. The second session of the workshop discussed extension as a tool to increase woodfuel production on farmers' land. An overview of various extension methods and some case studies to illustrate alternative extension approaches under different circumstances were presented during the workshop and included in this report. The third session on woodfuel production and utilization consisted of three presentations discussing species selection, productivity of fuel wood in agroforestry systems, technical aspects on woodfuel characteristics and small-scale utilization of woodfuel. The last two sessions of the workshop discussed woodfuel energy aspects in Indonesia and a framework for collecting field data respectively. The workshop was closed by discussions on national level issues related to marketing, extension, woodfuel production and utilization.

The report is available from the RWEDP secretariat and from the APAN Secretariat, P.O.Box 481, Bogor 16004, Indonesia. See also News and Notes, Wood Energy News Vol.10 No.2.

News and Notes

Trade in Woodfuel and Related Products:

RWEDP, in collaboration with the Pakistan Forestry Institute (PFI), organized a four day regional workshop from 1–4 October 1995 in Peshawar, Pakistan. The course was attended by 32 representatives and resource persons from various government and non-governmental organizations, including training institutions. Majority of the participants represented the forestry and power/ energy sectors, some others belonged to their respective planning commission or academic institutes.

As the role of non-forest land in woodfuel supply is unique, and the woodfuel trade is also quite prominent in Pakistan (90 percent of the woodfuel requirement is supplied from non-forest sources and about 41% of consumption is met by purchased woodfuels from markets), this country was considered appropriate to host this first of its kind regional course on trade in woodfuel and related products. Ten countries from both south-east and south Asia participated in the course.

Besides an overview paper which presented the up-to-date status of woodfuel supply/demand, resource management, and woodfuel flow systems in selected countries of Asia, six case studies (two each from Pakistan and Philippines and one each from India and Myanmar) were presented to provide insight information on the prevailing systems of woodfuel trade and marketing, also the variation in it from one country to another.

The one day field trip part of the course allowed participants to observe and assess the development of non-forest area woodfuel production, flow and marketing in and around Peshawar City which is the achievement of past less than two decades. The bandwagon effect of poplar planting under agroforestry systems is quite distinct and based on it a series of new woodbased industrial, commercial activities have been generated creating employment and income. The income and employment aspect' of private sector forestry activities was clearly visible in the sites visited.

The workshop session of the course identified a general list of activities to be undertaken both at regional and at the country levels. Areas that have been identified for consideration include: developing better understanding, institutional set-up and formulation of conducive policies and plans. The workshop was rated successful by participants in terms of achieving its preset objectives.

Stoves for Use with Loose Residues as Fuel

This 5-day regional workshop was organized by RWEDP in cooperation with the Institute of Energy of the Ministry of Energy of Vietnam. It was held in Hanoi, Vietnam from 16–20 October 1995. The workshop was attended by 23 representatives and resource persons from various government and international organizations as well as NGOs. The main objective of the workshop was to determine methodologies and formulate specific recommendations for the introduction of improved stoves which can use loose residues as fuel.

Due to various reasons, including increasing shortages of wood fuels, many people in RWEDP member- as well as other countries, are starting to use residues such as straw, leaves, husks, etc. as their main cooking fuel. However, many of the traditional stoves used for cooking are not very suitable for use with these loose residues. Residues behave differently when combusted and this often results in the users having to spend more time to tend the fire and less time to carry out other chores such as taking care of children, food preparation, etc. Burning loose residues often results in more ash, smoke, etc. and produces a less clean kitchen and possibly more unhealthy working conditions for the users. Besides the user-related factors, the higher amount of ash, differences with fuel feeding techniques and the variations in combustion characteristics of the fuel, etc. were also identified as potential obstacles in terms of designing stoves to be used with loose residues.

Based on presentations made by the participants as well as resource persons, extensive discussions were held with regard to the issues involved as well as the present state of the art of stoves used with loose residues such as rice husks, sawdust, etc. It was concluded that, even though residues have become more important as a fuel, often this shift from fuelwood to residues is only partial and is influenced by factors such as availability and preferences for certain occasions, etc. This will influence the design of the stove as the multi-fuel flexibility of the stove should preferably be maintained. The lack of information on residues such as availability and accessibility, seasonality, degree of monetization, time budgeting, etc. was also found to be a factor which impedes activities to assist users of stoves which can burn residues in an effective and efficient manner.

The participants recommended that more activities be undertaken with regard to stoves for use with loose residues such as for instance providing basic information on characteristics of the different types of residue fuels and how these characteristics influence stove design and use. Besides, it was also recommended that programmes for the promotion of residue stoves should:

- Have the benefit of comprehensive surveys and assessment exercises before the start of a project. This should involve the participation of formal and informal local leaders and other respected individuals.
- Strive for a balance in both the development of stove designs and program strategies with regard to: affordability / durability, the need for efficiency / the need for convenience, user needs / program priorities, multiple fuels and functions in one stove/ greater specialization
- Be focused and clear to ensure the credibility of the technology and the program. In addition, the stove should have significant and perceivable benefit for the users in order to ensure successful adoption of the technology.

Integration of Woodfuel Production in Agriculture, Forestry and Rural Extension Programmes

A five day sub-regional training workshop on "integrating woodfuel production in the implementation of agriculture, forestry and rural extension programme in south Asia" was held in Rajendrapur, Bangladesh, from 25–29 October 1995 for the seven south Asian member countries of RWEDP. Two national agencies of the Government of Bangladesh, the Bangladesh Forest Department (BFD) and the Bangladesh Agricultural Research Council (BARC), collaborated with RWEDP in hosting this training course. The sub-regional training course was the second of its kind, the first course was held in April 1995 in West Java, Indonesia, for the eight RWEDP member countries in Southeast Asia.

The South Asian training workshop was attended by 25 representatives and resource persons from six (excluding Maldives) member countries, which constitute a common regional forum called the South Asian Association for Regional Cooperation (SAARC). The composition of participants included multi-sectoral, multi-disciplinary individuals (GO's, NGO's, including training institutions) actively involved in the implementation of forestry, agroforestry or rural extension programmes which integrate forest management and/or tree planting in the sub-region.

The workshop was inaugurated by the Secretary of the Ministry of Environment and Forest of the Government of Bangladesh and many senior officials from relevant institutions attended the opening session.

The training workshop played a key role in increasing the understanding of participants about the importance of wood energy in national energy balance and economy, about the factors that affect household level decisions on production and conservation and marketing and investment in natural resources use/management. Seven topical papers were presented: one background paper from RWEDP; one paper from the Asia Pacific Agroforestry Network (APAN) to explain the household level decision making mechanism; and five case studies, one each from Bangladesh, India and Sri Lanka, and two from Pakistan, to explain country situation. The second case study from Pakistan specifically covered the aspect of wood energy related training curricula development in the Pakistan Forestry Institute (PFI), particularly in relation to its specialized "wood as energy" course in forestry at the M.Sc. level. The specific issues of community forestry and woodfuel production in non-forest lands were discussed extensively in the meeting.

Selection of Bangladesh as the host country was based on its peculiar position in terms of resource use patterns and practices, particularly the interlinkages between high population density, traditional landuse system biased in favour of agriculture, and resource use dictated by scarcity and search for easily available substitutes.

The positive achievement of new strategy pursued for the management of encroached degraded sal forest around Dhaka through application of agroforestry practices in different forms was clearly visible during the field trip. Also visible were the common industrial and commercial activities in rural and peri-urban areas that relied on wood for energy.

The meeting also served as a forum for networking important individuals and institutions who are involved in wood energy related development in the sub-region. At the end of the day, participants prepared an outline for replicating similar training programmes at the country level in their respective country group. The overall rating of the workshop by participants was "successful".

Events

Event, Description (Info)	Date, Venue
Rural Projects: Design, Monitoring and Evaluation, short course Design of rural projects, methods required to monitor their progress, and evaluations of their impact, needs of target communities and design requirements of major multilateral and bilateral agencies (ANUTECH)	22 Apr–24 May 1996 Canberra, Australia
Energy Strategies in Developing Countries in the 21st Century: Challenges and Opportunities, International Energy Conference and Exhibition The scope of this conference includes rational use of conventional and new and renewable forms of energy, the global environment issues, rural and urban energy challenges, energy systems analysis and prospects, scientific and industrial transfer of technology and energy sustainability and energy options. (CICCST)	3–7 June 1996 Beijing, China
9th European Bioenergy Conference This conference, which is sponsored by the European Commission and the Danish Energy Agency, aims at reviewing progress in technological development with a view to accelerating the deployment of bioenergy, addressing manufacturers, agriculture and forestry feedstock producers; end-users including municipalities, utilities and the agro and forestry industries; researchers, developers, consultants, policy makers and the media (DIS).	24–27 June 1996 Copenhagen, Denmark
Forestry for Rural Development, Postgraduate Course (11 months) Rural forestry focuses on the planning, management and controlled utilization of forests and trees in rural areas, a.o. for energy. The involvement of local people in the different stages of planning and implementation is a specific characteristic of rural forestry (ITC)	Starting August 1996 Enschede, Netherlands
Socio-economic Information for Natural Resource Management, MSc course (18 months) The course aims to develop knowledge and skills in the interconnected fields of spatial aspects of land and resource planning and policy support, and information acquisition and its management, with a particular focus on georeferenced, socio-economic information. During the MSC part, students can specialize in| Rural Energy and Development. (ITC)	Starting August 1996 Enschede, Netherlands
Environmental Assessment for Developing Projects, short course Skill in environmental assessment for use in project planning and management, EIA procedures, environmental economics/valuation, methods in social impact assessment and the role of the community in environmental management (ANUTECH)	30 Sep–25 Oct 1996 Canberra, Australia
Development, Operations and Management of Community-Based Forest-Producs Enterprises, short course Organizing, developing and managing forest products enterprises, their role in the promotion of socio-economic development, properties of forest products, particularly non-timber resources, and processing technologies for their efficient utilization. Also many other forestry-related short courses (UPLB).	1–4 October 1996 Los Baños, Philippines

ANUTECH: ANUTECH/Australian National University, GPO Box 4, Canberra, ACT, 2601, Australia. ☎ +61-6-249 5671, 249 0617, 🖹 249 5875, 257 1433

CICCST: China International Conference Centre for Science and Technology, ENERGEX'96 Secretariat, P.O. Box 9651, Beijing 100086, Chinalian National University, GPO Box 4, Canberra, ACT, 2601, Australia. ☎ +86-10-257 5681, 257 5685, 🖹 257 5691

DIS: DIS Congress Service Copenhagen A/S, Herlev Ringvej 2C, DK-2730 Herlev, Denmark, ☎ +45-4492 4492, 🖹 4492 5050

ITC: ITC Student Registration Office, Attn. Mrs A. Scheggetman, P.O. Box 6, 7500 AA Enschede, The Netherlands, ☎ +31-53-4874 205, 🖹 4874 238, 💻 scheggetman@itc.nl

UPLB: University of the Philippines Los Baños, attn. The Director, Institute of Forest Conservation, P.O. Box 434, College 4031, Laguna, Philippines, ☎ +63-94-3340/3206, 🖹 2268, 2736, 3340, 💻 trv@mudspring.uplb.edu.ph

European boiler and turbine technology; Midtkraft/Peter Bandtholz, EC-ASEAN COGEN Programme