BIOMASS/WOOD ENERGY RESOURCES: COMMERCIAL PROSPECTS FOR WOOD-BASED TECHNOLOGIES[1]

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SUMMARY
The paper summarises the important role of biomass/wood energy in ASEAN and other Asian countries. Benign environmental characteristics are elaborated. Prospects for enhancing modern applications are indicated, and the options for dendro-power are discussed.

Wood/Biomass Energy

Asia

Wood is an important fuel in Asia[2] where most countries meet some 50% of their national energy needs from wood [Fig. 1]. The current economic value of woodfuel for 16 developing countries in Asia is estimated at 30 billion US$ per year [Table 1]. Biomass energy includes fuelwood, charcoal, wood residues and agriculture residues. Total biomass energy in Asia is about 15,000 PJ per year [Ref.3].

The share of biomass/wood in the total energy consumption has been decreasing for most countries, which often leads to the misconception that biomass energy is being substituted by conventional energy (e.g. fossil fuels) and that it is phasing out. On the contrary, biomass energy consumption is still increasing in absolute terms, mainly due the population growth but sometimes also due to increased consumption per capita, as is the case for Thailand [Fig.2]. Contrary to common belief, overall consumption of woodfuel does not necessarily decrease with increasing GDP/cap [Fig.3, Ref.2]. Conventional energy is mostly used for new applications such as new industries, transport and household electricity, whereas wood and other biomass continue to be applied for domestic activities such as cooking, and various industrial and commercial activities.

ASEAN member countries

In ASEAN member countries like in other Asian countries, biomass is an important source of energy. In ASEAN, biomass energy represents about 40% of total energy consumption, i.e. more than 3,300 PJ per year. The bulk is from woodfuels with an estimated value of 8 billion US$ per year [Ref.1]. Main applications are in the domestic sector and small-scale industries, but also increasingly in modern systems for combined heat and power generation.

In ASEAN countries the use of conventional energy like oil, coal, gas and electricity has increased enormously in the last 25 years. During the eighties, consumption has more than doubled, with an average annual growth rate of 7%. Although less spectacular and somewhat overshadowed by the booming consumption of conventional energy, also the consumption of biomass energy has increased substantially. For the seven ASEAN countries where biomass is an important energy source (Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand and Vietnam), consumption increased with an average annual growth rate of nearly 2%

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[2] Reference is made to 16 developing countries in Asia, which are member countries of RWEDP, i.e. Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam.

between 1985 and 1994. Consumption is highest in Indonesia, accounting for more than half of the total consumption, which is due to its large population, whereas the increase is highest in Malaysia and Vietnam [Ref.4].

Biomass energy characteristics and potentials

Biomass energy can be sustainable, environmentally benign and economically sound. Moreover, biomass energy creates substantial local employment. The advantages are being recognised in industrialised countries, where several governments have successfully adopted articulate policies for promoting biomass energy. For instance, countries like Sweden, USA and The Netherlands have strong policies to promote wood-based power generation [Ref.4]. Strikingly, the USA consumes as much biomass energy per capita as South-Asia, which indicates that biomass energy can very well be a modern form of energy.

The potential of modern applications of wood energy is not yet fully appreciated in Asia, where woodfuel is largely considered a traditional fuel only. Also the importance of woodfuel for local economies is still largely overlooked. Woodfuel-related activities are the main source of income for some 10% of the rural population in Asia. Tropical countries enjoy favourable conditions for growing biomass. However, constraints to optimal use as an energy source are still to be resolved. Main issues are legal and institutional barriers, as well as lack of information and technology transfer. Furthermore, common misconceptions about the role of biomass energy have to be redressed. It should be emphasised that the larger part of woodfuels comes from private land, including plantations on a sustainable basis. Therefore, woodfuel use is not the root cause of deforestation, and biomass energy will not phase out in the foreseeable future. In fact, biomass energy is more than a traditional commodity, and it's potential can be developed much further.

THE ENVIRONMENTAL PREMIUM

Growing trees for woodfuel and other purposes has obvious advantages for the local environment. In addition, the use of wood/biomass energy offers an environmental premium for the global environment. This will be briefly elaborated here.

Implications of woodfuel use for the global environment can be evaluated by estimating the associated greenhouse gas emissions. As the main greenhouse gas, only CO_2 (carbon dioxide) is considered here, leaving aside gases like methane and other carbon-hydrogens. Any emissions caused by woodfuels can be compared with emissions from alternative fuels.

Though combusting wood, of course, emits CO_2 into the atmosphere, regrowth of wood captures CO_2 from the atmosphere. As a first approximation it can be stated that woodfuel use is carbon neutral, i.e. there is no net emission of carbon into the environment. The approximation is supported by the evidence of two dominant mechanisms. First, it is observed that by far the largest part of woodfuel use takes place on a sustainable basis. This applies to virtually all woodfuels originating from non-forest land (e.g. agriculture land, plantations and homegardens), and to most of the woodfuels from forestland.

Sustainability implies carbon neutrality, because the same amount of CO_2 emitted by wood combustion, is recaptured from the atmosphere by regrowth of wood. Second, with regard to woodfuels acquired as leftovers from non-sustainable logging and land conversion, it is noted that not-using the leftovers for fuel (or for other purposes) would imply that they will decompose by natural processes. Eventually, natural decomposition leads to the same amount of carbon emitted in the atmosphere as when the woody material would be combusted (though not necessarily distributed amongst CO_2, methane and other greenhouse gases in the same way). Obviously, if woodfuels were not utilised, some alternative energy source would be required and used. For most applications and in most countries, the hypothetical alternative would be a fossil fuel, i.e. coal, gas, or oil products. For few applications and in few countries, hydro and wind power could be the hypothetical alternative, whereas within the next 15 years or so the option of other renewables like solar photo-voltaics is negligible in terms of energy quantity. The effects of fossil fuel use on the global atmosphere have been well documented. Typical data for the emission of CO_2 per fuel and per unit of energy are available [Ref.3]. Furthermore, the other renewable energy sources are considered to be carbon neutral, like wood.

The implications of woodfuel use in Asia for the global environment can then be evaluated by estimating how much CO_2 emission from hypothetical alternatives is avoided by woodfuel use. The most likely (or least unlikely) mix of alternative energy sources varies per country. For the purpose of the present estimate, LPG can be considered as the alternative. This leads to a simplistic though conservative estimate, because per unit of energy coal emits 30% more and kerosene 7% more CO_2 than LPG. The results are represented in Table 2. Switching between wood and other biomass fuels like agri-residues are ignored, because carbon neutrality applies to the other biomass fuels for the same reasons as for wood.

From Table 2 it is seen that in 1994 woodfuel use aggregated for 16 developing countries in Asia results in avoided emission of about 278,000 kton CO_2 per annum as compared to hypothetical LPG use. This equals 6% of the current CO_2 emission due to total fuel use in the same countries. By the year 2010 the figures would be 349,000 kton and 3% respectively.

Table 2 Greenhouse Gas Implications of Woodfuel Use for 16 developing countries in Asia

Environmental effect	1994		2010	
Total CO_2 emission due to energy use	4,317,000	kton	10,602,000	kton
Avoided CO_2 emission by woodfuel use (as compared to LPG)	278,000	kton	349,000	kton
Avoided CO_2 costs by woodfuel use	14,000	mill. US$	17,500	mill. US$

The economic benefit of current woodfuel use in Asia for the global environment can be appreciated by estimating the cost, which would otherwise be required for avoiding or recapturing the emitted CO_2 from the atmosphere. Cost estimates for the latter vary a lot, depending on conditions and technological options (like removal, storage, recapturing, avoiding, etc, of the CO_2). Based on estimates of the International Panel on Climate Change [Ref.3], 50 US$ per ton avoided/recaptured CO_2 is a typical figure within the present range of options. Hence, it can be estimated that in 1994 about 14 billion US$, respectively in 2010 about 17 billion US$, for CO_2-related costs are avoided by woodfuel use in 16 developing countries in Asia.

ENHANCING MODERN APPLICATIONS

A common mis-concept is that wood/biomass energy is a 'dirty' fuel. This perception may be based on observations of smokey kitchens in traditional households and the like. However, the cause is not the fuel as such, but rather the technology (or lack of technology) commonly applied for combusting biomass fuels. Diesel, kerosene and coal are also 'dirty' when not properly combusted. Clean, convenient, efficient and economic technologies are available for utilising biomass fuels. It is a commercial challenge to widely disseminate such modern technologies in the domestic, commercial, industrial and utility sectors.

Great advancements in utilising biomass fuels in a modern way have already been made. Examples are improved stoves and combustion chambers and the increasing application of co-generation in industries. Modern technologies allow not only to combust wood in a clean and efficient way, but also more difficult biomass feedstocks like rice husks. For larger-scale applications, gasification technology provides very good options.

Economies of scale offer major advantages in biomass energy. These apply not only to machinery and equipment, but also to logistics with regard to securing regular inputs and utilising the outputs in the form of heat and/or electricity, as well as infrastructural investments and managerial capacities. Government and private sector in industrialised countries are taking advantage of these characteristics.

It is observed that many countries in Asia avail of a large under-utilised reservoir of agri-residues, wood residues and even potential energy plantations, which can be tapped for energy applications. The benefits will be in terms of economic growth, foreign currency saving, employment generation, and local environmental management. An additional advantage is the environmental premium for the global environment.

In the next section options for modern applications are elaborated for the case of dendro-power. The section is based on the conclusions and recommendations of a recent expert consultation convened by RWEDP at Manila, April 1998, on 'Options for Dendro-power in Asia' [Ref.5].

PROSPECTS FOR DENDRO-POWER

Cogeneration based on wood residues from some processing industry is a form of dendro-power. A step further is to grow, supply and use wood purposely for generating power. This is sometimes called 'dedicated dendro-power'. Dendro-power can be dedicated or based on a combination of biomass feedstocks, or even a combination of wood and coal. Dedicated dendro-power is currently being implemented in several industrialised countries, Brazil, and other parts of the world. It is noted that a dedicated dendro-power programme in the Philippines in the early 1980's was terminated for various reasons. Today's dendro-power projects are commercial undertakings. Some may of them cash in on an environmental premium.

Dendro-power potential

Dendro-power provides a significant potential to contribute to national economic growth and employment generation in rural areas, as well as local and global environmental management. With modern technologies, wood and other biomass can provide a competitive and sustainable fuel for processing and conversion into electricity in many situations. This position is expected to develop considerably when more expertise is gained with using biomass as a modern energy carrier. The development of dendro-power fits well in general trends towards deregulation and privatization in the power sector, and/or decentralized power supply in remote areas. Mainstream as well as niche markets for dendro-power do exist in developing countries in Asia. The governments of these countries can formulate a strategy for the development of modern dendro-power.

Developing countries in Asia should explore the sustainable potential of wood and other biomass fuels to help meet their growing demand for electricity, in addition to the already existing use of these fuels for process heat. Countries can initiate the identification and preparation of viable dendro-power projects in niche markets. Amongst potential niche markets are power plants based on combinations of woodfuel with agro-residues in order to overcome seasonality in the supply of the latter. Also, co-firing of woodfuels with coal or lignite using modern technologies should be explored and experience with large-scale supply of biomass should be gained in such applications. The potential of dendro-power for mainstream applications and major markets in suitable areas in Asia should be studied.

Authorities should proceed with the implementation of clear regulations and mechanisms for wheeling and banking of power so as to accommodate independent power production.

Resource base

Many countries in Asia possess a large potential resource base for bio-energy fuels. The resource base consists of (1) agro- and forest residues that cause a disposal problem, (2) agro- and forest residues that have alternative uses but can be used under certain conditions, and (3) eventually wood and biomass specifically grown for energy purposes. However, site-specific data and evaluation of the resource base and its potential are not yet available. Efforts can be made to obtain detailed and site-specific information on present and future alternative uses of bio-resources.

Developing countries in Asia should engage in establishing databases for evaluating the potential of bio-energy resources for modern applications in the power sector on an area-specific basis. Competing uses, supply patterns, markets and prices should be included in these databases. The potential of diversified biomass fuel supplies (dedicated wood plantations, available wood residues, other biomass) should be evaluated for feeding multi-fuel boilers and gasifiers.

As yet there is limited experience in Asia with large-scale woodfuel plantations, both technically and organizationally. The potential of dedicated woodfuel plantations and residues from other sources should be inventorised in various areas in the context of complementing and competing interests. Special consideration areas are buffer zones around protected areas and areas where erosion prevention, water retention, biodiversity conservation etc. can be obtained.

Technologies

Several mature and proven small-scale and large-scale technologies for dendro-power plants are available and more technologies are emerging. Economies of scale provide substantial benefits for dendro-power plants. The feasibility of such options must be traded-off against constraints in the resource base, logistics of support, and other potential limitations. However, larger scale biomass energy systems should be considered. Vertical integration of activities in dendro-power (from biomass resource development to power generation) provides the most feasible approach in the initial stages of local market development, since it shields the resource base off from competition. Expertise is available and can be further complemented to prepare and implement dendro-power strategies and projects.

Developing countries should seek international cooperation for the preparation and implementation of dendro-power projects. Partners can be technology suppliers as well as specialized technical and financial consultants, and others. At the same time, these countries should make efforts to further develop local technologies and expertise required for dendro-power plants, including manufacturing capabilities for dendro-power equipment. South-South cooperation in R&D efforts for dendro-power development should be promoted. Developing countries in Asia should also seek cooperation with bilateral and multilateral organizations for supporting R&D on dendro-power in Asia.

State-of-the-art proven technologies should be selected for current applications in Asia. New, emerging techniques (such as gasification; BIG/CC) are to be considered seriously. Asia can be a major market for such advanced systems, because of available capital and infrastructure and often cheap biomass supply in the form of residues. The feasibility of a demonstration project for dedicated dendro power generation should be studied[3]. For the Asian context especially multi-fuel systems are of interest.

Climate policies

The sustainable use of wood and other biomass fuels provides a strong support to the implementation of international policies with regard to global climate change. Many industrialized countries have made substantial progress in applying modern technologies for biomass fuel utilization. Also developing countries are gaining experience in these options. Financial support mechanisms are being developed by international financial institutions and/or industrialized countries that enable developing countries and economies in transition to apply the modern bio-energy options. More and more large actors, such as utilities, oil companies, etc., are coming in which could be major partners for developing countries in developing and implementing dendro-power.

The role of governments is to provide the policies and framework for implementation by the private sector. It is increasingly being accepted that internalization of externalities in the energy sector is economically feasible and environmentally desirable. This can tip the balance in favor of dendro-power in many situations and considerably accelerate the implementation of energy from biomass.

Developing countries and economies in transition should convert the new options for dendro-power into projects, making full use of the modalities for funding and implementation. In order to fully exploit the new options, capabilities should be developed with expert inputs from the energy, environment, forestry and financial sectors. Initiatives should be taken for the provision of information, training and demonstration for policy makers, professionals (engineers, environmentalists, foresters, economists, and others) and the general public on the positive impacts of biomass energy for economic development, employment generation and environmental management.

Financing

The renewable energy sector is professionalizing rapidly, resulting in higher success rates for projects. As yet, important barriers for obtaining financing for dendropower are:

- Uncertainties in fuel supply caused by competitive use of both the lands that it is on, the long tree harvesting times as well as alternative uses of the biomass once harvested.
- The low scrap value of highly specific and technical equipment.

More financing options besides the World Bank and Global Environment Facility (GEF) are becoming available such as the Clean Development Mechanism (CDM) and green banks. Developing countries should take advantage of the new mechanisms for financial assistance, at the same time serving their domestic priorities for power sector development and local environmental management. Governments should assist private sector organizations to actively access financial options.

[3] For instance, a project in the range of 20-40 MW requires some 12,000 hectares of fuelwood plantation and some US$ 50-100 million of investment.

CONCLUSIONS

Biomass need not at all be a 'dirty' fuel. Modern technologies are available for using wood/biomass fuels in a clean, convenient, efficient and sustainable way. In addition wood/biomass energy provides important environmental and other benefits. Good prospects exist for modern commercial utilisation of these fuels. A relatively new option is the application for dendro-power.

Figure 1. Shares of Wood Energy in Total Energy Consumption in Asian Countries

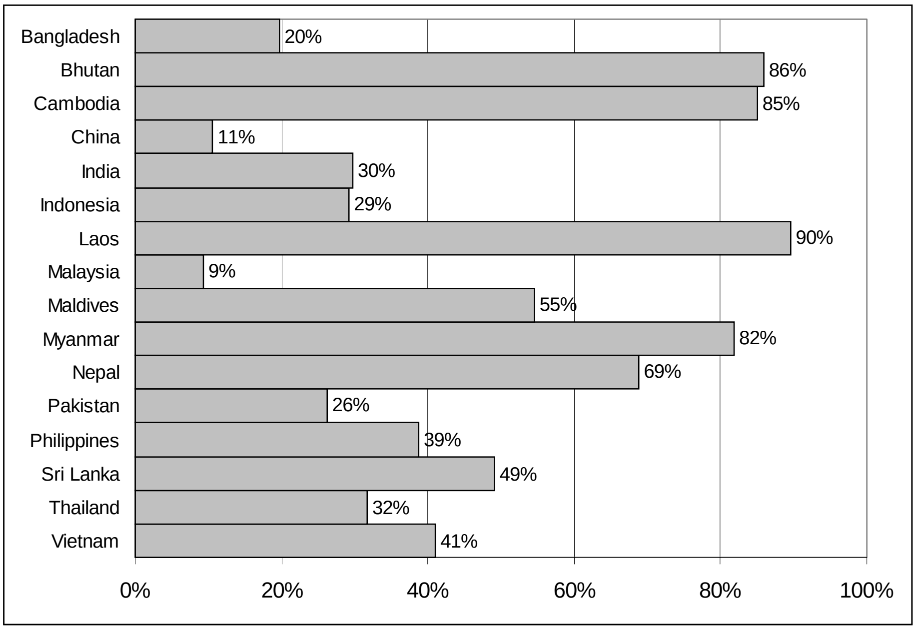


Table 1. Woodfuel values in million US$ using average woodfuel prices (1990)

Country	Fuelwood	Charcoal	Dom. FW	Dom. Char	Ind. FW	Ind. Char	Total
Bangladesh	306	-	255	-	50	-	306
Bhutan	37	3	33	-	3	3	40
China	9,320	-	9,320	-	-	-	9,320
India	9,080	-	8,440	-	640	-	9,080
Indonesia	2,317	-	2,317	-	-	-	2,317
Laos	88	-	88	-	-	-	88
Malaysia	31	49	31	49	-	-	80
Maldives	3	-	3	-	-	-	3
Myanmar	914	213	914	213	-	-	1,127
Nepal	469	-	451	-	17	-	469
Pakistan	1,318	-	1,317	-	-	-	1,318
Philippines	618	491	618	491	-	-	1,109
Sri Lanka	436	5	363	-	-	-	440
Thailand	432	1,595	432	1,595	-	-	2,027
Vietnam	1,139	139	1,055	133	-	1	1,278
RWEDP	26,506	2,494	25,637	2,481	710	4	29,000

Note: Assumed fuel prices are 40 US$/Ton or 2.67 US$/GJ for fuelwood and 250 US$/Ton or 8.62 US$/GJ for charcoal. The calorific values assumed are 15 GJ/ton for fuelwood and 29 GJ/ton for charcoal. End use efficiencies assumed are 20% for a fuelwood stove and 30% for a charcoal stove.

Figure 2. Increasing wood and biomass energy consumption in Thailand

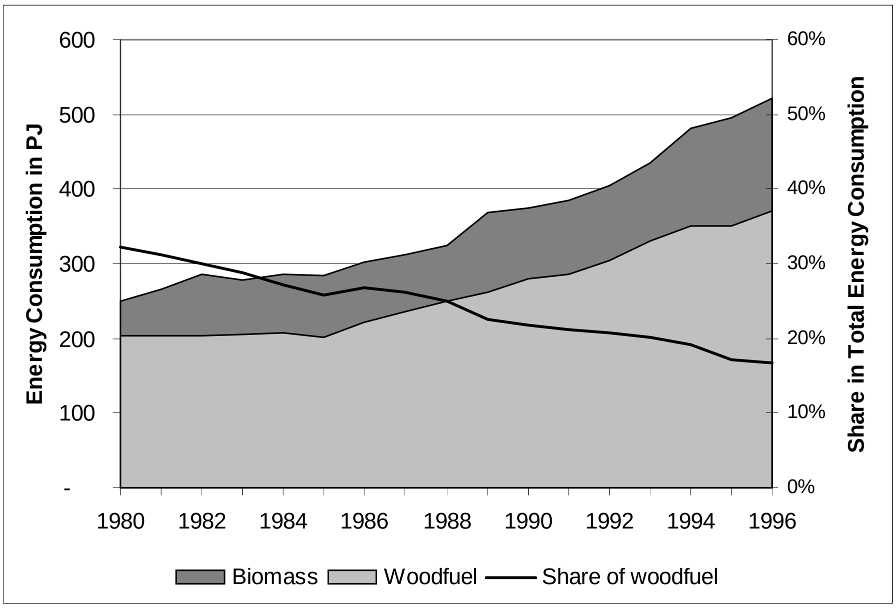
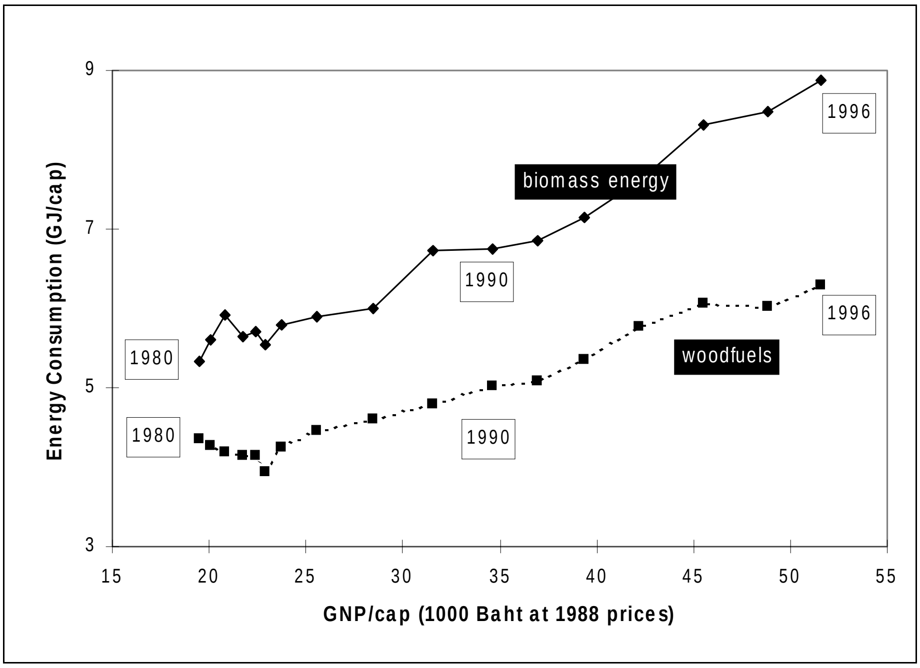


Figure 3. Wood/biomass energy consumption/capita vs. GNP per capita, 1980-96 in Thailand



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