BIOMASS ENERGY
IN
ASEAN MEMBER COUNTRIES

Current trends indicate that biomass will continue to be an important source of energy in Asia for the foreseeable future. This also applies to ASEAN member countries, notwithstanding their dynamic economic and social transitions. Government policies can support the good use of biomass energy, including energy from wood.

“BIOMASS: MORE THAN A TRADITIONAL FORM OF ENERGY”

FAO Regional Wood Energy Development Programme in Asia
in cooperation with the ASEAN-EC Energy Management Training Centre
and the EC-ASEAN COGEN Programme

SUMMARY

Biomass is an important source of energy in ASEAN member countries and its use is still increasing. In ASEAN, energy from biomass such as wood and agricultural residues represents about 40% of total energy consumption – more than 2.5 million Terajoules per year. The bulk is from woodfuels, with an estimated value of US$ 7 billion per year. Main applications are in the domestic sector and small-scale industries, but also increasingly in modern systems for combined heat and power generation.

Managed properly, biomass energy (or bio-energy) can be sustainable, environmentally benign and economically sound. Moreover, biomass energy creates substantial local employment. The advantages are also being recognised in industrialised countries, and several governments have successfully adopted articulate policies for promoting biomass energy.

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 biomass energy have to be redressed. It should be emphasised that the larger part of woodfuels come from non-forest land; woodfuel use is not the root cause of deforestation; biomass energy is more than a traditional commodity; and biomass energy will not phase out in the foreseeable future.

At present, AEEMTRC, COGEN and RWEDP cooperate in order to integrate information on biomass in energy data bases and assist in the development of sustainable energy policies.

It is recommended that energy policy makers in ASEAN member countries acknowledge the important role of biomass energy and its future potential. This will mean biomass energy can be integrated in overall energy policy making and planning. In particular the potential of modern applications for power generation should be given serious consideration as a way of ensuring optimal utilisation of each country's biomass resources.

BIOMASS ENERGY IN ASEAN ECONOMIES

The use of conventional energy like oil, coal and electricity has increased enormously in the last 25 years in ASEAN economies. During the 1980s, consumption more than doubled, with an average annual growth rate of 7%. Less spectacular, and somewhat overshadowed by this conventional energy boom, consumption of biomass energy has also increased substantially over the same period. Biomass energy includes fuelwood, charcoal and agriculture residues used as fuel.

For the five ASEAN countries where biomass is an important energy source (Indonesia, Malaysia, Philippines, Thailand and Vietnam), consumption increased on average 2% per year between 1985 and 1994, due mainly to population growth. Consumption is highest in Indonesia, accounting for more than half of the total consumption because of the large population, while the rate of increase is highest in Malaysia and Vietnam.

Despite this growth, the share of biomass energy in total energy consumption has been decreasing for most countries, which often leads to the misconception that it is being substituted by modern energy and is phasing out. In reality, conventional energy is mostly used for new applications such as new industries, transport and household electricity, whereas wood and other biomass continue to dominate in domestic activities such as cooking and in many traditional industries.

Only for Thailand, recent and regular national statistics on wood and other biomass energy consumption are available. Comparing these with population data, it appears that there is a strong correlation between population and biomass energy consumption between 1985 and 1995 (0.99). By using population forecasts, we can predict an increase of nearly 15% in biomass energy consumption by 2010 over that in 1995. As accurate data on supply sources, both from forest and non-forest areas, are lacking it is difficult to assess if there will be enough supply available to meet future demand.

For the other four major biomass-using economies in ASEAN, similar or even higher trends of increase in biomass energy consumption are forecast, considering their higher population growth and greater dependence on biomass energy (except in Malaysia). Of course the above is only a simple modelling exercise, but it highlights the need for more accurate, regular and detailed data on consumption and production of biomass energy and its sources in order to asses trends, to develop forecasts and to formulate appropriate policies.

ADVANTAGES & CONSTRAINTS

Advantages

Economy

Wood and other types of biomass are widely used as fuels in the (private) domestic and industrial sectors, basically because they are cheaper than other fuels. Local availability and reliability of supply add to the economic advantages. Modern applications in both industrialised countries and in South-East Asia have demonstrated that biomass energy can also be competitive for larger-scale industrial applications. For fuel-importing countries, the use of local biomass can save substantial amounts of foreign exchange. The value of woodfuels currently being used in ASEAN economies is equivalent to an estimated US$ 7 billion annually.

Environment

The sustainable use of biomass energy sources helps to manage the local environment. When wood and other biomass are properly valued by local populations as an important resource base, they are more likely to be protected. Sustainable use of biomass is also beneficial for the global climate, because it is carbon-neutral, whereas substitution by fossil fuels would add to the greenhouse effect. This is the main reason why many industrialised countries have embarked upon policies for increasing the share of biomass in national energy consumption.

Rural income

The use of wood and some other forms of biomass energy generates at least 20 times more local employment within the national economy than any other form of energy, per unit. A large amount of unskilled labour is engaged in growing, harvesting, processing, transporting and trading the fuels, which generates off-farm income for rural populations, either regularly or off-season. Policy makers in the European Union are increasingly coming to recognise the employment benefits for their own countries.

Social

In times of hardship, or when harvests are inadequate for subsistence, the opportunity to generate income in woodfuel business provides a safety-net for the people affected.

Efficiency

The application of biomass energy in modern technologies allows for increased energy efficiency by combined heat and power generation (cogeneration). Applications of cogeneration in decentralised systems based on locally available fuel resources help to further reduce losses in the transmission and distribution of power.

Energy mix

Incorporation of biomass fuels in national energy supply policy improves the energy mix by increasing the diversity of energy sources. This helps to reduce vulnerability to market fluctuations and can improve stabilization of prices.

Constraints

Misconceptions

It is sometimes assumed that biomass energy is a traditional commodity which will phase out in the near future. Some people even believe that woodfuel collection poses a major threat to tropical rainforests. Misconceptions such as these hamper the development of sound energy policies.

Data and planning

Systematic data are still inadequate or unavailable for biomass energy planning and for developing specific energy policies for supply and demand.

Technologies

Technologies for biomass combustion which are at present widely used in ASEAN economies still need to be improved towards best practice. Financial, institutional and legal issues have to be resolved to make the best use of available technologies.

UTILISATION AND SOURCES IN ASEAN COUNTRIES

Biomass fuels

Biomass fuels consist of both woody and non-woody biomass. The first come from trees and shrubs, the latter from crop residues and other vegetation. Both can be converted into charcoal. In ASEAN economies, important biomass fuels are wood and residues from coconut, rubber and oilpalm trees, as well as sawdust, bagasse and husks and straw from rice plants. They are used in both traditional and modern applications.

Utilisation of biomass fuels

Domestic

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

Industrial

Numerous industries in ASEAN member countries rely on biomass fuels for process heat and drying of the final product. Many are small-scale and based on traditional technology. These industries usually purchase the fuel, but some also collect biomass fuels from free supply sources. The industries include: agricultural and food processing (like sugar, rubber and coconut processing, rice parboiling, fish and meat drying and smoking); metal processing and mineral-based activities (e.g. brick making, lime burning, ceramics and pottery, smithing, foundry and jewellery); and forest products and textile industries (e.g. bamboo and cane, distilleries, timber drying, match factories, silk and textiles). Besides these industrial activities, services rely on biomass fuels (e.g. road tarring, soap making, tyre retreading, paper making, fishing net and boat making, food preparation and catering services).

The current situation is not expected to change as long as the supply of biofuels is secure and their price remains competitive with commercial fuels like coal, gas and electricity. The consumption of biomass fuels may even increase with growth in population.

Bio-energy-using industrial and other commercial activities are mainly found in rural areas, but also exist in townships and even metropolitan cities like Bangkok, Jakarta and Manila. Also, many households in large urban centres use biomass fuels, in particular charcoal. Densified biofuels (briquettes of charcoal fines and loose residues) are becoming more popular in urban centres where different forms of woodfuels have already been accepted as traded commodities. At present, many higher-income rural families, urban households and industrial enterprises are purchasing biomass fuels, especially wood and charcoal, to meet their energy needs.

Modern applications

More recently, modern bio-energy has developed through adoption of technologies like cogeneration (generation of heat and power in wood and agro-based industries) and dendrothermal power plants (generation of electricity by burning woody biomass). Cogeneration is gaining increasing acceptance. Efficient, mature and proven biomass-based energy conversion technologies are available both within and outside the ASEAN region. Cogeneration of heat and power from residues in forest-based and agro-industries is being increasingly promoted (particularly in Indonesia, Malaysia, the Philippines and Thailand) by the private sector, mostly for own use. Utility companies in Western countries already supply electricity and heat from biomass to national grids and local communities.

Sources of biomass energy

Wood

The forest source is one of many sources of woodfuel production. It consists of government-owned and managed natural forests and tree plantations. However, this is not the only or even the main source. The situation in Indonesia, Malaysia, the Philippines and Thailand presents a typical scenario. In these countries, in recent years non-industrial plantations of different types (e.g. coconut, rubber and oilpalm plantations, fruit orchards, and trees in homesteads and homegardens) have gained recognition as important sources of woodfuel supply. These non-forest sources, managed and operated mostly by the private sector as informal business enterprises, are gaining prominence in supplying traded woodfuels to markets.

In the countries of South-East Asia, forest sources contribute between 10 and 50% of total national woodfuel supplies, with the balance coming from non-forest sources. The share of non-forest woodfuels in total household-level consumption in Indonesia is reported to be as high as 93%, and the share in total woodfuel supply in the Philippines and Thailand as 85% and 50% respectively.

Forest and non-forest sources produce woodfuels by the felling of trees which have grown naturally, or trees which were raised on single or multi-purpose plantations (i.e. as the main products of dedicated woodfuel plantations or as by-products of non-industrial plantations). Alternatively, woodfuels are obtained as lops and tops from forest harvesting; as dead wood, fallen branches, twigs and dead stumps at site; as by-products of wood-based industries (e.g. waste and scrap wood, sawdust); as surplus non-commercial wood derived from land clearing; or as recovered wood from replacement or demolition of old structures and constructions (e.g. wood from old poles, posts, buildings, scaffolding). The latter are used mostly by the urban poor.

Other biomass

Agro residues like rice husk and straw, coconut husk and shells, palmoil kernel shells and fibre, and bagasse are the other main sources of biomass fuels. They are important for both the domestic and the industrial sectors. In Thailand, the energy balance shows that bagasse and rice husk accounted respectively for 7.9% and 1.6% of all energy used in the country in 1995. In Indonesia, residues accounted for 7–8% in 1992, in Malaysia 15–16% in 1990, and in the Philippines about 12% in 1989. These amounts are basically consumed in the industrial sector (palmoil, coconut, sugar and rice milling). Data for the domestic sector are often not available, but evidence from limited surveys indicates that biomass in the form of residues plays an important role, in particular in areas where wood as a source of energy is in short supply.

People involved

In addition to the millions of users of biomass fuels in ASEAN countries, numerous actors play specific roles in the supply and distribution of traded biomass fuels from

their sources to final users (e.g. collectors or gatherers, transporters, middlemen, wholesalers and retailers). Woodfuel collection for self-use and for the market can be an important occupation in rural areas. For the better-off it may be part-time off-season work, but for the poor it can very well be a full-time occupation for livelihood. And for yet others it may provide an opportunity for self-employment in woodfuel-related business to earn cash income and supplement household income. Most fuelwood gatherers live in villages close to the forests. They may be poor with very small land holdings, or landless labourers.

Estimated employment of woodfuel on the basis of person-days involved in production of one terajoule (TJ) of energy, compared to other commercial fuel alternatives, shows just 10 person-days per TJ for kerosene, compared to 200 to 350 person days for charcoal, depending upon productivity of site, efficiency of producers and the distance to the market.

For instance, over 830,000 households were employed in woodfuel-related activities in the Philippines in 1992 (536,000 in gathering, 158,000 in charcoal making and selling, and 40,000 rural and 100,000 urban traders). It was the main source of income for about 10% of rural households, supplying about 40% of their cash earnings.

Environment

If the supply source is properly managed, woodfuel can contribute positively to both the local and the global environment. Degradation of watershed and catchment areas occurs only when woodfuel is extracted in an unsustainable manner from environmentally sensitive sites. Also, woodfuel is a carbon-neutral energy source (that is, the CO_2 released by its burning is matched by the amount used up in its production), provided the rate of harvest of the wood is equal to the rate of re-growth, so it need not contribute to the greenhouse effect. With present improvements in wood combustion technologies, other emissions like carbon monoxide (CO), polycyclo-aromoatic-hydrocarbons (PACs), nitrous oxides (NO_x) and particulate matter can also be significantly reduced.

Considering the important contribution from non-forest production sources, it has been concluded that in most areas sustainable production of wood for energy can be viable. The present supply-demand imbalances may not be as serious as has been projected for most countries. It is also observed that, except in some highly populated forest deficit areas, the use of woodfuel by a majority of rural households is not the root cause of deforestation. In the present context of warnings against deforestation and growing concerns about biodiversity and environmental conservation, the role of government-raised plantations as newly emerging additional sources of woodfuel becomes more prominent as far as traded woodfuel is concerned.

MAKING THE MOST OF BIOMASS ENERGY

Biomass resources, particularly residues from forests, wood processing, agricultural crops and agro-processing, are under-utilised in ASEAN countries. These resources are renewable, environmentally friendly in energy production, and sustainable in terms of supply.

Some of these residues are already used as raw materials for other products (such as particle board and fibreboard), as fodder and fertilizer, or as household and industrial fuels. However, large portions are still unused and represent potential sources of energy. Energy generation technologies specifically designed to use biomass residues are available and are becoming more and more economical.

Countries have yet to make optimum use of the additional power generation potential from their biomass residue resources, which could help them to partially overcome the long-term problem of energy supply. However, in order to make the most of biomass energy, various aspects must be taken into account:

Financial

- There are several factors limiting the potential for large-scale fast-growing fuelwood plantations on a commercial scale: international petroleum fuel prices, remaining subsidies on commercial fuels, large initial investment requirements for woodfuel plantations, long gestation period between planting and harvesting, and conversion and transportation costs. This implies that the development of woodfuel should focus on the by-products of agroforestry and on the use of wood and biomass residues from relevant processing industries at their source.

- Biomass fuels are mostly used in the household sector, primarily by the rural and urban poor and middle-class people in small towns. These people usually end up paying more for their household energy than their counterparts in larger urban centres. Cost-benefit analyses should incorporate avoided costs.

- The low income level of the majority of rural woodfuel users can not support high investments in modern biomass-based energy generation. Governments should come in with financial schemes.

Technological

- Biomass has a lower calorific value than fossil fuels. Densification (briquetting) of biomass residues increases accessibility but involves a cost, which may be out of reach of those present users who get their biomass fuels free. Detailed study of the local fuel market and careful selection of technology should precede major investments in biomass energy development.

- Prevailing practices of technology transfer do not sufficiently take into account the local conditions under which imported technology has to be operated and managed, the training required for its use, maintenance requirements and capabilities, and backstopping arrangements. Promoters need to consider both hardware and software aspects of technology transfer.

- Research and development for biomass production and use on a commercial basis has not yet received adequate attention in the region.

Institutional

- Governments' policies relating to biomass energy development and the role of the private sector are not yet clearly defined.

- Only limited opportunity exists for exchange of information and sharing of experiences with regard to the use of modern biomass energy technologies amongst implementing organisations within ASEAN. It is important to facilitate transfer of know-how within the region. It may be desirable to develop and institutionalise a system for facilitating information sharing and technology transfer within the region.

- Government support with regard to the increased use of residues is often inadequate and at times conflicting. This may result in implementing agencies being unable to carry out their mandated tasks.

Information

- Information on the amount of biomass that may be sustainably available for power generation does not exist in most countries. Relevant information includes biomass from both existing natural resource bases and additional production from new sources, including currently under-utilised residues. Further reliable information must be generated for data bases with regard to prices, competing uses, cost of biomass energy in relation to alternatives, energy market, size, and supply sources.

- Data bases should be accessible to agencies willing to finance, implement, monitor or use biomass energy. Exchange of information between countries in the region can be promoted by networking and through collaboration with regional and international agencies.

- No dedicated system exists for information flow on research and development in biomass energy. This needs to be established and regularly upgraded.

Legislation

- Most policies and legislation today are not conducive to biomass energy development, e.g. sectoral policies and legislation governing private trees in non-forest lands, including planting, harvesting, utilisation, transport of tree and wood products, tree and land ownership and tenure systems.

- Some countries' policies use subsidies to promote the use of commercial fuels, instead of developing the sources and supply of biomass energy, which could contribute positively to the balance of trade.

- Present misconceptions about use of biomass fuel being the root cause of deforestation and environmental degradation do not provide a conducive atmosphere for bio-energy development. Appropriate legislation which regulates only indiscriminate biomass use needs to be promoted.

- Prevailing arrangements do not encourage private-sector participation in the development of biomass resources in forest and non-forest areas. Utilisation of biomass for commercial energy production and marketing requires legislative provisions and incentives. Wherever feasible, countries should encourage, through legal and financial provisions, the plantation of fast-growing multipurpose trees, if not as single-purpose plantations then as part of larger, multiple-use production systems.

AEEMTRC-COGEN-RWEDP INSTITUTIONAL COOPERATION

AEEMTRC, COGEN and RWEDP are all involved in biomass energy in the ASEAN region. The three organisations have complementary strengths and have agreed to co-operate in various aspects of their work. A Memorandum of Understanding formalises their cooperation on information relating to wood and biomass energy. The cooperation of other institutions with similar interests is invited.

Acknowledging the need for improved data, common policies and concerted action, the objectives of the present Memorandum of Understanding are to:
- Integrate wood and biomass energy information into energy data bases;
- Identify data gaps which limit the integration of wood/biomass energy considerations into long-term development programmes;
- Identify data collection activities which countries need to undertake to fill these data gaps;
- Assist in the development of sustainable energy policies.

AEEMTRC, COGEN and RWEDP seek advice and guidance on the following questions:
- How can ASEAN Member Countries further benefit from biomass energy projects and programmes in the region?
- What specific needs for further action exist?
- How should reporting to ASEAN Ministers on Energy and Senior Officials on Energy be arranged?

ASEAN-EC Energy Management Training and Research Centre

AEEMTRC is based in Jakarta. The objectives are to further enhance the cooperation between the seven ASEAN countries, and to strengthen the political, economic and commercial links between the ASEAN and the European Union in the field of energy. AEEMTRC is guided by a Project Steering Committee composed of Senior Officials on Energy (SOE's) from the respective governments and an EC representative. In 1996 the ASEAN Ministers on Energy Meeting (AMEM) decided that AEEMTRC be transformed into an ASEAN energy centre, with effect from January 1999. The centre will be placed under the auspices of the AMEM and the SOE Leaders. The mission is to accelerate the integration of energy strategies within ASEAN to ensure over the long-term the necessary energy development in harmony with the economic growth and the environmental sustainability.

EC-ASEAN COGEN Programme

The COGEN Programme is an economic cooperation programme between the European Commission (EC) and the Association of South-East Asian Nations (ASEAN) coordinated by the Asian Institute of Technology (AIT), Bangkok. Its aim is to accelerate the implementation of proven technologies generating heat and/or power from wood and agro-industrial residues through partnerships between European and South-East Asian companies. In a short period of time, the COGEN Programme has established references of European and Euro-ASEAN equipment in selected wood and agro-industries in ASEAN. It is now involved in the promotion of reference projects, thus forging closer links between European suppliers and ASEAN customers and partners. The Programme is currently involved in the implementation of over US$ 100 million worth of Euro-ASEAN biomass energy equipment.

FAO Regional Wood Energy Development Programme in Asia

RWEDP is a long-term project implemented by the Food and Agriculture Organization of the United Nations. The project is funded by the Government of The Netherlands and based in Bangkok. RWEDP has 16 member-countries in Asia, including 5 ASEAN Member Countries (Indonesia, Malaysia, Philippines, Thailand and Vietnam), as well as 3 incoming ASEAN Member Countries (Cambodia, Laos and Myanmar). RWEDP focuses on wood/biomass energy and aims to (1) strengthen institutional capacities for databases, (2) assist in policies and planning, and (3) develop capabilities for implementing programmes. Main areas of expertise are wood energy resource development, wood energy conservation, and wood energy planning and policy development.

A CALL FOR ACTION

ASEAN Member Countries have experienced high economic growth in recent years. They are now under enormous pressure to ensure reliable energy supplies in order to maintain current, or even accelerated, growth rates. Most of the additional energy demand is being met by fossil fuels. As ASEAN countries are in the tropics they have favourable conditions for growing biomass, which can strengthen their self-reliance in terms of energy. Clear and consistent policies are needed to make the most of this. Modern power generation from biomass sources should be further developed.

Data collection

Data on supply and demand of biomass energy should be collected systematically and periodically. The data should be used by planning units as a basis for energy policies.

Incentives

Fiscal and pricing policies should be reviewed, so as to remove discrimination in favour of certain fuel sources. Biomass energy should be allowed a “level playing field” in competition with other renewables and fossil fuels.

Barriers

Barriers to the production, free flow and sustainable use of wood and biomass fuels should be removed.

Technology transfer

Transfer of improved biomass combustion technology should be promoted both within the region and from outside. This can be implemented by stimulating leading institutes and organizations to acquire knowledge and cost-effective equipment and to establish demonstration sites for improved use of biomass fuels.

Information centres

Establishing national energy information centres to assist private-sector initiatives should be encouraged. These information centres should aim to serve as “one-stop agencies”, providing all information on supply and demand projections, government regulations, technology suppliers, etc. They should fully incorporate biomass energy.

It is recommended that:

1. ***Asean Ministers on Energy acknowledge the important role of biomass energy in Member Countries, as well as its future potential.***

2. ***Biomass energy is fully integrated in national energy policies and planning.***

3. ***Serious thought is given by policy makers to optimising modern power generation from biomass sources.***

Annexes

Annex 1 Biomass energy in ASEAN economies (graphs)

Annex 2 Residue potential in ASEAN countries

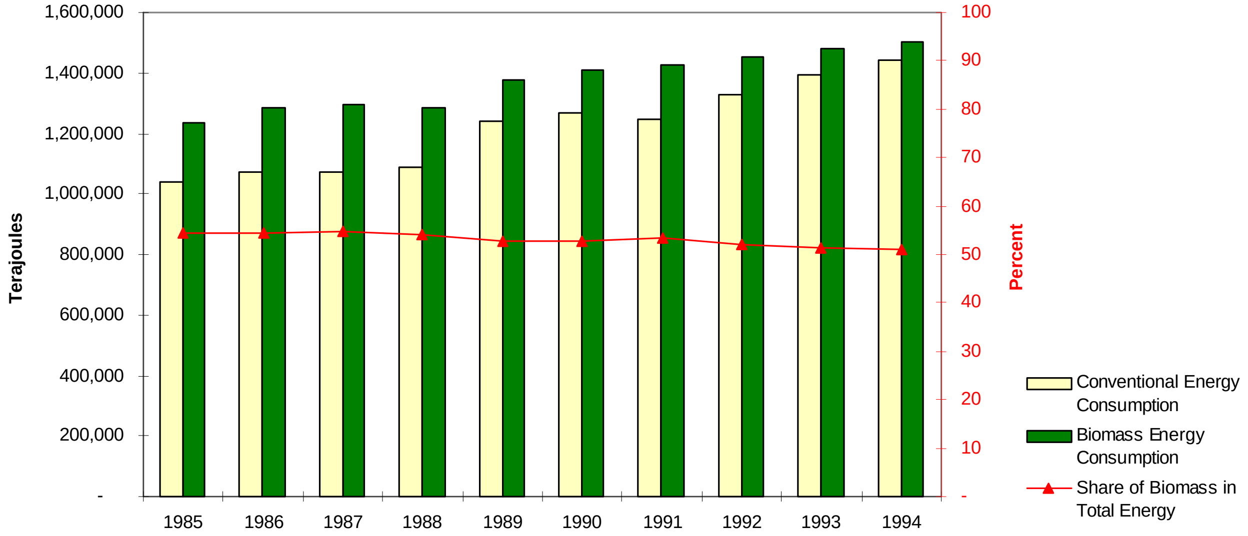
Annex 3 Example: a woodwaste power plant in Indonesia

Annex 4 Biomass energy in selected industrialized countries

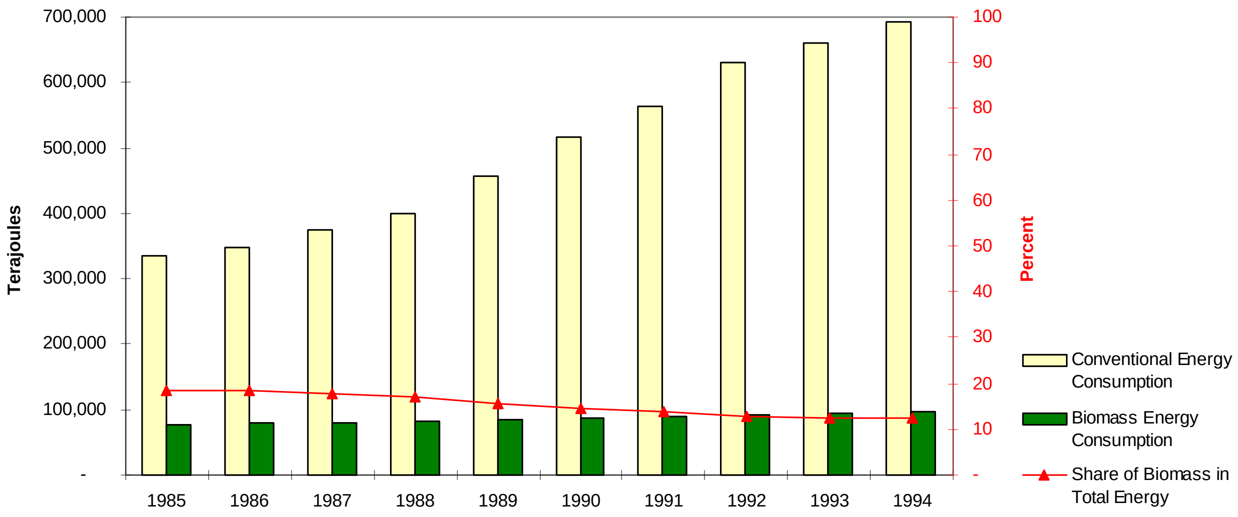
Annex 5 Example: biomass energy in Denmark

BIOMASS ENERGY IN ASEAN ECONOMIES

Indonesia

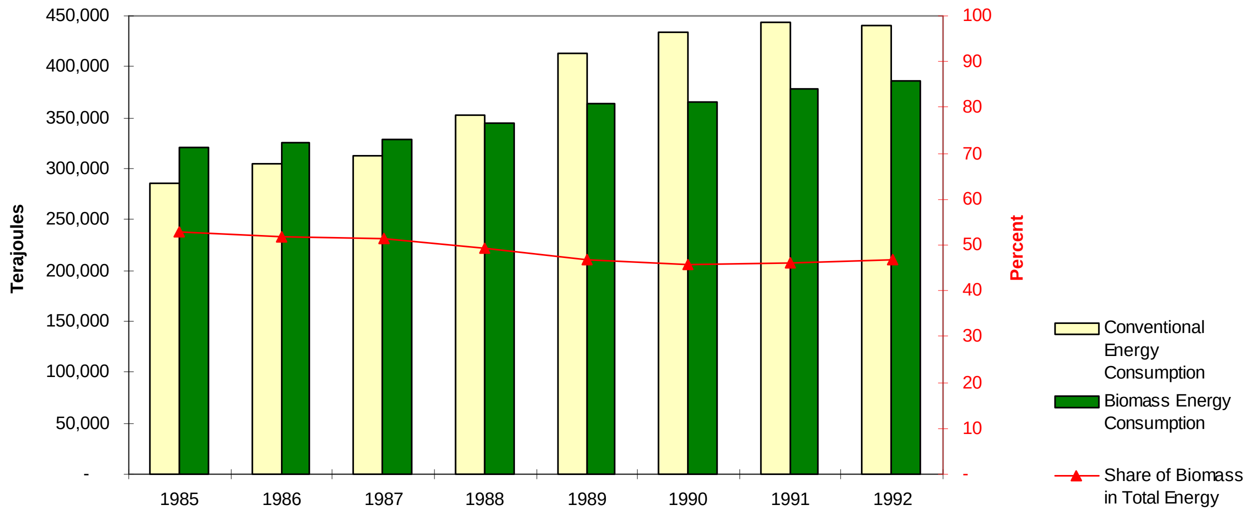


Malaysia

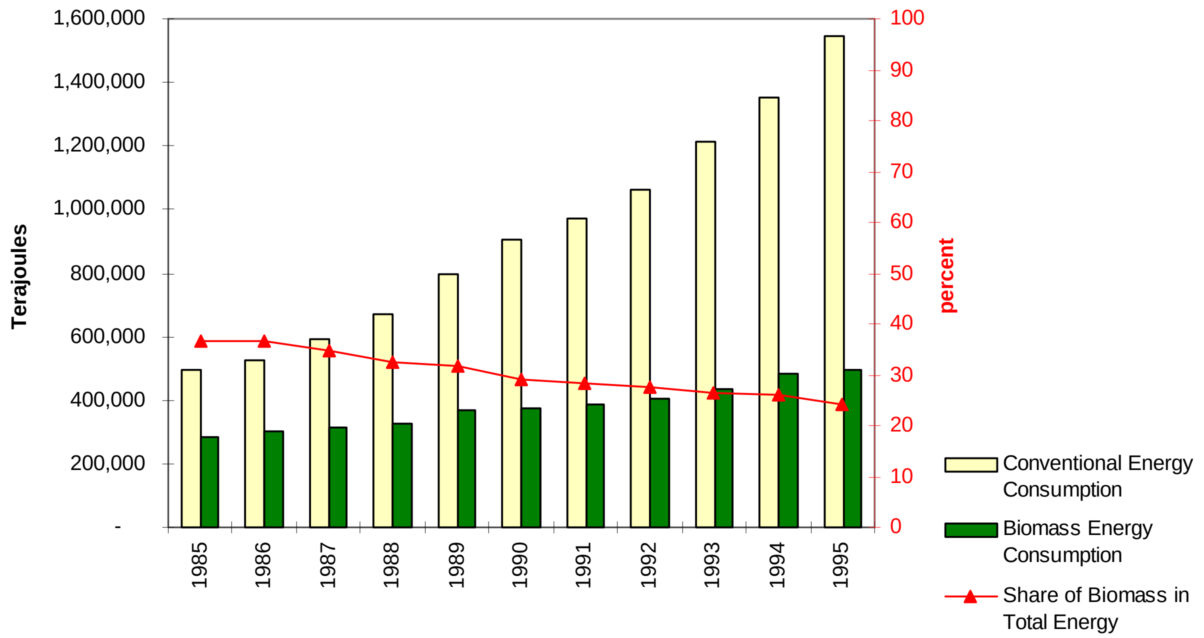


Note: 1 Petajoule (PJ) = 1000 Terajoule (TJ) = 23.88 ktoe

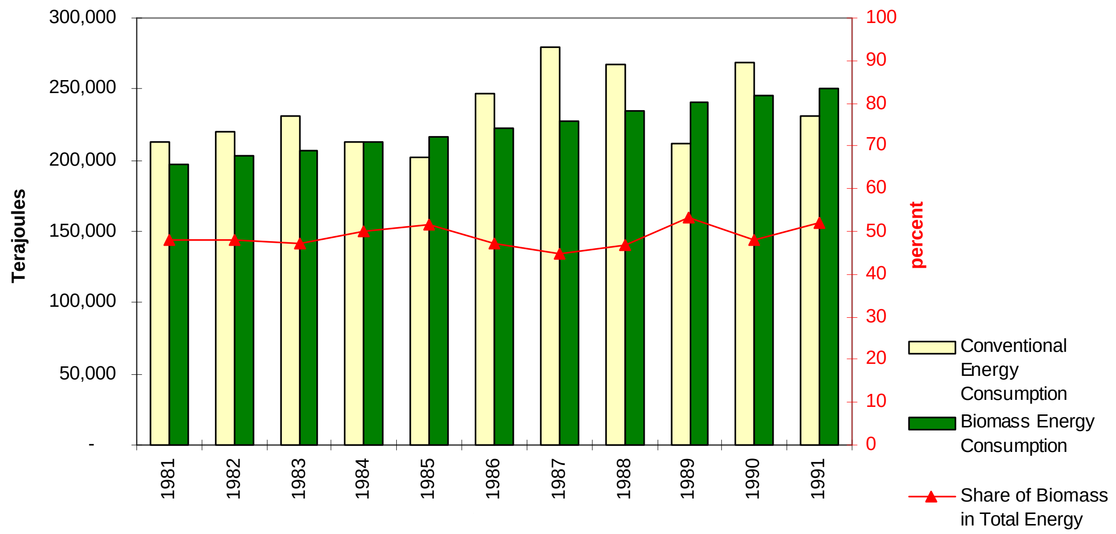
Philippines



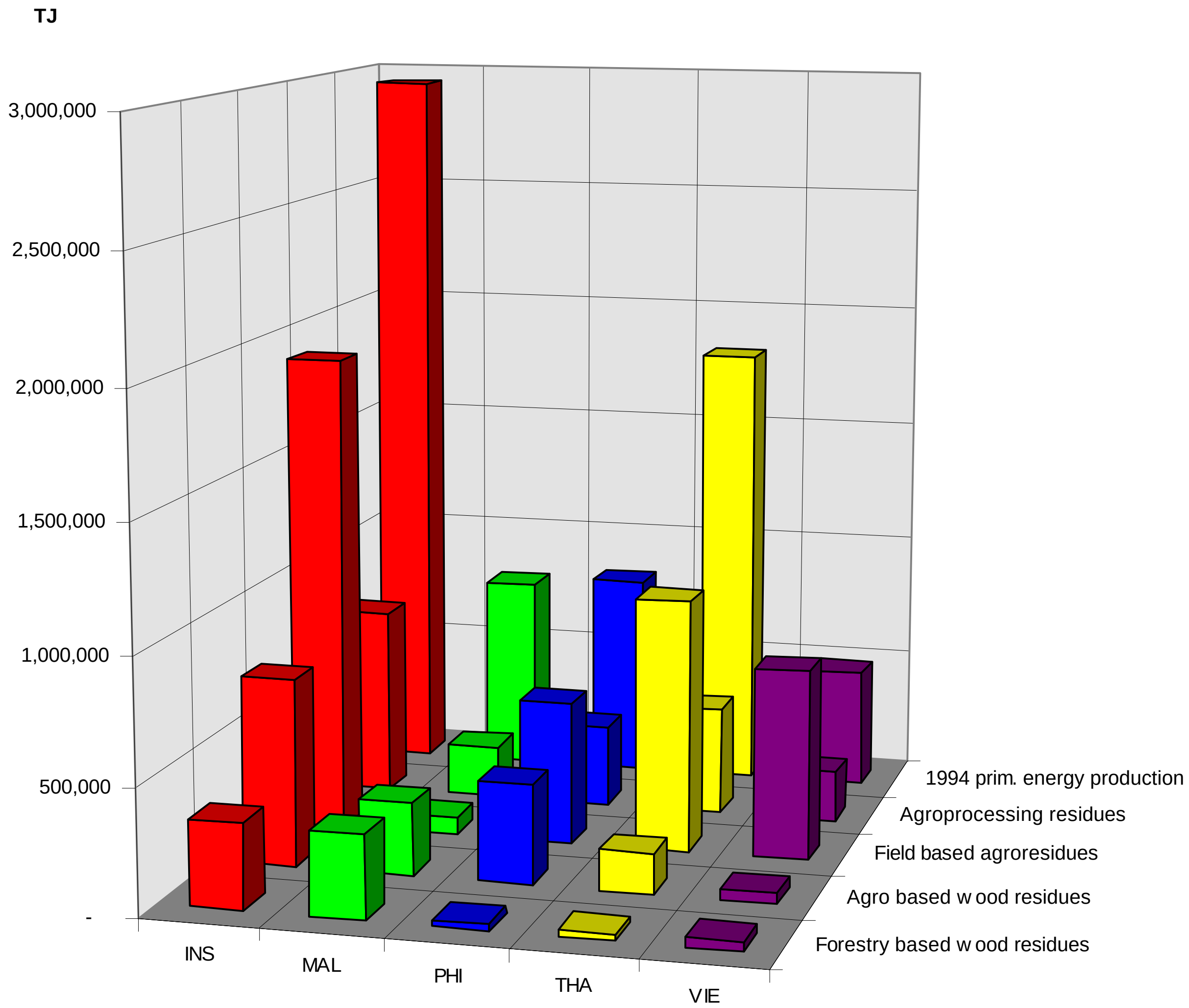
Thailand



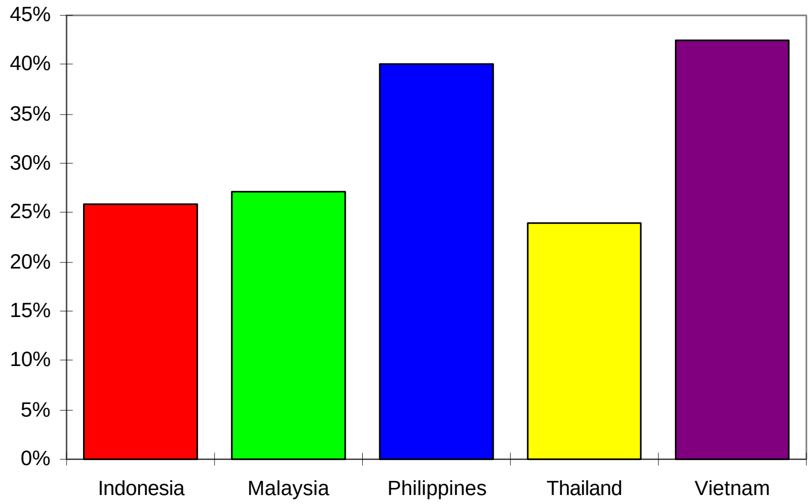
Vietnam



RESIDUE POTENTIAL IN ASEAN COUNTRIES



ENERGY POTENTIAL OF AGROPROCESSING RESIDUES AS PERCENTAGE OF TOTAL PRIMARY ENERGY PRODUCTION



EXAMPLE:

A WOODWASTE POWER PLANT IN INDONESIA

Many wood-processing industries are used to simply dumping their woodwastes, causing significant environmental pollution. At the same time, these industries buy in fuel oil. In Indonesia and Malaysia a trend is now emerging to establish integrated wood-processing complexes, where woodwastes from processing are being used to supply energy for the complex, making the units both more efficient and more economical, and minimising pollution.

Plywood Manufacturing

One example is the Indonesian plywood manufacturing company PT Siak Raya Timber, located in Pekanbaru, Sumatra, Indonesia. The company employs 6,000 people and produces a yearly average of 160,000 m^3 of plywood and secondary processing plywood products. In addition, an affiliated woodworking factory produces about 50,000 m^3 per annum of downstream products. The raw materials used for these products come mainly from company-owned forests in central Sumatra. In the process, a lot of residues are produced. As yet the company generates electricity using diesel gensets, but it has decided to install an energy plant, using its own wood residues as fuel, to meet its heat and power requirements.

Cost reduction and reduced environmental impact will be achieved by replacing the existing diesel engines by the new energy plant fuelled by wood residues, generating 5.55 MW of electricity for captive use. In this way, expected increased expenditure on fossil fuels is also avoided. Contracts have been signed with European equipment suppliers. This is slightly more expensive locally manufactured equipment, but it is assumed that reliability and efficiency are higher, thus minimising the operation and maintenance costs.

For this project, the EC-ASEAN COGEN programme has carried out a pre-investment study. Operating staff are to receive special training and the plant will be monitored after implementation.

Technology

The turnkey-supplied plant will consist of the following main components:

- a fuel-handling and boiler-feeding system;
- a water tube boiler with a capacity of 40 tonnes per hour, at 33 bar and 385 ºC;
- a 5.55 MW extraction-condensing turbo-generator set;.
- a river water-cooled surface condenser;
- a power transmission system.

Economics

Excluding civil and structural works, the total investment cost for the equipment on a turnkey basis is US$ 5.6 million. Based on the present diesel consumption and price, the annual savings in diesel purchase will be more than US$ 1.7 million. The expected pay-back period is around three years after commissioning.

BIOMASS ENERGY IN SELECTED INDUSTRIALIZED COUNTRIES

Several industrialised countries promote biomass energy, for both environmental and socio-economic reasons. These countries use locally available wood and biomass fuels as alternatives to oil or coal, taking advantage of recently developed technologies, and thus avoid CO_2 emissions and reduce their own dependency on oil. A few examples are given below:

Sweden

In Sweden, biomass and peat contribute about 12% of the total energy supply of around 1,600 PJ/a. The main source is liquors from pulp mills, but woodfuels (logs, bark and sawdust), municipal solid waste and peat are all used for district heating, home heating and in the forest products industry itself. Biomass-based district heating has increased more than fivefold in less than 20 years, from 5 PJ in 1980 to 53 PJ today. Of this, 27 PJ comes from woodfuel, 15 PJ from refuse and 11 PJ from peat. In addition, some 7 PJ of biofuels were used for electricity generation last year. Seventy buses are currently running on ethanol to demonstrate the potentials of liquid biofuels.

Finland

The situation in Finland is similar to that in Sweden, with as much as 30% of total energy supply coming from biofuels, hydroelectricity and peat. Again, of the total of around 330 PJ/a being supplied by biofuels, pulp waste liquors accounts for the largest proportion (45%), followed by peat (19%), woodwaste (18%) and firewood (18%), with municipal waste less than 1%. Over 140 biomass-fuelled district heating systems exist, varying in size from less than 1 to over 50 MW. One of the largest cogeneration plants is peat-fired and produces around 80 MW of electricity and 120 MW of district heat.

Whether peat is renewable and counts as biomass, or is close to the initial stages of the formation of coal and other fossil fuel, is a matter of debate. Finland has over 10 million ha of commercial peat reserves which should last for at least 200 years at the present rate of use, though renewal of the exploited land takes several thousand years. However, it is generally included along with wastes and residues, partly because it can be utilised with similar burners or grates. Tree planting is another ongoing strategy to extend the energy potential of Finland.

Austria

In Austria, renewable energy sources supply 27% of the country's primary total energy consumption (PTEC) of 1,143 PJ/a, with biomass providing 13%. Of the biomass used, almost 98% is fuelwood, bark, wood chips and other forest industry by-products. Most of these are used in over 530,000 small wood-burning installations and 400,000 tiled stoves, as well as 63,000 larger furnaces and 200 district heating plants. The other 2% is made up from biogas plant, together with small-scale use (0.4% or 0.6 PJ) of rapeseed methylester (RME), produced in six installations as a substitute for diesel fuel. However, Austria is currently considering producing up to 150 million litres of RME per year from 150,000 ha of rapeseed plantations. This represents an annual yield in energy terms of about 500 PJ. Other ongoing developments include the use of straw and fast-growing trees for energy.

The European Union

In the European Union, the amount of land set aside for rapeseed for fuel has expanded from 200,000 ha in 1992 to nearly one million ha in 1995. This was stimulated by the revised Common Agricultural Policy, with more direct payments to farmers - in theory to compensate for lower prices. Vagaries in the weather in 1995 have resulted in a shortfall in cereals, higher prices, and an unexpected bonus to many farmers as well as suggestions that the set-aside area should now be decreased.

Bio-energy research in Europe focusses on the production of liquid fuels from lignocellulosic materials, thermochemical conversion as well as gasification linked to power generation.

USA

The use of wood for energy in the USA is growing steadily, at about 1.2% per year, expected to reach around 3,000 PJ by the year 2,000. Around 70% of the woodfuels are used within the forest products industries themselves, the rest for household heating and electricity generation. Wood-based electricity generation is expected to grow fast, consuming approximately 500 PJ in 2000, 1,000 PJ by 2010 and possibly reaching 3,000 PJ by 2030.

The production of electricity from wood has been highly successful in moderate-scale facilities in northern New England and the upper Midwest, with some 700 MW electricity generating capacity provided by 30 or more cogeneration or free-standing plants built over the last decade. Many of these plants are located at pulp and paper or other forest-product mills that produce both steam and electricity. New technologies are being developed for co-firing biomass in coal-fired boilers.

Dry densified woodfuels, such as pellets and briquettes, can be burned efficiently in furnace/boiler units and wood stoves by commercial or residential users. For instance, wood or biomass is pelletised and is fed into coal boilers in a mix of 15% pellets and 85% coal. This low-cost supplemental fuel helps dispose of wood wastes, produces lower emissions of sulphur dioxide and other undesirable gases, and reduces fossil-fuel consumption.

If short-rotation forestry is implemented over the next decade as expected, dedicated energy crops may overtake agricultural and forest residues as a source of fuel for electricity generation before 2020. In some regions relatively large power stations in the 60–100 MWe range are possible, making the economics much better than those for smaller systems such as those found in Europe.

The other major biomass use is in the production of bio-ethanol for addition to petrol, as an oxygenate and octane enhancer. The corn-processing industry now uses around 20 million tonnes of maize a year (some 10% of total corn use in the USA), with a recent annual growth rate of around 4%, mainly accounted for by increased production of fuel alcohol. The primary driving force for expanding ethanol sales is now the reformulated gasoline programme, which began on 1 January 1995, as mandated by the Clean Air Act Amendments of 1990. In the Chicago and Milwaukee markets, ethanol's market share was as high as 70%, while it captured almost 100% of the premium winter oxygenated fuel markets in Colorado. For regions where transportation and other distribution costs limit competitiveness, gasoline is blended with ethanol-derived Ethyl Tertiary Butyl Ether (ETBE) at the refinery, and shipped in common carrier pipelines. A tax exemption for biofuels is put in place to support this.

The potential market for corn-based ethanol is limited once industrial use starts to compete with food use. A present priority issue for the US government's renewable energy activities is therefore research on producing new liquid biofuels and blending additives from other agricultural materials and wood.

An ambitious programme has been launched to produce up to 20% of liquid fuel requirements from short-rotation woody plantations and other biomass. A major goal of the programme is to reduce the cost of producing ethanol from energy crops from US$ 0.33 per litre in 1990 to less than US$ 0.25 by 2005 and under 20 cents by 2010. For ethanol from cellulosic waste materials, the goals are 13 cents per litre in 2005 and 9 cents in 2010. It is this setting of specific objectives and targets that distinguishes the US R&D strategy from that in the European Union.

EXAMPLE:

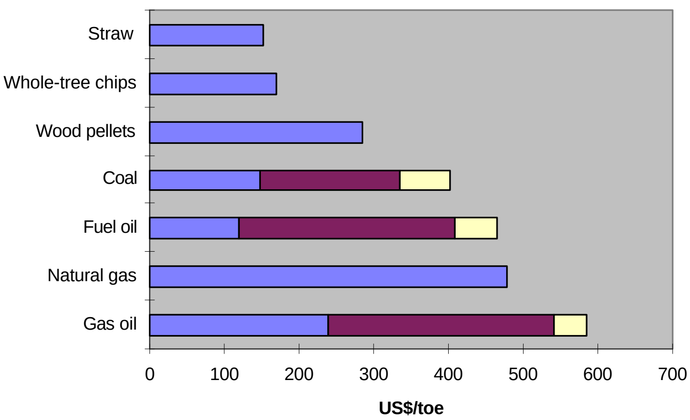
BIOMASS ENERGY IN DENMARK

At present, 6% of Denmark's total energy consumption is covered by biomass energy, representing 75% of the country's renewable energy production. Denmark is an agricultural country and generates large amounts of straw (2.3 Mt/a or 46 PJ) and animal wastes (3 Mt/a or 26 PJ), which are increasingly being used as sources of energy. Straw presses have been developed that efficiently process the straw into bales of standard sizes, which are used in 8,000 on-farm heating systems (0.39 Mt/a) and, increasingly, purchased by electric utilities for power generation (0.26 Mt/a) and/or district heating (0.28 Mt). Electricity generation from straw is set to expand further, as the Danish power utilities have signed contracts for 1.4 Mt/a.

Though only 12% of the country is forested, 70% of all wood residues from forestry, or 5.1 PJ, is being used for energy purposes. The majority of these residues are chipped in situ using mobile equipment. All industrial woodwaste (0.15 Mt/y or 13.2 PJ) is already pelletized and used as an energy source. The main use for both wood chips and wood pellets is in district heating plants that previously used coal.

Municipal solid waste (MSW) is also increasingly being used for energy. Households separate organic from non-organic waste. The organic waste is used in biogas digester plants which generate heat and electricity from the biogas. Combustible waste accounts for 10 PJ out of 80 PJ of heat delivered by district heating systems. By 2000, all combustible wastes will be used for energy purposes, mainly in cogeneration facilities. All waste incineration and district heating units above 1 MW will be converted to cogeneration units by the same deadline.

Pricing differentiation of fuel types, which promotes the development of bioenergy in Denmark



Energy policies

In reaction to the 1973 oil shock, Denmark put emphasis on energy conservation and fuel substitution (from oil to natural gas and biomass) to reduce the country's dependence on oil imports. Individual heating systems were replaced by more efficient district heating systems. An energy tax was introduced on oil and coal to keep consumer prices high. Tax earnings were invested in energy-saving equipment and research into modern biomass systems. Cogeneration district heating plants were converted to use straw, wood chips and waste. Burning straw in the field was prohibited in 1990. The issue of global warming led to the introduction of a CO_2 tax in combination with incentives for decentralized electricity generation using renewables. Other incentives are funding of up to 30% of the cost of biomass-fired boilers and biogas plants, and support for research into modern biomass energy crops and systems.

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