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Library Update November 2006

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Current Journal Articles and Reports

Woody Biomass User's Experiences Offer Insights for Government's Efforts Aimed at Promoting its Use. Washington D.C. U.S. Government Accountability Office, 2006. (GAO-06-336)
Along with the need for thinning vegetation on public lands, the US federal government is seeking to stimulate a market for the resulting material, including the smaller trees, limbs and brush—referred to as woody biomass. This material has traditionally had little or no commercial value. The increased use of woody biomass faces obstacles, including the high cost of harvesting and transporting it and an unpredictable supply in some locations.

GAO agreed to identify key factors facilitating the use of woody biomass among selected users; identify the challenges these users have faced when using woody biomass and discuss any insights that these findings may offer for promoting the greater use of woody biomass.
(To request email library@energylibrary.org.nz and quote **BIO1GAO**)

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Particle emissions from biomass combustion in small combustors L. S. Johansson et al, Biomass and Bioenergy V25, 4 , October 2003, 435-446
Literature data on particle emissions are compared with emissions from combustion of wood pellets and wood briquettes in commercial small-scale combustion devices: a pellet stove, two pellet burners and two smaller district heating boilers. The influence of operating parameters and fuel quality was investigated. Mass concentration, number concentration and number size distribution of particles were determined. The mass size distribution was analysed as well as the inorganic components. Gaseous compounds were recorded to give information about the combustion conditions. The mass concentrations of particles were between 34 and 240 mgNm−3, increasing during unsatisfactory operation conditions. The number concentration was in the range of 107–108 particles per Ncm−3. The particle emission was dominated by submicron particles (size <1 μm), both from number and mass perspective. The main inorganic components of the submicron particles were potassium, sulphur, chlorine and oxygen. Small amounts of sodium, magnesium and zinc were also found. The contents of potassium, chlorine, and sulphur in the fuel are important for the composition of the emitted inorganic submicron particles.
(To request email library@energylibrary.org.nz and quote **BIO1Johansson**)

Increasing biomass utilisation in energy systems: A comparative study of CO2 reduction and cost for different bioenergy processing options B Wahlund et al, Biomass and Bioenergy V26, 6 , June 2004, 531-544
Emissions of greenhouse gases, such as CO_2, need to be greatly reduced to avoid the risk of a harmful climate change. One powerful way to mitigate emissions is to switch fuels from fossil fuels to renewable energy, such as biomass. In this paper, we systematically investigate several bioenergy processing options, quantify the reduction rate and calculate the specific cost of reduction. This paper addresses the issue of which option Sweden should concentrate on to achieve the largest CO_2 reduction at the lowest cost. The results show that the largest and most long-term sustainable CO_2 reduction would be achieved by refining the woody biomass to fuel pellets for coal substitution, which have been done in Sweden. Refining to motor fuels, such as methanol, DME and ethanol, gives only half of the reduction and furthermore at a higher specific cost. Biomass refining into pellets enables transportation over long distances and seasonal storage, which is crucial for further utilisation of the woody biomass potential.
(To request email library@energylibrary.org.nz and quote **BIO1Wahlund**)

Co-gasification of woody biomass and coal with air and steam. K Kumabe et al, Fuel 2006
The co-gasification of woody biomass and coal with air and steam was carried out in order to supply syngas for the synthesis of liquid fuels from the biomass with coal. The experiment was performed using a downdraft fixed bed gasifier at 1173 K. The effect of the feedstock with a varying content of woody biomass and coal on the co-gasification behavior was studied by varying the biomass ratio from 0 to 1; this ratio is the woody biomass content in the total feedstock on a carbon basis. The conversion to gas on a carbon basis increased with an increase in the biomass ratio, whereas the conversions to char and tar decreased. With an increase in the biomass ratio, the H_2 composition decreased and the CO_2 compositions increased. However, the CO composition was independent of the biomass ratio. A low biomass ratio led to the production of a gas favorable for methanol and hydrocarbon fuel synthesis, and a high biomass ratio led to the production of a gas favorable for DME synthesis. The synergy due to the mixture of woody biomass and coal might be observed in the extent of the water–gas shift reaction. The co-gasification conditions in the study provided a cold gas efficiency ranging from 65% to 85%.
(To request email library@energylibrary.org.nz and quote **BIO1Kumabe**)

Effect of raw material composition in woody biomass pellets on combustion characteristics. Christofer Rhén et al. Biomass and Bioenergy 2006
Char yield, char combustion time and char combustion rate of pellets made from different tree parts of Norway spruce and industrially made stem wood pellets of Norway spruce and Scots pine were studied. The pellets were incinerated in a laboratory scale oven at various temperatures, gas flows and oxygen concentrations.
It was found that the combustion time for a single pellet mostly depended on the raw material composition and to a minor extent on the density. Pellets made of bark had up to a 50% longer char combustion time compared to that of stem wood pellets, due to differences in char yield. Industrially made stem wood pellets of pine and spruce sawdust were found to have small differences in combustion characteristics. The variations in combustion characteristics of pellets are discussed in relation to composition of raw material.
(To request email library@energylibrary.org.nz and quote **BIO1 Rhén**)

Bioenergy logistics chain cost structure and development potential: report to Enova by Energidata AS Transportokonomisk Institutt and KEMA Consulting, 2006.
Norway has significant resources in the form of residues from the wood base industry, but the costs involved are not easily identified. Topics covered include: logistics chain wood chip delivery, district heating and micro grid systems, wood pellets in central heating and household applications.
(To request email library@energylibrary.org.nz and quote **BIO1Energi**)

Broader horizons for biomass: A variety of feedstocks and downstream product options are in the pipeline. R Marshall, Chemical Engineering V 113, 10, October 2006, 21-25.
Marshal discusses the diverse range of biomass energy sources that are presently being explored by this fast growing industry. Current research opportunities and upcoming areas of market expansion are discussed.
(To request email library@energylibrary.org.nz and quote **BIO1Marshall**)

Canadian biomass to bioenergy report. Ottawa, Canada : Climate Change Solutions, 2006.
Contents include: Policy setting; Biomass volumes, woody biomass, annual residue production; pulp chips; existing hog fuel piles; forest floor biomass; Biomass usage; imports and exports; barriers to increase production and trade.
(To request email library@energylibrary.org.nz and quote **BIO1Solutions**)

A fuel of convenience : Why pellets are packing the power J Jones, Renewable Energy World, May-June 2006, 32-41.
Pellet production exceeded 5000 tonnes in twenty one countries in the year 2005, and according to Hilli, a CEO for one of the worlds largest pellet producers, pellet consumption in Europe is looking to triple in the next five years. Jones takes a look at what is going on in this fast growing production industry.
(To request email library@energylibrary.org.nz and quote **BIO1Jones**)

CEN technical specification for solid biofuels-Fuel specification and classes E Alakangasa et al. Biomass and Bioenergy V 30, 11 , November 2006, 908-914
The European Committee for Standardization, CEN (TC335) is currently preparing 30 technical specifications for solid biofuels. The two most important technical specifications being developed deal with classification and specification (CEN/ TS 14961) and quality assurance for solid biofuels (CEN/ TS 15234). The classification of solid biofuels is based on their origin and source. The fuel production chain of fuels shall be unambiguously traceable back over the whole chain. The

biofuels are divided into the following sub-categories for classification: (1) woody biomass, (2) herbaceous biomass, (3) fruit biomass and (4) blends and mixtures. The purpose of classification is to allow the possibility to differentiate and specify biofuel material based on origin with as much detail as needed. The quality classification in a table form was prepared only for major traded solid biofuels: briquettes, pellets, exhausted olive cake, wood chips, hog fuel, wood logs, sawdust, bark, and straw bales. Additionally, a general table was compiled for other biofuels. The most significant properties are normative, and shall be stated in the fuel specification. The classification is flexible, and hence the producer or the consumer may select from each property class the classification that corresponds to the produced or desired fuel quality. This so-called "free classification" does not bind different characteristics with each other. An advantage of this classification is that the producer and the consumer may agree upon characteristics case-by-case. To protect household consumers, examples of so-called "high-quality" fuels are given as an informative annex A of CEN/ TS 14961. This paper describes the fuel specifications and classes of solid biofuels, which was published in April 2005.
(To request email library@energylibrary.org.nz and quote **BIO1Alakangasa**)

Clean Energy from Wood Residues in Michigan: discussion paper. M Lansing, Michigan Biomass Energy Program, 2006.
This report explores the potential for biomass energy in Michigan by focusing on wood residue as and energy feedstock. It aims to provide a background on residue wood energy for policy makers, businesses. In addition, provides an introduction to biomass energy; background on wood energy in the US and Michigan; discussion of characteristics of wood energy feedstock; explanation of wood to energy pathways with associated harvesting, transport and storage considerations; a presentation of options for energy conversion technology; a comparison of environmental impacts of wood energy versus coal and natural gas; an assessment potential economic and energy supply impact; outlooks for the future of wood energy in Michigan.
(To request email library@energylibrary.org.nz and quote **BIO1Michigan**)

A comparative analysis of woody biomass and coal for electricity generation under various CO2 emission reductions and taxes. J Gan and C Smith, Biomass and Bioenergy V 30, 4 , April 2006, 296-303 Proceedings of the third annual workshop of Task 31 'Sustainable production systems for bioenergy: Impacts on forest resources and utilization of wood for energy' October 2003, Flagstaff, Arizona, USA
Mitigating global climate change via CO2 emission control and taxation is likely to enhance the economic potential of bioenergy production and utilization. This study investigated the cost competitiveness of woody biomass for electricity production in the US under alternative CO2 emission reductions and taxes. We first simulated changes in the price of coal for electricity production due to CO2 emission reductions and taxation using a computable general equilibrium model. Then, the costs of electricity generation fuelled by energy crops (hybrid poplar), logging residues, and coal were estimated using the capital budgeting method. Our results indicate that logging residues would be competitive with coal if emissions were taxed at about US$25 Mg^{-1} CO2, while an emission tax US$100 Mg^{-1} CO2 or higher would be needed for hybrid poplar plantations at a yield of 11.21 dry Mg ha^{-1} yr^{-1} (5 dry tons ac^{-1} yr^{-1}) to compete with coal in electricity production. Reaching the CO2 emission targets committed under the Kyoto Protocol would only slightly increase the price of fossil fuels, generating little impact on the competitiveness of woody biomass. However, the price of coal used for electricity production would significantly increase if global CO2 emissions were curtailed by 20% or more. Logging residues would become a competitive fuel source for electricity production if current global CO2 emissions were cut by 20–30%. Hybrid poplar plantations would not be able to compete with coal until emissions were reduced by 40% or more.
(To request email library@energylibrary.org.nz and quote **BIO1Gan**)

Biomass back on track By Elisa Wood. Energy Risk November 2006
This article on biomass power generation is a topical update on what is happening in the U.S. industry today. Several factors that are likely to have a positive effect on this industry are brought to light, such as the governmental push towards renewable carbon-neutral electric fuels or the possibility of a carbon emission cap.
(To request email library@energylibrary.org.nz and quote **BIO1Wood**)

A comparison of avoided greenhouse gas emissions when using different kinds of wood energy. A Petersen-Raymer. Biomass and Bioenergy V 30, 7, July 2006, 605-617
In this study, micro-level data from wood energy producers in Hedmark County were gathered and analysed. The aim was to find how much greenhouse gas (GHG) emissions various kinds of wood energy cause (not only CO_2, but also CH_4 and N_2O), which energy they substitute, their potential to reduce GHG emissions, and the major sources of uncertainty. The method was life cycle assessment. Six types of wood energy were studied: fuel wood, sawdust, pellets, briquettes, demolition wood, and bark.
GHG emissions over the life cycle of the wood energy types in this study are 2–19% of the emissions from a comparable source of energy. The lowest figure is for demolition wood substituting oil in large combustion facilities, the highest for fuel wood used in dwellings to substitute electricity produced by coal-based power plants.
Avoided GHG emissions per m^3 wood used for energy were from 0.210 to 0.640 tonne CO_2-equivalents. Related to GWh energy produced, avoided GHG emissions were from 250 to 360 tonne CO_2-equivalents. Avoided GHG emissions per tonne CO_2 in the wood are 0.28–0.70 tonne CO_2-equivalents. The most important factors were technology used for combustion, which energy that is substituted, densities, and heating values. Inputs concerning harvest, transport, and production of the wood energy are not important.
Overall, taking the uncertainties into account there is not much difference in avoided GHG emissions for the different kinds of wood energy.
(To request email library@energylibrary.org.nz and quote **BIO1Raymer**)

Environmental, economic, social and political drivers for increasing use of woodfuel as a renewable resource in Britain. H McKay, Biomass and Bioenergy V 30, 4 , April 2006, 308-315 Proceedings of the third annual workshop of Task 31 'Systainable production systems for bioenergy: Impacts on forest resources and utilization of wood for energy' October 2003, Flagstaff, Arizona, USA
Present woodfuel usage in Britain is negligible. Historically, Britain has been fortunate in having abundant coal, oil and gas.
At an EU level, biomass is seen as an important element of energy, environment and agriculture/forestry policy. In the European context, biomass is taken to include agricultural and industrial wastes in addition to forest woodfuel, and it is regarded as a potential source of heat, fuels and electricity. In the UK, energy policy as a whole is based on four considerations—environment, energy reliability and security, affordability for the poorest in society and competitive pricing for businesses, industries and households. Within UK policy, the dominant driver for greater use of biomass as a renewable source of energy is climate change mitigation; energy security is an emerging driver; all other potential benefits of biomass as a renewable resource are of limited significance. At the moment, the UK focus is narrower than in Europe. National targets are set only for electricity generation. Furthermore, expansion of energy crops, which are defined in the major regulations as 'crops planted since 1989 and grown primarily for the purpose of being used as a fuel' and, therefore, do not include material from extant forests, is seen as the main way to ensure energy security and minimise carbon expended to transport the

raw material to the point of end use. Nevertheless, woody biomass from forests, sawmills, urban areas and transportation corridors is already available in vastly greater quantities than 'energy crops'.
At a regional and local scale, global environmental issues are of lower relative importance and a much wider range of potential benefits tend to be taken into consideration. For example, the economic benefits of woodfuel heating in areas without connections to the gas grid have been an important consideration in the steady increase in woodheat developments. In other areas where there is a less obvious financial driver, rural development is a powerful determinant of support for woodfuel projects.
(To request email library@energylibrary.org.nz and quote **BIO1Mckay**)

Thermal Energy Electricity and Transportation Fuels from Wood. J Zerbe Forest Products Journal, V 56, 1 2006 6-14
In response to a growing need to reduce our dependency on fossil fuels, Zerbe explores several ways in which the wood industry can contribute. A sample of topics discussed include: The economic advantage of wood in bioenergy conversion; various technologies including pyrolysis in the absence or oxygen, gasification, wood pellets and bricks, micro medium and large scale thermal energy heating units; electrical generation and cogeneration.
(To request email library@energylibrary.org.nz and quote **BIO1Zerbe**)

Biomass as feedstock for a Bioenergy and Bioproducts Industry : the technical feasibility of a million tonne annual supply. Oak Ridge National Laboratory. 2005.
The purpose of this report is to determine whether the land resources of the United States are capable of producing a sustainable supply of biomass. Forest derived biomass and agricultural derived biomass resources are reviewed.
(To request email library@energylibrary.org.nz and quote **BIO1Oak**)

A National Strategy for Improving Woody Biomass Utilization through USDA Forest Service Programs and Activities. Washington, D.C. The Woody Biomass Utilization Team, USDA Forest Service, 2005.
The focus of the strategy is on underutilized woody material for which commercial value is low and markets are currently small to nonexistent. For the purposes of the strategy, woody biomass is defined as material from trees and wood plants including limbs, tops, needles, leaves and other woody parts grown in a forest, farmland and includes by-products of forest management.
(To request email library@energylibrary.org.nz and quote **BIO1Forest**)

The pellet Market in Italy: Main Barriers and Perspectives C Zaetta et al 2nd world Conference on Biomass for Energy, Industry and climate Protection 2004
Between the years 2000-2004 national pellet production in Italy increased from 100,000 tons per year to 160,000 tons per year, whilst national consumption increased to 210,000 tons per year. This report discusses some of the technological and financial issues faced by the industry during this period. Topics include: production costs and prices, uncertainties faced by manufacturers of pelletising equipment, the use of pellets in civil heating and energy conversion systems and the need for chemical and physical standard specifications of pellets to enhance the image of this product with consumers.
(To request email library@energylibrary.org.nz and quote **BIO1Zaetta**)

Wood wastes and residues generated along the Colorado Front Range as a potential fuel source. J Ward et al, Res. Pap. RMRS-RP-50. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 2004.
The purpose of the research was to determine wood waste sources for use as a fuel in cement kilns and power plants. Research identified four sources which included primary and secondary wood processing residues and forest residues.
(To request email library@energylibrary.org.nz and quote **BIO1Ward**)

Wood pellet production costs under Austrian and in comparison to Swedish framework conditions G Theka and I Obernbergera Biomass and Bioenergy V 27, 6, December 2004, 671-693 Pellets 2002
Owing to the rapidly increasing importance of pellets as high-quality biomass fuel in Austria and Europe within the last years, many companies, mainly from the wood industry, are thinking of entering this market. The calculation of the production costs before starting a pellet plant is essential for an economic operation. Based on comprehensive investigations within the EU-ALTENER project "An Integrated European Market for Densified Biomass Fuels" calculations of the pellet production costs loco factory for different framework conditions with basic data based on already realised plants as well as a questionnaire survey of pellet producers in Austria, South Tyrol and Sweden have been performed.
The production costs for wood pellets are mainly influenced by the raw material costs and, in the case of using wet raw materials, by the drying costs. Depending on the framework conditions these two parameters can contribute up to one-third of the total pellet production costs. Other important parameters influencing the pellet production costs are the plant utilisation (number of shifts per week) as well as the availability of the plant. For an economic production of wood pellets at least three shifts per day at 5 days per week are necessary. An optimum would be an operation at 7 days per week. A low plant availability also leads to greatly increased pellet production costs. A plant availability of 85–90% should therefore be achieved.
The calculations show that a wood pellet production is possible both in small-scale (production rates of some hundred tonnes per year) as well as in large-scale plants (some ten thousand tonnes per year). However, especially for small-scale units it is very important to take care of the specific framework conditions of the producer, because the risk of a non-economic pellet production is considerably higher than for large-scale systems.
The direct comparison of typical pellet production costs in Austria and Sweden showed the Swedish pellet production costs to be considerably lower due to larger plant capacities, the combination of pellet production and biomass CHP or biomass district heating plants and the implementation of technologies which allow an efficient heat recovery from the dryers. Moreover, another difference between the Austrian and the Swedish framework conditions is the price of electricity, which is much lower in Sweden
(To request email library@energylibrary.org.nz and quote **BIO1Theka**)

A consideration of the economic efficiency of hydrogen production from biomass W Iwasaki, Journal of Hydrogen Energy V 28, 9 , September 2003, 939-944
A feasibility study of a hydrogen production system using woody biomass with a pyrolysis process was conducted as part of NEDO's WE-NET project. Using the pyrolysis process, various solid fuels and waste materials can be gasified, and synthesis gas suitable for hydrogen production can be obtained without the need for a pure oxygen supply. Using this system, it is expected that 7.4 billion m3/yr (NTP) of hydrogen from biomass stock will be produced for domestic supply in Japan. The capital cost of the plant used in this study is $3950/kWH2 out, and product supply cost is 0.108 $/kWhH2 out.
(To request email library@energylibrary.org.nz and quote **BIO1Iwasaki**)

Effects of increased biomass pellet combustion on ambient air quality in residential areas—a parametric dispersion modeling study C Bomana et al, Biomass and Bioenergy V 24, 6 2003 465-474
Sweden's goals of contemporaneously reducing CO2 emissions and phasing out nuclear power will require a maximum utilization of biomass fuels. This would imply a significant shift from electricity and fuel oil to biomass generated heat, but must also be accomplished without a deterioration of the local air quality. The most suitable energy carrier seems to be pelletized biomass fuels with their associated low emissions and considerable residential conversion potential. Using an underlying statistical design, a parametric dispersion modelling study was performed to estimate and illustrate the combined effects of source-specific, meteorological and modelling variables on the ambient air quality in a typical residential area for different conversion scenarios. The work nicely illustrated the benefits of combining statistical designs with model calculations. It further showed that the concentration of combustion related ambient THC was strongly related to conditions affecting the source strength, but only weakly to the dispersion conditions and model variables. Time of year (summer or winter); specific emission performance; extent of conversion from electricity; conversion from wood log combustion; and specific efficiency of the pellet appliances showed significant effects in descending order. The effects of local settings and model variables were relatively small, making the results more generally applicable. To accomplish the desired conversion to renewable energy in an ecologically and sustainable way, the emissions would have to be reduced to a maximum advisable limit of 25±7 mgTHC/MJfuel (given as CH4). Further, the results showed the potential positive influence by conversion from wood log to low emission pellet combustion.
(To request email library@energylibrary.org.nz and quote **BIO1Bomana**)

Particle density determination of pellets and briquettes F Rabiera et al, Biomass and Bioenergy V 25, 4, 2003, 435-446
Several methods and procedures for the determination of particle density of pellets and briquettes were tested and evaluated. Round robin trials were organized involving five European laboratories, which measured the particle densities of 15 pellet and five briquette types. The test included stereometric methods, methods based on liquid displacement (hydrostatic and buoyancy) applying different procedures and one method based on solid displacement.
From the results for both pellets and briquettes, it became clear that the application of a method based on either liquid or solid displacement (only tested on pellet samples) leads to an improved reproducibility compared to a stereometric method. For both, pellets and briquettes, the variability of measurements strongly depends on the fuel type itself.
For briquettes, the three methods tested based on liquid displacement lead to similar results. A coating of the samples with paraffin did not improve the repeatability and the reproducibility. Determinations with pellets proved to be most reliable when the buoyancy method was applied using a wetting agent to reduce surface tensions without sample coating. This method gave the best values for repeatability and reproducibility, thus less replications are required to reach a given accuracy level. For wood pellets, the method based on solid displacement gave better values of repeatability, however, this instrument was tested at only one laboratory.
(To request email library@energylibrary.org.nz and quote **BIO1Rabiera**)

Long distance bioenergy logistics: an assessment of costs and energy consumption for various biomass energy transport chains R. Surrs. Copernicus Institute, 2002. (Report NWS-E-2002-01)
In this extensive energy and cost analysis study on long distant bioenergy transport systems, a model system is created based on previous patterns in Latin-America and Europe. The likely influences on cost and energy consumption are discussed.
(To request email library@energylibrary.org.nz and quote **BIO1Surrs**)

The redox process for producing hydrogen from woody biomass R. Sime et al, International Journal of Hydrogen Energy V 28, 5, May 2003, 491-498
Hydrogen may be made from biomass fuel gas using a method of cyclic reduction and oxidation (REDOX) of iron oxides. The production of hydrogen using REDOX technology has been modelled. These studies showed that hydrogen production efficiency depends significantly on the gasifier fuel gas composition and the thermochemical properties of the REDOX material. A lab scale REDOX system was developed to provide experimental data. Good agreement between experimental and theoretical data was obtained. The inherent thermodynamic constraints of the REDOX process limit the maximum efficiency. The REDOX hydrogen
(To request email library@energylibrary.org.nz and quote **BIO1Sime**)

Sustainable cofiring of biomass with coal A Demirba, Energy Conversion and Management V 44, 9 , June 2003, Pages 1465-1479
Biomass is an attractive renewable fuel to supplement coal combustion in utility boilers. Coal cofiring was successful with up to a 20% biomass mix. Results of extensive applications have shown that cofiring of biomass with coal have accomplished the following: (1) increased boiler efficiency, (2) reduced fuel costs and (3) reduced emissions of NO_x and fossil CO_2. Every ton of biomass cofired directly reduces fossil CO_2 emissions by over 1 ton. Woody biomass contains virtually no sulfur, so SO_2 emissions are reduced in direct proportion to the coal replacement. Biomass is a regenerable biofuel. When a fossil fuel is replaced by a biofuel, there is a net reduction in CO_2 emissions. Biomass can contain considerable alkali and alkaline earth elements and chlorine, which, when mixed with other gas components derived from coal such as sulfur compounds, promotes a different array of vapor and fine particulate deposition in coal fired boilers
(To request email library@energylibrary.org.nz and quote **BIO1Demirba**)

Power generation using dedicated woody crops: thermodynamics and economics of integrated plants R. Carapellucci Renewable Energy V 27, 1 , September 2002, 143-159
Biomass will continue to play a significant and probably increasing role in the world's future energy mix, due to the strategic role it has for large availability, environmental concerns and technological advances. The raw biomass has a relatively high moisture content, requiring thermal drying processes in order to minimise stack losses.
In this paper, integrated plant configurations burning dedicated woody crops for electric power generation and different options for pre-drying the biomass are discussed. Conventional indirect drying, using steam extracted from the turbine, and direct drying processes with hot gas turbine exhaust gases, are compared, assessing their influence on plant layout and performance. Moreover, a detailed economic analysis has been carried out for evaluating the levelized cost of the electricity produced, as well as the profitability of each plant configuration.

The study shows that using the heat recovered from gas turbines for biomass drying enhances the feasibility of biomass-fired power plants, improving performance and reducing woody biomass crop requirements with respect to conventional configurations. The analysis also demonstrates that the proposed solutions allow reducing the cost of electricity produced and shorten payback periods.
(To request email library@energylibrary.org.nz and quote **BIO1Carapellucci**)

Web Links

The U.S. Department of **Biomass Program** is aimed at reducing dependency on oil and to encourage the biomass industry. Provides information on grants, technology, latest research. There are five research and development areas including biomass feedstock.

IEA Bioenergy was established in 1978 by the International Energy Agency (IEA). There are 21 member countries collaborate in energy related research. The website is comprehensive.

The **EU website for bioenergy** has a wood energy barometer for European countries, including the United Kingdom.

Bioenergy Australia was established in 1997 with the aim to encourage the use of biomass for energy, liquid fuels and other bio products. The **quarterly newsletter** provides recent news and there are links to publications.

EECA (Energy Efficiency Conservation Authority) encourages the use of all renewables including biomass.

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