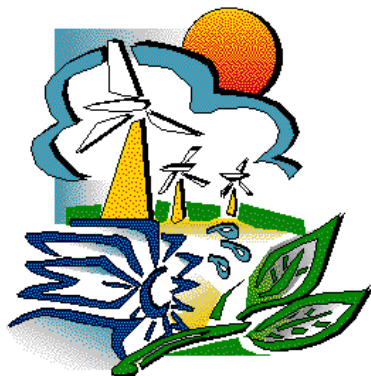




IRISH ENERGY CENTRE
RENEWABLE ENERGY INFORMATION OFFICE

“The Use of Wood Fuelled Combined Heat and Power in the Finnish Forestry Industry”

Report of the Study Tour Facilitated by The Renewable Energy Information
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Wood Fuelled CHP- A General Introduction

Background*

Combined Heat and Power (CHP) is a very common industrial energy efficient technology used increasingly in industry world-wide. In the UK alone, 10,000 MW of CHP is to be installed by 2010. As wood processing is an energy intensive industry, CHP can make a significant impact on profitability. Evidence shows that CHP can reduce total site energy costs by over 30%. In Europe, leading wood fired CHP equipment supply companies are based mainly in Scandinavia.

There are currently four large industrial wood processing plants in Ireland . They have a combined heat capacity of over 110 MW and a combined electricity requirement of over 40 MW. All of these plants use wood waste to provide their process heat and then buy in their electricity separately. None of these plants currently uses CHP. Evidence shows that in the Paper and Board sector, CHP can reduce total site energy bills by as much as 30%.

All of these Irish plants could generate electricity from wood fired CHP. A recent report on the total renewable energy resource in Ireland has also highlighted the significant potential of wood biomass CHP. If the four companies were to employ this technology it would add some 30,000 toe (tonnes of oil equivalent) to Ireland's Renewable Energy Balance and would represent almost a quarter of Ireland's renewable electricity production in 2000. In addition, all of the wood fuel for these CHP plants would be grown in Ireland, providing a secure, long term, supply of electricity and heat from a major national resource.

As wood biomass is CO₂ neutral, the savings in terms of CO₂ emissions (the main greenhouse gas) could be in excess of 300,000 tonnes annually. This would represent a total CO₂ emissions saving, for Ireland, of about three quarters of a percent of total annual energy CO₂ emissions.

Why invest in Wood Biomass CHP?*

- CHP will reduce your energy costs.
- CHP is widely used by your competitors in Europe and elsewhere.
- CHP can offer security against energy price fluctuations.
- CHP provides a secure supply of energy to your site.
- CHP can help your business comply with environmental legislation.
- CHP can improve your profit margin and give your company a competitive edge.

The Benefits of Investing in Wood Biomass CHP

Benefits	Fossil Fuel CHP	Wood Biomass CHP
Energy Cost Savings	Yes	Yes
<i>Secure Energy Supply</i>	Medium term	Long term
<i>Secure Energy Prices</i>	Medium term	Long term
<i>Better Control</i>	Yes	Yes
<i>Environmental Benefits</i>	Yes	Yes
<i>CO₂ Emissions</i>	136 Tonnes/TJ	0 Tonnes/TJ **
<i>Local Job Creation</i>	Short term	Long term
<i>Imported Fuel</i>	Yes	No, a national resource
<i>Local Self Sufficiency</i>	No	Yes
<i>Sustainable Development</i>	No	Yes

** Wood Biomass is CO₂ neutral, 1 TJ = 278,000 kWh

* **Source:** "Report on Wood Biomass Combined Heat and Power for the Irish Wood Processing Industry- January 1999", Renewable Energy Information Office Publication - available on the web site: www.irish-energy.ie/reio.htm by clicking on the Reference Centre Link



IRISH ENERGY CENTRE
RENEWABLE ENERGY INFORMATION OFFICE

The Renewable Energy Information Office Facilitated Study Tour

“The Use of Wood Fuelled Combined Heat and Power in the Finnish Forestry Industry”

The study tour was facilitated by the Renewable Energy Information Office of The Irish Energy Centre and took place in Finland from Tuesday 29th August to Friday 1st September. The objective of the study tour was promotion of the use of combined heat and power production in the Irish wood processing industry. The visit was aimed at boardmills, the larger sawmills and the main forestry organisations

PROGRAM

Wednesday 30th August 2000

International Wood Energy Seminar Nordic Treasure Hunt: Extracting Energy from Forest Residues
Jyväskylä, Finland, Organised by Finnish Wood Energy Technology Programme and OPET Finland

Thursday 31st August 2000

Morning

METKO Forest Machinery Exhibition, Jämsänkoski

Afternoon: Small Scale Wood Heating Plant Visit

Visit to Konnevesi Heating plant

Hosted by Mr. Juha Huotari of Sermet Oy

A 1.25 MW_{th} district heat plant fuelled by wood chips, sawdust and peat

Afternoon: Large Scale Combined Power and Heat Plant Visit

Visit to Sateri Oy Power and Heat Plant

Hosted by Fortum Heat and Power

A 10 MW_e and 50 MW_{th} industrial process plant fuelled by peat, wood waste, mill sludge and industrial waste

Evening

Presentation: “*How to Design and Realise Wood fired CHP Plants for Mechanical Wood Industries*”

Speaker: Mr. Yrjö Orispää, Managing Director, Protermo Oy

Conference Room, Hotel Alexandra, Jyväskylä

Friday 1st September 2000

Small Scale Combined Heat and Power Plant visit

Visit to Karstula CHP Plant

Hosted by Mr. Juha Houtari of Sermet Oy

A 10 MW_{th}/ 1 MW_e CHP plant fuelled by wood residues from an adjacent loghouse factory

Large Scale Combined Heat and Power Plant Visit

Visit to Forssa CHP plant

Hosted by Mr. Visa Ahola of Foster Wheeler

A 17 MW_e and 48 MW_{th} fluidised bed boiler fuelled by wood wastes, forest chippings, peat and building waste



IRISH ENERGY CENTRE
RENEWABLE ENERGY INFORMATION OFFICE

Wednesday 30th August 2000

Nordic Treasure Hunt: Extracting Energy from Forest Residues

The Nordic countries all have significant experience and know-how in wood energy. The European Commission has set ambitious targets for the use of renewable energy sources. In Denmark, Finland and Sweden forest chips play important role not only as an energy source but also in forest management.

This seminar focused on forest residues and its uses in the context of Nordic experiences and technologies. Competitiveness and costs as well as environmentally sound forestry are the key issues. The seminar was organised in collaboration with the Finnish Wood Energy Technology Programme and OPET Finland. In connection with the Programme the annual seminar was held on August 30, 2000 at the conference centre in Paviljonki, Messukatu 10, Jyväskylä, Finland.

The seminar was followed by an excursion to the METKO 2000 exhibition, the leading event for forestry machinery in Finland. It gathered the professionals of forest contracting as well as the marketing companies supplying machinery, services and products to this sector.

The Tekes` Wood Energy Technology Programme 1999-2003 focuses on developing the production technology and improving the quality of forest chips from logging residues and small-sized trees. OPET Finland, a Finnish member of the European Network for the Organisations for the Promotion of Energy Technologies, serves as a gateway to Finnish energy technologies and market actors, networking experiences from Finland to Europe and vice versa.

PROGRAMME

Wednesday 30th August 2000

- 8.00 Registration
Chairperson Satu Helynen, VTT Energy
- 9.00 **Renewable Energy Sources in Finnish Energy Policy and Climate Change**
Finnish Ministry of Trade and Industry, Energy Department
Role of Technology Development in Promoting Wood Energy
Satu Helynen, VTT Energy
Research on Bioenergy in Sweden - Present Status and Future Plans
Erik Ling, Swedish National Energy Administration
- 10.40 **Wood Energy and Technology in Denmark**
Niels Heding, Danish Forest and Landscape Research Institute
Forest Chips in Finland - Use, Experiences and Prices
Pentti Hakkila & Ismo Nousiainen, VTT Energy
Forest Chips in the Energy Strategy of Large Pulp and Paper Company - Case
UPM Kymmene Oyj, Juha Kouki, UPM-Kymmene Oyj
- 13.30 **Technology of Fuel Chip Production in Sweden**
Gert Andersson, SkogForsk
Cost, Competitiveness and Trade of Wood Fuels in Sweden
Bengt Hillring, Swedish University of Agricultural Sciences
Cost Factors of Fuel Chip Production
Antti Asikainen, University of Joensuu
- 15.30 **Cofiring of Wood - Fuel Handling and Cocombustion**
Timo Järvinen & Markku Orjala, VTT Energy
Practical Experiences of Large-Scale Use of Forest Fuels in Sweden
Ulf Johnsson, Växjö Energi
- 16.40 Discussion and conclusions of the seminar

Thursday 31st August 2000

- Visit to Forest Exhibition METKO in Jämsänkoski
- 9.00 **Departure for METKO Forest exhibition by bus (60 km south from Jyväskylä)**
- 13.30 **Departure for Helsinki by bus (220 km)**

For further information on the seminar and to order proceedings, see the following web site:
www.tekes.fi/opet/



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Thursday 31st August 2000

Konnevesi

A district heating plant designed for wet solid fuels 1.25 MW_{th}

The site visit to this plant was hosted by Juha Huotari, Engineering Director, Sermet Oy. Technical Details of the plant are as per the attached OPET Fact Sheet

Features of the plant are as follows:

- The plant is fully automated and unmanned. The plant is computer monitored i.e. the plant operator is informed of the plants performance via mobile telephone. The plant monitoring system is also connected by modem to the operator and manufacturers computers
- This plant was factory assembled and turn-key delivered to the site in five modules
- Ash from the boiler grate falls into cooling water before it is taken by conveyor to a storage bin. It is easily moved from the storage bin to be transported off site. This ash may be mixed with fertilisers and spread on existing forests

The total cost of the plant, including an extension of the district heating network was 615,000 Euro

Points made during discussion at the plant are as follows:

Question: The fuel being used in the plant is a mixture of sawdust, wood chips and peat. The fuel supply which is stored on site had a very low moisture content (approximately 40%). The point was made that by-products from Irish saw mills would rarely have such a low moisture content.

Response: The fuel used in the Sermet Biograte can have a moisture content between 40-60%. The higher the moisture content however the less electricity is produced.

Question: How much electricity is produced from 1 tonne of saw mill by products? The point was subsequently made that in Ireland there is generally 1-2 dry cubic metres in each tonne of saw mill by product.

Response: In Finland 1 tonne consists of 4 dry cubic metres approximately. Each cubic metre produces 0.7 MWh

Question: A saw mill can generate and use its own electricity by placing a CHP plant adjacent to or in his saw mill. In the forestry industry is it feasible to set up a CHP plant adjacent to a large user of heat/ electricity e.g. a hospital

Response: Each case is site specific and a study would have to be carried out taking all of the aforementioned factors into account as they tend to vary in each case

Conclusions:

There are a number of factors to be taken into account in determining the amount of electricity which can be generated e.g. moisture content and type of fuel used

A value must also be placed on the saw mill by products so that the profitability of wood fuelled CHP can be determined.

Each case must be studied individually. It was concluded that feasibility studies should be carried out individually for each one. The possibility of receiving financial support for same should be investigated and it was suggested that Enterprise Ireland may be of help in this regard. It is hoped that these feasibility studies would lead to the development of wood fuelled CHP plants in the wood processing industry in Ireland and could in turn be used as a reference for the whole of the Irish wood industry.

Further information on this type of biomass plant is available at www.tekes.fi/opet/

REIO notes on the energy content on wood:

1 cubic meter of wood chips weighs approx. 250 kg

1 tonne of wood chips fills approx. 4 cubic metres

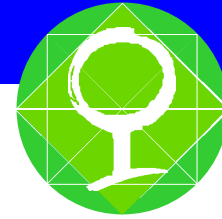
The calorific value of one cubic meter of wood chips is approx. 2.6 GJ or 722 kWh

The calorific value of one tonne of wood chips is 10.4 GJ or 2889 kWh

[These calculations are based on Norway spruce wood chips with a moisture content of 40% which is equal to the moisture content in 'storage-dry' wood chips]

Further details of the energy density of as received solid wood fuels is available on the following web site:

www.finbioenergy.fi



A district heating plant designed for wet solid fuels 1.25 MW_{th}

Konnevesi

Konnevesi is town of 3300 inhabitants and it is located 60 kilometres to the Northeast of Jyväskylä. In the beginning of the 1980s a district heating network was built in the town of Konnevesi. Originally there were two heavy fuel oil fired boilers with thermal capacities of 1.3 MW and 0.6 MW. Heat demand of the network increased and investment for a new 1.25 MW_{th} biomass heating plant was made at the beginning of the 1997. The district heating network was also extended to accommodate the increased heat demand of the town. The new heating station was commissioned in September 1997. Konnevesi municipality owns both the network and the plants.

The main fuel is wood chips (7000 bulk m³/a) and in addition have sawdust and peat used sporadically. Fuel is bought from Vapo Oy, which delivers wood chips to the plant. Moisture content of used fuel has been remarkably high, up to 65 w-%.

The 1.25 MW biomass plant was delivered by Sermet Oy. Sermet developed and patented the BioGrate

boiler, which is used in the plant. The boiler plant was delivered as a completely factory-made package.

The fuel storage is equipped with push-bar unloaders. Fuel is transferred with drag-chain conveyors into the fuel bin in the boiler room and then fed into the primary combustion chamber by a stoker screw through an inlet in the centre of the grate. The grate is divided in sections, each of which can be programmed to rotate at a desired speed to ensure stable feeding and combustion of the fuel. The movement of the grate is adjusted in such a way that the fuel is distributed as an even bed over the whole grate. The fuel dries and ignites on the grate. The fuel feed is automatically controlled according to the outlet temperature of boiler water. The flue gases are cleaned by a multi-cyclone dust particulate separator.



The turn-key delivered plant transported in five modules from the factory to Konnevesi. Schedule for the new biomass heating plant investment:

- Contract 4/97
- Designing 5/97
- Manufacturing 6-7/97
- Assemblage at the factory 8/97
- Delivery and commission 9/97
-

Efficiency of the plant has been high in the whole range of capacity, almost 90%. The new biomass plant produces 5000 MWh/a, which is 80% of annual heat consumption. The remainder is produced by old heavy fuel oil fired boilers, which are used for peak loads and in summer time, when heat consumption is small. Heated building volume in Konnevesi is about 100 000 m³.

Investment costs for the plant were 437 000 EUR including the extension of district heating network 605 000 EUR. The Ministry of Trade and Industry gave financial support for the investments 30% (181 000 EUR). Further funding came from loans. It is possible that the municipality will sell the plant for a private entrepreneur in the future.

Technical data

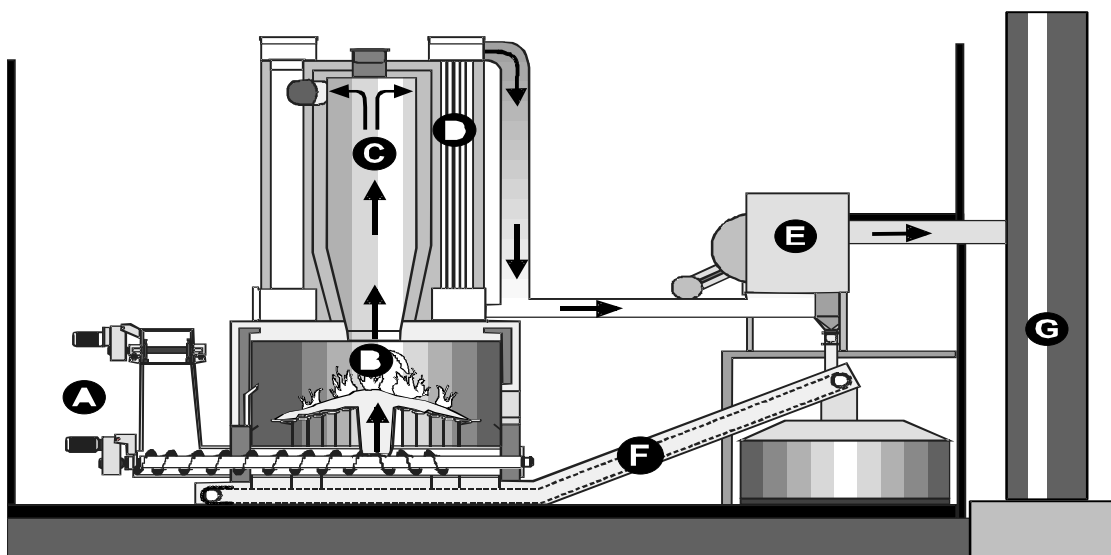
Boiler	Underfeed rotating grate, 1.25 MW
Fuel	Wood chips, sawdust, peat
Heat production	5000 MWh/a
Efficiency	90 %
Investment costs	605 000 EUR (including extension of district heating network)
Investment support	181 000 EUR (30%)

Additional information

Sermet Oy
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team@sermet.fi
www.sermet.fi

Produced by OPET Finland, VTT Energy 24.8.2000

Sermet BioGrate compact 1-4 MW



- A** Fuel feed
- B** Primary combustion chamber
- C** Secondary combustion chamber
- D** Boiler
- E** Flue gas cleaner
- F** Ash removal
- G** Stack

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Visit to Säteri Combined Heat and Power Plant A 50MW_{th} Bubbling Fluidised Boiler CHP plant

This visit is hosted by Fortum Heat and Power

The Säteri power plant consists of a bubbling fluidized bed (BFB) boiler which was upgraded in August 1999. The upgrading included installation of 50 MW_{th} bubbling fluidised bed boiler and capacity increase of the K5 boiler.

The plant provides electricity as well as steam to Sateri Oy.

The visit included a general introduction of Fortum and a tour of the plant. The Sateri plant is one of a number of CHP plants operated by Fortum in the region and forms part of a local power and heat plant group.

Technical parameters:

- Fuel input 50 MW_{th}
- Steam flow 17 kg/s
- Steam pressure 60 bar
- Steam temperature 500°C

Fuels:

- Peat
- Wood
- Mill sludge
- Industrial waste



Improved bottom ash removal as a result of BFB boiler conversion



Säteri Oy Plant

Presentation: "How to design and realise profitable wood fired CHP plants for mechanical forest industries"

Speaker: Mr. Yrjö Orispää, Managing Director, Protermo Oy

Location: Conference Room, Hotel Alexandra, Jyväskylä

Presentation Content

- Introduction (e.g. advantages of CHP generation, typical stages of a CHP project)
- Necessary input data for performing a feasibility study (e.g. present and future energy consumption, available fuels, present and future energy prices)
- Energy generation alternatives (e.g. power plant concepts and size classes, main design parameters)
- Basis for feasibility calculations
- Criteria for feasibility assessment
- Procurement alternatives
- Conclusions

The full presentation report follows on the next page:

How to design and realise profitable wood fired CHP plants for mechanical forest industries

**Speaker: Mr. Yrjo Orispaa,
Managing Director,
Protermo Oy**

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How to design and realise profitable wood fired CHP plants for mechanical forest industries

INTRODUCTION

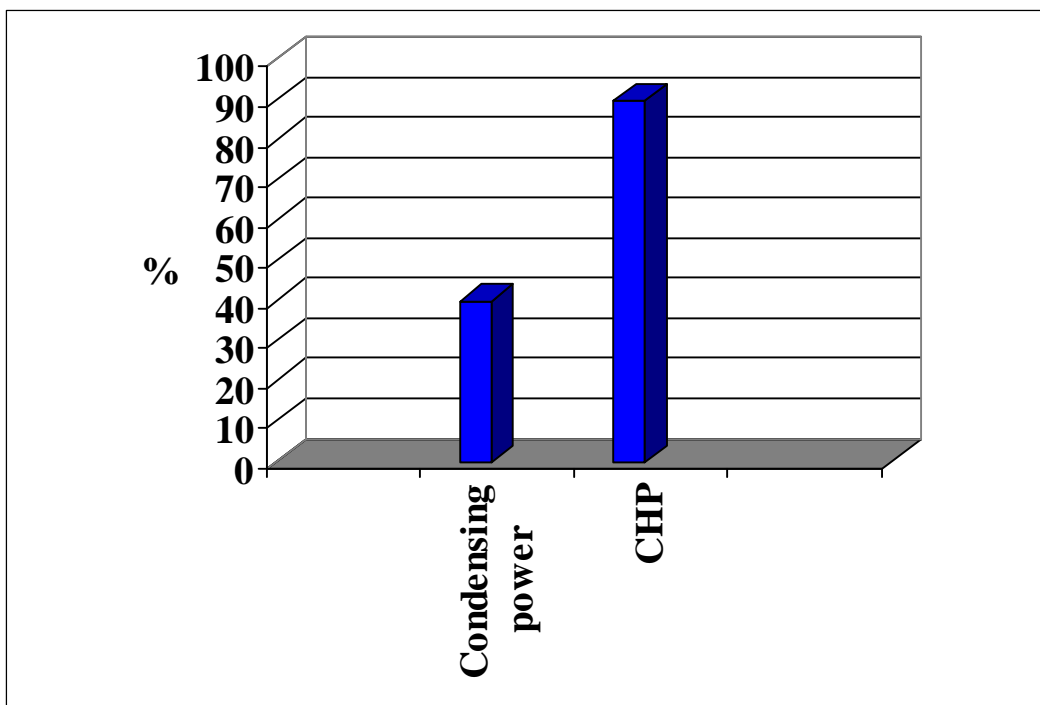
Combined Heat and Power (CHP) production is an energy conversion process where electricity and useful heat are produced simultaneously in a single process.

The advantage of applying CHP is based on the high overall efficiency of the process compared to generating electricity and heat separately.

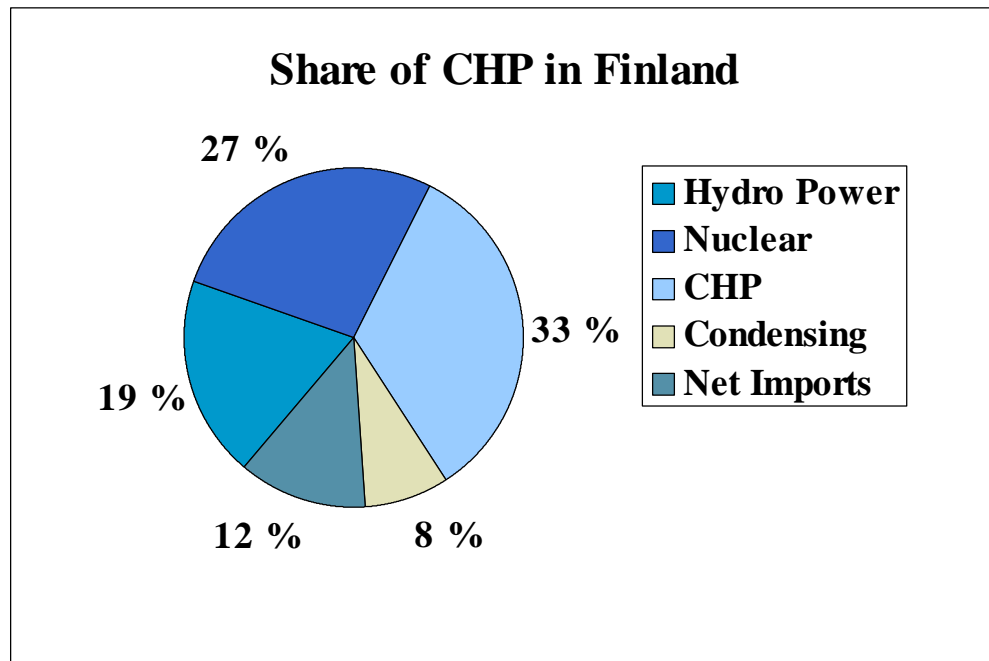
When the efficiency of a modern conventional large scale condensing power plant generating only electricity remains at around 40 %, the CHP plants achieve an efficiency of 80 to 90 %.

As a result, fuel consumption compared to corresponding generation in separate processes is lowered approximately by one third.

The emissions from energy generation are reduced correspondingly. This is one of the reasons, why the authorities favour CHP generation, because it is one of the few technologies, which can effectively contribute to the reaching of the goals of the Kyoto agreement.



Doubling the share of CHP electricity from 9% to 18% in 2010 is a target proposed by the European Commission for the European Union. Presently, the electricity production by CHP in the member states of the European Union varies between 1% to 40%. In Finland the share of CHP electricity is one third of the total supply.



In CHP generation a wide variety of fuels can be used including those with a low calorific value and high moisture content. Traditionally, biofuels have been used in CHP generation, mainly in connection with forest industry processes. In mechanical forest industries suitable biofuels for CHP generation are bark, chips, sawdust and other wood waste. With increasing energy prices and improving power plant concepts, CHP electricity generation even in smaller scale has nowadays become an attractive alternative for saw mills and particle board mills.

However, there is no universal rule of thumb to determine, which project is viable and which one is not. The feasibility has to be separately verified in each case.

Normal phases of a CHP project are the following:

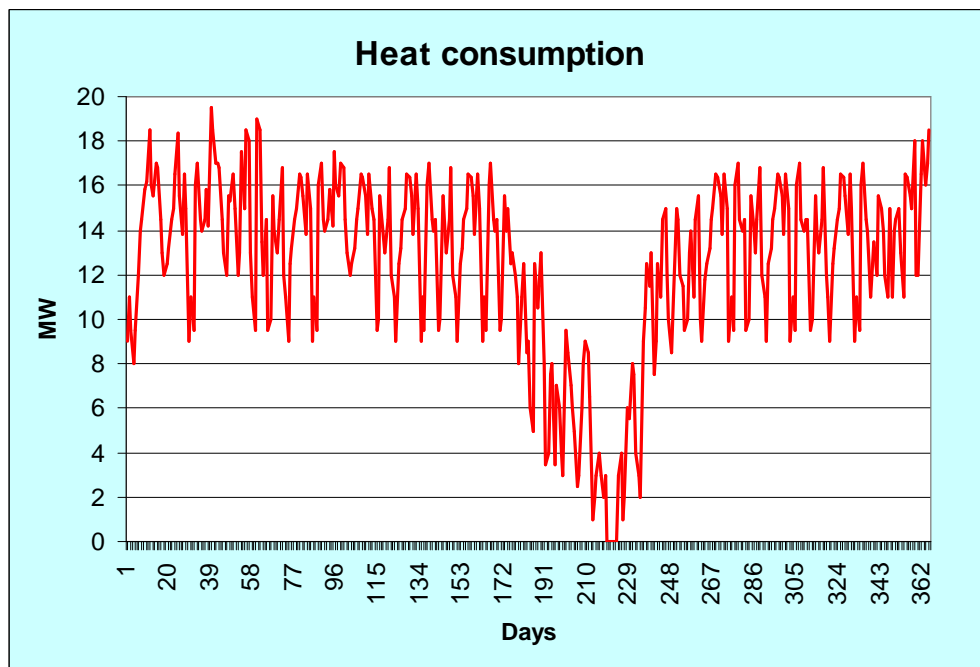
- pre-feasibility study
- feasibility study
- basic design including final investment budget
- investment decision
- detailed design and procurement of equipment
- construction and erection
- taking into operation.

A pre-feasibility study may include several investment alternatives from which the most profitable will be selected for a more detailed feasibility study. Sometimes the pre-feasibility and feasibility study phases may be combined.

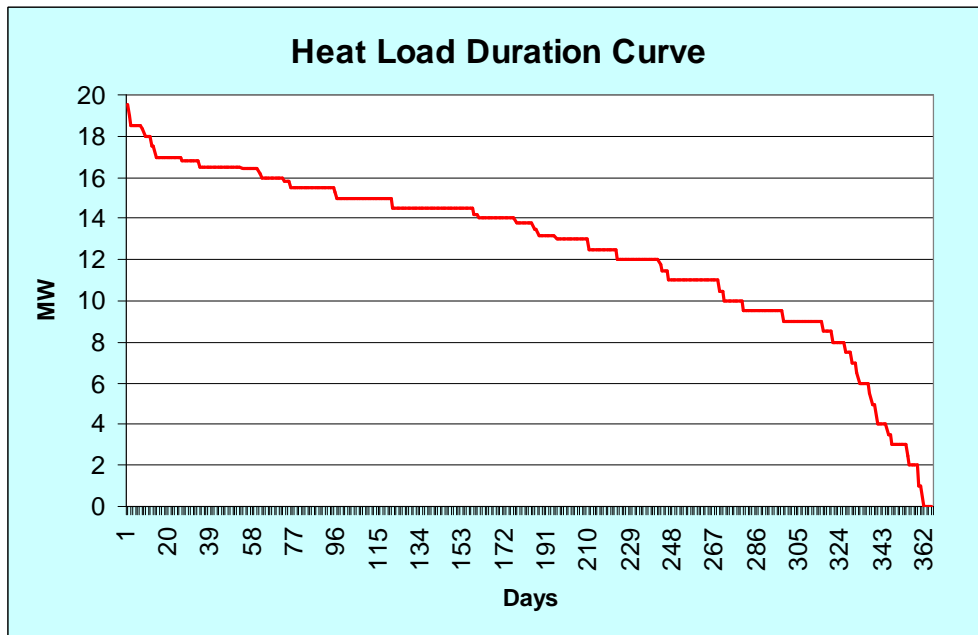
In a feasibility study, one investment alternative is normally compared to a zero alternative, which means that only heat is generated locally and all electricity is purchased from outside.

INPUT DATA FOR A FEASIBILITY STUDY

CHP electricity generation is based on available heat load of the mill. Therefore, it is essential to know the variation of the heat load at least on a daily basis. The same applies for the electricity load. The following figure shows a typical daily variation of heat consumption during one year.



For practical purposes, the loads are also presented in the form of the so-called duration curves. This means that the loads are piled from left to right in a decreasing order as shown in the following figure:



In practice the most profitable size-class for CHP heat generation lies in the range of 50 % of the peak heat load (in the above figure at about 10-12 MW). The electricity generation capacity depends on many factors such as steam parameters, but normally it varies between 30 and 50 % of the heat capacity. This means that in this case the power plant can generate some 3-5 MW of electricity.

Since the feasibility calculations are made for several years, often up to 25 years, it is also necessary to know the planned capacity changes of the mill and their effects on heat and power consumption.

Other data normally needed for performing a feasibility study are the following:

- amount and quality of biofuels
- electricity and fuel prices
- available power plant site and soil quality
- availability and quality of cooling and raw water
- requirements for connecting the plant into grid
- environmental requirements
- cost of labour
- interest rates
- state subsidies
- taxation

ENERGY GENERATION ALTERNATIVES

During the pre-feasibility study phase, various power plant concepts, size classes and design parameters may be considered. In case of mechanical forest industries possible concepts would be:

- steam boiler and steam turbine
- steam boiler and steam engine

A steam engine is an alternative under 1 MWe size class. As to steam boilers, there are various firing systems available, such as:

- mechanical grate combustion
- rotating grate combustion
- fluidised bed combustion

Live steam pressure and temperature have to be optimised also.

BASIS FOR FEASIBILITY CALCULATIONS

Feasibility evaluation of a selected power plant alternative is based on the estimated investment and operation costs of the plant. The investment cost is often verified by asking binding offers for the main equipment, i.e. steam boiler and steam turbine or engine. The main portion of operating expenditure is composed of fuel costs. The annual fuel consumption can be calculated based on available heat load data and corresponding energy generation.

For calculating the feasibility of the power plant project, a cash flow analysis for 20 to 25 years is often performed. This yields as a result annual cash flows before and after taxes.

CRITERIA FOR FEASIBILITY ASSESSMENT

The main criteria for evaluating the feasibility is the net present value (NPV) of the project. This is received by discounting the annual cash flows to the start of the project by means of a selected discount rate.

In addition, other feasibility criteria normally applied are the Internal Rate of Return (IRR) and pay-back time. These too, can be derived from the cash flow calculation.

If the feasibility study shows a positive result, an investment decision can be made.

PROCUREMENT ALTERNATIVES

The most often used methods for the procurement of the power plant equipment are the following:

- turn-key method
- procurement of equipment in smaller packages

The advantage of the turn-key method is the minimum personnel requirement from the buyer's side. However, once the contract has been made, the buyer has very little to say about the individual design and equipment choices. Also, the total price of the plant may often be higher than in the second alternative.

A procurement method, where the buyer and the power plant engineer together participate in all the design and procurement phases of the project, often leads to a more economical end result than the turn-key method.

CONCLUSIONS

For the successful realisation of a power plant project it is essential to perform a reliable feasibility study before making the final investment decision.

It is also important, that the procurement method is selected so that it leads technically and economically to the most optimum solution.



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Friday 1st September 2000

Honkarakenne Oy, Karstula

A Wood fuelled 10 MW_{th}/ 1MW_e CHP plant heating a wood processing factory and a town centre

The site visit to this plant was hosted by Juha Huotari, Engineering Director, Sermet Oy.

Technical Details of the plant are as per the attached OPET Fact Sheet

The Wood fuelled CHP plant at Karstula is located adjacent to a loghouse factory, Honkarakenne Oy. The plant is currently under construction and will be commissioned in October 2000.

A number of products are produced from this Sermet boiler: heat which is used as part of the timber drying process in the wood processing factory, hot water which is used in the municipal district heating network and also process steam. 1 MW of electricity will be generated from the plant for use in the wood processing company. The electricity will be generated using a steam engine and generator.

The fuels used in the plant are loghouse factory by-products.

Following the plant tour a short presentation of Kuiruvesi CHP plant, which also makes use of Sermet Biograte technology was made by Mr. Juha Houtari, Sermet Oy



Kiuruvesi CHP plant

This photograph demonstrates how boiler housing may be aesthetically pleasing

A wood fuelled 10 MW_{th} / 1 MW_e CHP plant heating a wood processing factory and a town centre

Honkarakenne Oy, Karstula

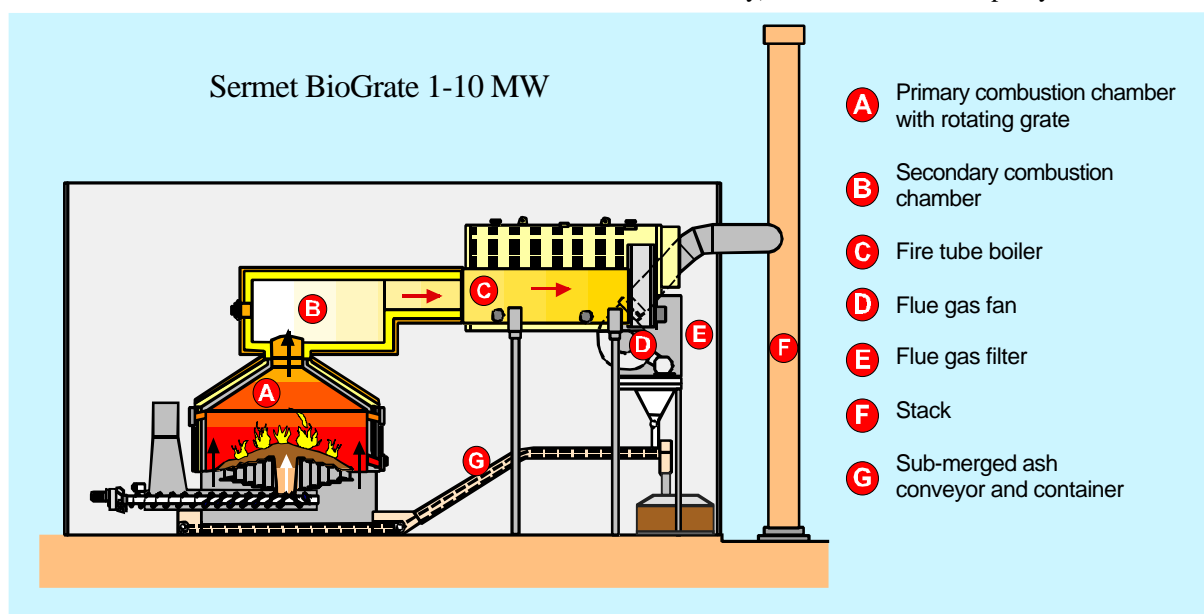
A new 10 MW_{th} / 1 MW_e wood fuel CHP plant will start operation in October 2000 in Karstula. Karstula is a town of 5000 inhabitants and it is located in Central Finland, 100 km Northwest of Jyväskylä. The plant is located near to a loghouse factory, Honkarakenne Oy. Honkarakenne produces 90 000 m³/a sawn timber and logs for loghouses.

Background to this project:

- Increased production of Honkarakenne
- Increasing energy demand for log drying and hot working
- Possibility to use loghouse factory's by-products, cutter shavings, bark and sawdust, as fuel
- Extension of the district heating network in Karstula town.

Honkarakenne Oy has made significant investments to develop its factories in Karstula. In order to meet the increased heat demand for dryers, it was decided to substitute old oil boilers with a wood fuelled CHP plant, because the factory needed both more heat and electricity. It produces 400 truck loads (70 GWh) wood residues per year, which can be used as fuel. Measured average moisture content of fuel (cutter shavings 44%, bark 30%, and sawdust 26%) has been 36%. Moisture content depends on combination of residues and in practise it will be higher, because share of cutter shavings will be smaller.

The owner of this CHP plant is a brand-new company, Puulaakson Energia Oy. Puulaakson Energia is owned by Honkarakenne, Keski-Suomen Valo (an energy utility) and Karstula municipality. Investment costs of



OPET – Organisations for the Promotion of Energy Technologies

the plant are ultimately 4.54 million EUR, but the project is supported with one million EUR by Ministry of Trade and Industry. Support granted for investment was increased, because of new technology which is used in the plant.

The plant has a thermal capacity of 10 MW_{th} and it will produce 3 MW heat for the municipal district heating network, 3 MW process steam and 3 MW heat for Honkarakenne. In addition the plant produces 1 MW_e of electricity for the wood processing company. Estimated heat production will be 45 GWh and electricity production 5 GWh. Share of energy for the district heating network (11 000 MWh) doesn't meet demand, so Karstula town has its own district heat production too.

Sermet Oy will deliver the plant in factory-made package. The plant has a patented combustion technique, BioGrate, capable of burning biomass fuels with moisture content from 30% to 65%. The BioGrate boiler is equipped with underfeed rotating grate, which moves the fuel bed cyclically by hydraulics equipment. The movement of the grate is adjusted in such a way that the fuel is distributed as an even bed over the whole grate. The fuel dries and ignites on the grate. The main advantages of the rotating grate are:

- there are no cold spots in the primary combustion chamber
- the burning surface is even
- movements of the grate zones are smooth
- *the secondary combustion chamber ensures complete combustion*

Electricity is produced by using a steam engine driven generator. A modern steam engine gives a high power

to heat ratio when the heat load is matched and is therefore well suited to small electricity capacities. In this type of plant efficiency is high throughout the plant part load range. The plant will be fully automatized and unstaffed.

The first Sermet BioPower CHP installation has been operating since autumn 1999, in Kiuruvesi, in Finland. The 8 MW biomass CHP has been reliable and producing environmentally friendly heat and power for a sawmill and municipal district heating network.

Technical data

Boiler	BioGrate, 10 MW
Estimated electricity production	5 GWh
Estimated heat production	45 GWh
Moisture content of fuel	35-45 w-%
Investment costs	4.34 million EUR
Investment support	1 million EUR
- Fuels: Cutter shavings, bark, sawdust	
- Fully automatized	
- Underfeed rotating grate	
- Steam engine	
- Low emissions	

Additional information

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Produced by OPET Finland, VTT Energy 7.8.2000



A loghouse produced by Honkarakenne Oy

The CHP district heating plant fuelled by wood -the Forssa biopower plant

The Forssa biopower plant is the first CHP district heating plant in Finland fuelled entirely by wood. It is a back counterpressure plant with a boiler specially adapted for the use of solid biofuels. The technology permits the use of practically all other available fuels.

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TECHNICAL DATA

- Power production 17.2 MW_e
- District heat production 48 MW_{th}
- Annual production
cogeneration power 57 GWh
district heat 155 GWh
- Steam temperature 510 °C
- Steam pressure 61 bar
- Steam flow 22.8 kg/s

COST DATA

- | | |
|-------------------------------------|----------------------|
| • Building | 20 Million FIM |
| • Boiler/Piping/Fuel Transportation | 40 Million FIM |
| • Turbine/Generator | 15 Million FIM |
| • Automation System | 10 Million FIM |
| • Other | <u>9 Million FIM</u> |
| • Total in 1996 Million FIM | 94 |

The boiler is a conventional fluidised bed boiler with a maximum capacity of 66 MW_{th}. The district heat water is heated in two stages. In the first stage hot water is generated with back pressure steam and the second stage with bleeding steam. This special solution enables a fairly high power to heat ratio, 26.3% at full load and 28.8 at 40 % load. The plant is provided with an auxiliary water cooler (10 MW_{th} max) to prime the power production and to help to use the plant in summer, when the district heating demand is low.

The commercial operation of the plant started up in September 1996. The plant produces all heat and a third of the electrical power required by the city of Forssa for almost all the year (except a short maintenance period in the summer).

BENEFITS

The primary fuel is woodworking industry waste, including sawdust and bark, together with forest chippings, building waste and other wood-containing substances. Wood is a renewable fuel resource which does not increase the greenhouse effect. When wood is burnt in the fluidised bed boiler there are no sulphur emissions and the nitrogen oxides emissions are very low.

The main waste product of a wood-fuelled power plant is ash, which may be returned to the forest as a part of natural recycling. The ash can be used in the landfilling or in landscaping.

Clean wood fuel, new combustion technology and high-quality electrostatic precipitator ensures improvement of the air quality in the city of Forssa. The plant emissions can be compared with emissions of wood decaying naturally.

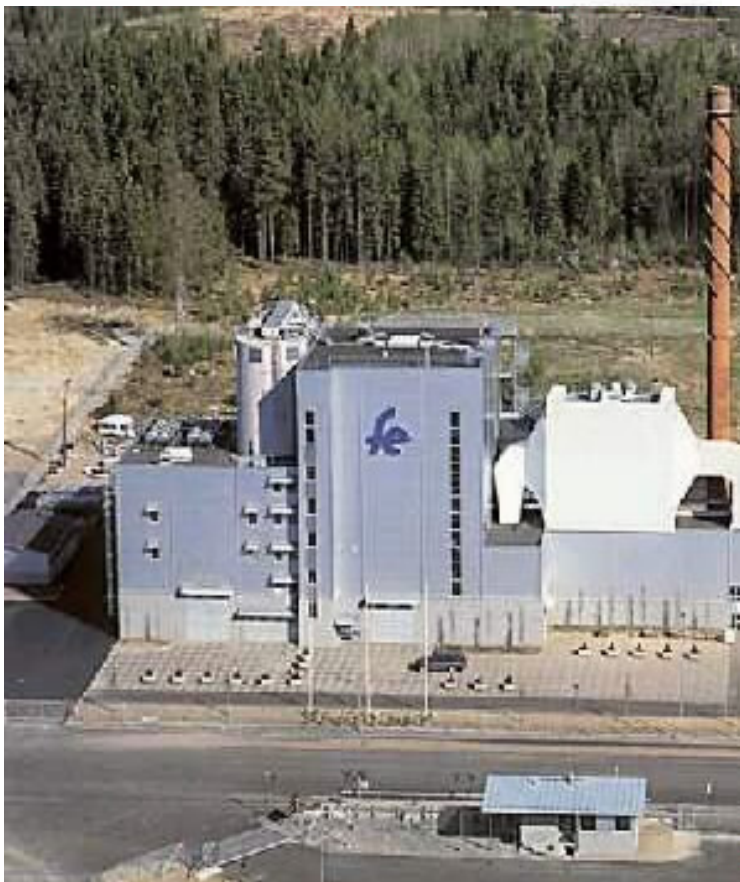
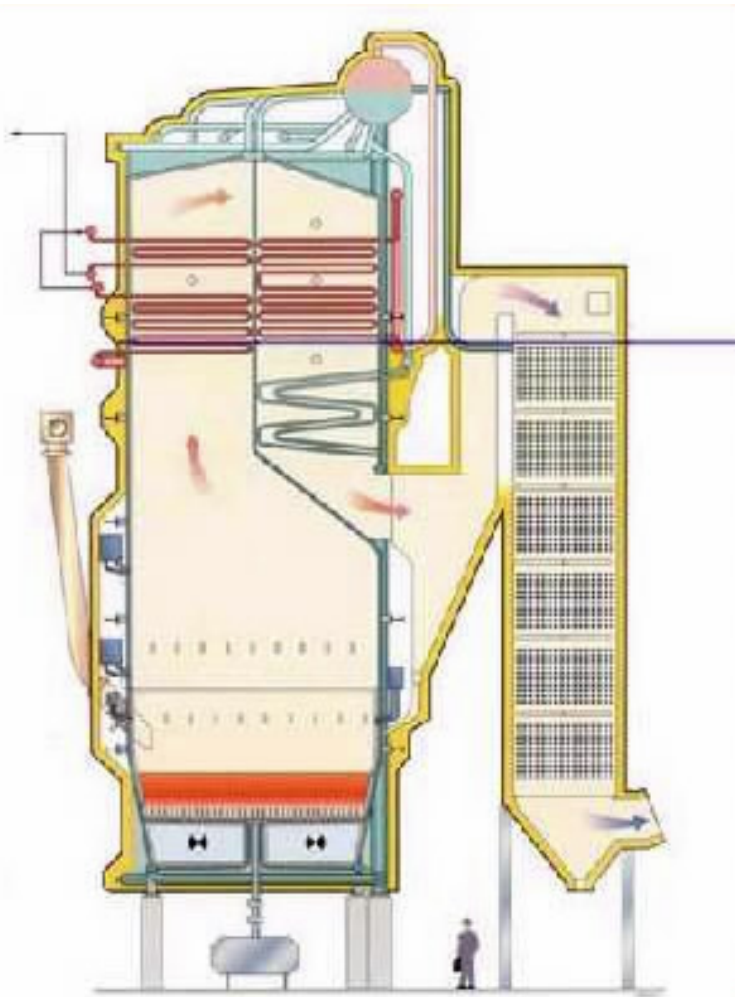
As the plant is a CHP plant there is no waste heat to the waterways, the heat recovered and utilised in district heating.

The owner of the plant, Forssan Energia Oy is a local energy production, distribution and transmission company. By the plant commissioned in 1996 Forssan Energia Oy extended the production of district heat and electricity and replaced old oil fired plants.

There is wood fuel available from different sources to feed the CHP plant. From the first beginning the aim has been to minimise the consumption of imported oil in local energy production. Most of the wood fuel burnt in the boiler is obtained from the vicinity of Forssa. It is planned that in the future the plant will accept the recycled material from the neighbouring landfill disposal site as fuel.

The annual wood fuel demand is 400,000 cubic metres.

PICTURES
Boiler & Plant



Contact Information

BOILER PLANT MANUFACTURERS

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FEASIBILITY STUDY GRANT SUPPORT

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www.enterprise-ireland.com/

OTHER USEFUL WEBSITES

AFB-net

The European bioenergy network, AFB-net, concentrates on actions to promote biomass utilisation and business opportunities in Europe.
www.vtt.fi/virtual/afbnet/

OPET

Network of Organisations for the Promotion of Energy Technologies
<http://www.tekes.fi/eng/international/opet/mainpage2.html>

Additional Information and Recommended Reading

- 1) **Report on Wood Biomass Combined Heat and Power for the Irish Wood Processing Industry- January 1999**, Renewable Energy Information Office Publication. which is available on the website: www.irish-energy.ie/reio.htm by clicking on the Reference Centre Link
- 2) **"Wood for Energy Production - Technology, Environment, Economy"** is available in pdf format for download on the website of The Centre for Biomass Technology: www.videncenter.dk/. A copy of this report is also available from the Renewable Energy Information Office Tel: 023 29146 e-mail: renewables@reio.ie
- 3) **"Introduction to Large Scale Combined Heat and Power (Revised)"** is available in pdf format on the "Energy Efficiency Best Practice Programme" website: www.energy-efficiency.gov.uk. It is listed in the publications section of the website as GPG043
- 4) **"Financing Large-Scale CHP for Industry and Commerce"** is available in pdf format on the "Energy Efficiency Best Practice Program" website: www.energy-efficiency.gov.uk. It is listed in the publications section of the website as GPG220
- 5) **"How to Appraise CHP-a simple investment appraisal methodology"** is available in pdf format on the "Energy Efficiency Best Practice Program" website: : www.energy-efficiency.gov.uk. It is listed in the publications section of the website as GPG227
- 6) **Cogeneration Ready Reckoner Software** www.isr.gov.au/resources/netenergy/domestic/cogen/cogen.html
Cogen-RR is a software programme designed to assist users with a first pass technical and financial analysis of cogeneration at their site. The Ready Reckoner conducts a simple technical and financial analysis of a cogeneration opportunity intended for quick preliminary evaluations. The software package is distributed by the Australian Commonwealth Department of Primary Industries and Energy and can be downloaded from the address given above
- 7) **Bioenergy in Finland, Review 1998**. Eija Alakangas VTT Energy, Agriculture and Forestry Biomass network (AFB-net), Jyväskylä 1998, FINBIO publications 6. This ALTENER supported review is a comprehensive review of bio-energy in Finland. Available on website: www.finbioenergy.fi/index_english.asp by clicking on the "Bioenergy Information" and "Publications" links.
- 8) **Feasibility Study Support Application Form** Financial support for a feasibility study into the use of wood fuelled CHP in the timber industry may be available from Enterprise Ireland. The application form for support is available from Mr. Willie Fitzgerald, Food and Timber Department, Enterprise-Ireland Tel: 01 8082005 e-mail: Willie.Fitzgerald@enterprise-ireland.com
- 9) **"Finnish Energy Technology Cases" OPET Finland**. This comprehensive list of project examples includes case studies of small and large scale CHP projects in Finland, and also projects dealing with wood handling and energy efficiency. It is available on the following website:
www.tekes.fi/eng/international/opet/mainpage2.html