EUBIONET II
International Training Programme
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WOOD FUEL PRODUCTION
For Small Scale Use and District Heating Plants

Summary Report

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Acknowledgements

I would like to acknowledge North Korelia Polytechnic and in particular Mr. Anssi Kokkonen for organising and implementing the International Training Programme on wood fuel production in Finland. I would also like to extend my gratitude for his hospitality throughout our stay in Finland.

In addition I wish to acknowledge Ms. Eija Alakangas of VTT Processes for her role in the overall organization of this programme and for her generosity in sharing her experience and knowledge of the wood fuel industry with us. Many thanks also to Dominik Röser of Metla, the Finnish Forest Research Institute, for his time and commitment during this training programme.

The following technical and presentation material has been summarized from each speaker's notes and handouts. Each individual speaker is listed at the beginning of their presentation.

Finally, I would like to acknowledge the role which COFORD played in contributing necessary funding for this trip.

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1.0 INTRODUCTION

The mitigation of climate change requires the reduction of CO_2 emissions. In Finland, one of the major means to meet this challenge is to replace the use of fossil fuels with forest biomass.

Finland is a world leader in the utilization of bioenergy, specifically from forest biomass. The role of wood as a source of energy is more important here than in any other industrialized country, as 20 % of the primary energy consumed in Finland is derived from wood-based fuels. In 1999, an extensive programme of research under the auspices of the Wood Energy Technology Programme was initiated by the National Technology Agency, Tekes. Today, as a consequence of that programme, much of the population and many decision makers in government and industry in Finland support the increased use of forest energy wholeheartedly. Therefore, a key goal of the Finnish energy and climate strategy is to increase the use of wood fuels and specifically to raise the annual production of forest chips to 5 million m^3 or 0.9 Mtoe by 2010.

In Finland, the forest energy sector has adopted a pioneering role, the engineering industry has developed innovative technology and equipment, and heating and power plants have adapted their fuel handling and combustion facilities for wood fuels. Consequently, Finland has strengthened its position among the forerunners in the field of wood energy.

In light of the Finnish experience and expertise in the area of wood-based fuels, North Karelia Polytechnic and VTT Processes organized an international Training Programme on wood fuel production methods. This training was part of the EUBIONET II project which is funded by the Intelligent Energy - Europe (EIE) Programme of the European Commission.

The aims of EUBIONET II are as follows:

- To give a clear outlook of current and future biomass fuel market trends in Europe.
- To give feedback on the suitability of CEN 335 biofuel standards for trading of biofuels.
- To give a well-analysed estimation on the techno-economic potential of biomass fuel volumes until 2010 based on existing studies and expert opinions.
- To enhance biomass fuel trade and technology transfer through networking.
- To analyse, select and describe the most suitable trading and business models for small and large scale biofuel supply chains for heat and power production by taking into account environmental aspects and sustainability.
- To enhance biomass use by co-operation and information dissemination with different market actors in the fuel utilization chain.

In accordance with these aims, the EUBIONET II Wood Fuel Production International Training Programme took place in Joensuu, Finland from 3 to 7 October 2005. The focus of the training was specifically on wood fuel production for small-scale use and district heating plants. The following report is a synopsis of the training and information exchange that occurred during the programme.

2.0 OVERVIEW OF TRAINING PROGRAMME

The Training Programme on wood fuel production for small-scale use and district heating plants consisted of a series of lectures, discussions and site visits to wood fuel production sites and heating stations fuelled by wood chips or pellets. The range of topics discussed was extensive and included the following key areas:

- Wood energy in Finland; wood fuel properties and standardization.
- Integrated procurement of wood fuels, forest residues and small sized trees.
- Production and drying of log wood; equipment – splitters and wood processors; e-trading of log wood.

- Costs of wood fuel procurement; wood fuel logistics; and contractors in the wood fuel production system.
- Biomass heating entrepreneurship: business models and contracting, wood heat pricing basis and risks.

Field and site visits were as follows:

- Site visit to Koli with company presentations by Kesla Oy, John Deere Forestry Oy (formerly Timberjack), Prentin Paja Oy organized by Wenet (Wood Energy Net).
- Field visits near the municipality of Eno: to a wood chip heating plant, to a site to view the harvesting of energy wood, to a site to examine a small scale wood heating system.

Presentations in each of the key areas are summarized below.

3.0 SYNOPSIS OF PRESENTATIONS

3.1 Bioenergy in Finland
Eija Alakangas – VTT Processes

Finland is a country with 5.2 million inhabitants and a land area of 338,145 km^2, 68 % of which is covered by boreal coniferous forests (see Figures 1 and 2). The country is sparsely populated with long transportation distances and a long heating season because of its northerly location. The Finns have focused on versatile bioenergy technologies; indigenous energy sources include wood energy, hydropower, peat and wind energy.

Finland is currently a European leader in bioenergy use with Renewable Energy Sources (RES) accounting for 23% of total energy consumption in 2003, 87% of which was generated from wood energy. In 2004, total electricity production was 86.8 TWh, of which that generated from RES accounted for 29.7%.

Fig1.   Typical mixed forest in Northern Finland.

Fig 2. Land use characteristic of Southern Finland.

Energy-intensive industry such as the forest and paper industry, metal and engineering, and chemical industries represent approximately 80% of Finland's industrial production. The forest and paper industry alone accounts for 63 % of industrial energy consumption.

An examination of wood flows in industry in 2004 indicates that 42 % of wood is used in energy production. In addition to supplying the home market, Finland is an exporter of wood biomass. Total wood pellet production in Finland in 2004 was 190,000 tons, of which 83 % was exported.

The Finns intend to increase renewable energy use from 333 PJ in 2003 to 412 PJ by 2010 and to 490 PJ by 2015. In order to support current growth trends and to reach future targets the Finnish government has initiated a number of measures including support for research and development, investment aid, support for forest chips production, CO_2 tax for fossil fuels in heat production, production support for electricity from RES and training and information dissemination.

3.2 Wood Fuel Properties and Standardisation

Eija Alakangas – VTT Processes

This presentation consisted of a detailed examination of wood fuel properties and their standardization.

Physical and mechanical properties discussed included moisture content, ash content, ash melting behaviour, particle size, density, mechanical durability and calorific value. These properties were discussed in terms of their interdependency, an important factor being moisture content. The calculation of net calorific value for moist fuel (wet basis) and the net calorific value of wood as received (dry matter) were outlined in detail as was the storage space required for 10 MWh energy.

This led into a detailed outline of the typical content of wood biomass and the biochemical composition of wood. Chemical fuel analysis consists of an assessment of major elementary parameters including: carbon, hydrogen and nitrogen content; sulphur, chlorine, fluorine, bromine and CHN analysis; and ash, moisture, volatiles and fixed carbon content. A variety of metals are also analysed for, including major and minor elements. Properties such as sulphur, chlorine and heavy metals are important for environmental reasons; whereas, high alkali content may indicate a risk for corrosion and slagging of boilers.

A range of fuel properties, including total moisture, ash content, volatile matter, element concentration and heating value, were given for different fuel types for comparison purposes.

The technical specifications for solid biofuels currently being prepared by the European Committee for Standardization CEN (TC335) were also discussed in detail. The two most important specifications being developed deal with classification and quality assurance for solid biofuels. The classification of solid biofuels is based on their origin and source. Biofuels are divided into the following subcategories 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 was presented in table form and has been prepared only for major traded solid biofuels.

All of this information is outlined in greater depth in a paper entitled '*CEN Technical Specification for Solid Biofuels – Fuel Specification and Classes'* by Eija Alakangas which was distributed with the programme notes.

Fig 3. The technical specifications for solid biofuels are currently being prepared by the European Committee for Standardization CEN (TC335).

3.3 Procurement of Forest Energy

Markku Halonen – UPM Kymmene Forestry Dept. and Power Plants

The procurement of forest energy for consumption as fuel in UPM – Kymmene power plants was the subject of this presentation. It began with a detailed outline of harvesting logging residues: specifically small whole trees from early thinnings; the extraction of stumps; and the storage of wood energy.

Forest energy is produced from logging residues consisting of small-sized whole trees and stumps. Biomass is harvested in such a way that the long-term nutrient balance of forests does not change, and damages caused by logging machines or insects, and nutrient washouts do not increase. The main harvesting stages of forest biomass are cutting (or stump extraction) and collecting to heaps, outdoor drying in summer, forest hauling, and correct storage (see Figures 4 – 6). Wood for energy use in UPM – Kymmene power plants is transported to the plants and chipped or crushed either at the power plant or at roadside landings. The target for the consumption of forest fuels is 20 to 30 % of the total energy requirement. Forest fuels are used together with peat for optimum total heat generation.

Fuel quality is dependent on dryness and cleanness. The calorific value of the fuel improves significantly by reducing its moisture content. Rain and snow increase the moisture content of the logging residue and reduce its calorific value. Other factors reducing the quality of forest fuels are sand and stones.

The energy content of 1 solid cubic metre of wood fuel at 50% moisture content is about 2,300 kWh. This is equal to 22.5 cubic metres of chips. The energy generated from 1 solid cubic metre of wood is equal to about 10% of the annual demand of a medium-sized one-family house.

Fig 4. Traditional method of drying split firewood.

Fig 5. Whole tree thinings stacked for air drying

Fig 6. Mobile whole tree chipper.

3.4 Production and Drying of Log Wood

T. Tahvanainen and L. Sikanen – Finnish Forest Research Institute

This presentation began with a discussion of the different classes of log wood as defined by the European Committee for Standardization's standard proposal; it included an outline of length and diameter specifications for various classes.

The drying of fuel logs was an important element of the discussion. The moisture content of fresh fuel logs is 35% to 50% on a green basis whereas the objective for ready-to-burn logs is a moisture content of < 20%. Natural drying of fuel logs was compared with artificial drying. The advantages of the former are that it is cheap and natural, however, it requires large storage space with capital tied in and drying takes between 1 to 2 years. This form of drying is currently used for 80 to 85% of fuel logs sold. Alternatively, artificial drying is expensive with high investment costs, however, it is efficient with fast rotation of storage and drying time is only a matter of days or weeks. This form of drying is currently used for 15% to 20% of fuel logs sold.

A variety of chopping techniques were outlined from traditional chopping to semi-industrial chopping and ultimately industrial chopping. Saw cut and hydraulic split machines were assessed as were shredders. The current restrictions of chopping technology were addressed with the recognition that a technology leap is required. This led to a discussion of the potential for producing fuel logs by sawing.

Finally, the fuel log supply chain was discussed briefly as was the current level of production of fuel log entrepreneurs throughout Finland.

3.5 Delivery Logistics and Home Logistics of Chopped Firewood

T. Tahvanainen and L. Sikanen – Finnish Forest Research Institute

This presentation consisted of an overview of the delivery logistics for firewood. Typical transportation equipment including cars, jeeps, farm tractors and small trucks for more efficient deliveries were compared in terms of efficiency. Commercial delivery services with a variety of packing procedures for cost-efficient deliveries were also assessed.

In terms of home logistics, the features of an estate that define how easy the firewood is to deliver and how easy it is to use are important. In 25% of Finnish households inadequate firewood storage decreases the use of wood in heating. This is a major factor reducing the use of commercial chopped firewood. Packed deliveries are becoming more popular because they save on delivery time and in an urban environment they lend new possibilities for efficient delivery systems.

The logistics of deliveries in terms of the time requirements for chopped wood delivery and delivery options for a small town with a delivery terminal were compared. The benefits of using delivery terminals in long distance delivery were highlighted. In conclusion: commercial transportation services can beat the "semi-professional" alternatives in efficiency; the size of the delivery unit has a remarkable effect on transportation efficiency; and, delivery terminals can increase efficiency in long distance delivery.

Fig 7. Wood stacked for transport to manual log burner.

3.6 Markets for and E-Trade of Chopped Firewood in Finland

T. Tahvanainen and L. Sikanen – Finnish Forest Research Institute

The use of chopped firewood in Finland declined steadily from the 1950s to the 1970s where it remained stagnant until the 1990s. From this point on the use of forest chips and chopped firewood has been climbing steadily and is anticipated to continue to do so in line with Government targets and policies. By 2001, wood energy constituted 20 % of the sources for primary energy production in Finland.

One reason for the increase in consumption of chopped firewood and wood pellets is the fact that this source of fuel is cheaper than others. Suppliers within the Finnish market for chopped wood are mainly non-professionals who are part-time suppliers, typically farmers. The share of commercial firewood is low but the market is growing.

The problems for the firewood user in the late 1990s included the fact that the wood was mostly procured as de-limbed stems, reliable deliverers were difficult to find, there were large quality variations, and the terms of service varied. The problems for the firewood producer were the difficulties in finding customers, the expense of marketing, problems in raw material procurement, and the lack of transportation equipment. The main problem for the forest fuel supplier consisted in the difficulty in finding stands and forest owners for energy wood harvesting.

The solutions to the above problems were found in the establishment of the MottiNetti PKS network in 2001, an on-line trading system for wood energy. This has resulted in more buyers for wood sellers, lower marketing costs, more even demand and better profits. The benefits for customers include the increased number of sellers, easier buying mechanisms, lower energy costs and better quality products. It has been a more effective way of marketing good forestry and a new tool to promote rural livelihood.

The development of MottiNetti began with the firewood trade in North Karelia in 2001 and brought in other forest services in 2002. By 2004 there were over 180 firewood sellers or forest owners in the net, there had been 25,000 visits in the service, MottiNetti entrepreneurs' sales had increased by 25 % and forest fuel suppliers had started to use the system. By 2005 there were 1.5 million people within the service. Harvesting and delivery logistics are currently under development.

3.7 Contractors in Wood Fuel Production System

Tomi Salo – Trade Association of Finnish Forestry and Earth Moving Contractors

The Trade Association of Finnish Forestry and Earth Moving Contractors (TAFFEC) is an association for the machine contractors in the bioenergy, earth moving and forest machine trade. It was established in 1969, has 17 member associations and over 2,500 contractor members.

TAFFEC gathers machine contractors together and consequently facilitates joint initiatives to improve the qualifications, know-how and social security of its members. It acts as the representative body for machine contractors in all decision making, negotiates collective agreements and looks after members' interests as employers. It also gives expert advice on questions of labour and on contract law.

TAFFEC improves members' skills and knowledge through training, information and development projects. This includes developing tools to facilitate efficiency such as computer programs, guides and quality systems. TAFFEC also facilitates commercial collaboration amongst members and even leisure time activities.

FinnMetko Ltd. Is a marketing company owned by TAFFEC which produces guides and books as well as training and consulting services.

A profile of the "average" machine entrepreneur involved in wood fuel production was outlined. These entrepreneurs have a key role to play in the forest energy value chain. Their interest in the forest energy business has increased because they see opportunities to be involved in a profitable business with reasonable risk.

An overview of the "big picture" illustrating the bioenergy business and entrepreneurship was given. There are many opportunities in the forest energy business for entrepreneurs including those presented by the range of different forest energy fuels, procurement methods and business models available. Harvesting and processing of logging residues for energy is the biggest source of business for entrepreneurs at the moment. This business is quite profitable without subventions and the average price of forest chips with storage at energy plants is approximately €12/MWh for the supplier.

The harvesting and processing of young forests for energy is a potential business sector for entrepreneurs but business models are still undeveloped for this sector. The profitability of harvesting young forests depends on the level of subventions and this constitutes a risk for entrepreneurs.

The harvesting and processing of stumps for energy is another potential business sector for entrepreneurs but under-developed power plant technology limits this business to small scale plants (boilers under 5MW). Forest energy production and small scale direct selling is a new choice and challenge for machine entrepreneurs. Interest in this business is growing and is expected to dominate business choice in the future.

Machine entrepreneurs are suppliers of machine services such as chipping and bundling with specialised knowledge. Their customers include the Forest Owners Association, bioenergy companies, forest companies and others. Building upon this, entrepreneurs have become suppliers of forest chip, energy and machine service to various customers. The future lies in energy companies owned by machine entrepreneurs in partnership with forest companies. The only way to build sustainable forest energy business is through a partnership approach between all sides.

The presentation concluded with a SWOT analysis for entrepreneurship in the forest energy business sector. The following strengths, weaknesses, opportunities and threats were identified:

- **Strengths**: Machines and special tools; practical know-how; ability to take risks; TAFFEC.

- **Weaknesses:** Heavy loan load; defective marketing skills; defective cost accounting skills; poor co-operation between entrepreneurs.
- **Opportunities**: Networking; new business models; new entrepreneurial generation; successful co-operation between entrepreneurs.
- **Threats**: Dummies/straw (paper) man; over capacity - unsustainable investment subsidy policy; oligopsonistic market model – too few buyers of machine services and traditional business models; unstable subvention policy; fettered creativity.

3.8 Wood Energy in Tuupovaara

Anssi Kokkonen – North Karelia Polytechnic

The village of Tuupovaara is located in North Karelia in the province of Eastern Finland. From the beginning of 2005 it has been part of the City of Joensuu.

The Tuupovaara Energy Co-operative (TEC) was established in 1996 by eight founding members; today it has fifty members. This organisation was the first energy cooperative in North Karelia. However, since its inception six new co-operatives have started. In 2000, TEC was nominated heat entrepreneur of the year in Finland.

There are two wood chip heating plants in Tuupovaara, Pätsi and Roihu. Pätsi is owned by the City of Joensuu; Roihu is owned by TEC. The annual use of wood fuels in Pätsi is 3,400 l-m^3 of wood chips and 500 l-m^3 of saw dust and shavings, whereas the annual use in Roihu is 1,900 l-m^3 of wood chips and 200 l-m^3 of saw dust and shavings (see Figures 8 to 10).

The Pätsi plant started in 1997 and provides heat for the town's administrative offices, a health care centre, two retirement homes and a housing association (13,000 m^2 heated area). The boiler is a 0.6 MW system, with fuel feeding by screw conveyors and 120 l-m^3 fuel storage capacity. It operates at an efficiency level of 80 % with a heat production of 2,400 MWh. Overall investment costs were ca. €327,500.

The Roihu plant started in 2001 and provides heat for the schools of Tuupovaara, a day care centre, sports hall and teacher's dormitory (11,000 m^2 heated area). The boiler is a 0.5 MW system, with fuel feeding by screw conveyors and 150 l-m^3 fuel storage capacity. It operates at an efficiency level of 80% with a heat production of 1,300 MWh. Overall investment costs were ca. €266,300.

Fig. 8 District heating plant.

Fig 9. Sample of wood chips used in district heating plants.

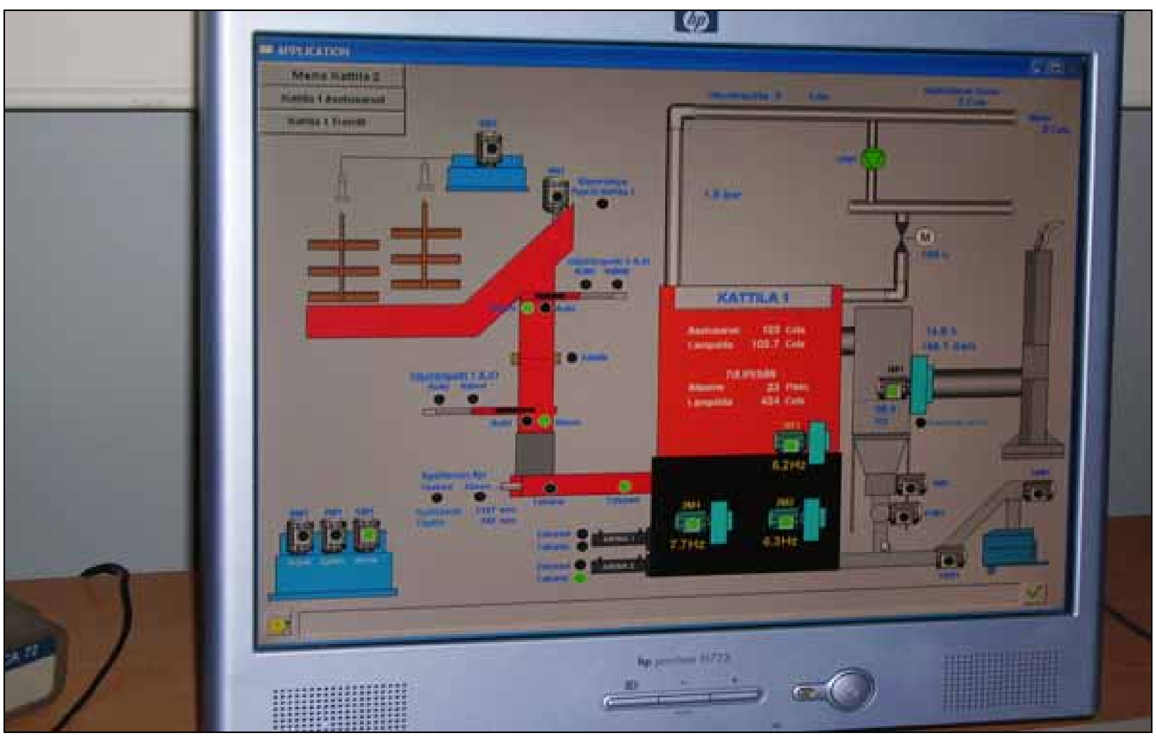

Fig 10. Computer control panel for heat plant accessible via the internet.

3.9 Heat Energy Entrepreneurship

Asko Puhakka – North Karelia Polytechnic

North Karelia Polytechnic (NKP) was founded in 1992 and is amongst the first polytechnics to be established in Finland. It currently operates here and in other areas of Europe. There are 7 study fields; 22 degree programmes; 4,000 students; and, 400 teachers and other staff. It is funded by the Ministry of Education and is maintained by the City of Joensuu. Its total turnover in 2004 was €25 million.

NKP is very active in the whole area of bioenergy. This institution provides specialised education in heat energy such as wood energy counselling studies and heat energy entrepreneurship studies. It also provides education materials and is involved in development projects.

Given this experience, this presentation focused on heat energy entrepreneurship as a new operational model. During the starting phase of heat energy entrepreneurship in the 1990s, entrepreneurs gained experiences by heating small-scale units such as local schools and rest-homes. The main operations included fuel supply for the boiler and some control and maintenance work. The total volume of the business was low. Now, established heat entrepreneurs are ready to invest in new heating plants which makes it possible for a customer to buy a heating service very comparable to district heating.

Operational models of heat energy entrepreneurship were discussed. One operational model occurs when an entrepreneur or a group of entrepreneurs invests and owns a heating plant and also takes care of the fuel supply and maintenance work. The entrepreneur sells heat energy to the customer as a comprehensive service and the price for the heat is set in relation to the energy unit (€/MWh).

Another operational model occurs when the municipality or the customer owns the heating plant and energy entrepreneurs take care of the fuel supply and technical maintenance work. The municipality, as an investor of the plant, has the main economic risk whereas the entrepreneur's risk is limited to their own business activity and compling with the contract rules.

Presently, the number of heating plants taken care of by heat energy entrepreneurs equals those taken care of by public limited companies. The size distribution of these plants ranges from 0-200 kW to over 1000 kW; the largest number of plants falling into the 0-200 kW cohort. The number of plants taken care of by heat energy entrepreneurs started to grow in 1998 and peaked in 2004 at just under 40 plants.

The contractual stakeholder groups in the heat energy business include: the municipality and heat energy entrepreneurs providing the service; the owners of the real estate; and the actors along the raw material supply chain.

When considering heat energy entrepreneurship as part of municipal energy solutions, the requirements of municipal energy must be considered. These include: satisfying multiple concerns related to politics, environment, economics and technology; competition with large energy companies; and, appropriate knowledge of legislation, negotiation skills etc. A number of things must be taken into consideration when performing profitability calculations including repayment period, interest rates and the use of alternative fuels.

3.10 Case Study: Eno District Heating Plants and the Development of the Eno Energy Coo-perative

Jussi Kupari and Lasse Okkonen, North Karelia Polytechnic

This presentation first outlined the early stages in the development of the Eno Energy Co-operative (EEC). Introducing a heat production system based on wood combustion required a long development and consultation process among the forest owners and decision-makers in the municipality of Eno. The first meeting dealing with the topic took place in February 1996. Successful examples from neighbouring municipalities had an encouraging effect on promoting the project development in Eno. Research into the profitability of the project has been aided by the Metka and ROIHU development projects, carried out by the Forest Centre of North Karelia, which were designed to promote the development of heating power plants and the use of wood as an energy resource. The crucial factor was the official decision-maker's positive attitude towards renewable and 100% domestic energy.

The meeting that led to the formation of the Eno Energy Co-operative was held on the 15th of September 1999, in the premises of the Co-operative Bank in Eno. At the time of the foundation of EEC there were only 12 members. This number has since increased to 42. The Co-operative has been a registered enterprise since December 1999.

Any person or business which is a resident of the municipality of Eno, owns forest land or is otherwise active within this business sector can be accepted as a member if they can provide the Co-operative with raw wood material, or co-operate in other ways with the Co-operative. The membership fee is € 200, which is the same amount as the entrance fee. One member is organising the chipping and transportation of the wood. The plants are operated and controlled by three members. The co-operative received the Pro-Countryside award in 2002.

The advantages of wood fuelled heat production are varied. By generating heat energy from using wood as fuel, almost all the capital investment stays within the municipality. In addition, there are advantageous effects for the areas local forestry and landscape as well as beneficial effects for employment. The combustion of wood does not result in a net increase in carbon dioxide emissions, since growing forests (a carbon sink) absorb the same amount of carbon dioxide as is released in the combustion or, alternatively, rotting process of wood.

Today, the purpose of the Eno Energy Co-operative is to produce heating energy by providing wood chips for the district heating power plants that were constructed in the villages of Eno and Uimaharju in 2000, 2002 and 2004. The Co-operative is also responsible for the operation of these plants. The municipality owns the Eno I plant, whereas the Uimaharju plant and Eno II plant is owned by the energy Co-operative.

Heating is provided for the Eno primary and secondary school buildings, the high school, library and sports hall buildings by Eno I Plant. In Uimaharju the primary and secondary school, the health centre and the municipal community centre, completed in the spring of 2002, which also houses the new S-market business premises, are included in the list of users. In addition, management companies for terraced houses are among the customers. The Eno II Plant provides heating for the municipal office building, the health centre, the fire station, four business premises and six terraced houses.

In total, heating is provided for a total space of approximately 170,000 b-m^3. In Eno I Plant a total of approximately 1,800 MWh is required per year, which is equivalent to approximately 3000 l- m^3 (loose cubic metres) wood chips; the plant has a power capacity of 0.8 MW. Annually, 4,200 MWh of energy is required in Uimaharju, which represents 7,000 l- m^3 of wood chips; the boiler of the plant has a capacity of 1 MW. In the Eno II Plant, 3,300 MWh and 6,000 l- m^3 of wood chips are required and the two boilers at the plant have a power capacity of 0.8 MW and

1.2 MW. All equipment used in these heating plants were manufactured by Vaasan Kuljetuskanavat Ltd.

The energy production of these plants equals the annual consumption of 500 private homes.

3.11 Heating Based on Wood Chips in Finnish Municipalities – Pricing Mechanisms and Risks

Niko Suhonen, North Karelia Polytechnic

This presentation consisted of an overview of a study examining the economic aspects of wood energy usage from the customers point of view, the heat prices that municipalities are paying, the contractual basis for changes in heat prices, and risks that municipalities confront.

The focus and scope of the study involved heating plants using wood chips with a power capacity of between 100 to 1000 kW. The energy source for these plants is mostly chips from small-sized trees. Entrepreneurs manage small pole stands and produce/sell heat for the municipality. The research sources consulted for the study included national statistics, heating contracts from municipalities, and a survey of heat prices paid by municipalities (€/MWh, VAT 0%).

The acquisition process for a Heating Plant using wood chips requires involvement at the political level, with the municipality, and with the entrepreneur. Political decisions concerning heat energy alternatives that take into account economics, environment and social values are necessary. The municipality enters into discussions with the entrepreneur regarding the acquisition process, tendering and associated legislation, the overall decision making process and contract regulated prices for heat.

According to this survey (in 2005), where the municipality owned the infrastructure for heat production, the heat price settled between €25.92/MWh and €31.86/MWh (VAT 0%). In the situations where entrepreneurs owned the infrastructure, heat prices were not comparable.

Regarding heat pricing mechanisms, the study found that heat price was regulated according to some external factor. Where municipality owns the infrastructure the most popular factor was the price of fuel oil. The second significant price regulation method was the use the prices of a selection of fuels. Where the entrepreneur owned the infrastructure the popularity of these two methods was reversed. When the heat price is regulated according to the fuel selection, the price has less variation. The price of light fuel oil is not a well cost-correlated pricing mechanism.

There are set principles in pricing including: cost-correlation; transparency and simplicity; steadiness and forecast ability; and, equality for similar customers. Cost-correlation in particular focuses on the external factors that correlate with the price of heat produced with wood chips such as the price of fuel chips for example. Fuel chips and chips from small-sized trees are not the same. Other cost-correlated indexes include machine cost index, earnings index etc.

Important aspects of this discussion as outlined by the speaker are the risks that a Municipality has to consider when investing in wood chip heating plants. Heating plants fuelled with wood chips require larger investments than other alternative heating options, also the risks are higher. These risks should be discussed with stakeholders to ensure the responsibilities in heat production are identified and defined.

Additional risks that the Municipality has to consider include the potential risk that the entrepreneur poses to the Municipality in terms of the lack of professional skills, capital adequacy, staff and equipment resources etc. In addition there are economical risks including the price development of alternative fuels that may become cheaper in the future, and technical risks such as equipment failure leading to stoppages. Other risks include environmental risks, administrative risks and contractual risks.

In conclusion the following points were articulated: there is a need for research into different kinds of price dependencies and mechanisms that would be cost-correlative with the costs of heating based on wood chips; it is essential to determine entrepreneur's viewpoints and needs concerning pricing mechanisms and risks in this area; and finally, risks exist but they careful planning can mitigate against them.

4.0 SUMMARY AND OVERVIEW OF DISCUSSIONS

Finland is a country with 5.2 million inhabitants and a land area of 338,145 km^2, 68 % of which is covered by boreal coniferous forests. This country is currently a European leader in bioenergy use with Renewable Energy Sources (RES) accounting for 23% of total energy consumption in 2003, 87% of which was generated from wood energy. The Finns intend to increase renewable energy use from 333 PJ in 2003 to 412 PJ by 2010 and to 490 PJ by 2015. In order to support current growth trends and to reach future targets the Finnish government has initiated a number of measures including support for research and development, investment aid, support for forest chips production, a CO_2 tax for fossil fuels in heat production, production support for electricity from RES and training and information dissemination.

In Finland, the procurement of forest energy for consumption involves harvesting logging residues: specifically small whole trees from early thinnings, the extraction of stumps, and the storage of wood energy. Biomass is harvested in such a way that the long-term nutrient balance of forests does not change, and damages caused by logging machines or insects, and nutrient washouts do not increase. The energy content of 1 solid cubic metre of wood fuel at 50% moisture content is about 2,300 kWh. This is equal to 22.5 cubic metres of chips. The energy generated from 1 solid cubic metre of wood is equal to about 10% of the annual demand of a medium-sized one-family house.

The technical specifications for solid biofuels are currently being prepared by the European Committee for Standardization CEN (TC335). The two most important specifications being developed deal with classification and quality assurance for solid biofuels. The classification of solid biofuels is based on their origin and source. 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 use of chopped firewood in Finland declined steadily from the 1950s to the 1970s where it remained stagnant until the 1990s. From this point on the use of forest chips and chopped firewood has been climbing steadily and is anticipated to continue to do so in line with Government targets and policies. One reason for the increase in consumption of chopped firewood and wood pellets is the fact that this source of fuel is cheaper than others. The problems for the firewood user in the late 1990s were resolved by the establishment of an on-line trading system for wood energy. This has resulted in more buyers for wood sellers, lower marketing costs, more even demand and better profits. The benefits for customers include the increased number of sellers, easier buying mechanisms, lower energy costs and better quality products. It has been a more effective way of marketing good forestry and a new tool to promote rural livelihood.

The “average” machine entrepreneur involved in wood fuel production has a key role to play in the forest energy value chain. Harvesting and processing of logging residues for energy is the biggest source of business for entrepreneurs at the moment and this business is quite profitable without subventions. The harvesting and processing of young forests for energy is a potential business sector for entrepreneurs. Forest energy production and small scale direct selling is a new choice and challenge for machine entrepreneurs. Interest in this business is growing and is expected to dominate business choice in the future.

During the starting phase of heat energy entrepreneurship in the 1990s, entrepreneurs gained experiences by heating small-scale units such as local schools and rest-homes. The main operations included fuel supply for the boiler and some control and maintenance work. The total volume of the business was low. Now, established heat entrepreneurs are ready to invest in new heating plants which makes it possible for a customer to buy a heating service very comparable to district heating. Presently, the number of heating plants taken care of by heat energy entrepreneurs equals those taken care of by public limited companies. The size distribution of these plants ranges from 0-200 kW to over 1000 kW; the largest number of plants falling into the 0-200 kW cohort. The number of plants taken care of by heat energy entrepreneurs started to grow in 1998 and peaked in 2004 at just under 40 plants.

The Tuupovaara Energy Co-operative (TEC) was established in 1996 by eight founding members; today it has fifty members. There are two wood chip heating plants in Tuupovaara, Pätsi and Roihu. The Pätsi plant started in 1997 and provides heat for the town’s administrative offices, a health care centre, two retirement homes and a housing association (13,000 m^2 heated area). The boiler is a 0.6 MW system that operates at an efficiency level of 80 % with a heat production of 2,400 MWh. The Roihu plant started in 2001 and provides heat for the schools of Tuupovaara, a day care centre, sports hall and teacher’s dormitory (11,000 m^2 heated area). The boiler is a 0.5 MW system that operates at an efficiency level of 80% with a heat production of 1,300 MWh.

Introducing a heat production system based on wood combustion required a long development and consultation process among the forest owners and decision-makers in the municipality of Eno. The crucial factor was the official decision-maker's positive attitude towards renewable and 100% domestic energy. In Eno, heating is provided for a total space of approximately 170,000 b-m^3. The energy production of these plants equals the annual consumption of 500 private homes.

The advantages of wood fuelled heat production are varied. By generating heat energy from using wood as fuel, almost all the capital investment stays within the municipality. In addition, there are advantageous effects for the areas local forestry and landscape as well as beneficial effects for employment. The combustion of wood does not result in a net increase in carbon dioxide emissions, since growing forests (a carbon sink) absorb the same amount of carbon dioxide as is released in the combustion or, alternatively, rotting process of wood.

The acquisition process for a Heating Plant using wood chips requires involvement at the political level, with the municipality, and with the entrepreneur. Political decisions concerning heat energy alternatives that take into account economics, environment and social values are necessary. There is a need for research into different kinds of price dependencies and mechanisms that would be cost-correlative with the costs of heating based on wood chips; it is essential to determine entrepreneur's viewpoints and needs concerning pricing mechanisms and risks in this area; and finally, risks exist but they careful planning can mitigate against them.