FINLAND

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Current situation on CHP and biomass CHP in the national energy sector.

One of the strengths of Finland's energy economy is the variety of the production structure. During the last 20 years the use of wood and peat has doubled. Only the use of firewood in households has decreased from 1970, currently accounting about 45 PJ. Use of wood fuels in district heating has increased in last two years, accounting about in 8% of the fuels consumed in DH. In 2000, the percentage for wood energy was over 20%, the rest of the renewables is mosty hydropower.

Energy balances in Finland (Source: Energy Policies of IEA Countries, 2001)

	1999	%
Population (millions)	**5.17**	
Energy consumption/capita	**4.88**	
Total energy production (Mtoe)	**15.4**	
Coal	-	-
Peat	2.0	13.0
Oil	0.1	0.6
Gas	-	-
Biomass & Wastes	6.3	40.9
Nuclear	6.0	39.0
Hydro	1.1	7.1
Solar/Wind/Other	0.0	0.0
Net energy imports (Mtoe)	**16.8**	
Coal	2.7	16.1
Oil	9.9	58.9
Gas	3.3	19.6
Electricity	1.0	6.0
Total supply - TPES (Mtoe)	**33.4**	
Coal	3.7	11.1
Peat	1.6	4.8
Oil	10.4	31.1
Gas	3.3	9.9
Biomass & Wastes	6.3	18.9
Nuclear	6.0	18.0
Hydro	1.1	3.3
Solar/Wind/Other	0.0	0.0
Electricity Trade	1.0	3.0
Electricity generation	**6.0**	
Electricity generation (TWh)	69.4	

	1999	%
Total final consumption	**25.2**	
Coal	0.9	3.6
Peat	0.4	1.6
Oil	8.7	34.5
Gas	1.5	6.0
Biomass & Wastes	4.6	18.3
Solar/Wind/Other	-	-
Electricity	6.4	25.4
Heat	2.8	11.1
Total industry consumption	**12.4**	
Coal	0.9	7.3
Peat	0.3	2.4
Oil	2.0	16.1
Gas	1.4	11.3
Biomass & Wastes	3.5	28.2
Solar/Wind/Other	-	-
Electricity	3.6	29.0
Heat	0.6	4.8
Transport consumption	**4.6**	
Total other sectors consumption	**8.2**	
Coal	0.0	0.0
Peat	0.0	0.0
Oil	2.1	25.6
Gas	0.1	1.2
Biomass & Wastes	1.1	13.4
Solar/Wind/Other	-	-
Electricity	2.8	34.1
Heat	2.1	25.6

The Finnish share of renewables in energy consumption is the third highest percentage in the EU. For years, Finland has exploited the combined heat and power (CHP), as well as district heating, which operate with high power-to-heat ratio. About 73% of district heat for municipalities are produced by co-generation.

Combined heat and electricity generation based on locally available fuels like wood and peat accounts for the bulk of bioenergy production in Finland. Multifuel boilers fired with peat, wood fuels, coal and natural gas are widely used. Co-generation is the natural choice in Finland since both heat and electricity are required in industrial as well as in municipal energy production. About 33% of electricity generated annually becomes from combined heat and power. In CHP the total efficiency is very high, 85-90% of the fuel input can be utilized.
Many large cities own CHP power plants, which produce both power and heat. Most of their output is still sold within the area of the owner cities. Medium – sized and small towns purchase district heat from CHP plants or industrial CHP plants owned by other companies, or produce it themselves in heat-only boilers. The fuels used in CHP and in district heating production vary from municipality to municipality. The most common fuels were natural gas 38%, coal 27%, peat 18%, oil 6%, wood and wood residues 9% and others 2%. In the future the fuel mix will change considerably. Natural gas and wood will largely be used as substitutes for coal, oil and peat. Also the use of recovered fuels has increased considerably during the last few years.

RTD and Demonstration projects on biomass CHP
The competitiveness of bioenergy and other renewable energy sources will be promoted through investment in long–term research and development in terms of specific development programmes. The thresholds hampering the getting of the R&D findings and results onto the market will be lowered by supporting projects aimed at the commercializing of new technologies. The aim is to increase the use of wood for energy production so as to make it a significant fuel at district heating stations and at power and heat supply stations in cases where natural gas is not available.
Total government energy research development and demonstration funding for renewable energy R&D&D amounted 10 million EUR in 2000. Most of the governmental support is granted though Tekes, the National Technology Agency of Finland. Tekes co-ordinates and offers financial support for participation in international technology initiatives. Tekes is also funding R&D projects on renewable energy sources. The total funding of Tekes for renewable energy sources was 13 million EUR. Most of the energy research funding is allocated through energy technology programmes.

Legislation and support mechanisms
The increasing use of bioenergy has been part of Finnish energy policy for some twenty years. The target is to increase the renewable energy sources at least 50% by the year 2010 from the level of the year 1995. 90% of this increase is expected to consist of bioenergy. The target of bioenergy has been divided to various sectors of use, and different biofuels are chosen on the basis of their competitiveness. According to estimates available, the additional amount of wood fuels available from the industry would equal to 0 – 1.4 Mtoe. Forest fuels and firewood represent 0.6 – 2.2 Mtoe, wastes 0.7-0.9 Mtoe and agrobiomass 0.1 – 0.5 Mtoe, depending on the production level of the forest industry and the price level of fuels. The total amount would be equal to 1.4- 5.0 Mtoe. The total target amount of the use would be 2.8 Mtoe, the percentages being 50% industrial wood residues, 30% forest fuels and 50 % recovered fuels.
The share of renewable energy sources in power production would increase to 8.3 TWh from the level in 1995, if the power consumption were as presented in the scenario of the Finnish Ministry of Trade and Industry, issued in autumn 1998. The major part, 75% would be generated from biofuels (6.2 TWh, 1,050 MW). The percentage of bioenergy in the additional power generation is assessed to remain above 70% also in the vision for the year 2025, when

the new technologies with ahigh power-to–heat ratio are expected to be in extensive use in combined power and heat production.
Another very important objective of government policy is to increase the export of energy technology. At present, the value of energy technology exports amounts to some 3 billion Eur. Successful domestic export products include equipment used in energy use, such as frequency converters and electric motors as well as products representing power production technology such as diesel motors and steam boilers.
Measures for promotion of use of renewable energy sources include:

- Research and technical development
- Energy taxation and investment grants
- Training and information dissemination

Finland was one of the countries to introduce CO_2 taxation for fossil fuels in 1990. Taxation has been changed several times since then. In the end of 1997, a new taxation decision was made to promote the use of renewable energy. The tax paid by the consumer on the electricity produced with wood based fuel and for peat fuelled CHP (<40MVA) was refunded as subsidy to the producer 3.4 euros/MWh. In heat generation, no tax is levied on wood fuels. The new CO_2 tax was in 1998 13.8 euros/tonne of CO_2. The latest motion came into force 1st September 1998; the competitiveness of renewable energies was again slightly improved in the open energy market. Biomass plants (<1MWe) are getting 4.2 euros/MWh. The consumption of heat fuel is now calculated by multiplying the heat amount generated by the factor 1.00 (earlier 1.05). Hence, the percentage of heat recovered from fuels has been changed to be 100%. The new CO_2 tax is as of 1st September 1998 17.2 euros/tonne of CO_2. It has been proposed the electricity production support for forest chips should be higher, 6.9 euros/MWh. Also under discussion is that electricity production from sorted waste material should get electricity production support.
The Council of State's new decision (1999) on general conditions for granting energy supports and the Decision of the Ministry of Trade and Industry will guide the granting of energy supports within the budgetary framework confirmed annually by the Parliament. Projects involving innovative technology have priority, when energy support is granted.
In 2000 in total 19.5 million EUR was available for energy supports. Of this, 2.5 million EUR was funded for energy subsidies defined in the EU structural fund programmes for Community Objectives 6, 5b, and 2. In 1998 240 grant decisions were made and 60% were involved in renewable energy sources, especially for wood biomass 16.0 Meuros, of which about 80% was for renewable energy sources. For wood fuels investments were 13.8 MEuros for 100 plants. Especially investment for pellet utilization increased in 2001. In 2002 energy investment support was to be 25 Meuros.
In regions with the highest rates of unemployment, not only the plant investments but also the production of biomass have been subsidized. The Finnish ministry of agriculture and Forestry is supporting forest owners for harvesting and forest transportation of energy wood from young stands.
In 1999 subsidisation of harvesting and use of fuel wood was improved. In the end of year 1999 a new support scheme was introduced by the Ministry of Agriculture and forestry to cover also the chipping costs. This support has been about 0.3 million EUR in year 2000.

Existing CHP plants

- **Karstula**

The Karstula Power Plant was constructed in 2000. It is a CHP unit for log house factory and district heat. The biomass consists of bark, woodchips (saw industry) and sawdust. The technology used is combustion in a grate furnace coupled with a steam engine. The annual production of grid electricity is 5 GWh and the production of district heat is 45 GWh, including the process heat.

- **Kymijarvi Power Station, Lahti**

The Kymijarvi Power Station went into operation in 1976. Originally, the plant was heavy oil fired, but in 1982 it was modified for coal firing. In 1986, a gas turbine generator set was installed at the plant. In the gasification project a biomass gasifier was connected to the coal-fired boiler. Gasification enables the utilisation of locally available low-price biofuels and recycled refuse fuels, equivalent to an energy content of 300 GWh (180 kton) annually. It reduces maximum of 30% of the plant's annual coal consumption. The aim of the Lahti gasification project is to demonstrate the direct gasification of wet biofuel and the use of hot, raw and very low-calorific gas directly in the existing coal-fired boiler. The gasification of biofuels and co-combustion of gases in the existing coal-fired boiler offers many advantages such as recycling of CO_2, reduced SO_2 and NO_x emissions, an efficient way to utilise biofuels and combustible waste fuels, low investment and operating costs, and utilisation of the existing power plant capacity. The primary advantage of CFB gasification technology is that it enables the substitution of expensive fuels e.g. oil or gas with cheap solid fuels. These cheap fuels are typically different types of waste wood, bark, other biofuels and recycled refuse fuels. The gasification has been in operation since January 1998. Lahden, a local power company producing power and district heat for the town of Lahti, operates the plant.

- **Kuhmo, Finland**

The Kuhmo power plant, built in 1992 is the first commercial application of Foster Wheeler Pyroflow Compact technology. The second boiler of this type was constructed for the Fortum Service Oy (formerly Imatran Voima Oy) Kokkola power plant in 1994. The Kuhmo power plant supplies annually 85 GWh of district heat and 20 GWh of electricity to the town of Kuhmo and the power company Kuhmon Lδmpφ Oy. The Pyroflow Compact technology ensures a high rate of efficiency, as well as clean combustion even when biofuels are used. The plant needs 150000 to 170000 m^3 of wood annually, the major portion of which is available from the Kuhmo Oy sawmill adjacent to the power plant. Calculations indicate, however, that additional deliveries of wood chips from elsewhere will employ about 20 person. The circulating fluidised bed technology ensures an excellent combustion rate. During commissioning tests, the new boiler at Kuhmo achieved a 99.8 to 99.9% combustion rate with wood waste.

- **Alhomens Kraft, Pietarsaari**

Alholmens Kraft has built the industrial CHP plant producing steam for the adjacent papermill as well as electricity and heat. The wood fuel procurement system is innovative and based on bailing the forest residues. The plant uses annually 300000 bales of forest residues. Alholmens Kraft power plant introduces the “best practice” biomass/fossil fuel co-fired power plant concept with extremely diverse fuel selection suitable to be replicated almost anywhere in Europe. The main objective of the work is the demonstration of a new multifuel power plant concept. The aim is to demonstrate novel technology for solid multifuel and low emission cogeneration in commercial size. The plant is pro- environmental and cost effective. The annual production of power is 240 MW_e and the district heat capacity 60 MW_{th}. The capacity to produce process steam is 100 MW_{th}. The boiler is a CFB boiler. It is possible to burn mixtures of the design fuels or single design fuel, although the optimal fuel for this boiler design is biomass.

- **Rauhalahti, Jyvaskyla**

The Rauhalahti power plant commissioned in 1986 was originally equipped with pulverised fuel boiler, but in 1993 a new fluidized bed boiler was installed to enable the plant to meet the 1995 emission limits and allow multi-fuel operation. Milled peat is the primary fuel at the plant (over 1 mill m^3/y of peat); the daily consumption is 7000 to 8000 m^3 of peat, replacing imported fuels. Since 1993, the Rauhalahti Power Plant is able to use the remaining wood fuel from neighbouring industrial plants: sawing residues, bark and chips. Branches resulting from the clearing of parks and woods in the Jyvδskylδ area are also taken to the power plant and used as fuel. If necessary, coal can be used as reserve fuel, it is stored at the power plant site. Peat and wood are fed into the boiler along two combustion lines. Coal can be burnt either mixed with peat or as pulverised fuel by separate burners.

The Rauhalahti Plant is the chief supplier of heat for some 80000 people The town's district heating network is supplied with 700 GWh of heat annually. The plant has also a few big industrial customers. M-real Corporation, Kangas Paper Mill, Jyvδskylδ buys all the steam needed at the mill from the Rauhalahti Plant. The mill needs about 350 GWh/y of steam, to dry the paper pulp. Viherlandia, a horticultural cultivation, exhibition and sales centre, located next to the power plant, receives its heating energy from the power plant through a separate heat exchanger. The Rauhalahti Power Plant reaches 85 per cent efficiency. The power plant generates 400 GWh/y of electricity to the Finnish grid.

- **Stora- Enso, Fine Papers Ltd.**

Stora-Enso is as plant located in Oulou, constructed in 1997, that produces process steam and electricity for paper machines and other use for the paper mill. The process heat produced annually is 1010 GWh and the grid electricity is 460 GWh. The used biomass consists of sawdust, bark,woodchips (saw industry) and milled peat.

- **Kokkola**

The power plant located in Kokkola, was inaugurated in January 2002. It generates district heat at 50 MW nominal output and electricity at 20 MW nominal output. It burns woodchips and peat and utilises waste heat from the sulphuric acid plant of Kemira Chemicals at a maximum output of 18 MW. The annual production of district heat is 180 GWh and the grid electricity is 75 GWh.