Biomass CHP in Finland

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Finland in a nutshell

- Long distances, Nordic longitudes: (winter period 4.5 months: -5 → -20°C)
- Population 5.3 mill.
- Large land area: 30 mill. ha / forest area 23 mill. ha
- Ranked number one in World Economic Forum 2005 Competitiveness Rankings (www.weforum.org)
- Remarkable R&D incentives
- Bioenergy Country:
  - the third in use of renewable energy sources in EU
  - the first in use of bioelectricity in EU

- Famous: Bioenergy, Nokia, sauna, Santa Clause, lakes, Lapland, icehockey-skiing and ski jumping-rally teams,
- Forest industry: UPM Kymmene, Stora Enso, Metsäliitto, Vapo etc
Some Facts on Energy

- **Finland**
  - Total energy consumption **310 TWh/a** (electricity 90 TWh/a)
  - Energy intensive industry
  - *Largest user of biomass for energy production in the EU*
  - *Second biggest producer of CHP electricity in the EU*
    - Best thermal efficiency of CHP plants in EU (average 83%)
  - Biggest electricity consumption per capita in the EU
  - Second largest use of primary energy per capita in the EU
  - Coldest country in the EU:
    - = greatest heating demand
  - Major exporter of energy technology:
    - over 5 billion euros
  - No domestic fossil fuel resources

Source: Finnish Energy Industries
Bioenergy and CHP

- In 2009, CHP produced **75% of the heat** needed for district heating and generated **35% of electricity** production.
- **Over 400** medium and large scale **biopower and heating plants** (mainly CHP-plants), up to **the world’s biggest construction**
- Over 50 new CHP plants (2100 MWe + 1700 MWth) and 300 DH boilers (1000 MWth) has been built since 2000
- Investments continue in larger CHP and Heat-only plants
  - mainly in municipalities or industrial facilities
  - mainly multifuel boilers (biomass with peat, coal etc.)
- CHP technology, fuel procurement manufacture and logistic systems are **globally well-known:**
  - global exports

Source: Finnish Energy Industries
Bioenergy and CHP

• Use of wood biomass 26-27 TWh/a
  – Bark, wood residue chips, sawdust, stumps, recovered wood, forest chips
  – District heat and municipality CHP 7 TWh/a
  – Industrial heat and CHP 18 TWh/a
  – Condensing power 1 TWh/a

• In addition
  – Black liquor 40 TWh/a (pulp industry)
  – Small combustion of wood in households 13 TWh/a
  – Peat 25-30 TWh/a

• Energy industry’s wood supply still much dependent on forest industry

Source: Finnish Energy Industries
Biomass Supply into a Modern CHP-plant

- GPS
- Forest
- Distinct heating
- Bundling of residues
- Forest chips
- Raw material
- Log residues
- Process heat
- Flexible fuel utilisation
- Agricultural residues
- Windrowing
- Chopping
- Field
- Mill
- CHP plant
- Low CO₂ emissions
- Electricity
Fuel consumption in production of DH and CHP in Finland 2010
- fuel consumption 64,3 TWh

Source: Finnish Energy Industries
District heat production (cogenerated + separate heat) and the share of cogenerated heat

Source: Finnish Energy Industries
District heating and cooling 2010

- Heat sales (incl. taxes) 1 970 mill. €
- Sold DH energy 35,8 TWh
- Average price of DH (incl. taxes) 5,51 c/kWh
- DH apartments (buildings) 1,2 million
- Inhabitants in DH apartments 2,6 million
- Market share of DH:
  - total 49%
  - in cities 80%
- Sold district cooling energy 110 GWh

Source: Finnish Energy Industries
District heat consumption

GWh

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

2007  2008  2009  2010

reference year 1971-2000

Source: Finnish Energy Industries
Kerava Combined Heat and Power Plant

- Electrical Power: 21 MWe
- Process Heat: 10 MWth
- District Heat: 42 MWth

Production volumes:
- District Heat 300 GWh = 75% of Consumption in city Kerava
- Electricity 120 GWh = 25% of Supply

Investment: ~ 67 M€

32,000 inhabitants
Area of the city 31 km²

Fuels: Non-industrial round wood, Logging residues, Wood chips, Stumps, Peat

Source: PVO Oy
CHP Power Plant, City Kerava, Finland

ELECTRICITY PRODUCTION 21 MW

STEAM BOILER
- LIVE STEAM
  - 80 bar
  - 480 °C
  - 28 kg/s
- FUEL
  - WOOD CHIPS
  - FOREST RESIDUE
  - SAWDUST
  - BARK
  - PEAT

STEAM TURBINE

GENERATOR

DH-HEAT EXCHANERS

DISTRICT HEATING 50 MW

FEED WATER

Electricity customers 29,400 and District heating customers 1,320
CHP Power Plant, City Kerava, Finland

**BOILER - HYBEX® - BFB**
METSO POWER

- Steam flow: kg/s 28
- Steam temperature: °C 482
- Steam pressure: bar 80
- Area of furnace: m² 35

**STEAM TURBINE - MARCH 4-H3**
MAN TURBO AG

21,6 MWe

**FUEL INTAKE AND TREATMENT**
Formia Vesme Oy
Oy Alholmens Kraft Ab
City Pietarsaari, Finland
The Biggest BioCHP Plant

Forest industry CHP

Boiler capacity 550 MWth
194/179 kg/s
165/40 bar
545/545 ° C

Fuels
Wood fuels, Peat, Coal

Annual Use of Biofuels: 3,5 TWh
Electricity capacity 240 MWe, Process steam 100 MWth, DH 60 MWth
Kymin Voima Oy, Kuusankoski

- Biofuel fired BFB
- 76 MWe and 180 MWth
- Wood based fuels and peat

Source: PVO Oy
Kokkolan Voima Oy, Finland

- Biofuel fired BFB
- 20 MWe and 50 MWth
- Wood based fuels and peat

Source: PVO Oy
Jyväskylä CITY CHP “RAUHALAHTI”:
300 MW

District heat : 150 MW
Electricity: 87 MW
Steam: 67 MW

Fuels: Wood chips, stumps, sawdust, bark, peat, agrofuels, REF

Source: Jyväskylä Energy Oy
Jyväskylä City-CHP "KELJONLAHTI": 400 MW (wood based fuels and peat)

- District heat 200 MWth and electricity max. 210 MWe.
- Investment around 250 million euros
- 130 000 inhabitants in the city

Source: Jyväskylä Energy Oy
MIKKELI City-CHP: 220 MW

- DH covers 70% of city buildings (inhabitants 50 000)
- Fluidized-bed bioboiler
  - Fuels: wood fuels 50% and peat 50%
- Electricity: 62 MWe
- District heat: 120 MWth
Some Metso Power CHP bioplants in Europe

- Scottish and Newcastle, Manchester and Tadcaster, UK
  - 2 x Biopower 5 CEX
  - Spent grain and wood residues

- BestEnergy, six locations, Germany
  - 6 x Biopower 5 CEX
  - Forest residues

- LESS Timber, Čáslav, Czech Republic
  - Biopower 5 CEX
  - Wood residues from sawmill

- 4Energy Invest, Amel, Belgium
  - 2 x Biopower 5 CEX
  - Wood residues

- Vattenfall, Motala, Sweden
  - Biopower 5 DH
  - Forest residues

- RUP Brestenergo, Pruzhany, Belarus
  - Biopower 5 DH
  - Forest residues and peat

- Biokraft Oy, Vilppula, Finland
  - Biopower 5 HW
  - Bark
Trends for BioCHP in Finland

- Still huge biofuel potentials for new bioplants
- Action Plan for Renewables: 28,5% → 38% (2020)
- Forest industry with a strong advocate of wood-based fuels and peat. Integrated procurement methods
- Know-how experiences, Large manufacture industry,

  - High priority in Government’s policy.
  - The use of Electricity has been growing 2-3 % per year
  - International Markets are growing all the time
If the peak power demand ought to be covered by domestic production, new capacity of 7 000 – 8 000 MW would be needed by 2030.

Source: Finnish Energy Industry