

Finnish Country Highlights – Biomass Gasification in 2015

IEA Task 33 meeting

May 2015, Ponferrada, Spain

Ilkka Hannula



Vaskiluodon Voima – Substituting Coal for Biomass in a PC boiler

- 140 MW_{th} gasifier adjoined to the existing 560 MW coal-fired power plant
- PC boiler in operation since 1982
- Coal consumption 400,000 – 500,000 t/a
- Enables to replace up to 40 percent of coal
- Production capacity
 - electricity 230 MW
 - district heating 170 MW
- Vaskiluodon Voima's total investment ~40 MEUR



CARBONA

AND © Metso

metso

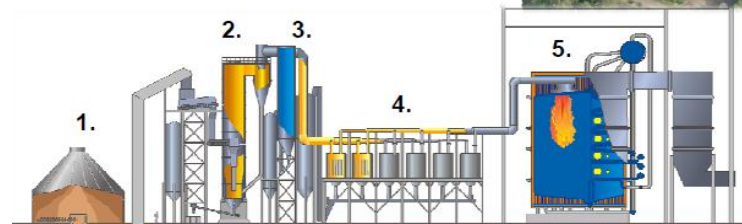
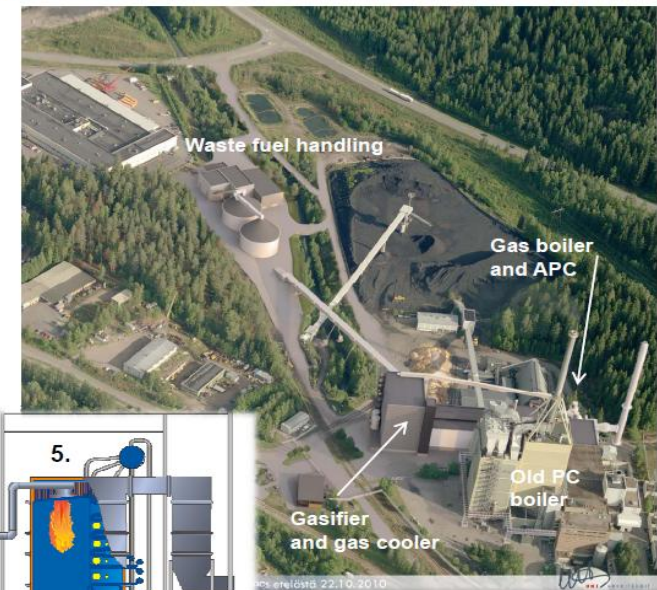
PAST LARGE PROJECTS:
Biomass and waste gasification for boilers and kilns

Lahti Energia – Gasification Power Plant

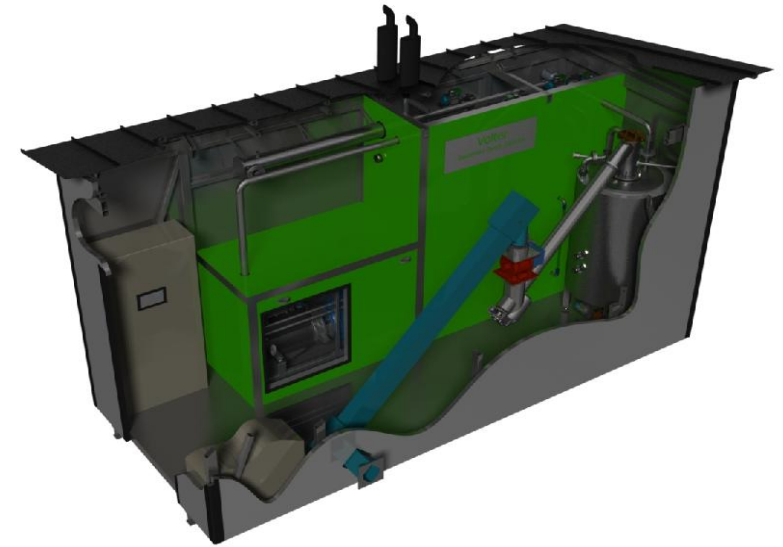
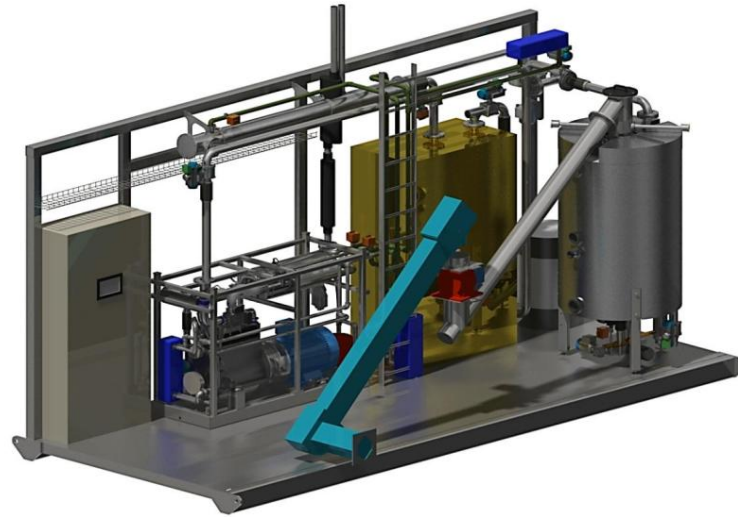
2 x 80 MW_{th} gasifiers
Waste-derived fuel
50 MW_e & 90 MW_{heat}

1. Fuel handling
2. Gasifier
3. Gas cooling
4. Gas filter
5. Gas boiler and flue gas cleaning

Start-up April 2012
Total investment 157 M€



Architecture study of the plant



Model:	Volter 30 (40)
Fuel:	Wood chips (birch, spruce, pine, aspen)
Fuel moisture:	<18%
Particle size:	8mm ≤ P ≤ 50mm, fine particles (<3,15mm) <1%, all <63mm
Plant structure:	Steel frame, Insulated with paroc (or similar) panels
Color:	As per agreement
Fuel supply:	Spring agitator, auger, rotating feeder
Generator:	Agco Sisu Power 4,9L, 4-cyl. (8,4L, 6-cyl.)
Output:	Generator output 30kW (40kW), thermal 80kW (100kW)
Plant usage (e):	ca. 1,5-2,5kW
Fuel consumption:	ca. 3,5 m3 (4,5 m3) of chips/24h at 100% power level
Automation:	Schneider electric PLC, GSM –alarms, remote internet control
Connections:	Electricity cable, Heat channel, water line, broadband, GSM-connection
Installation:	Asphalt or concrete base
Ash removal:	Automatic ash removal
Max. o.t./a:	7000h
Maint. interval:	once a week
Other:	

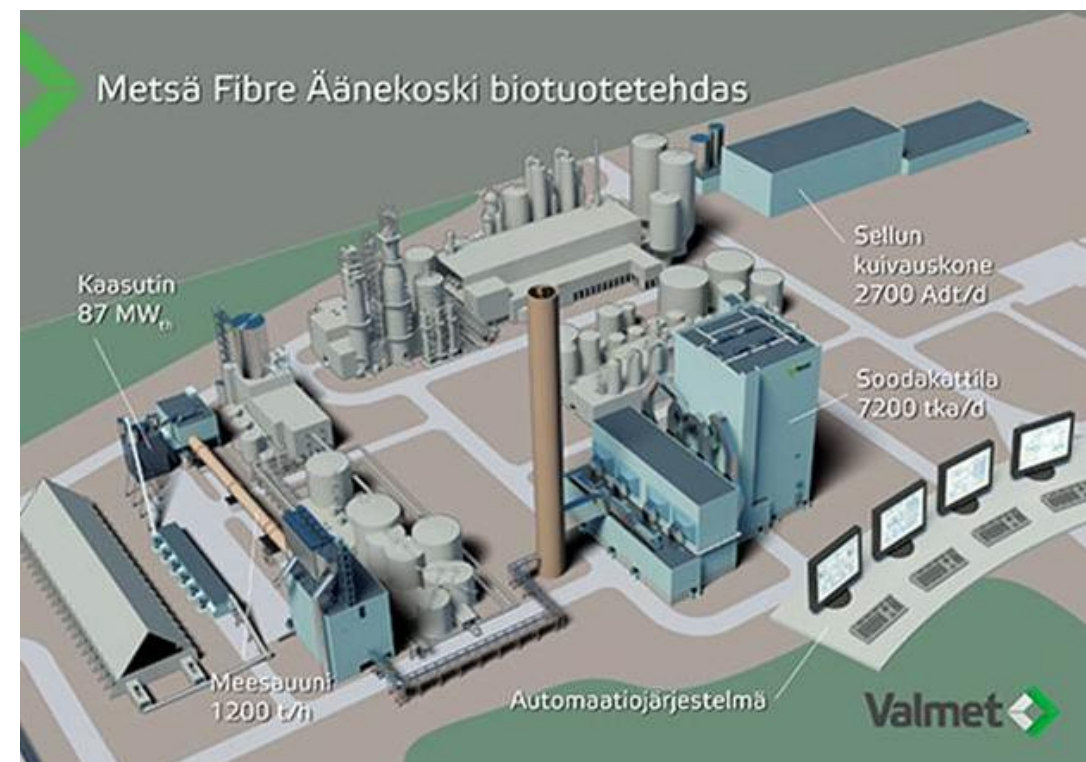
**SMALL-SCALE
COMBINED HEAT AND POWER**



- Volter 30
- Installed inside an existing building

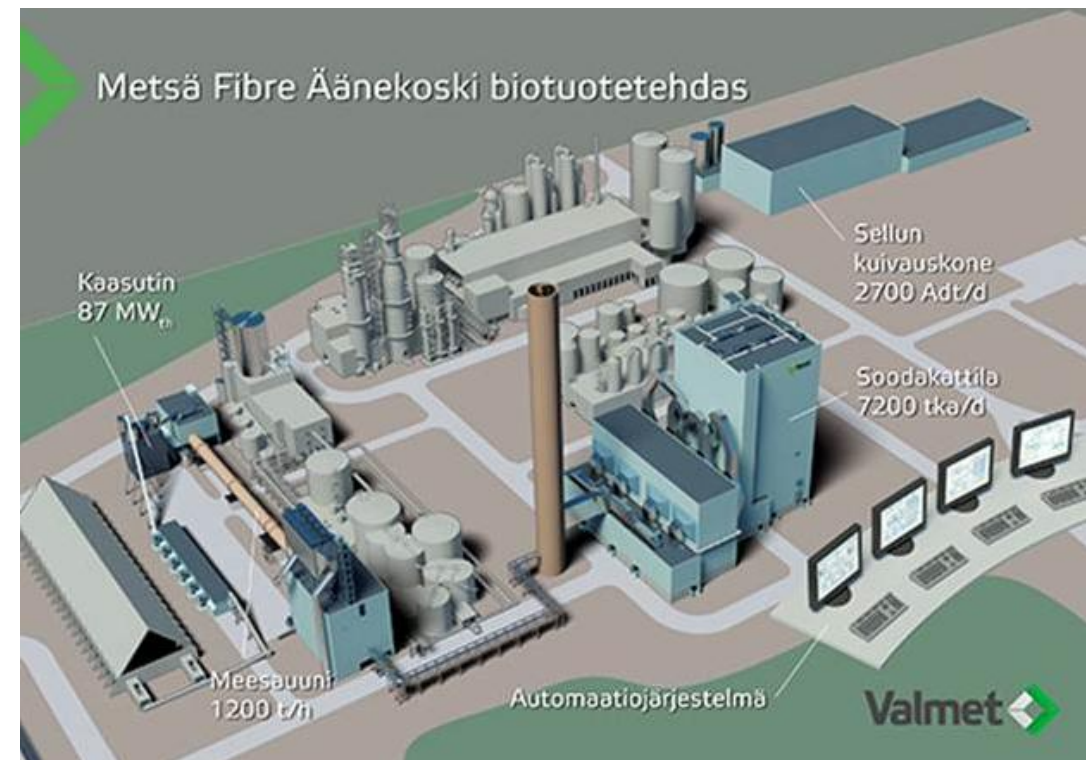
Metsä Group to build a new next-generation bioproduct mill in Äänekoski

- Constructions are ongoing and are scheduled to be completed during 2017
- The mill will use a total of 6.5 million cubic metres of wood raw material annually
- Pulp output will be 1.3 million tonnes (800 ktons softwood, 500 ktons hardwood)
- Investment 1.2 billion euros
- The wood raw material used by the mill and all side streams will be fully utilised as products and bioenergy
- No use of fossil fuels



Metsä Group to build a new next-generation bioproduct mill in Äänekoski

- All side streams from the bioproduct mill are planned to be utilised in the ecosystem that will be formed by various companies around the mill.
- Valmet Oy and Andritz Oy will be responsible for the main equipment deliveries.
- The gasification plant (dryer, gasifier, lime kiln) is delivered by Valmet



UPM BioVerno renewable diesel

- Diesel from tall oil residue
- Investment 175 M€
- Production of renewable diesel 100 kton/a



CRUDE TALL OIL

A residue of chemical pulping process containing natural extractive components of wood.

PRETREATMENT

Crude Tall Oil is purified: salts, impurities, solid particles and water are removed.

HYDROTREATMENT

Pretreated Crude Tall Oil is fed together with make-up and recycled hydrogen to the reactor where the chemical structure is modified. Reaction water is separated and directed to waste water treatment.

FRACTIONATION

Remaining hydrogen sulfide and uncondensable gases are removed. The remaining liquid is distilled to separate renewable diesel.

RENEWABLE DIESEL

High quality advanced biofuel suitable for all diesel engines.

RES-Infra: Gasification and Pyrolysis

- VTT will move it's Gasification and Pyrolysis test facilities to an industrial area in Kivenlahti, Espoo
- New pilot plants will also be constructed
- Start-up at new site in Q1/2015
- Efficient development from laboratory to industrial realization



Horizon 2020-projects, 2015-2020

- Biofuels for transport sector, renewable chemicals
- Fuel gas & pyrolysis oil for CHP and industrial applications
- Waste-to-Energy with material recovery

VTT RES-Infra Investment

New R&D Platform
2013-2015

Industrial projects

- Pyrolysis and gasification R&D
- Testing and piloting services
- Platform for new pilot plants

2G Biofuels R&D and Piloting project

7.2 M€ 2012-15



Pilot/PDU-scale Gasification Test facilities

Intermediate pressure CFB gasification pilot plant (existing test rig)

- Pressure 2-6 bar, fuel capacity max. 0.5 MW, gas flow rate 200 m³n/h
- CFB-gasifier, fluidisation by air/O₂/steam/recycle gas
- High-temperature filter, tar and methane reforming, gas cooling
- Slip stream or full stream testing of final gas clean-up and synthesis processes
- Large-scale synthesis gas applications



Dual fluidised-bed gasification pilot plant DFB (present plant will be modified)

- Fuel capacity max. 300 kW, Air gasification with single gasifier reactor (mainly waste gasification)
- Dual-Bed steam gasification High-temperature filter, tar and methane reforming, gas cooling
- Smaller size syngas applications 50 .. 150 MW to be integrated to forest industries and CHP

Bench-scale gasification and gas cleaning facilities

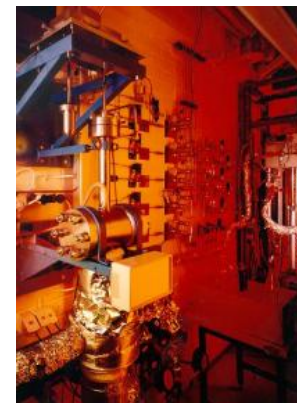
- Atmospheric-pressure BFB gasifier with hot filtration and catalytic reforming (syngas & fuel gas) - *New*
- Atmospheric-pressure CFB gasifier with hot filtration (fuel gas applications)
- Pressurized BFB gasification reactor for fuel and bed material characterization - *New*
- Pressurized filtration and reforming test facilities (operation with slip streams or with synthetic gas)
- Catalytic conversion R&D laboratory, Fuel reactivity and ash sintering R&D laboratory (at Otaniemi)

High-Pressure BFB gasification PDU (new test facility, to be built in 2015)

- Bubbling Fluidised-Bed gasification, fluidisation by air/O₂/steam/recycle gas
- max. pressure 25 bar, thermal capacity max. 0.5 MW, gas flow rate ca. 200 m³n/h
- High-temperature filter, tar and methane reforming, gas cooling
- Slip stream or full stream testing of final gas clean-up and synthesis processes

Auxiliary equipment

- Gas boiler with two-way connection to DH network of Espoo
- Fuel pretreatment unit, steam generators, compressors, sampling and analytical systems



Pyrolysis Test facilities at Kiviruukki

Fast Pyrolysis CFB Pilot Plant (current PDU to be scaled-up and modified)

- Bio fuel oil test production – fuel for boilers and ovens
- Catalytic fast pyrolysis – feed for hydro-treatment of co-feed to a refinery
- Capacity 350 kg of bio fuel oil or 150 kg of catalytic bio-oil a day, about 100 kW of feed biomass

Fast Pyrolysis BFB Bench-Scale Unit (current bench-unit to be modified)

- Characterization of biomass for fast pyrolysis – base data for mass & energy balances for techno-economic evaluations
- Both inert (Al_2O_3) and catalytic (zeolites) operation – fuel oils and co-feeds for refineries
- Capacity 1 kg/h feed

Batch Unit for Slow Pyrolysis

- Indirect heating of samples
- Volume 100 liter, maximum temperature of heating oven 1100 °C
- Amount of sample 6 kg, maximum temperature reactor about 550 °C
- Computer controlled, sampling for solids, liquids and gases

Pyrolysis Bio-Oil Test Rig

- Development of filtration, pumping, heating, homogenization, and for material testing in pilot-scale
- Feed vessel 1 m³, volume flow up to 2 m³/h

Thanks – Kiitos!

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