INTEGRATED HEAT, ELECTRICITY AND BIO-OIL PRODUCTION

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Jani Lehto, Metso
Pekka Jokela, UPM
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Metso: a global supplier of sustainable technology and services

- Our customers operate in the following industries:
  - Mining
  - Construction
  - Energy
  - Recycling
  - Pulp and paper

- About 29,000 employees (Dec 2008) in over 50 countries

- Net sales in 2008 EUR 6.4 billion

- Shares listed on NASDAQ OMX Helsinki Ltd
Power Business Line

• **Boilers**
  - Fluidized bed boilers
  - Oil and gas boilers
  - Power plants
  - Recovery boilers for chemical recovery
• **Evaporators**
  - Evaporators for black liquor concentration
• **Environmental systems**
  - Air pollution control systems
• **Services**
  - Rebuilds and upgrades
  - Maintenance
  - Spare parts
  - Accessory products
  - Partner services
• **New products and technologies**
  - LignoBoost for lignin removal
  - AshLeach for reducing the harmful chemicals in fly ash
  - Biomass gasification to replace oil and natural gas
CYMIC® - Circulating Fluidized Bed Boiler

Alholmens Kraft,
Pietarsaari,
Finland

Power plant: 240MW_e
Boiler:
Steam  550 MW_th
      194/179 kg/s
      165/40 bar
      545/545 °C
Fuels   Wood, peat, coal
Start-up 2001

Multifuel Plant
Metso and UPM develop biomass based bio-oil production

Metso and UPM have developed a new concept for the production of biomass-based bio-oil to replace fossil fuels in heating and power generation. Test production will begin at Metso's test plant in Tampere, Finland, in June 2009.

Bio-oil can be manufactured by UPM's renewable energy power plants which are equipped with a suitable boiler and functional raw material management. The raw material of the bio-oil is wood biomass – harvesting residues and sawdust, which is a by-product of the forest industry. Combining bio-oil production to an existing biomass based power plant creates significant cost and efficiency advantages as well as new business.

Metso and UPM have developed the bio-oil production concept in cooperation with the Technical Research Centre of Finland (VTT) and with funding of the Finnish Funding Agency for Technology and Innovation (Tekes). The technology used in combined bio-oil and renewable energy production is patented. It can be seen as continuation of the combined heat and power production concept developed in Finland.

Metso press release June 8, 2009
Joint Venture

• A new novel integrated wood based bio-oil concept will be developed. The concept includes whole business chain beginning from feedstock purchase and pre-treatment to bio-oil production, transportation, storage and end use

• The whole value-chain is represented in coalition
  - UPM as a supplier of raw material and end-user
  - Metso Power as an equipment supplier
  - VTT as a technology and research partner

• Integrated fast pyrolysis process is identified as an economically viable liquid biofuel concept to reduce CO2-emissions in several different studies¹

1) McKeough P., Solantausta Y. et al., Techno-economic analysis of biotrade chains. Upgraded biofuels from Russia and Canada to the Netherlands, VTT Research Notes 2312, Espoo, 2005

Outline for Joint Venture

• Phased joint venture
  - 2 phases for years 2007-2010

- Phase 1: Concept development and pilot preparation

• Phase 2: Piloting
  - Metso test plant at Tampere, Finland
  - Extensive test runs during 2009-2010
  - Bio-oil utilization tests to replace HFO and LFO during 2009-2010

• Next step: Commercial size demonstration
Pyrolysis Pilot

• Metso’s test plant at Tampere, Finland
  - Main boiler 4 MWth CFB-pilot
  - Pyrolysis input ~2 MW (~ up to 7 tons/d of bio-oil)

• Pyrolysis unit utilizes the hot sand in the fluidized bed boiler as a heat source

• Pyrolysis gases are condensed into bio-oil and the remaining solids, including sand and fuel char, returned to the fluidized bed boiler. In the boiler, the char and NCG are combusted to produce heat and electricity

• Pilot plant ready
  - Hot commissioning done
  - Bio-oil production successfully started
  - Extensive test runs during 2009-2010
Automatic Process Control

• New concept for automatic control system for the new integrated pyrolysis process has been developed
  - To secure the safety and the availability of the main boiler in any possible situation
  - To optimize the performance of main boiler, pyrolysis process and bio-oil quality

• Controls were designed in co-operation with Metso Automation

• Control strategy is based on
  - Years of experience on FB boiler controls
  - Simulations of new pyrolysis process integrated with FB boiler

• MetsoDNA control system includes
  - Distributed process control system
  - Operator user interface
  - Information management system
  - Advanced process controls
Quality Control Through Whole Fuel Chain

Feedstock moisture is the most important parameter to be followed.

Different on-line methods used for bio-oil quality control.

Main target is to produce high-quality bio-oil for end use.
UPM Concept

Metso Fast Pyrolysis Unique Characteristics

- Integrated process
  - Old infra can be used (retrofits)
  - New infra can be optimized
  - Reduced investment
- Unique concept: integrated heat, electricity and bio-oil production
- Plant optimization
  - Design
  - Operation
- High efficiency
- Scale-up
- No fossil fuel consumption
- No waste streams
- Metso: full scope supplier
UPM today

- 24,000 employees
- Sales 9.5 billion euros
- Production in 14 countries, worldwide sales network
- Listed in the NASDAQ OMX Helsinki Ltd.
- Modern and focused company with Finnish roots back to late 19th century
UPM's three business groups

Energy and pulp
- Finnish pulp mills
- Hydro power assets
- Shares of associated companies in pulp and energy
- Biofuels
- Forests & Timber

Personnel 5,000
Turnover 12%

Paper
- Magazine
- Fine
- Newsprint
- Speciality papers

Personnel 12,000
Turnover 72%

Engineered materials
- Labels
- RFID tags and inlays
- Plywood
- Wood plastic composites

Personnel 7,000
Turnover 16%
UPM worldwide

- Production plants
- Extensive global sales network
Bio Oil Field Test runs

- Business target to replace light and heavy fuel oil in heating applications
- Test runs to proof transportation, storage, feeding and burner operation from kW size to MW size
- Bio oil burner already purchased from Oilon
- VTT responsible for oil quality and research operations at the sites
- Light fuel test run duration at least one heating season (oil stability?)
- Heavy fuel test site connected into municipal district heating network