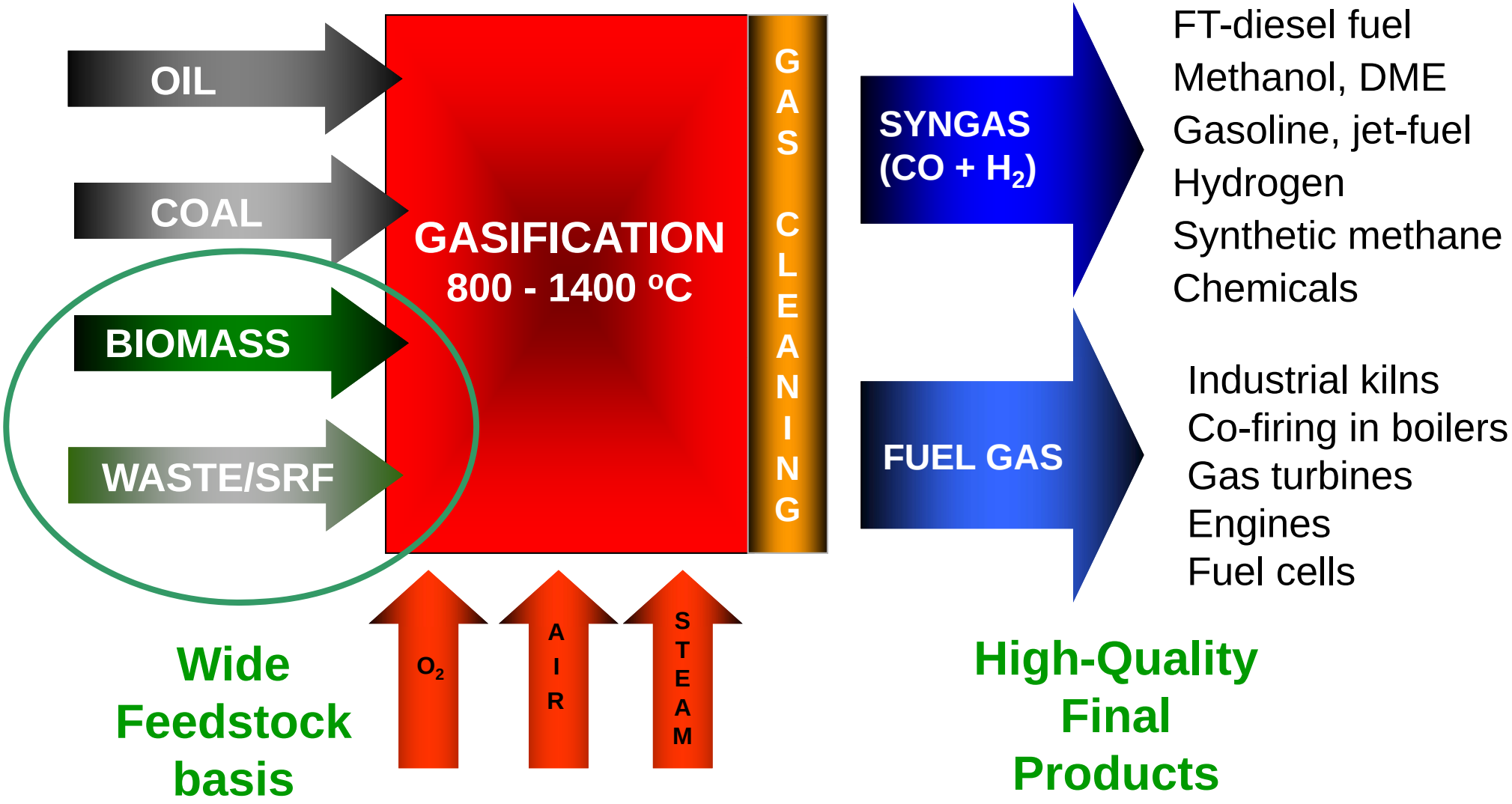
Business from technology

Biomass Gasification

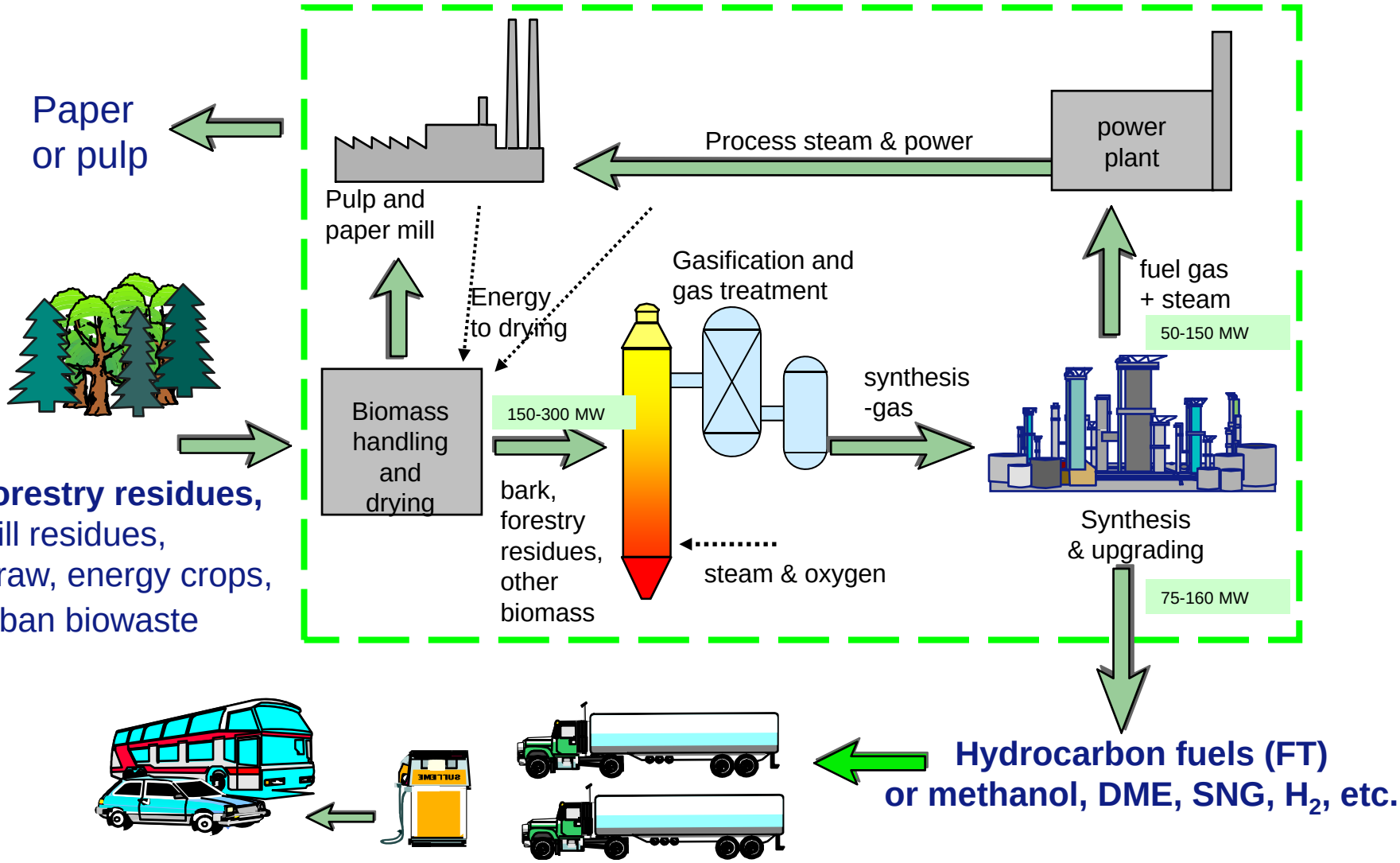
– IEA Task 33 Country Report - Finland

ESA KURKELA

18.10.2011 Piteå, Sweden


OIL
COAL
BIOMASS
WASTE/SRF
GASIFICATION
800 - 1400 °C
GAS CLEANING
SYNGAS
(CO + H2)
FUEL GAS
FT-diesel fuel
Methanol, DME
Gasoline, jet-fuel
Hydrogen
Synthetic methane
Chemicals
Industrial kilns
Co-firing in boilers
Gas turbines
Engines
Fuel cells
O2
AIR
STEAM
Wide Feedstock basis
High-Quality Final Products

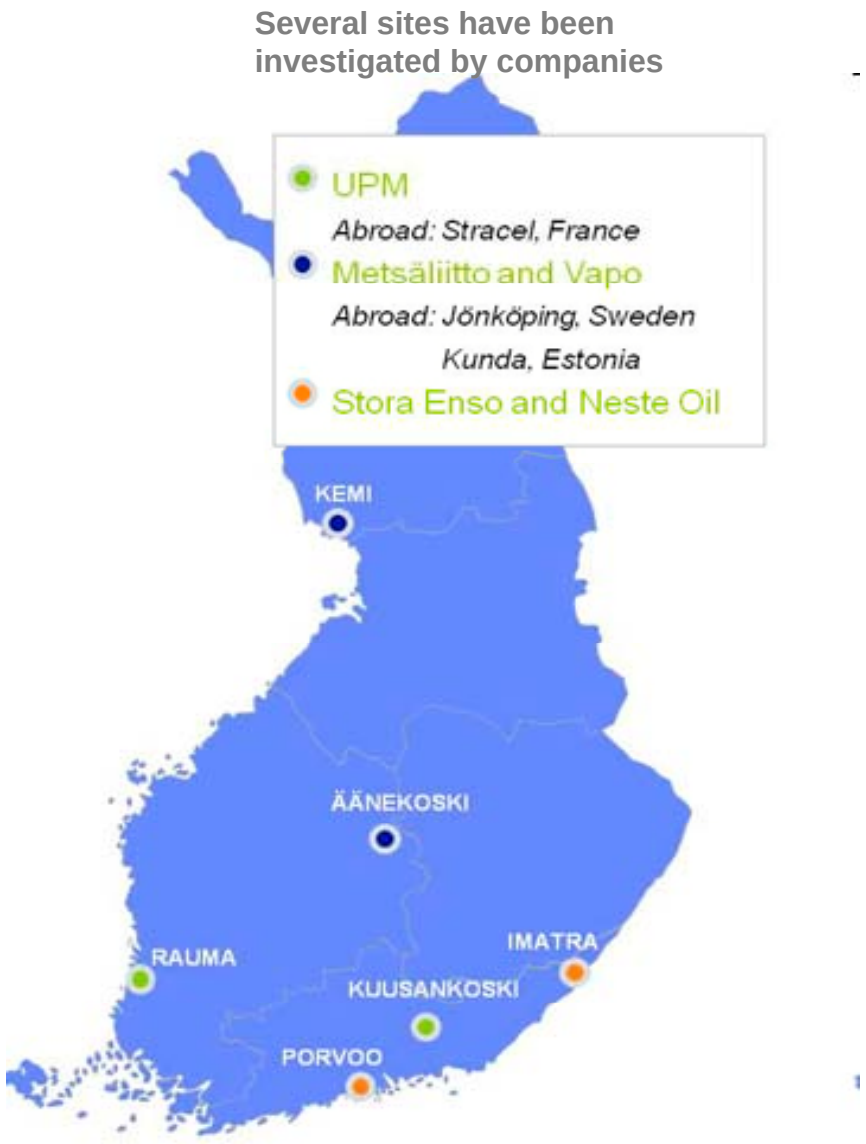
Syngas Route to Biofuels – Integrated Concept Studied at VTT's UCG-project in 2004-07



Biorefinery BTL Demonstration Plans in Finland

- Three consortiums are presently planning second-generation BTL biorefineries in Finland
- The planned capacities are 100 000 – 200 000 ton/a of diesel
- EU's NER300 funding has been applied - decisions expected at the end of 2012
- Overall investment costs in order of € 400 - 800 million?

- Very large-scale is needed to achieve positive economics?
- First plants will be more expensive than mature technology?



Gasification and Gas Cleaning Process

- developed and tested at VTT on 1 MW scale
-ca. 4000 operating hours with different wood residues

NEW INNOVATIVE TECHNOLOGY

FUEL-FLEXIBLE FLUID-BED GASIFICATION
- STEAM/OXYGEN
- PRESSURISED

GAS CLEANING
- TAR & METHANE REFORMING
- FILTRATION
- DIRTY SHIFT

ULTRA CLEANUP

FT-DIESEL CH_3OH

HYDROGEN SNG

GASOLINE JET FUEL

Typical pressures: 1 - 10 bar | 20 - 30 bar | 20 - 200 bar

GASIFIER TARGETS
- NO ASH-RELATED PROBLEMS
- SIMPLE DESIGN AND HIGH RELIABILITY
- HIGH C-CONVERSION TO GAS+TARS
- LOW OXYGEN CONSUMPTION

GAS CLEANING TARGETS
- COMPLETE TAR DECOMPOSITION
- 60-80% METHANE REFORMING
- H_2/CO RATIO SUITABLE TO FT-SYNTHESIS

THE OXYGEN STEAM BLOWN CFB GASIFICATION AND GAS CLEANING DEVELOPMENT

From: Sami Kokki, FW

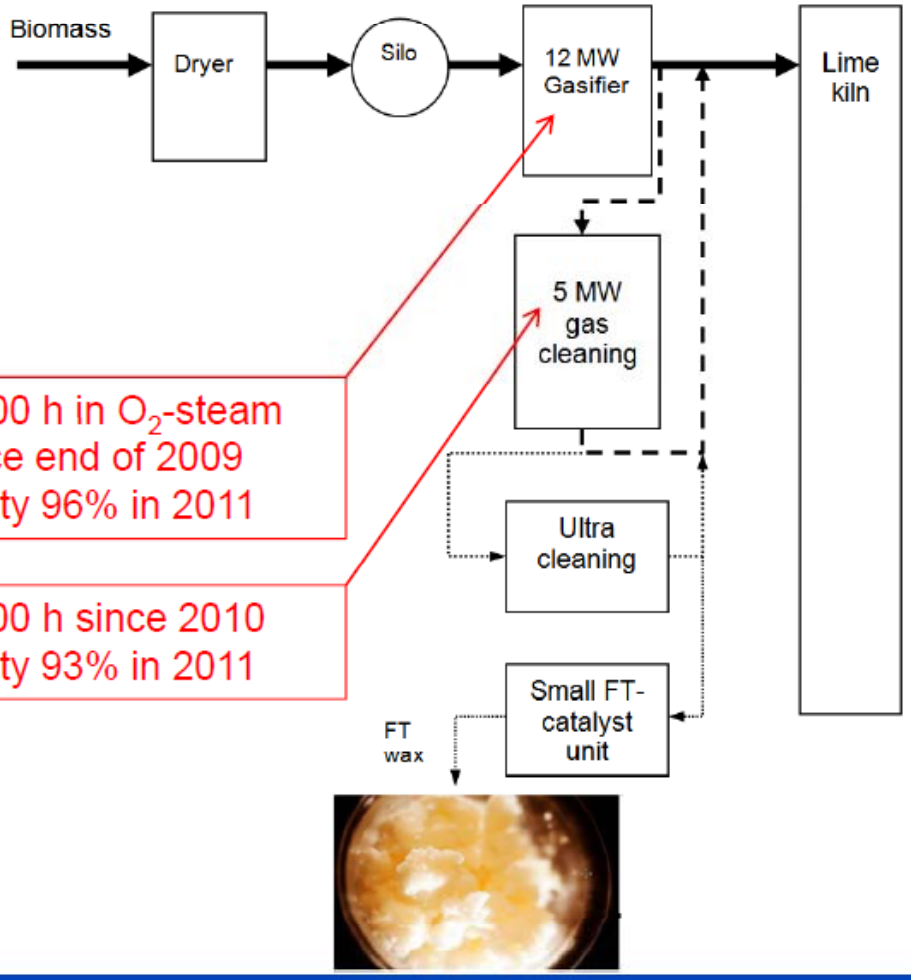
Nordic Bioenergy 2011, Jyväskylä, 6.9.2011

FOSTER WHEELER

PROCESSES CHAIN OF THE VARKAUS TEST PLANT

From: Sami Kokki, Foster Wheeler

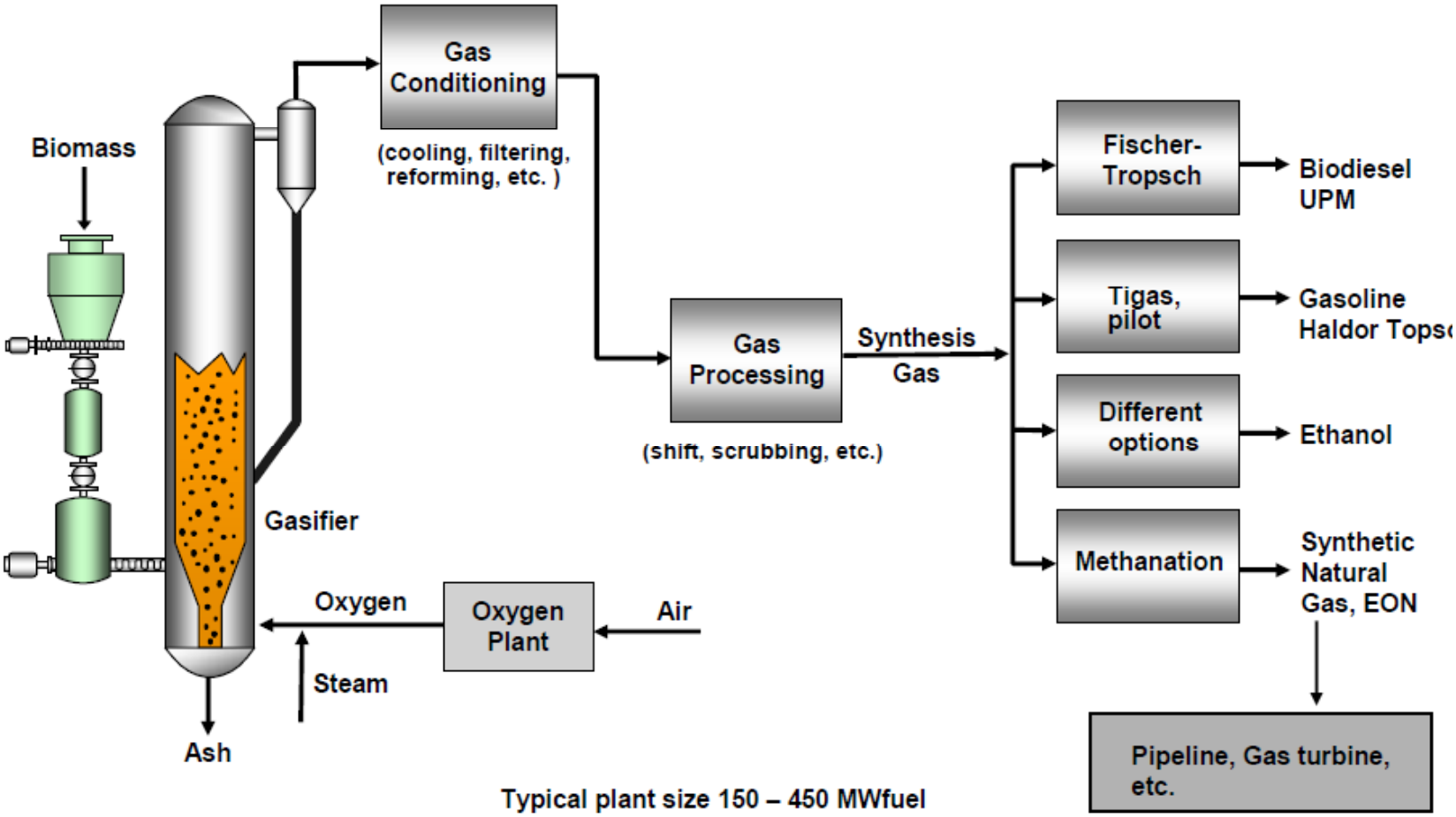
Nordic Bioenergy 2011, Jyväskylä, 6.9.2011



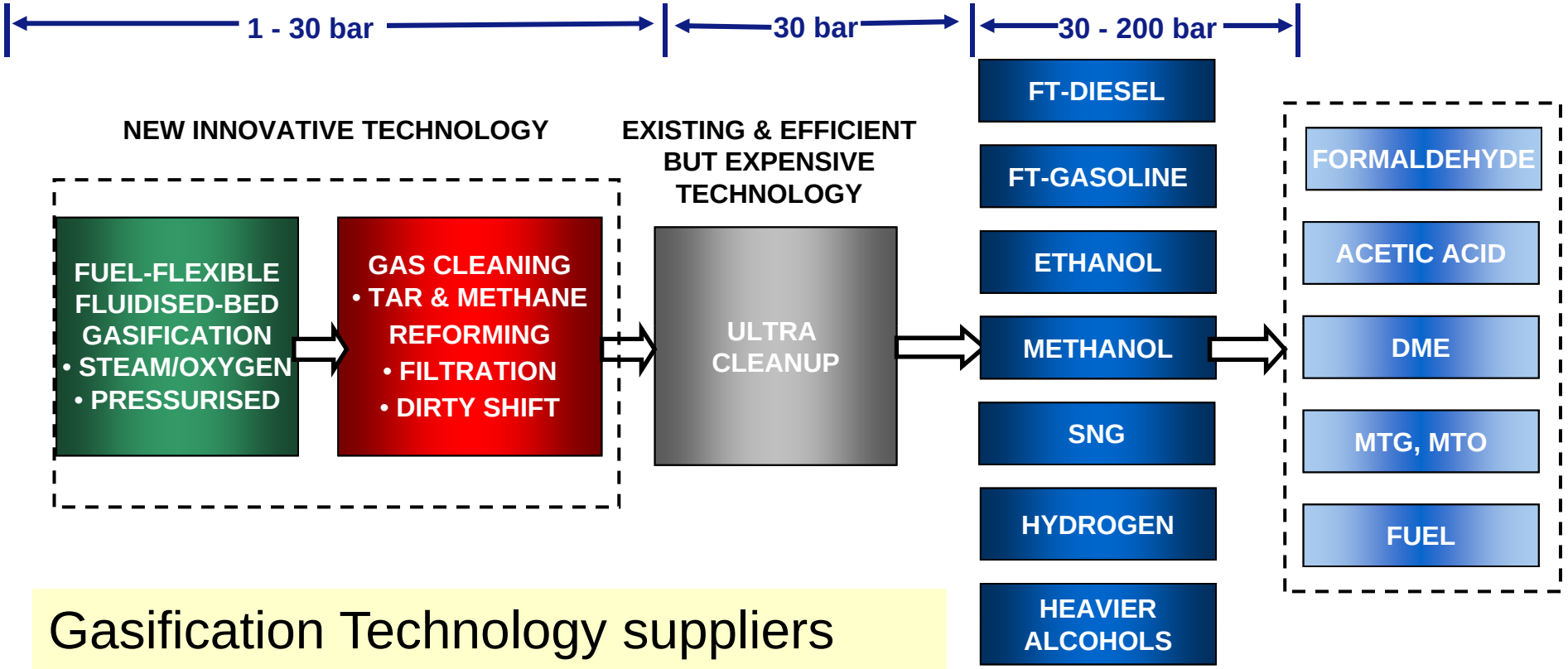
From: Jim Patel, Andritz-Carbona, 2011

Synthesis gas for transportation fuels and SNG

ANDRITZ Carbona active projects

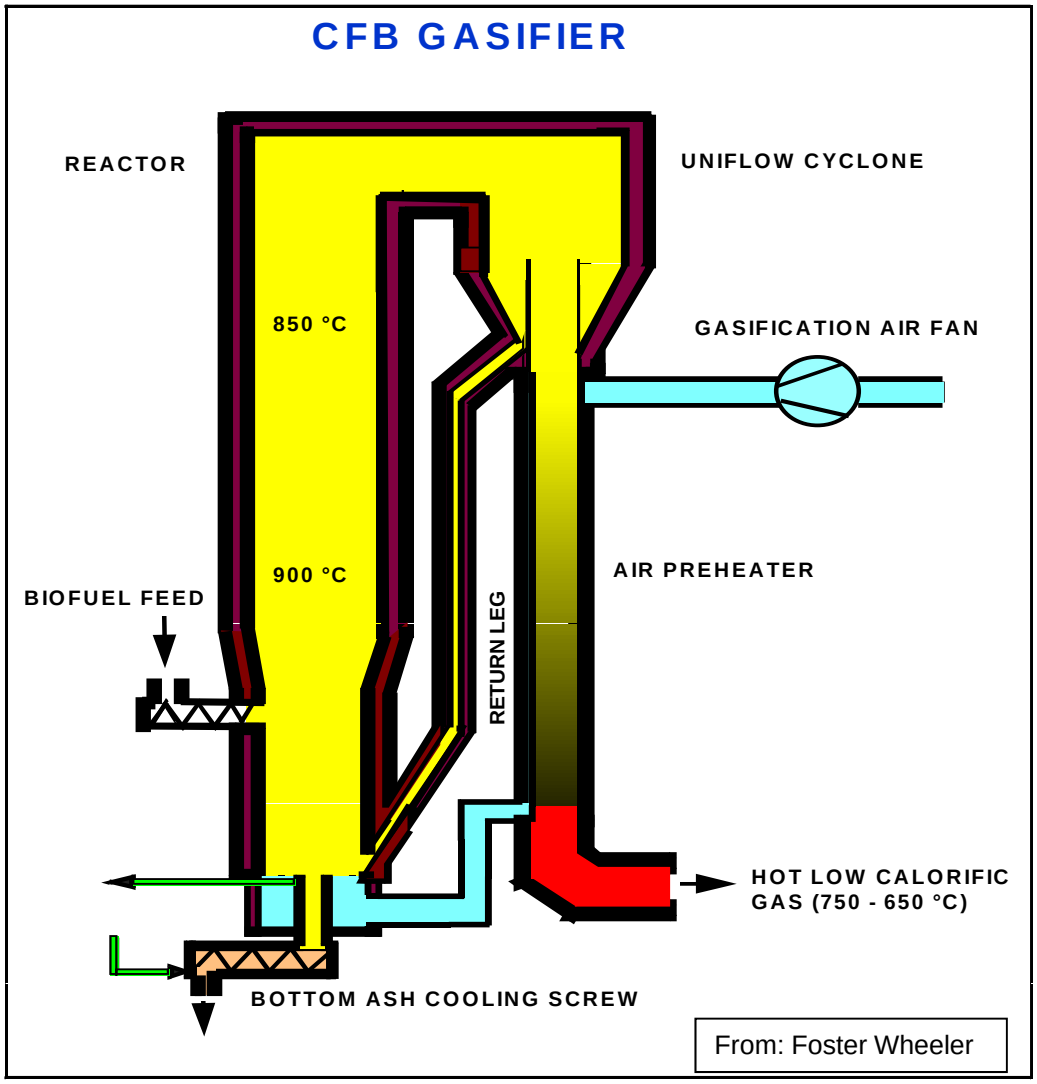


Gasification route to different products



Gasification Technology suppliers **Andritz-Carbona**, **Foster Wheeler** and **Metso** have also several studies and R&D&D projects abroad

Atmospheric-pressure CFB/BFB gasification for kilns and boilers



- Commercial lime-kiln gasifiers were constructed in 1980's by Ahlström
- New development by Foster Wheeler in 1990's for boiler applications
- Gasifiers are now offered by
  - Andritz Carbona
  - Foster Wheeler
  - Metso Power
- Feasible in size range 15-150 MW

VTT's role and activities

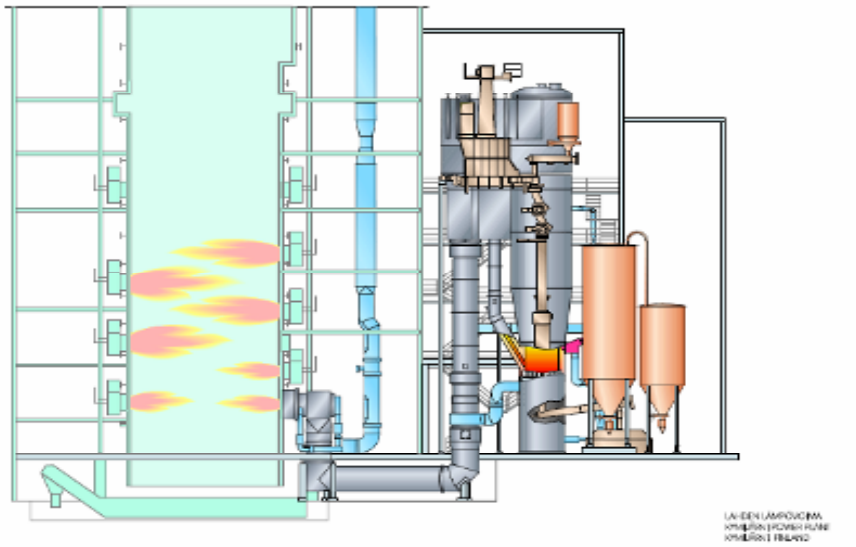
- IPR on gas reforming for clean gas applications
- support for industrial projects
- R&D on gas filtration, heavy metal removal and fuel characterisation

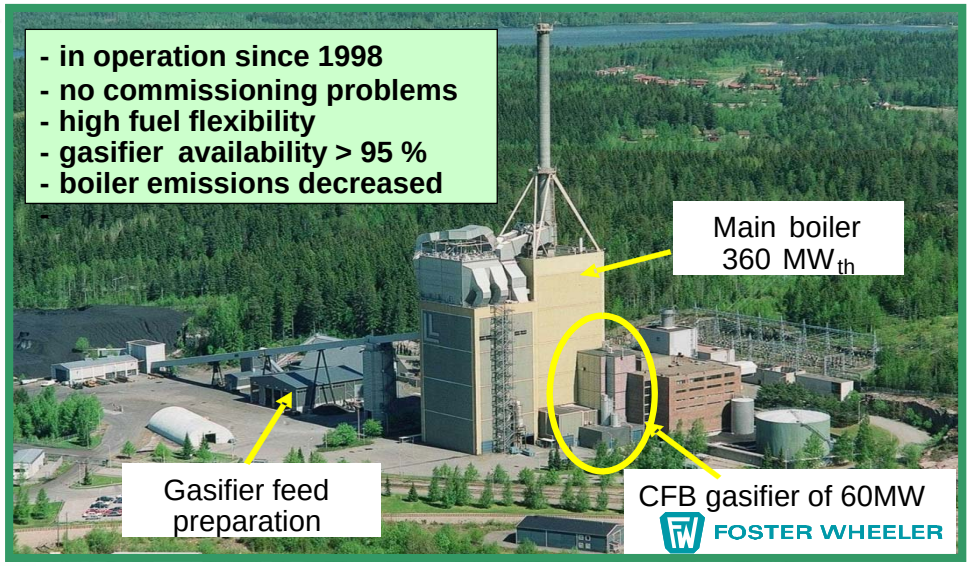
Efficient utilisation of wastes and biomass residues in existing power plants

a cost-effective way to reduce CO_2 emissions of power plants

FOSTER WHEELER

From: Foster Wheeler





New CFB gasification plants are in commissioning/under construction

- two new gasifiers (2x80 MW) at Lahti waste-to-energy plant (supplier: Metso)
- one large gasifier (140 MW) in Vaasa (supplier: Metso)
- lime kiln gasifier (48 MW) at Joutseno (supplier Andritz)
- lime kiln gasifier (12 MW) at Varkaus was returned to air-blown operation mode after succesfull test campaigns for Neste Oil and Stora Enso (Foster Wheeler)

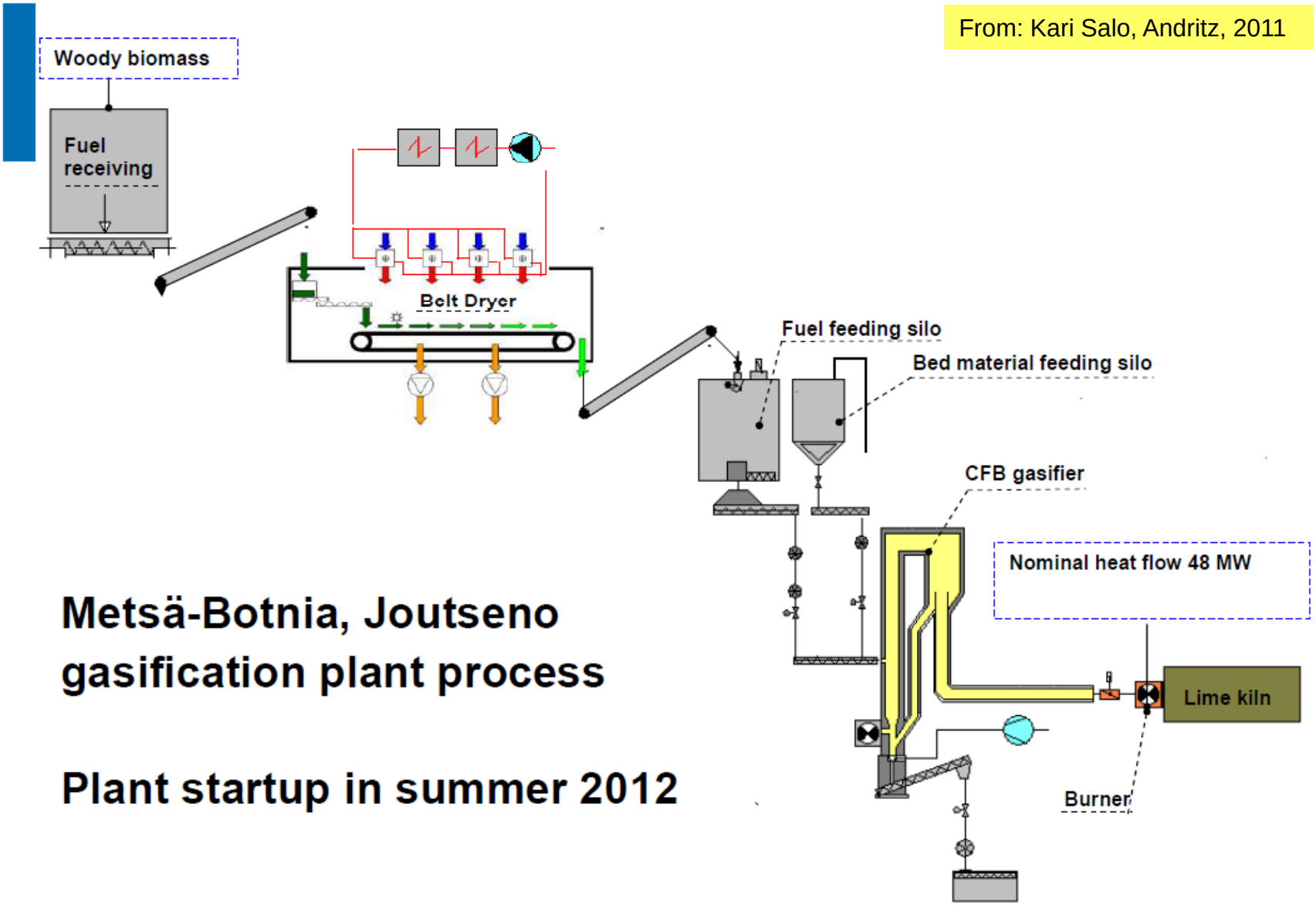
From: Kari Salo, Andritz, 2011

Metsä-Botnia, Joutseno gasification plant for lime kiln

CARBONA

ANDRITZ

From: Kari Salo, Andritz, 2011



Metsä-Botnia, Joutseno gasification plant process

Plant startup in summer 2012

CARBONA

ANDRITZ

From: Ville Hankalin, Metso
Nordic Bioenergy 2011, Jyväskylä

Metso's Gasification Projects

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

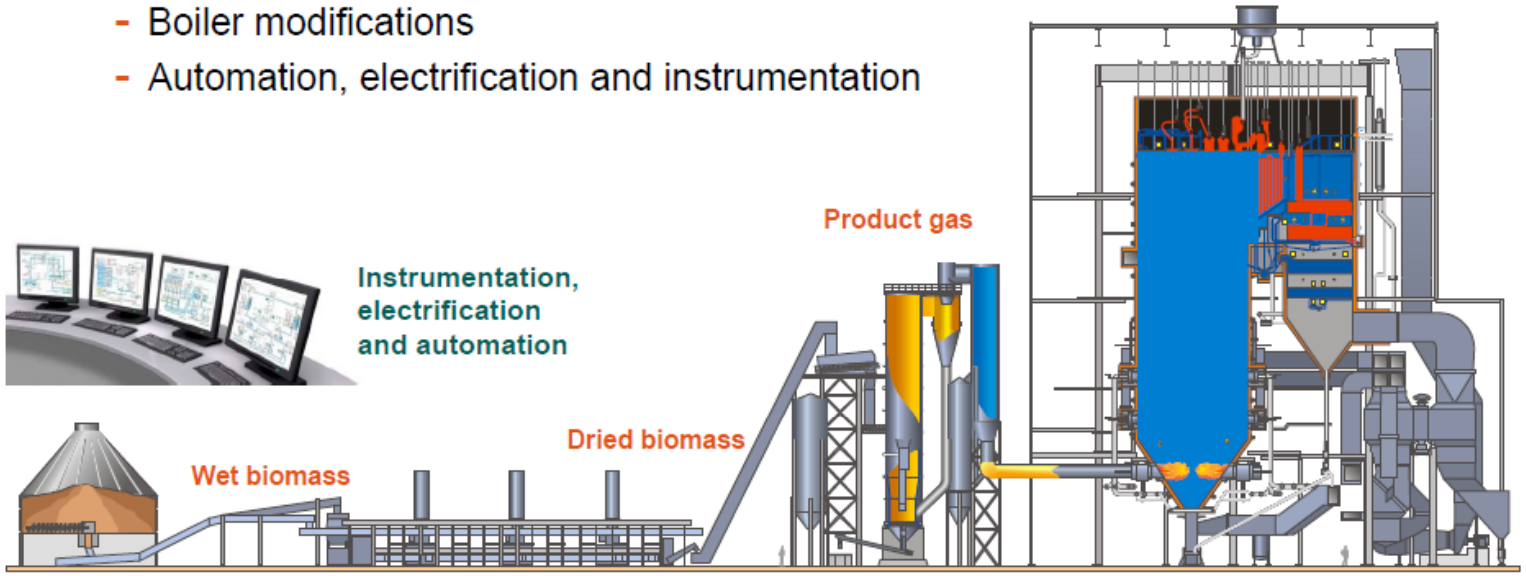
metso

From: Ville Hankalin, Metso
Nordic Bioenergy 2011, jyväskylä

Metso's Gasification Projects

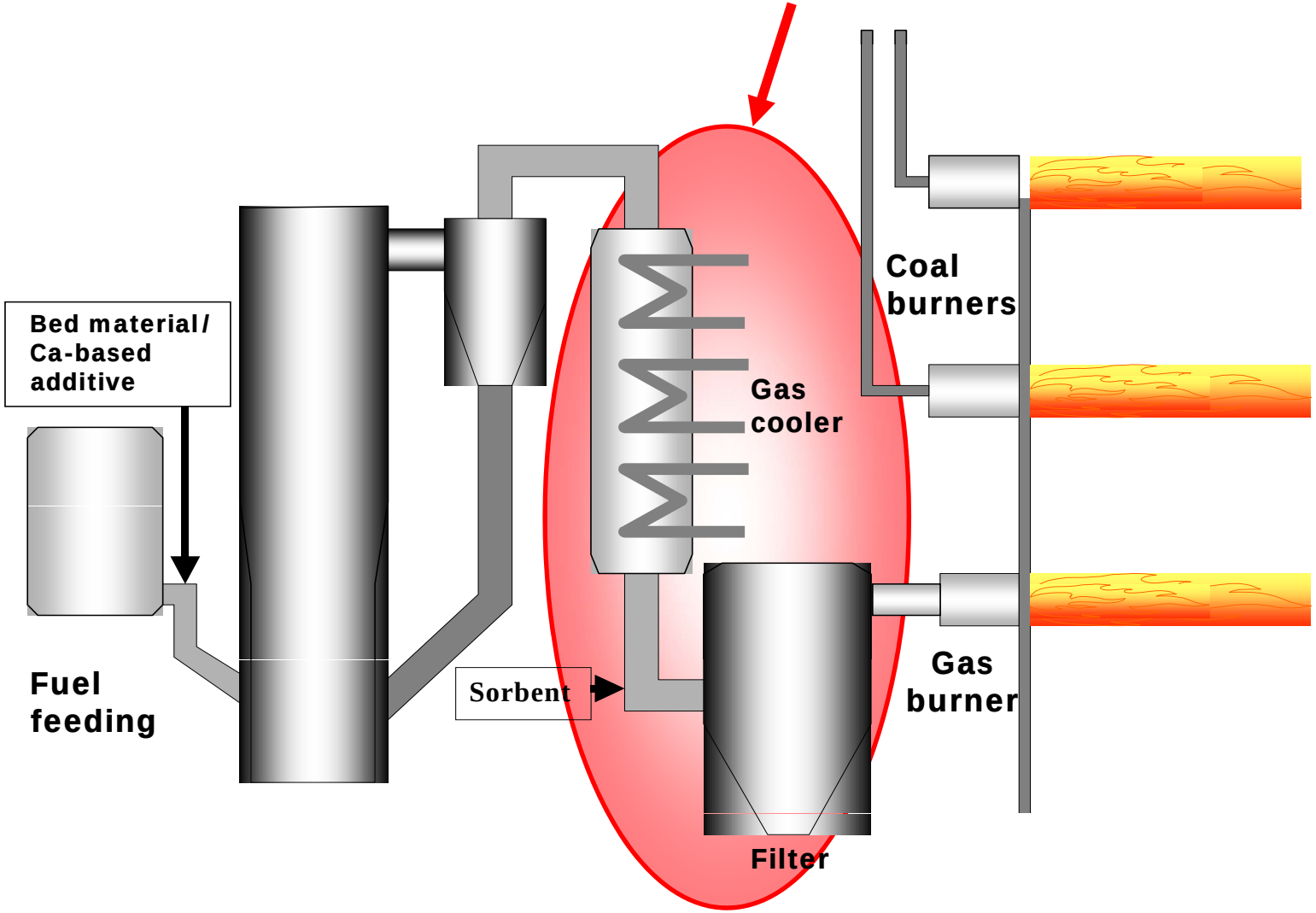
Vaskiluodon Voima – Substituting Coal for Biomass in a PC boiler

- Metso's scope
  - Fuel receiving and handling
  - Drying
  - Gasification
  - Boiler modifications
  - Automation, electrification and instrumentation



Gas cleaning: gas cooling followed by filtration

developed at VTT since late 1990's



From: Ville Hankalin, Metso
Nordic Bioenergy 2011, jyväskylä

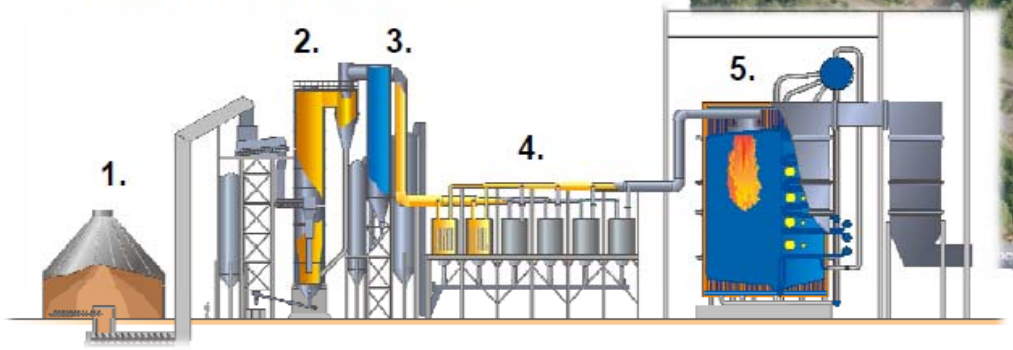
Metso's Gasification Projects

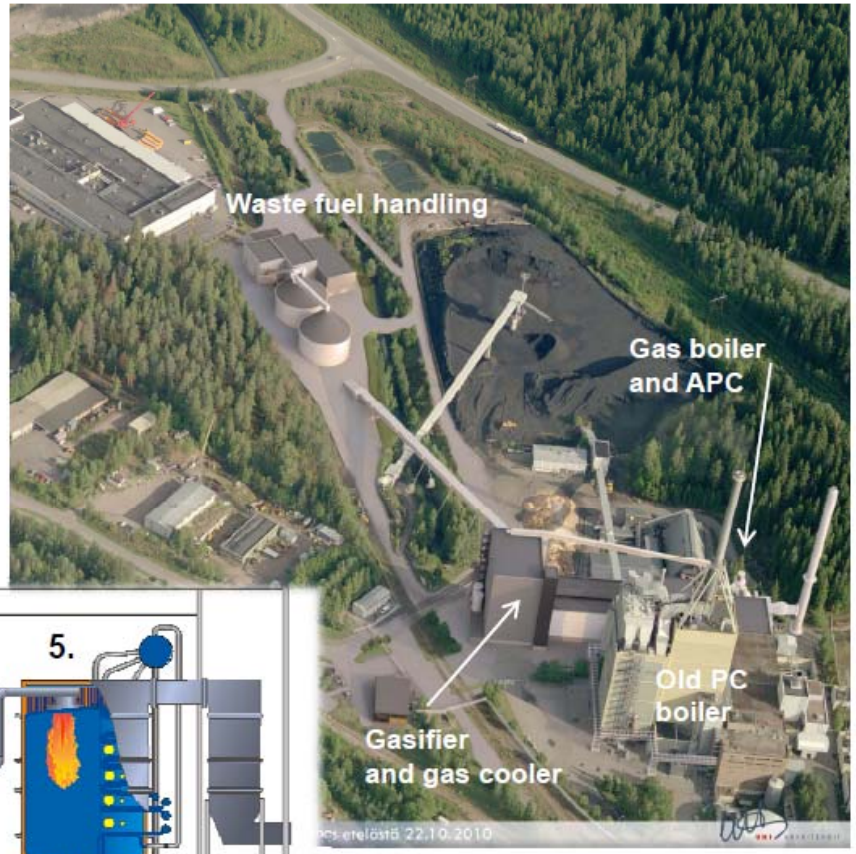
Lahti Energia – Gasification Power Plant

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

11 © Metso

metso

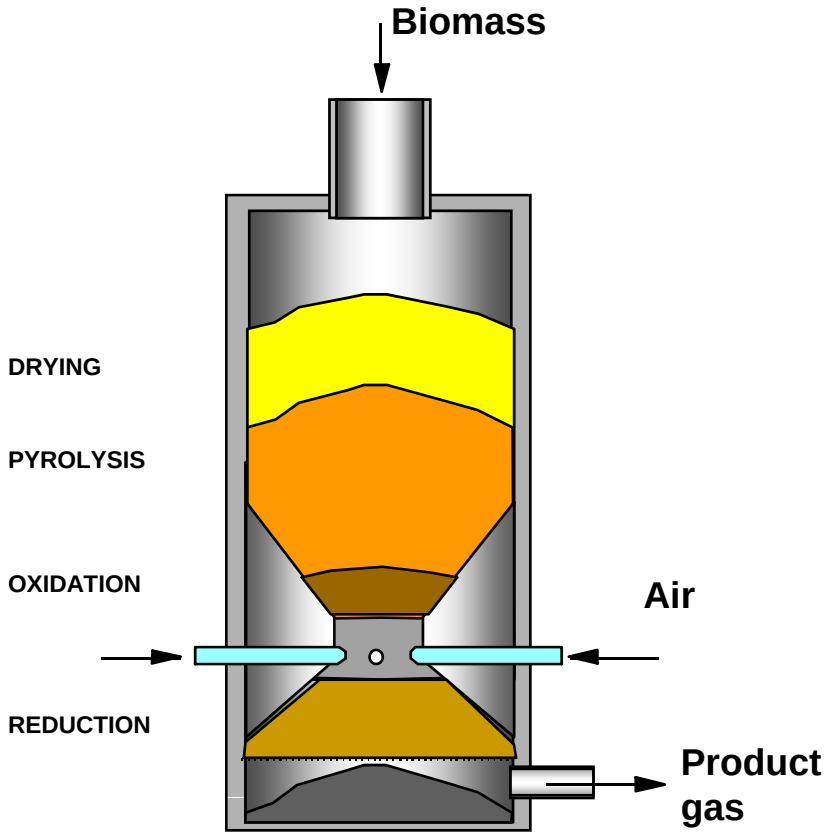
Downdraft gasification for the Small-Scale
- originating from II World War wood/charcoal gasifiers

Downdraft fixed bed gasifier:

- several developers since II world
- suitable only to high-quality fuels
  - 10 - 100 mm in size
  - moisture < 25 %
  - no ash sintering tendencies
- limited to smallest size < 1-3 MW_{fuel}
- poor carbon conversion

Advantages:

- low tar content and simple gas cleaning
- low investment cost and easy to operate
- suitable to small gas engines < 300 kWe (preferably naturally aspirating)



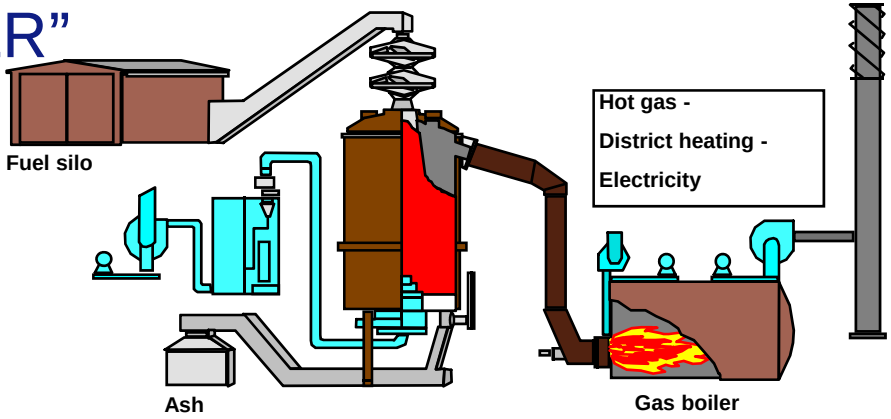
SME companies are developing small-scale gasifiers for gas engines in Finland aiming to 100 – 500 kWe (at least 5 different companies)

New R&D project at VTT with five SME companies is planned for 2012

-Global technology review
-Preliminary R&D on a couple of new ideas
-Support for SME developers

UPDRAFT GASIFIER "BIONEER"

- developed in 1980's, 10 plants
- for boilers and kilns, 5 MW scale
- tar containing gas
- high carbon conversion
- robust, flexible, fully automated
- Novel version in operation at Kokemäki



5 MW district heating plant, Jalasjärvi, Finland, in operation since 1987

Biomass-to-Syngas projects at VTT in 2011

- **NEXTUCG: 2007 – 2011**
  - Industrial project funded by NSE Biofuels (Neste Oil ja Stora Enso), co-operation also with Foster Wheeler
  - Resulted in NER300 proposal – large FT-production unit
- **PRODUCTION OF SNG OR H2 FROM BIOMASS 2011 - 2014**
  - Evaluation of process alternatives – less capital intensive and suitable to smaller size that BtL plants
  - Pre-competitive R&D on gasification and gas cleaning
- **US-CO-OPERATION PROJECT ON EVALUATION OF GASIFICATION-BASED SYSTEMS 2011-12**
  - Funded by Tekes and VTT (and DOE at Princeton)
  - Ilkka Hannula as visiting scientist at Princeton Univ.
  - Co-utilisation of biomass and coal for liquids and electricity and combinations of biotechnical and thermochemical routes
  - Evaluation of US development projects
  - Aspen modelling of selected concepts and technologies
- **NORDSYNGAS: 2010-14**
  - Nordic co-operation: Luleå, Piteå, Sinteff, VTT
  - Fundamental aspects of pressurised gasification
  - System studies related to integrated plants to pulp and paper industries
- **GASIFICATION REACTIVITY 2011 – 2014**
  - Fundamental research with Åbo Akademi and Jyväskylä Univ.
  - Funded by Finnish Akademi

LahtiStreams IP (Advanced Integrated Waste Management and WtE Demonstration)

(**Lahti Energia/FI**, VTT/FI, L&T/FI, Dong Energy/DK, FZK/D; total budget 23.5 M€))

- **Demonstration** of complete advanced waste management chain including:
  - > waste processing
  - > material recovery
  - > SRD/RDF production
  - **> advanced high efficiency WtE plant**
  - > further treatment of ashes

-**R&D** of
- waste processing and material recovery
- improved hot gas cleaning
- advanced ash treatment
- new gasification based high efficiency WtE technologies

http://www.lahtistreams.com/