

CARBONA BIOMASS GASIFICATION TECHNOLOGY

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CARBONA

SUMMARY

- **Biomass Gasification for Heat & Power and Syngas Production for Liquids**
- **Technology with Commercial Operating Plant Experiences**
- **Something about Carbona**
- **Carbona Biomass Gasification Technology**
- **Plant for CHP in Denmark**
- **Plants for Lime Kiln Gasifiers in Europe**
- **Program for Syngas Production**

CARBONA/ANDRITZ

- **Carbona is a biomass gasification technology based company supplying plants for various applications**
- **Andritz Oy acquired minority ownership in Carbona Inc. in 8/2006 with option for full ownership in future**
- **Andritz has biomass gasification background from 1980's as Ahlstrom Machinery Oy**
- **Carbona has developed biomass gasification technology since 1990**
- **Carbona now offering plants on combined Carbona/Andritz technology**
- **Initial target in P&P industry**
 - **Lime kiln gasifier**
 - **Fuel for power boilers**
- **Future target in P&P**
 - **Biorefinery/motor fuels**
 - **Biomass IGCC power plant**

CARBONA TECHNOLOGY & APPLICATIONS

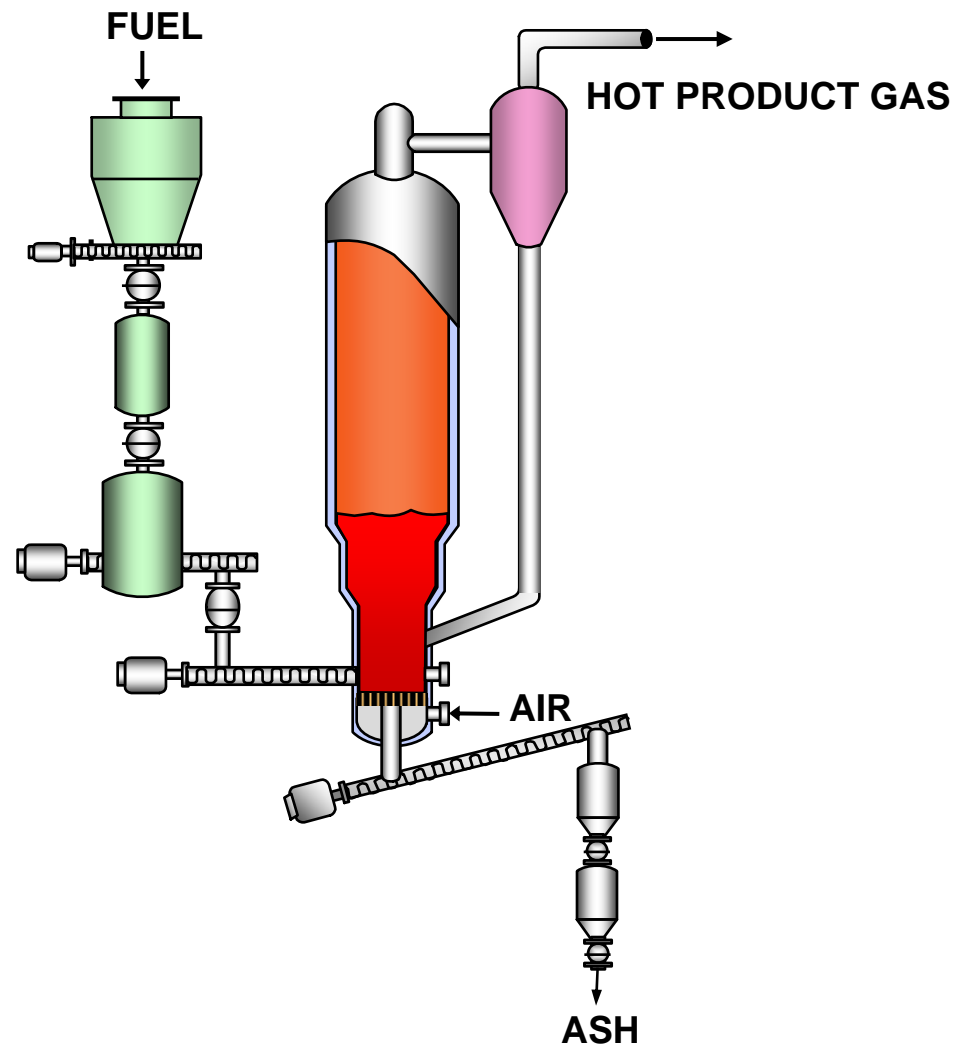
Fluidized Bed Gasification for Biomass

- **Bubbling Fluidized Bed (BFB) & Circulating Fluidized Bed (CFB)**
- **Low pressure and High Pressure**
- **Air or Oxygen**

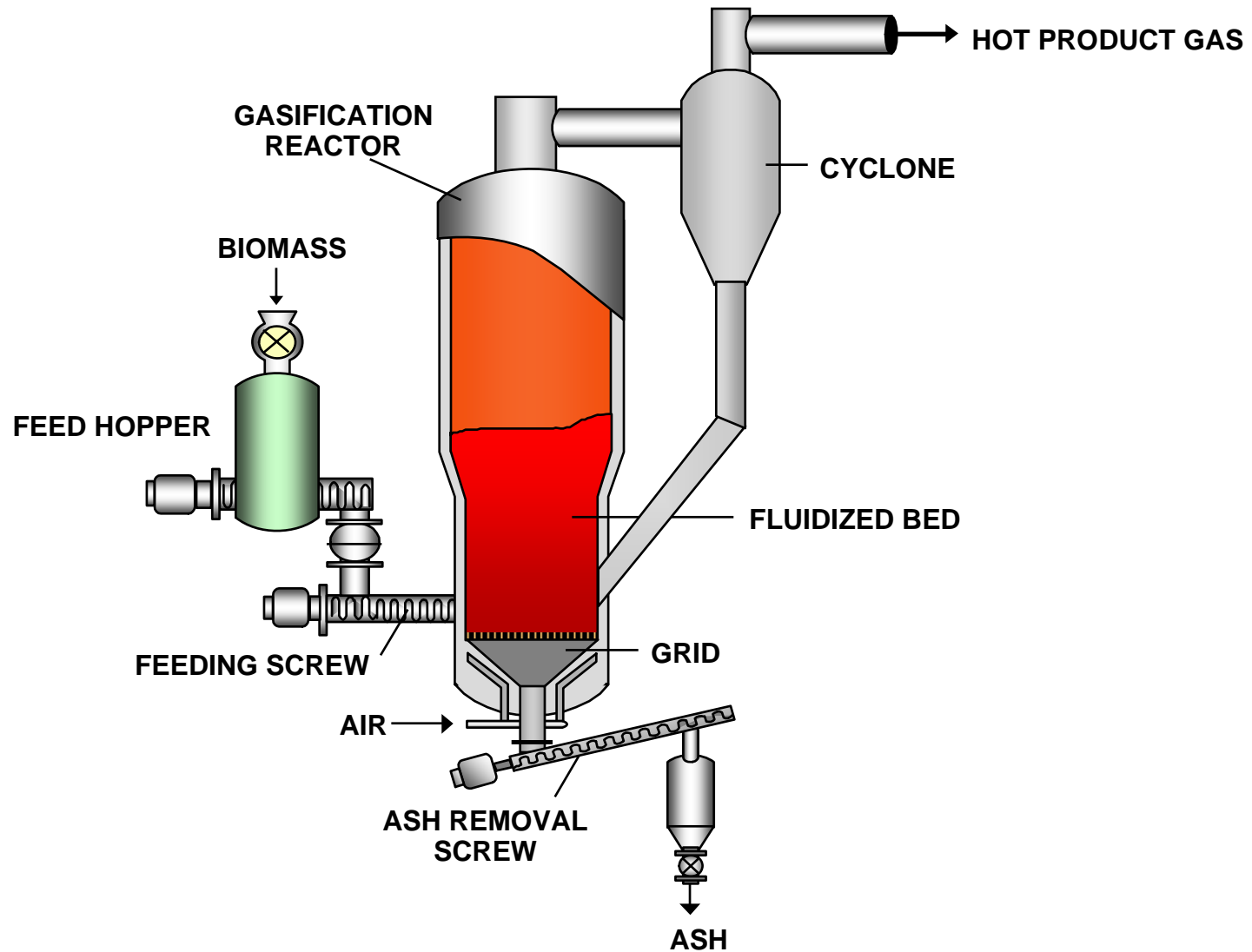
Applications

- **BFB, high pressure, oxy - Liquid Fuels, SNG, Hydrogen**
- **BFB, high pressure, air - IGCC (gas turbine)**
- **BFB, low pressure, air - BGGE (gas engine), small scale**
- **CFB, low pressure, air - Boilers and Kilns, large scale**

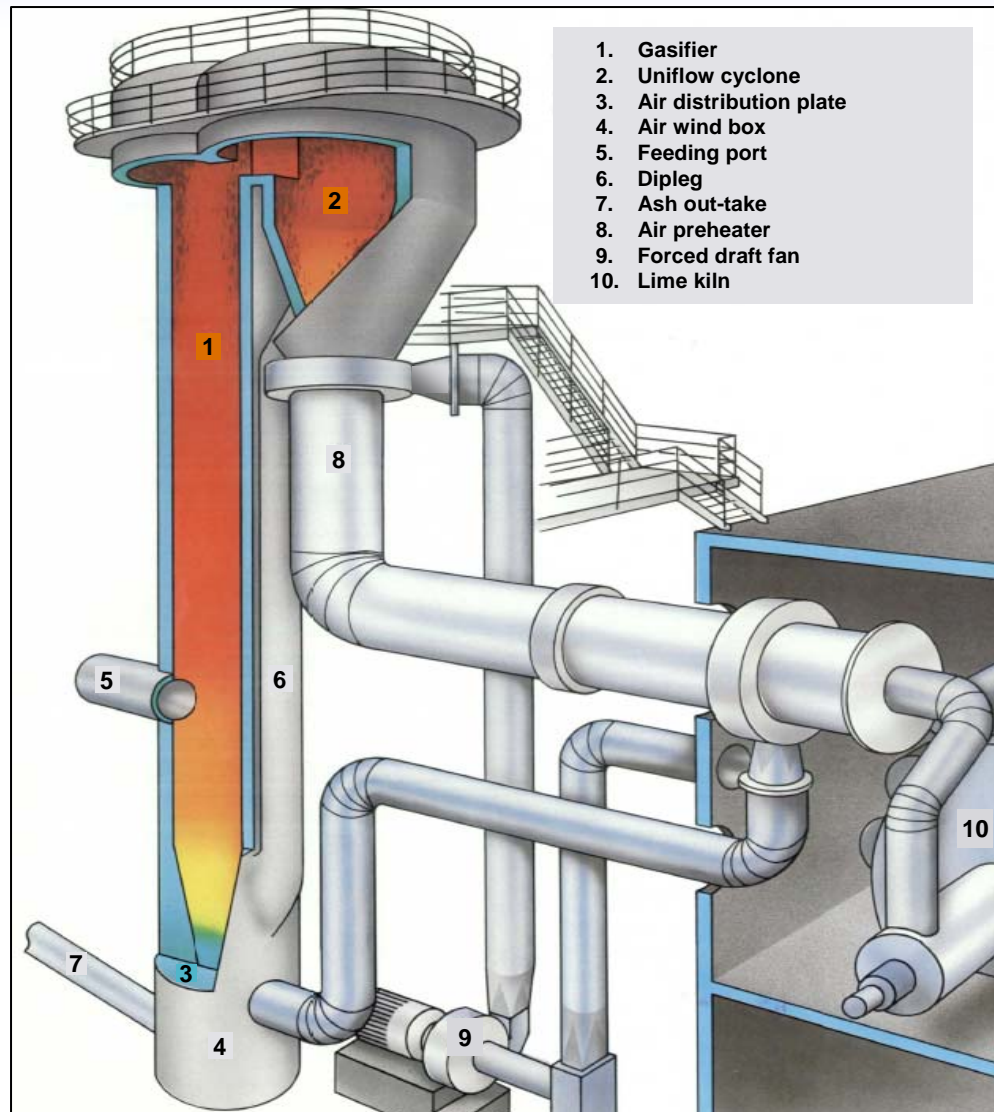
BFB GASIFIER HIGH PRESSURE



BFB GASIFIER LOW PRESSURE



CFB GASIFIER (Former Ahlström Pyroflow)

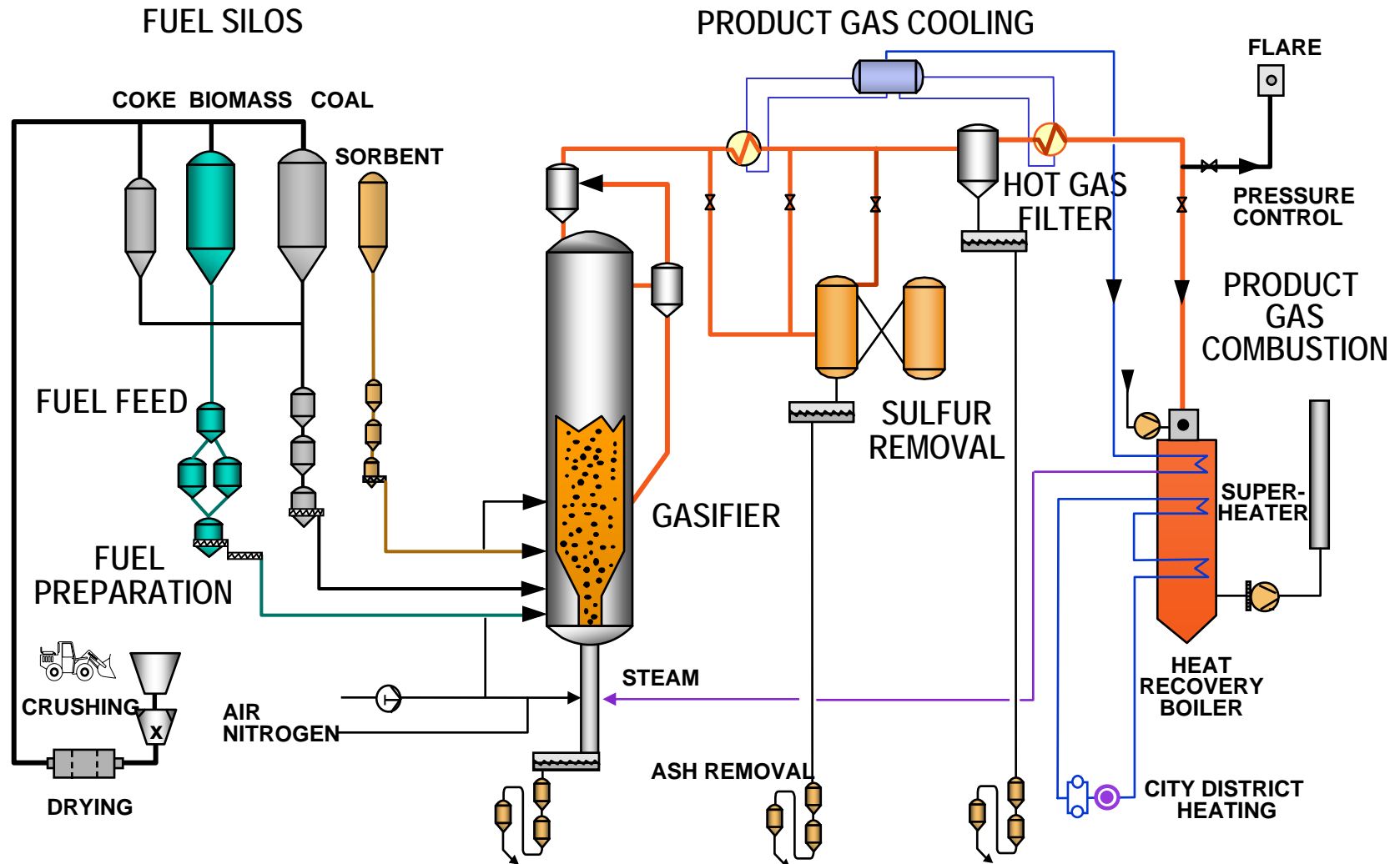


GASIFICATION PILOT PLANT

Tampere, Finland



PILOT PLANT PROCESS FLOW DIAGRAM



PILOT EXPERIENCE, FINLAND

- 26 test runs
- 3850 test hours
- 6000 tons of fuel processed
- 700 tons of Polish coal, Colombian coal, coke and lignite
- 5300 tons of biomass, wood chips, paper mill waste, forest residue, willow, straw, pellets
- mixtures of coal/wood and coal/straw
- test operating parameters:
 - pressure: up to 23 bara
 - temperature: 700-1100 °C
 - fuel input: 2-20 MJ/s (MWth)
coal 50 tpd, biomass 100 tpd
 - gas cleanup temperature: up to 650 °C

BIOMASS FEEDSTOCKS TESTED

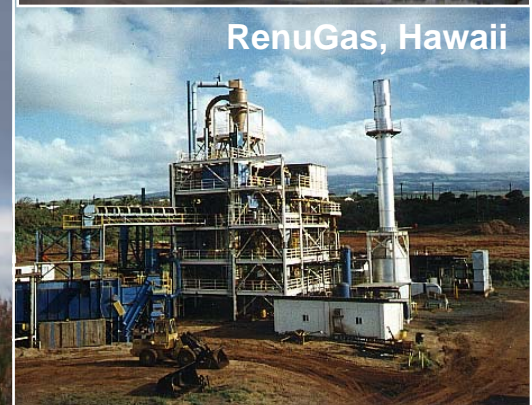
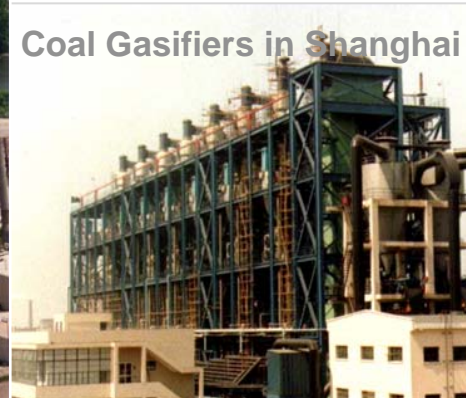
- Hard wood chips
- Soft wood chips
- Hard & soft wood mix
- Forest residue
- Bark
- Paper mill waste
- Wood pellets
- Saw dust
- RDF pellets
- Wheat straw
- Willow
- Alfalfa
- Rice straw
- Oil palm
- Bagasse



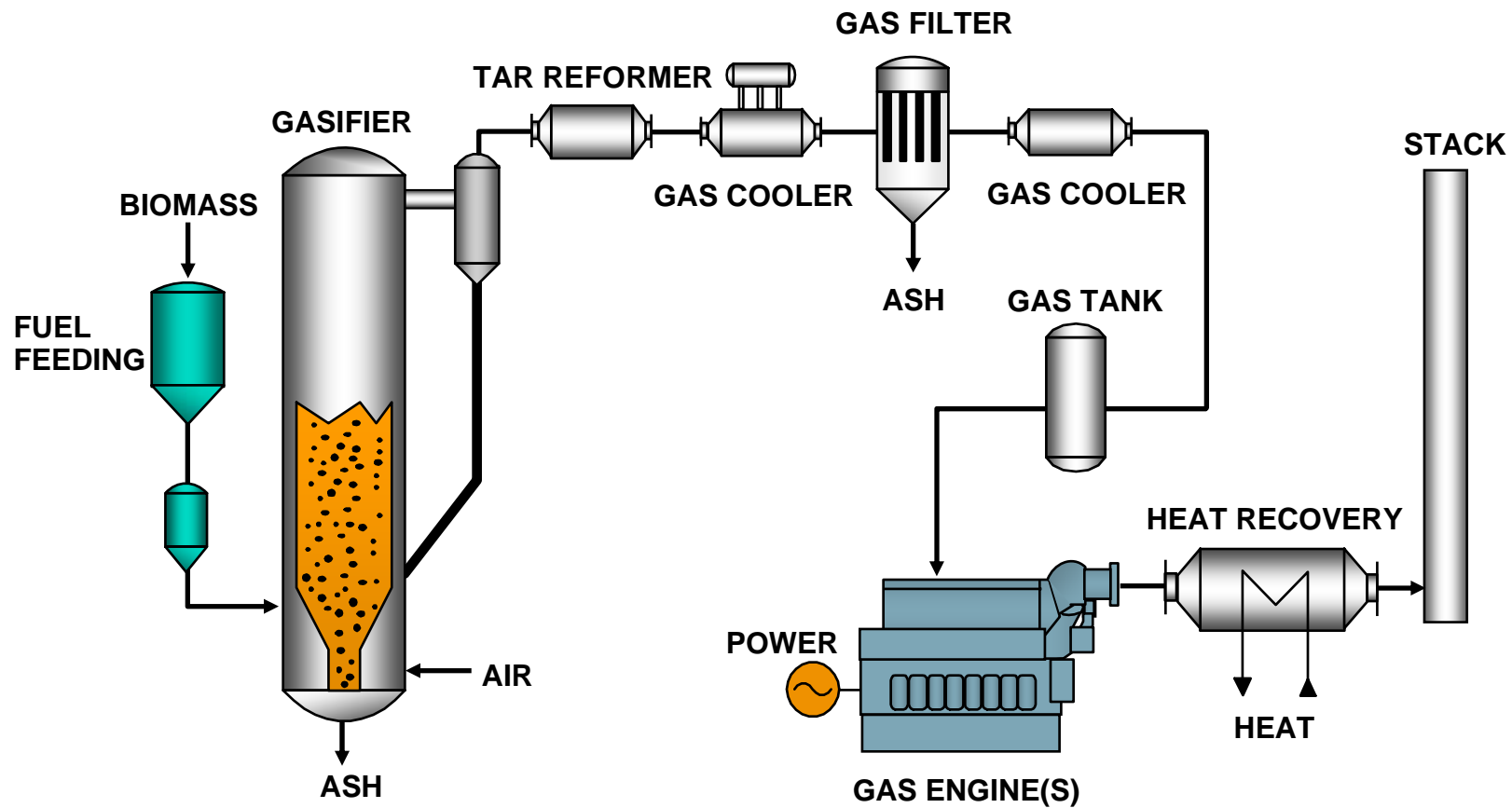
BIOMASS GASIFICATION REFERENCES BFB GASIFIER

Location	Year	Size/Fuel	Application
GTI, Chicago, USA RenuGas	1988	1 MW/biomass	Pilot Plant, air/oxygen
Tampella Power Finland	1991	20 MW/biomass (& coal)	Pilot Plant
Hawaii, RenuGas Maui, USA	1993	20 MW/bagasse	Pilot Plant
GTI, Chicago, USA	2005	4 – 8 MW/coal & biomass	Pilot Plant, air/oxygen
Skive Fjernvarme Denmark	2006	28 MW/wood pellets/chips	CHP (gas engines)

GASIFICATION PLANTS



BIOMASS GASIFICATION – GAS ENGINE CHP PLANT



SKIVE BGGE CHP PLANT

5.5 MWe and 11 MWth



SKIVE PROCESS DESIGN BASIS

- Plant Configuration:
 - low pressure fluidized bed gasifier
 - tar reforming
 - gas cooling and scrubbing
 - gas engines
 - district heating system
- Plant Capacity:
 - biomass feed 110 tpd
 - power generation max. 5.5 MW
 - 11.5 MW district heat, supply at 94/50 °C
- Fuel:
 - wood pellets, thermal input 19,5 MJ/s
 - 9.5 % moisture content
- General:
 - annual operation 8000 hours
 - technical life time >15 years
- Plant Efficiency:
 - electrical efficiency 28 % (LHV, net)
 - electrical efficiency 30% (LHV, gross)
 - overall efficiency 87 % (LHV)

TAR REFORMER

General

- Removes tars and higher hydrocarbons from gas
- Converts tars and higher hydrocarbons to lighter combustible gas components: Carbon monoxide (CO) and hydrogen (H₂)
- Removes also ammonia (NH₃)
- No loss of energy
- No waste

GASIFIER VESSEL



REFORMER



PLANT OPEN CONSTRUCTION

**Flare, Gasifier,
Reformer**



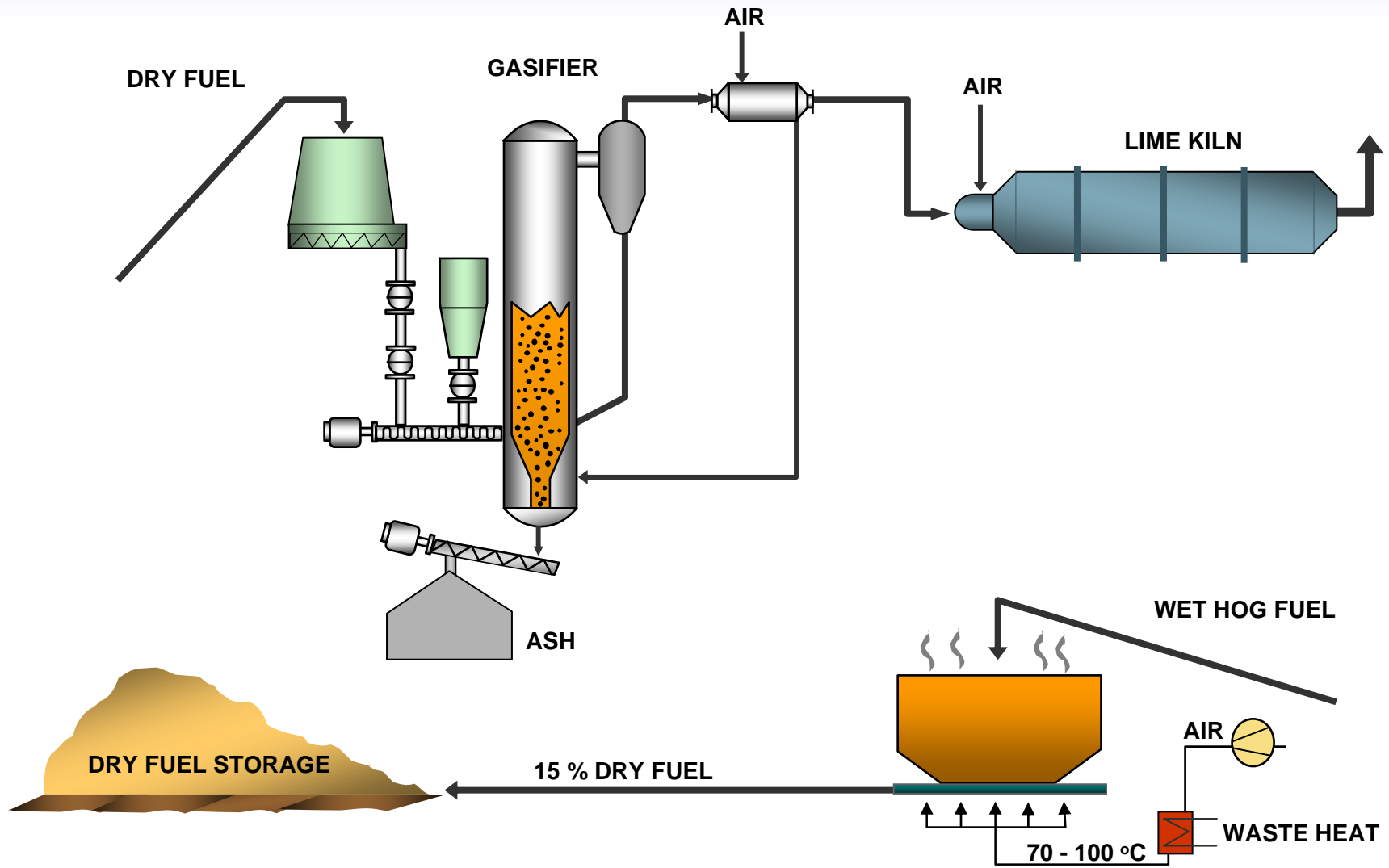
SKIVE PROJECT STATUS

Status at the end of March 2007

- **Building 100% Completion**
- **Mechanical 100%**
- **Piping 100%**
- **Electrical 100%**

- **Hot commissioning started in April 2007**
- **Gasification testing scheduled to start in May 2007**

PULP MILL LIME KILN GASIFIER



BIOMASS GASIFICATION REFERENCES

Andritz/Ahlstrom CFB Gasifier

Location	Year	Size/Fuel	Application
Wisaforest Oy Finland	1983	35 MW/ bark/saw dust	Lime Kiln
Norrsundet Bruk Ab Sweden	1985	25 MW/bark/saw dust	Lime Kiln
ASSI Karlsborg Bruk, Sweden	1986	27 MW/bark/saw dust	Lime Kiln
Portucell Rodao Mill, Portugal	1986	17 MW/bark	Lime Kiln/Boiler

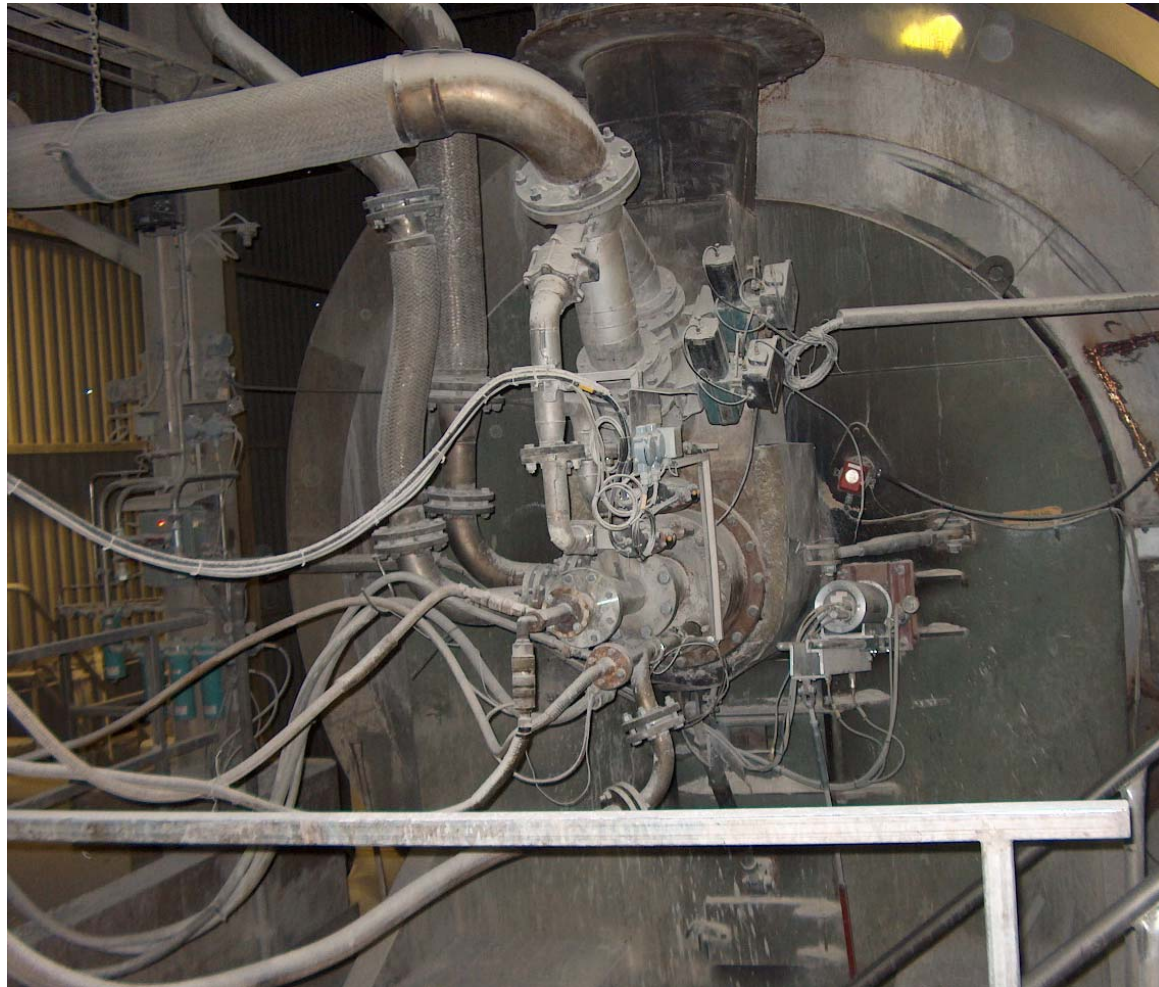
LIME KILN CFB-GASIFIER

CYCLONE

GASIFIER



LIME KILN GAS BURNER

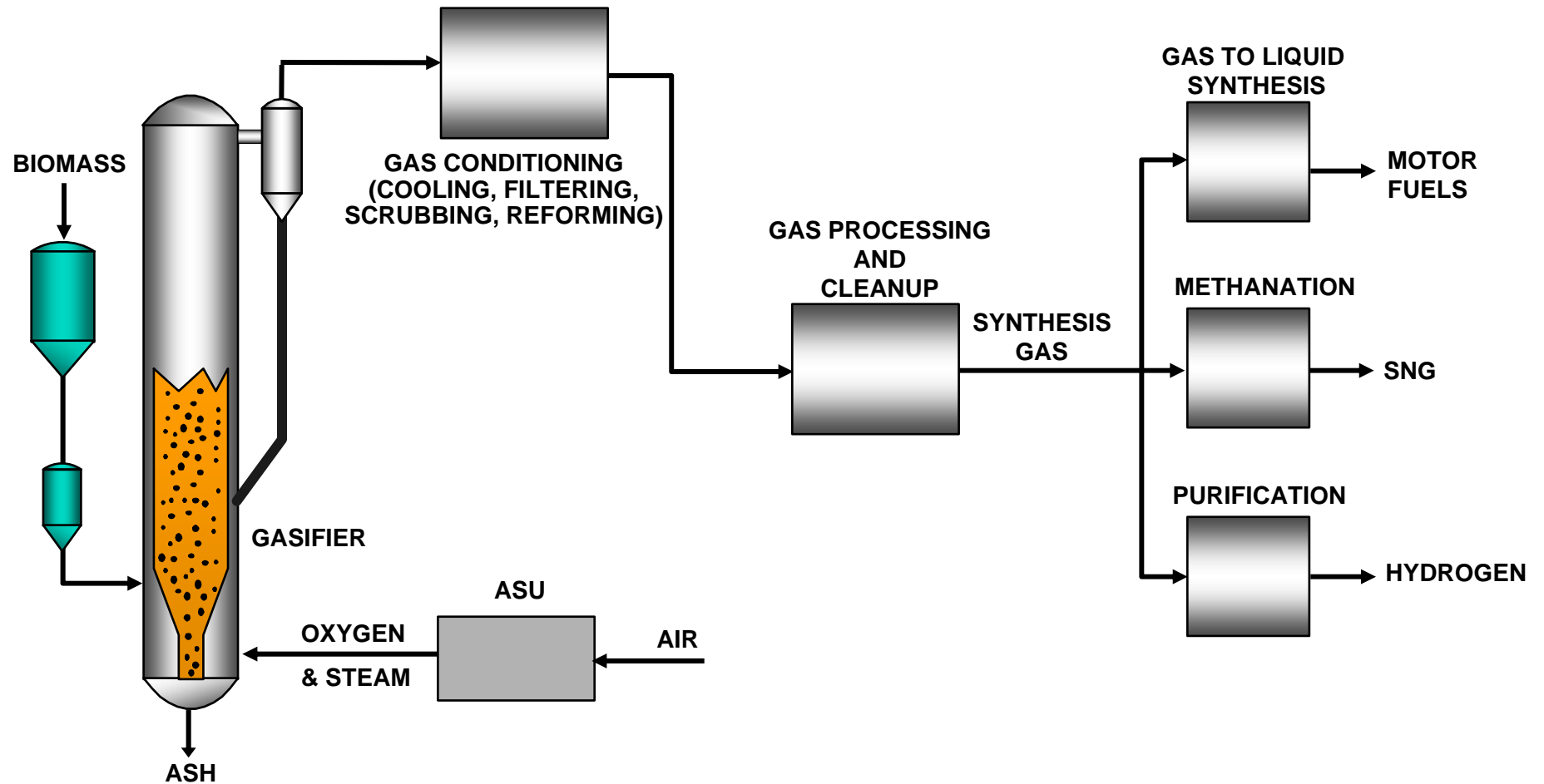


EXPERIENCE WITH LIME KILN GASIFIERS

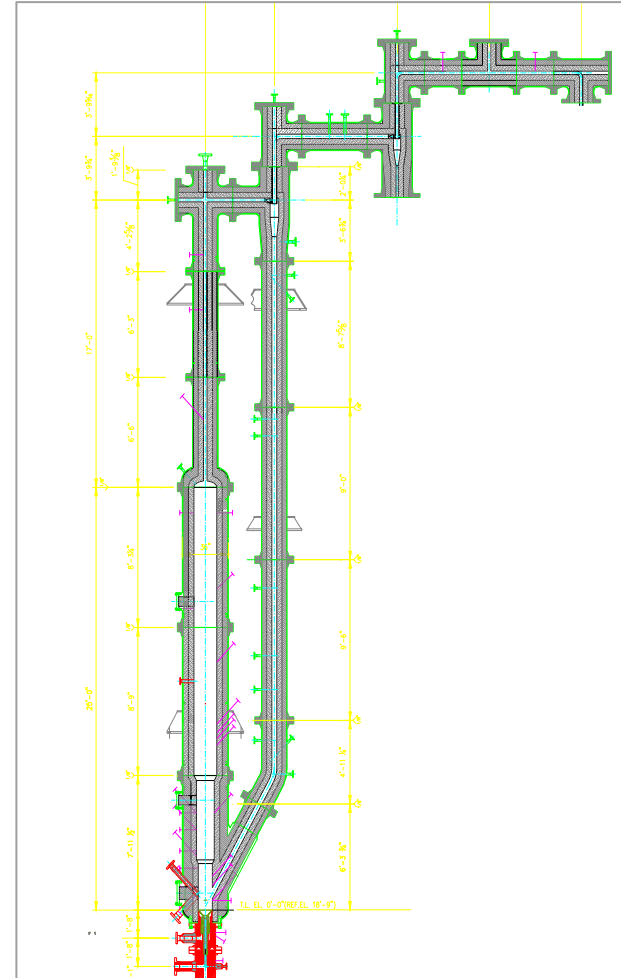
- **Four plants supplied in 1980's; one still operating**
- **Able to replace 100% of NG or oil with biomass gas**
- **Must dry fuel to about 15% moisture**
- **Able to maintain lime quality & kiln capacity**

BIOMASS GASIFICATION – SYNTHESIS GAS

HIGH PRESSURE OXYGEN GASIFICATION



GTI GASIFICATION FACILITY, FLEX-FUEL Chicago, USA



FLEX-FUEL PLANT

