

# **STRAW GASIFICATION- DEMONSTRATION OF TECHNOLOGY AND ECONOMICS**

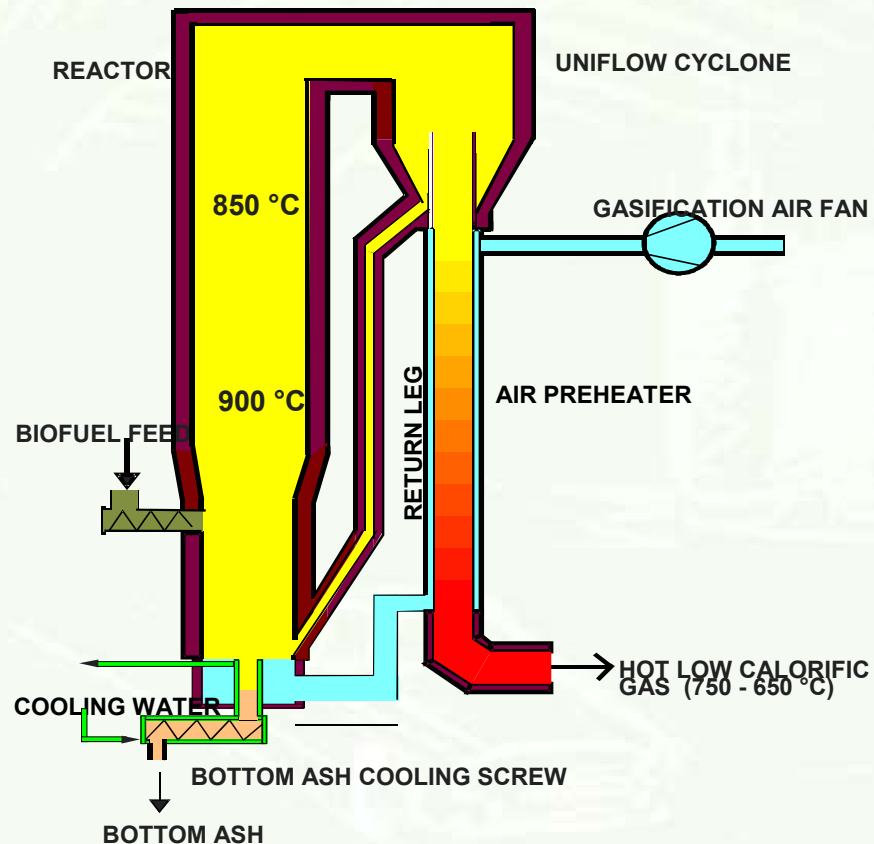
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**BIO-ENERGY  
ENLARGED PERSPECTIVES**

*Budapest ,16-17 October 2003*

# Foster Wheeler CFB Gasifier



# FWE Atmospheric FB Gasifiers

Customer	Size MW	Fuel	Application	Year
Hans Ahlstrom Laboratory, Finland	3	Misc.	Test unit	1981
Oy W. Schauman Ab, Finland	35	Bark, sawdust	Lime kiln fuel	1983
Norrsundet Bruks Ab, Sweden	25	Bark	Lime kiln fuel	1984
ASSI Karlsborg, Sweden	27	Bark	Lime kiln fuel	1984
Portucel, Rodao, Portugal	15	Bark	Lime kiln fuel	1985
Kemira Oy, Vuorikemia, Finland	4	Coal, peat	Test unit, clean gas	1986
Lahden Lämpövoima Oy, Finland	40-70	Biofuels	Hot raw gas to boiler	1997
Corenso United Ltd., Finland	40	Aluminious plastic waste	Cyclone cleaned gas to boiler	2000
Electrabel, Belgium	50	Biofuels	Hot raw gas to boiler	2002

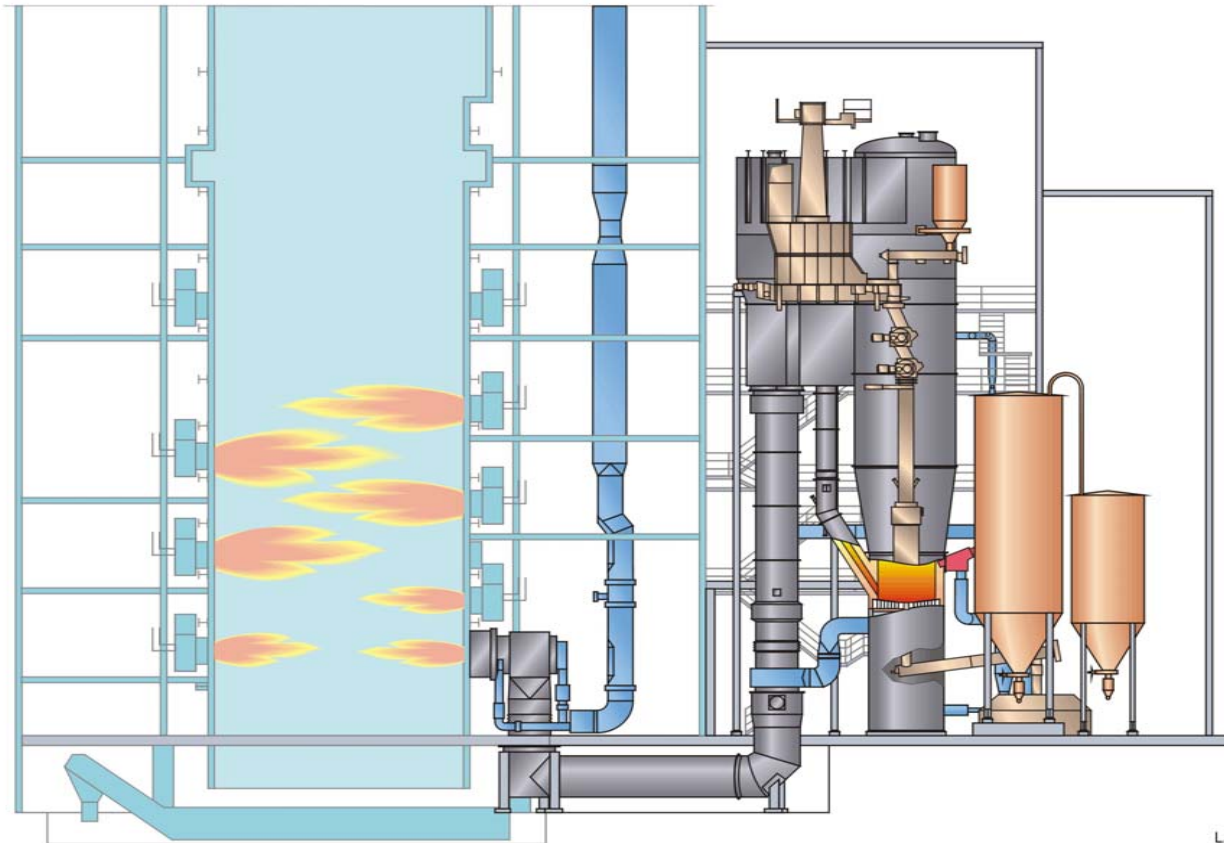
# Lahti Operating Experiences

- Commercial operation since March 1998
- Operating data 1998 - 2002
  - Operating time 27 000 hours
  - Gasifier availability 97.5% (average, 1998-2001)
  - Energy produced 1700 GWh
  - Fuel gasified 498 000 ton
    - Biomass, Recycled Fuels, Plastics, Paper
    - (Railway sleepers, shredded tires)

# FWE CFB Gasifier in Lahti, Finland



CFB BIOMASS GASIFIER  
40 - 70 MWth



LAHDEN LÄMPÖVOIMA  
KYMJÄRVI POWER PLANT  
KYMJÄRVI, FINLAND



# Straw Gasification

Foster Wheeler Energia Oy and Energi E2 agreed in 1998 to start the development of gasification technology for straw.

The project included also development of the straw feeders, based on the ideas of, and carried out by TK-Energy from Denmark.

# Straw Gasification

1<sup>st</sup> test with pelletized straw in 1999

2<sup>nd</sup> test with loose straw in winter 1999-2000

3<sup>rd</sup> test with loose straw in 2000, supported by EC

In the tests 220 tons of straw was gasified during more than 400 operating hours.

# Test Objectives

## 1<sup>st</sup> Gasification test

- to scope the process conditions for gasification, gas cooling, dust separation and gas combustion
- to study gas cleaning by a secondary cyclone

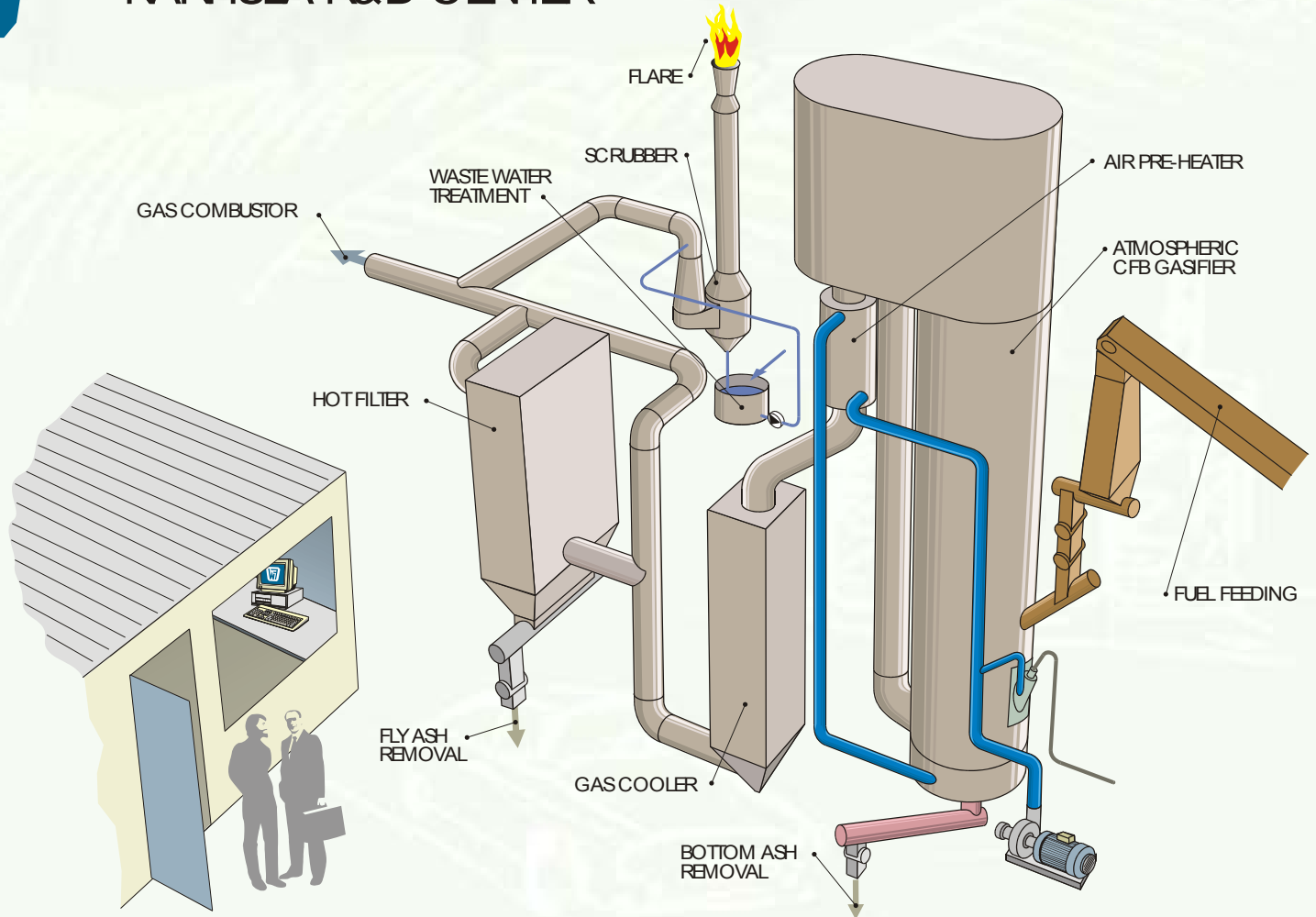
## 2<sup>nd</sup> Gasification test

- to test the newly developed straw feeding system
- to study syngas cleaning in a baghouse
- to find the ranges of applicable process conditions

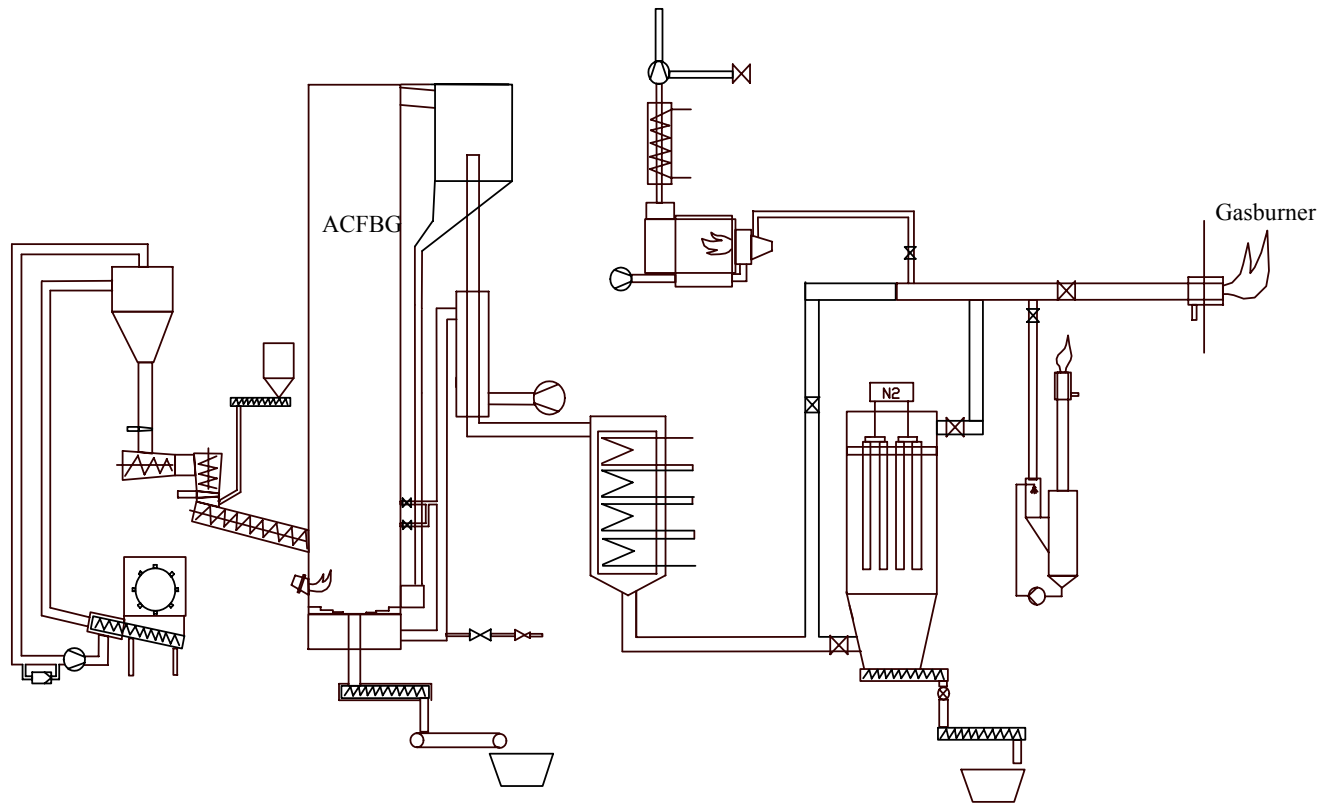




# FOSTER WHEELER ATMOSPHERIC CFB GASIFIER KARHULA R&D CENTER



# Straw Gasification



# Straw Gasification

The 3<sup>rd</sup> straw gasification test was executed in 2000.

The test consisted of 3 main validation tasks:

- The capability of the developed feeding system to feed loose straw into the gasifier
- The optimal process conditions and additives for gasifying loose straw
- The capability of the selected gas cleaning system to make the gas suitable for co-combustion in large CHP-plants

# Commercial Scale Design Study

In the design study a full-scale straw gasification plant of 100 MW<sub>th</sub> and the integration with an existing large CHP plant was investigated.

The practical solutions of all unit operations were developed.

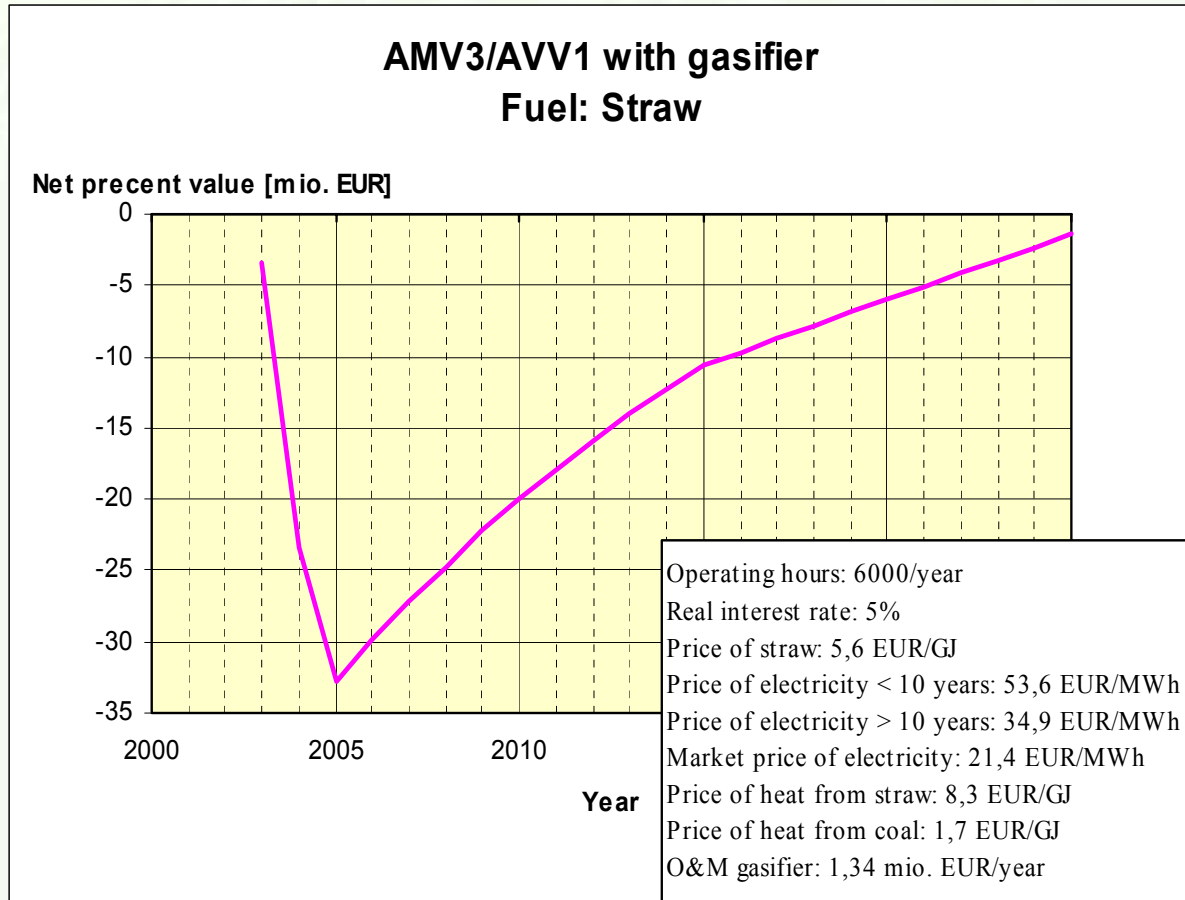
The budget for a complete plant was calculated and consequently the overall project economy was assessed.



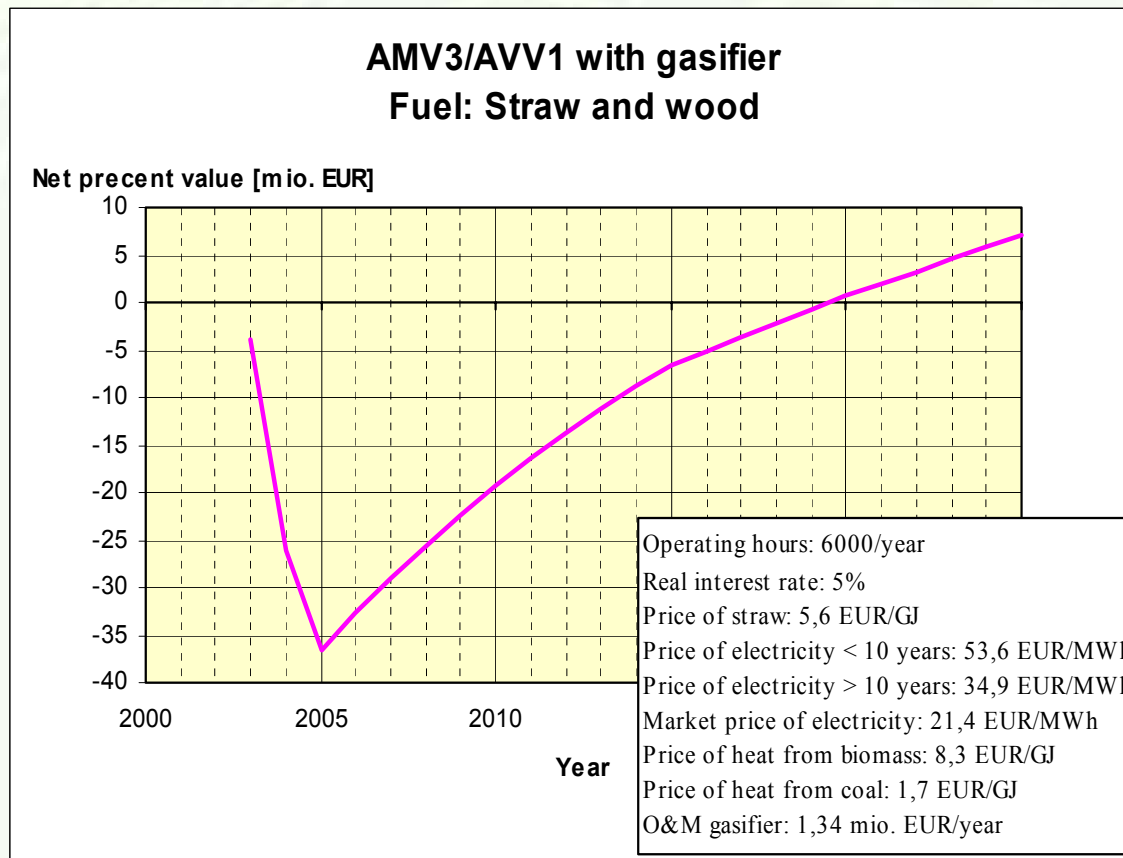
# Parameters Used in the Economical Evaluation

- Period of depreciation 20 years
- Real interest rate 5 % p.a.
- Inflation 2.5 % p.a.
  
- Total investment 42.3 M€
- Operating hours 6000 h/a

# NPV for 100% Straw Gasification



# NPV for 50% Straw / 50% Wood Gasification





# Conclusions

## Conclusions based on the test program:

- Loose straw gasification is technically feasible
- Smooth, stable operation in spite of high alkaline fuel could be achieved
- Wood and straw may be gasified together
- Carbon conversion in the range of 95 - 97% or higher is achieved
- Filter (3M) operated well without blinding by tars; it removed also alkalis and chlorides quantitatively
- In the gasification conditions, PAH were formed, dioxins and furans were not formed

# Conclusions (cont.)

## Conclusion from the design study:

- The economy of a 100MW<sub>th</sub> gasifier integrated with an existing large CHP plant is sensitive to the fuel and energy prices, and year 2001, slightly cheaper biomass fuel than straw should have been available for profitable operation in Denmark.
- Specially, in Copenhagen area, straw price is high and heat price is very low, ruining the economy of the evaluated investment