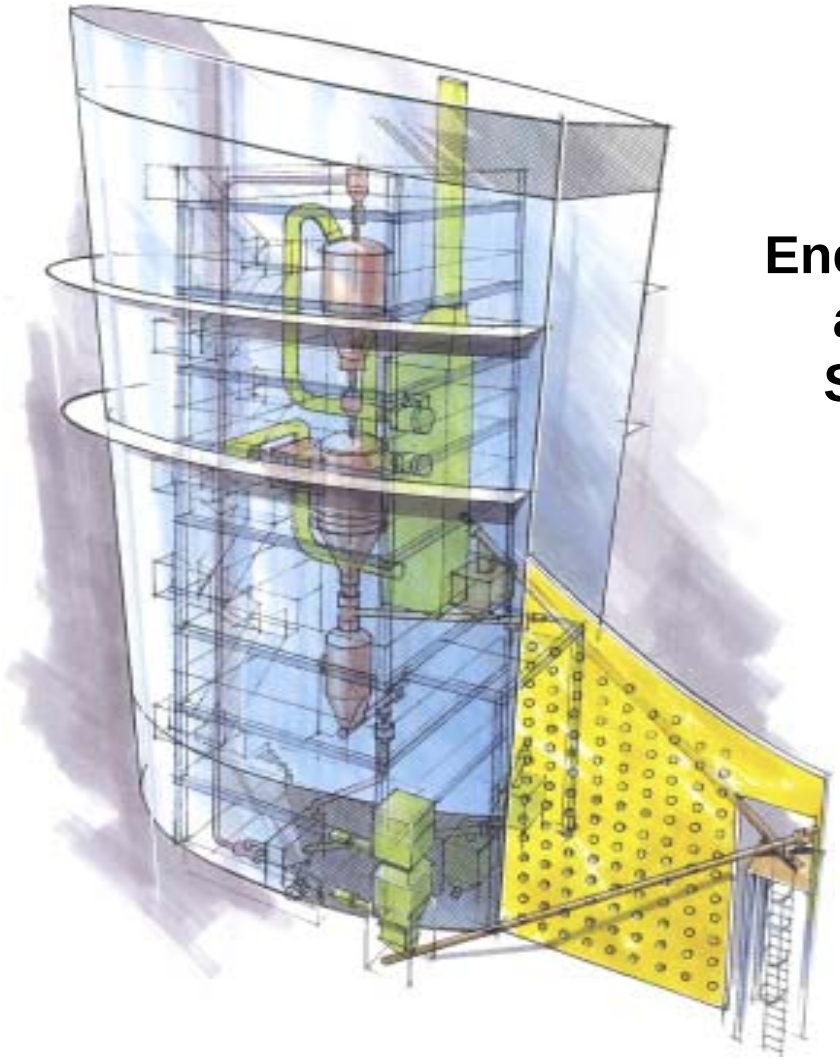
D.M.2



The BLUE TOWER

Energy and Hydrogen from Organic and Fossil Residues using the STAGED REFORMING Process

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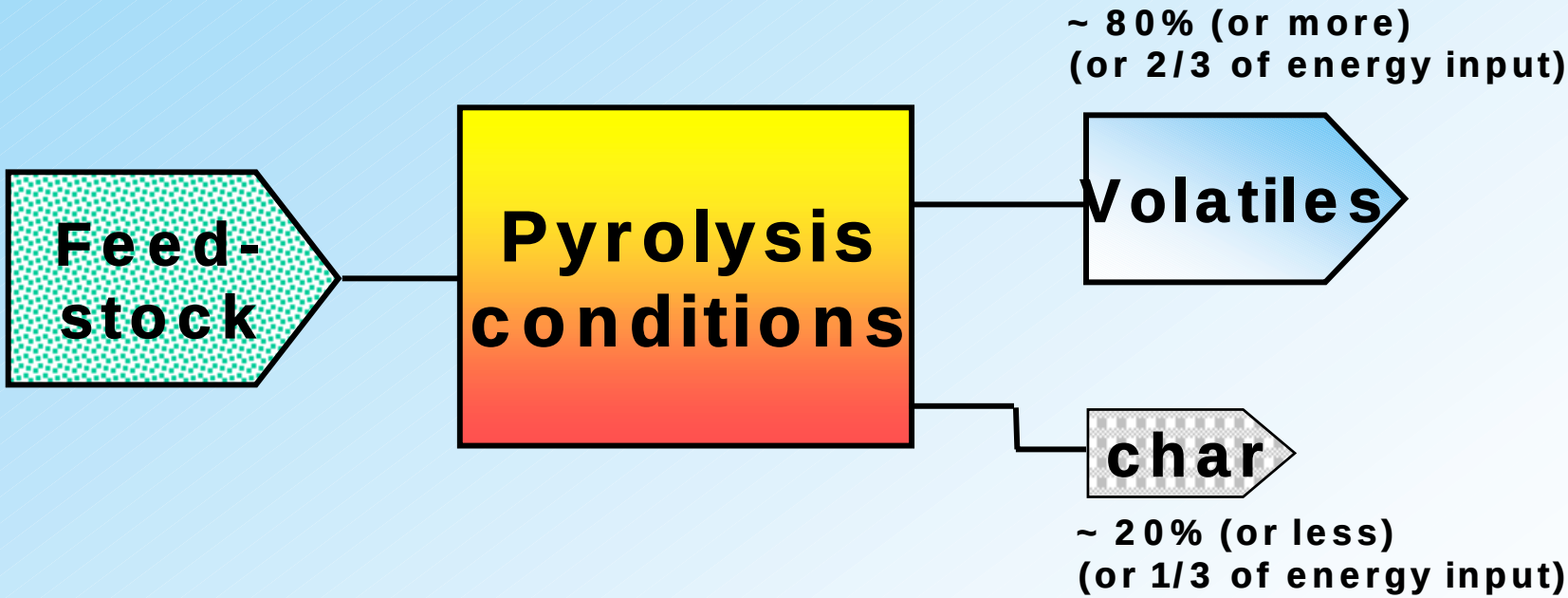
Gelsenkirchen, 02-Apr-2003

The STAGED REFORMING Process

STAGED REFORMING is a new gasification process for ...

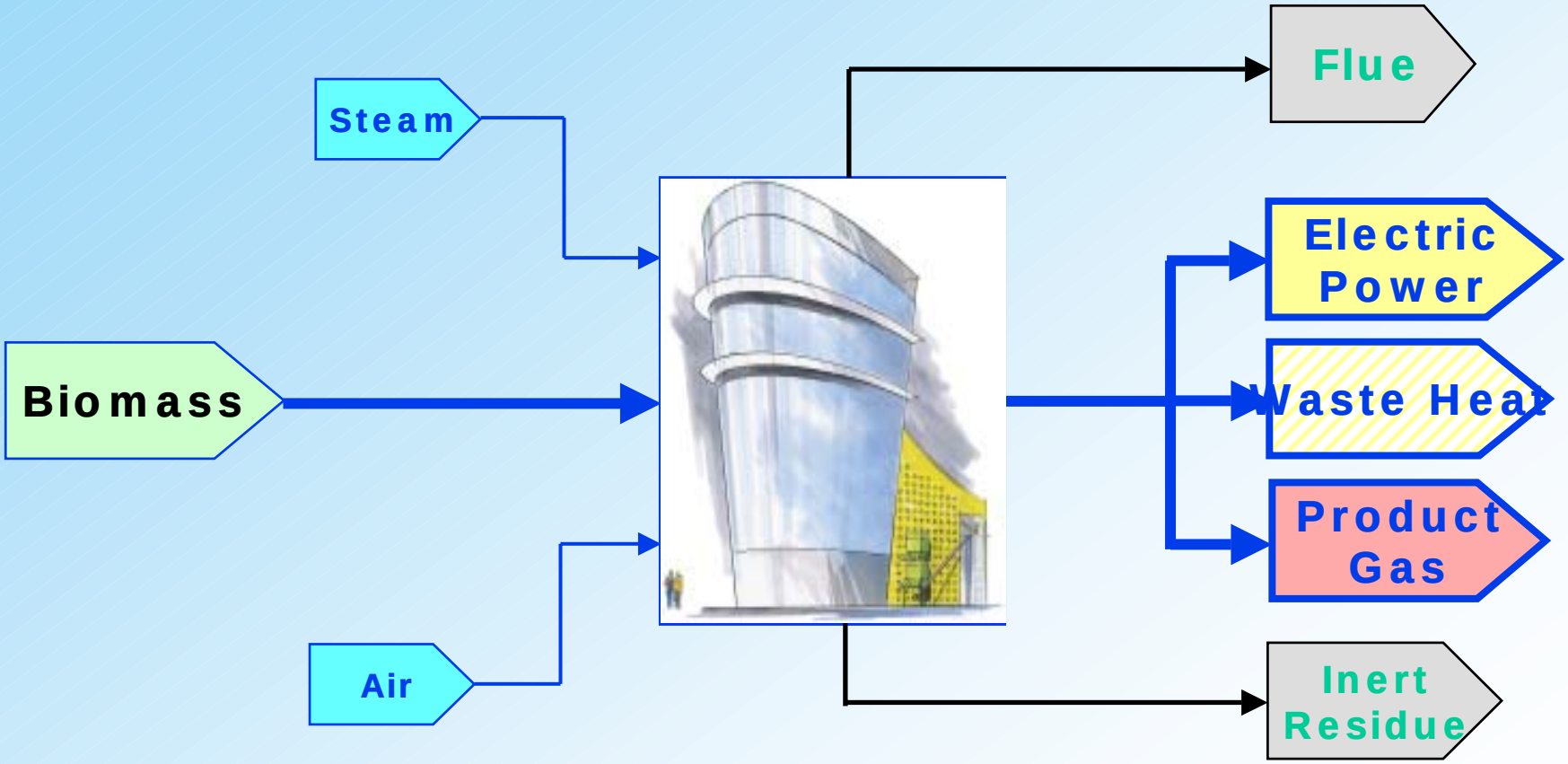
- all types of biomasses
- biogenic/organic residues
- and liquid fossil residues.

STAGED REFORMING – Feedstock Criteria

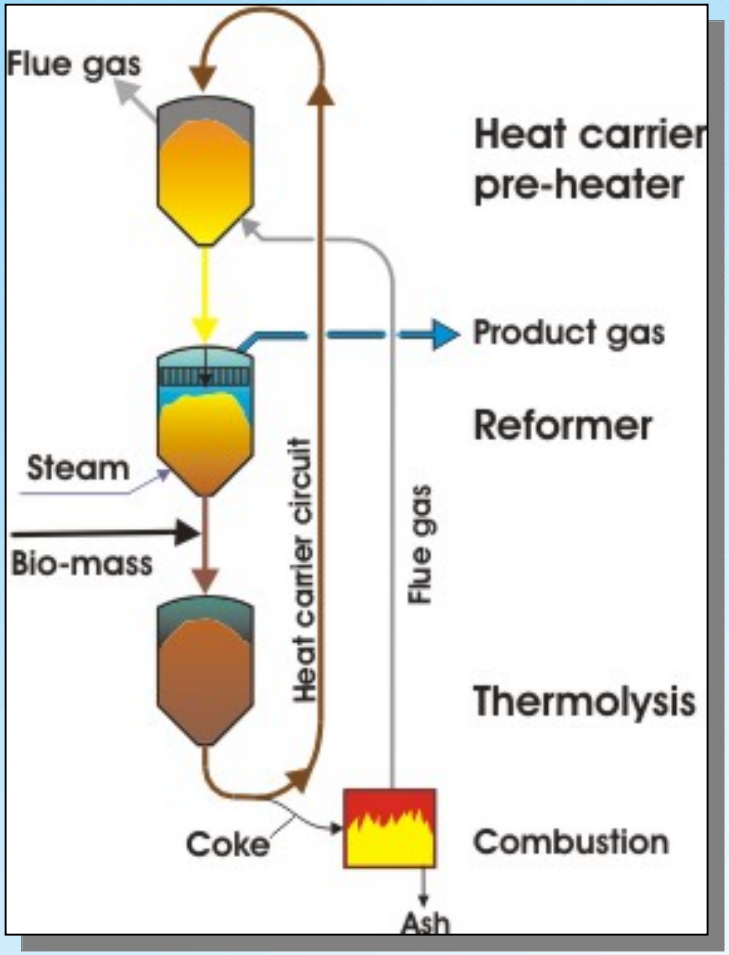


- Carbon derived materials
- Pre-drying (y/n): Depends on feedstock and project cor

STAGED REFORMING as a Gasification Process



STAGED REFORMING – Basic Sketch



Potential Feedstocks

- Wood
- Waste Wood, even if contaminated
- Branches, Leaves
- Hay, Straw, Silage
- Municipal Bio Waste
- Car Shredder Residue
- Slaughterhouse/Fish Residues
- Sewage and Paper Sludges
- Manure
- All Types of Agro Residues
- Foodstuff beyond Expiry Date
- etc.

Product Gas from STAGED REFORMING

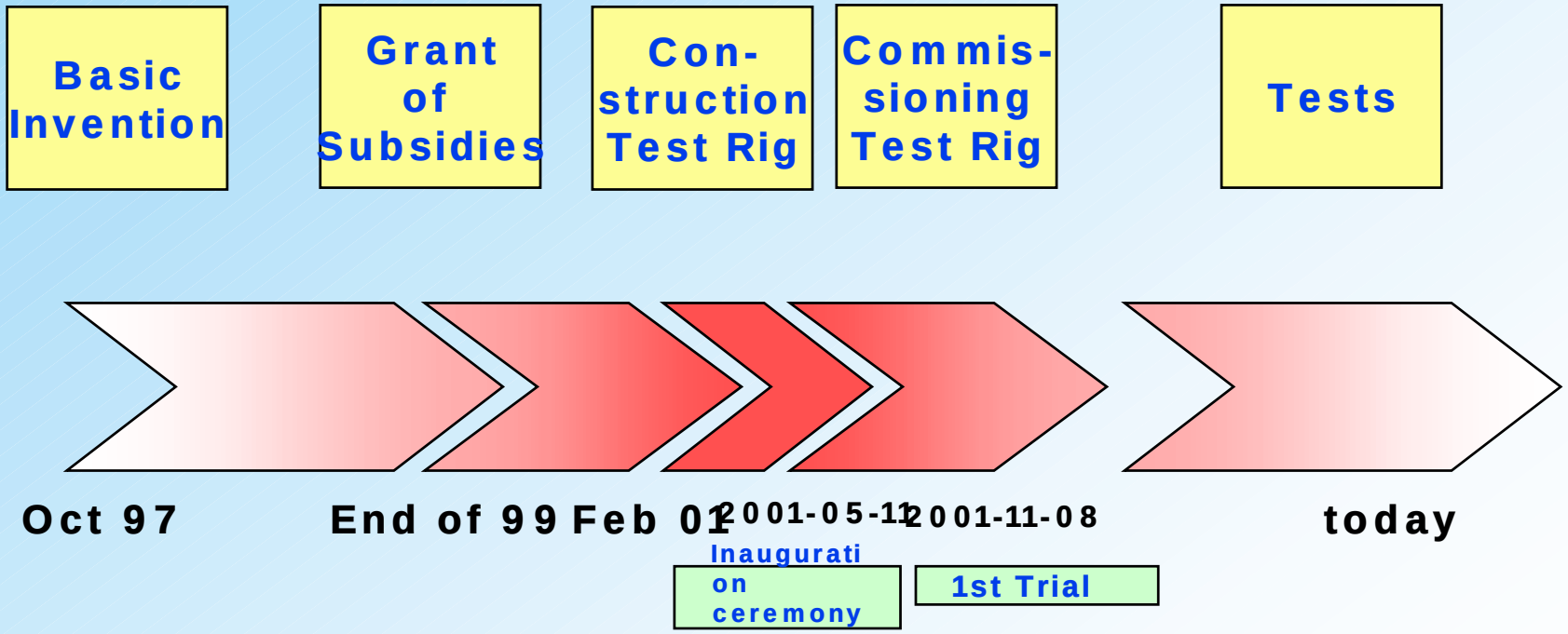
The product gas composition is expected to be
(Example: mixture hay/straw, main species, calculated)

Species	Vol.-% wet	Vol.-% dry
H_2	32.4	53.9
CO	9.2	15.3
CO_2	13.0	21.6
CH_4	4.2	6.9
H_2O	39.8	0

Properties of the Staged Reforming Process

- All types of biomass, biogenic residues can be used as feedstock. Many types of liquid and pasty fossil residues as well.
- Minimum pre-processing of the feedstocks
- Moderate to high ash and moisture content acceptable
- With biomass up to 60% hydrogen content of the product gas, with some kind of fossil residues much more (80 – 90%)
- Operation without liquid effluent is possible
- Simple Process

Development of Staged Reforming – Time Table

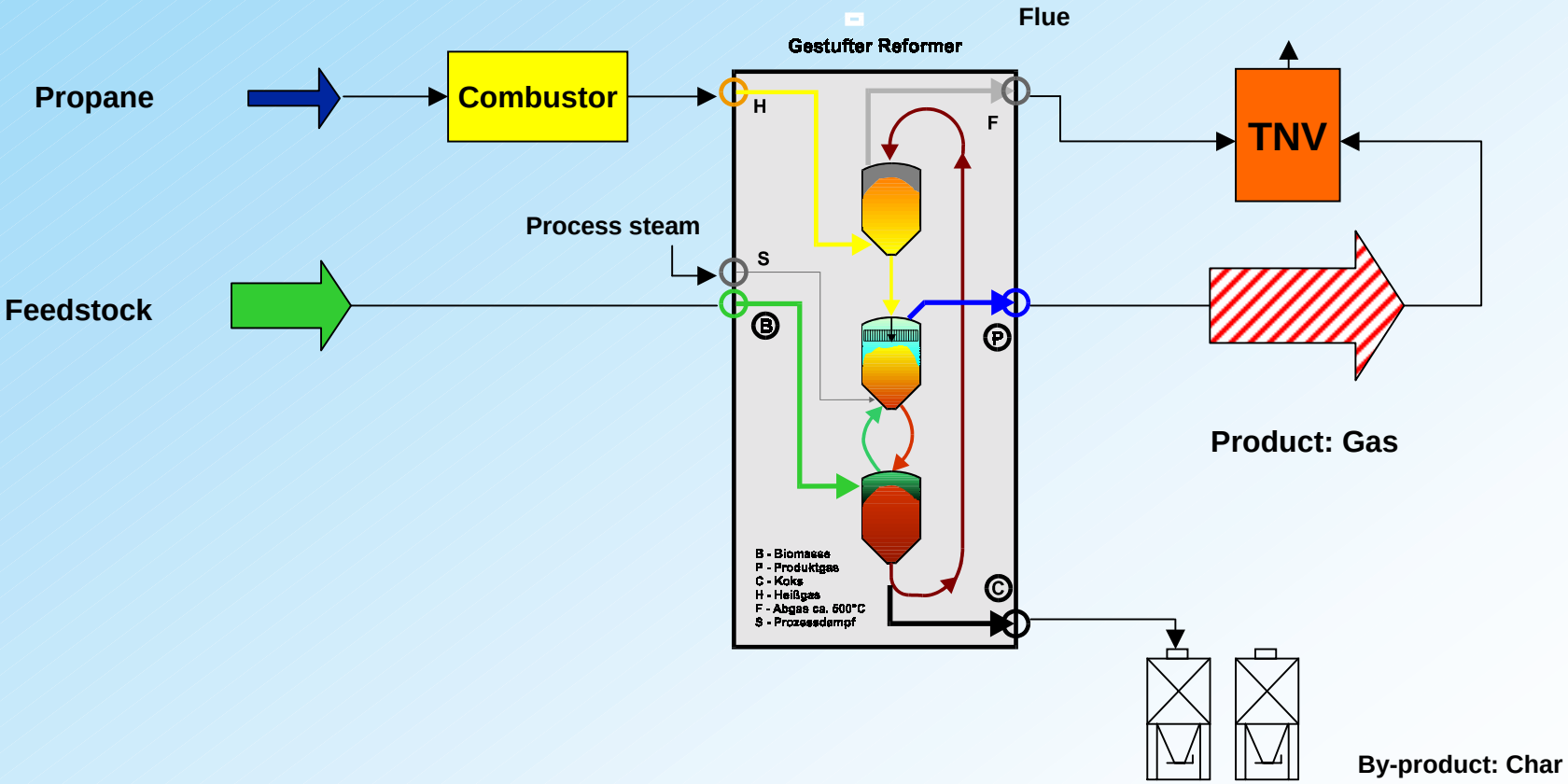


Staged Reforming – Test Plant

- Capacity 1 MW_{th} = 200 kg/h wood, dry
- Demonstration of Core Component only
- Budget of Project ca. 3 Mio. EUR
- 49% subsidies through NRW state (REN Pro

This is the plant you are able to visit tomorrow

STAGED REFORMING Test Plant – Process Arrangement

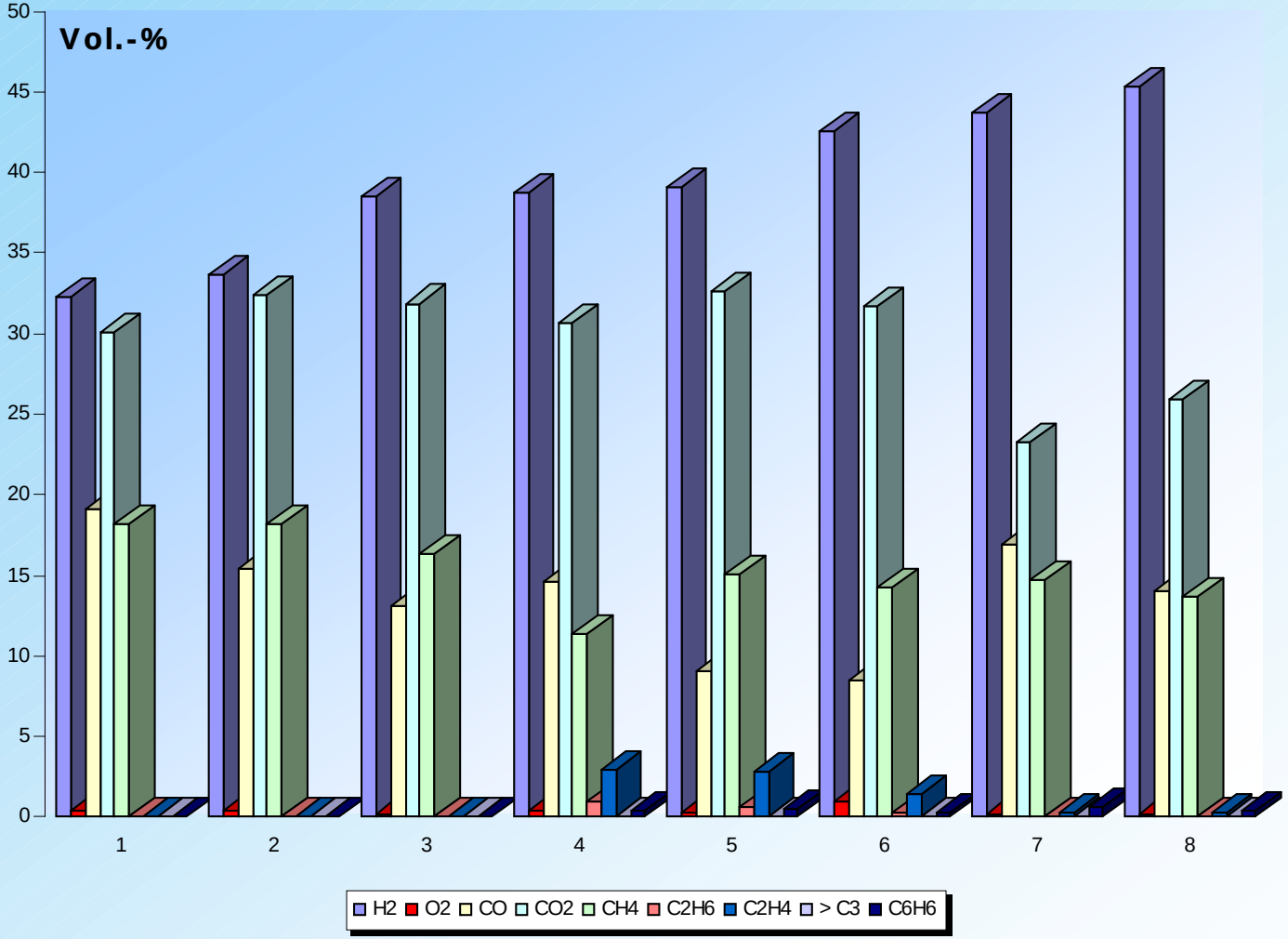


The BLUE TOWER test plant

Construction
End of April
2001

Plant finished
2001-05-11

STAGED REFORMING – Gas Composition



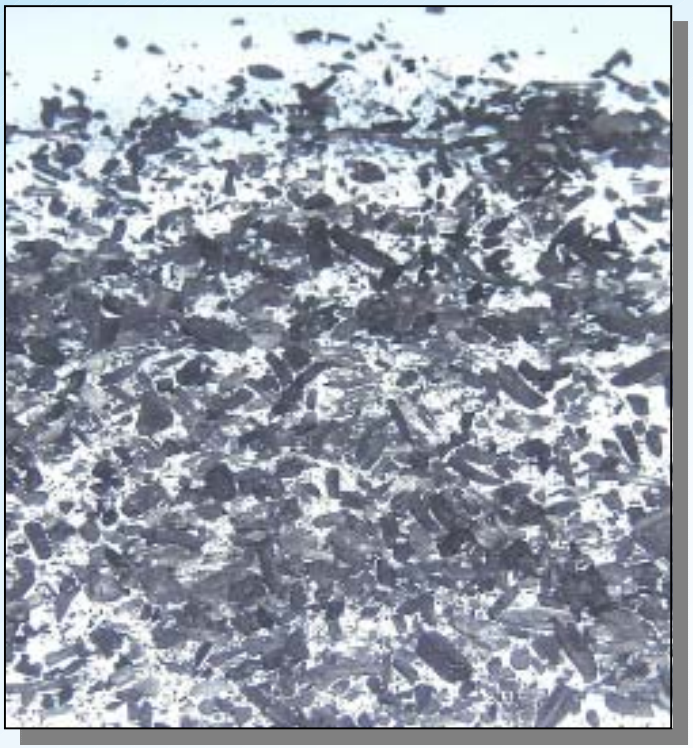
w/o N_2 (measured < 5%)

Trial campaigns

- November 2001 Samples 1-3
- December 2001 Samples 4-6
- April 2002 Samples 7 and 8

Pilot Project - Input and Output

Herten Green Cut Material



Pyrolysis char

Pilot project – Gas path

Segment valve between pyrolysis and reformer and catalyst duct

Aspects:

condensation of hydrocarbons (tars),

deposition of dust, soot etc.

Pilot project – Heat Carrier, High Temperature Valves

Heat Carrier Material:

Sintered corundum (> 99% Al_2O_3)

Segment valve

Pilot project – Conclusions

- It was shown that the STAGED REFORMING process is functional
- It was possible to obtain product gas of the quality expected
- Herten green cut, used wet with both coarse and fine particles could be gasified without problems. Dry and fine input materials require constant feeding.
- Essentially, the mechanical concept of the heat carrier concept was confirmed. Further optimisation during key demonstration projects

Key demonstration projects STAGED REFORMING

H2Herten Blue Tower:

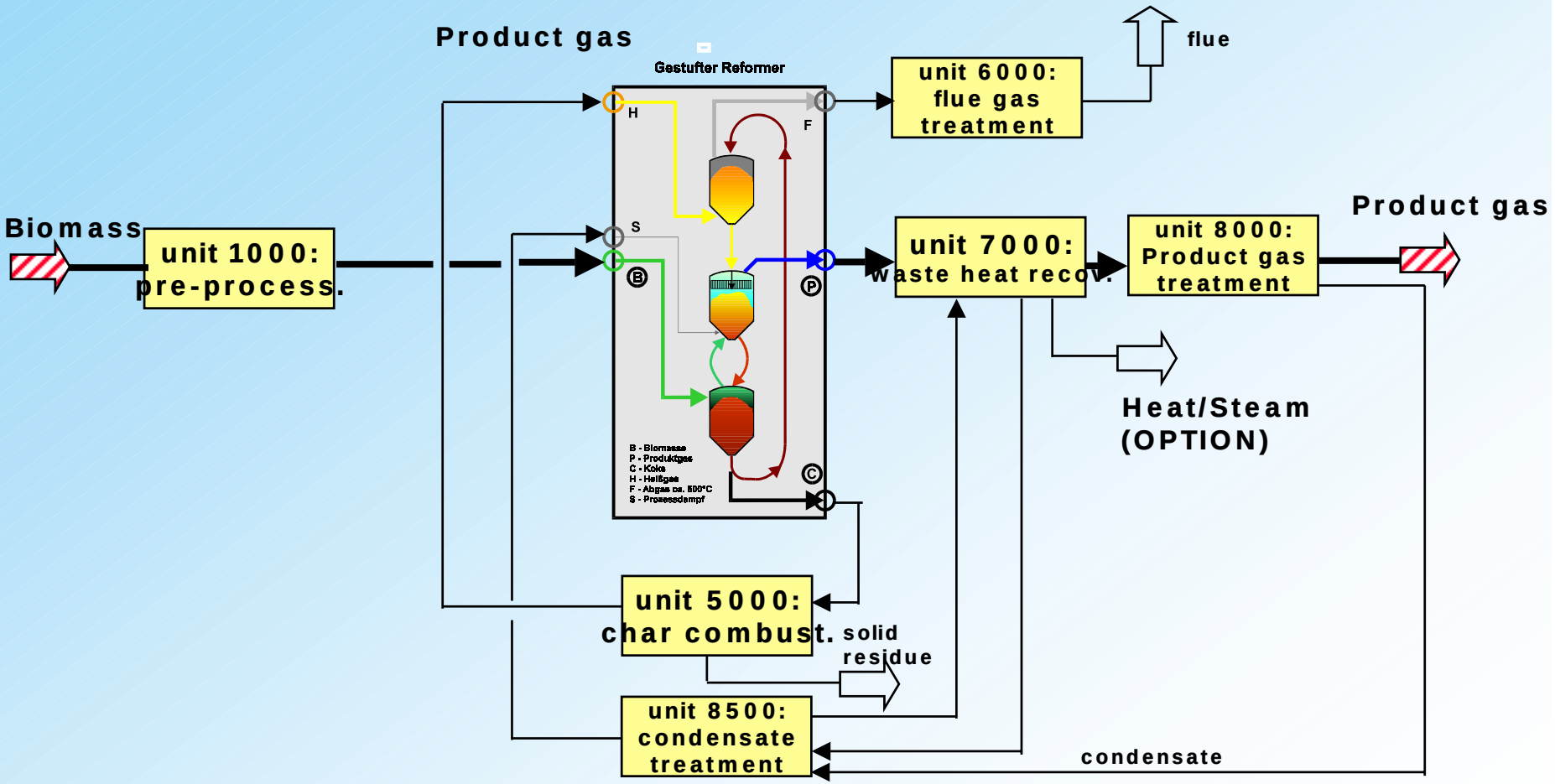
- Capacity 10 MW_{th}
- Feedstock: Waste Wood
- Products: 3 MW electric power and/or 500 Nm^3/h hydrogen (at a later stage)
- Gasifier operational in 2004 (expected; start of extended commissioning phase)

Key demonstration projects STAGED REFORMING

AVD Emsland:

- Capacity 2,5 MW_{th}
- Feedstock: Hay, straw, hemp, natural wood
- Product: 0,75 MW electric power (gas engine)
- Gasifier operational in early 2005 (expected)
- Special feature: Ash to fertilizer (phosphate recovery)

Key Projects – Standard Process Arrangements



Prospect of STAGED REFORMING

- Two licensees in Japan, one licensee in Mexico
- Other license contracts in negotiation, e.g. Brasil
- Several projects in Germany might be realised in parallel to key projects (2003-2005)
- Most projects focus on solving of organic waste disposal problems
- Hydrogen or synthesis gas production seems to be an option for the future

Thank you for your attention!

Please ask!

If you have questions ……..