Biomassevergasung und Gasverwertung

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Highlights der Bioenergieforschung
Nationale und Internationale Ergebnisse zu den IEA Schwerpunkten

28. April 2009

Overview

- IEA Bioenergy Task33 Thermal gasification of Biomass
- Austrian research in the area of advanced gasification

IEA Bioenergy Task 33

- The objectives of Task 33 are to review and exchange information on biomass gasification (BMG) research, development, demonstration, and commercialization
- Participating countries (12): Austria, Canada, Denmark, European Commission, Finland, Germany, Italy, The Netherlands, New Zealand, Sweden, Switzerland, and the USA
- Task Leader: Dr. Suresh P. Babu, Gas Technology Institute, Des Plaines, IL., USA.
- Actual Triennium is from 2007-2009, Proposal for next Triennium 2010-2012 is delivered to ExCo
- More details at http://www.ieatask33.org

Definition of gasification

Definition:

Gasification is a process by which either a solid or liquid carbonaceous material, containing mostly chemically bound carbon, hydrogen, oxygen, and a variety of inorganic and organic constituents, is reacted with air, oxygen, and/or steam. The reactions provide sufficient exothermic energy to produce a primary gaseous product containing mostly CO, H_2, CO_2, H_2O(g), and light hydrocarbons laced with volatile and condensable organic and inorganic compounds.

Main reactions:

devolatlisation:	C, CH_4, CO, CO_2, H_2, H_2O	
Boudouard-reaction	$C + CO2 \leftrightarrow 2\ CO$	$\Delta H = 159{,}9$ kJ/mol
Heterogenous water gas shift	$C + H2O \leftrightarrow CO + H2$	$\Delta H = 118{,}5$ kJ/mol
Homogenous water gas shift	$CO + H2O \leftrightarrow CO2 + H2$	$\Delta H = -40{,}9$ kJ/mol
Methanation	$C+ 2H2 \leftrightarrow CH4$	$\Delta H = -87{,}5$ kJ/mol

Overview on usage

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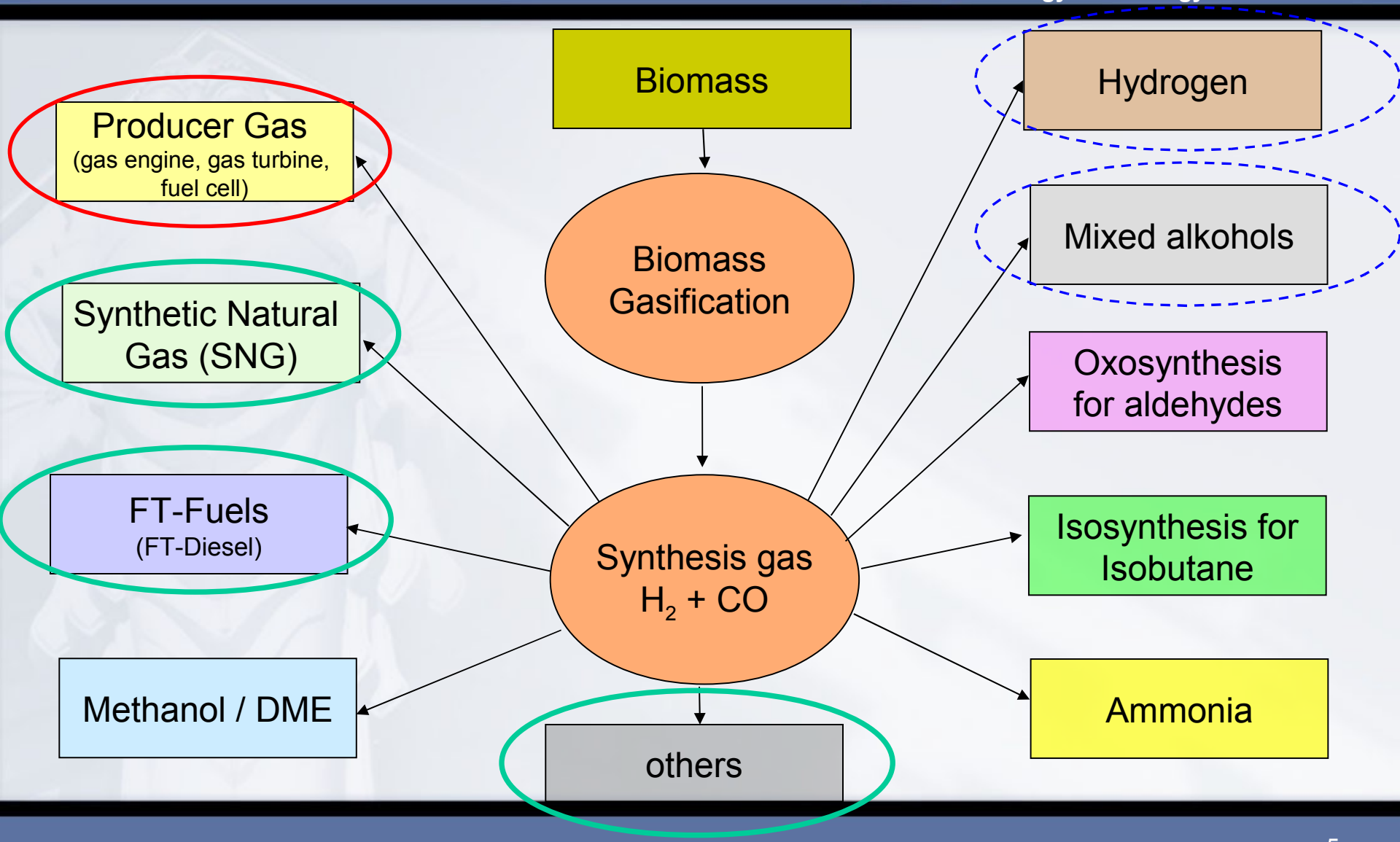

Efficiencies for electricity

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Learning curve

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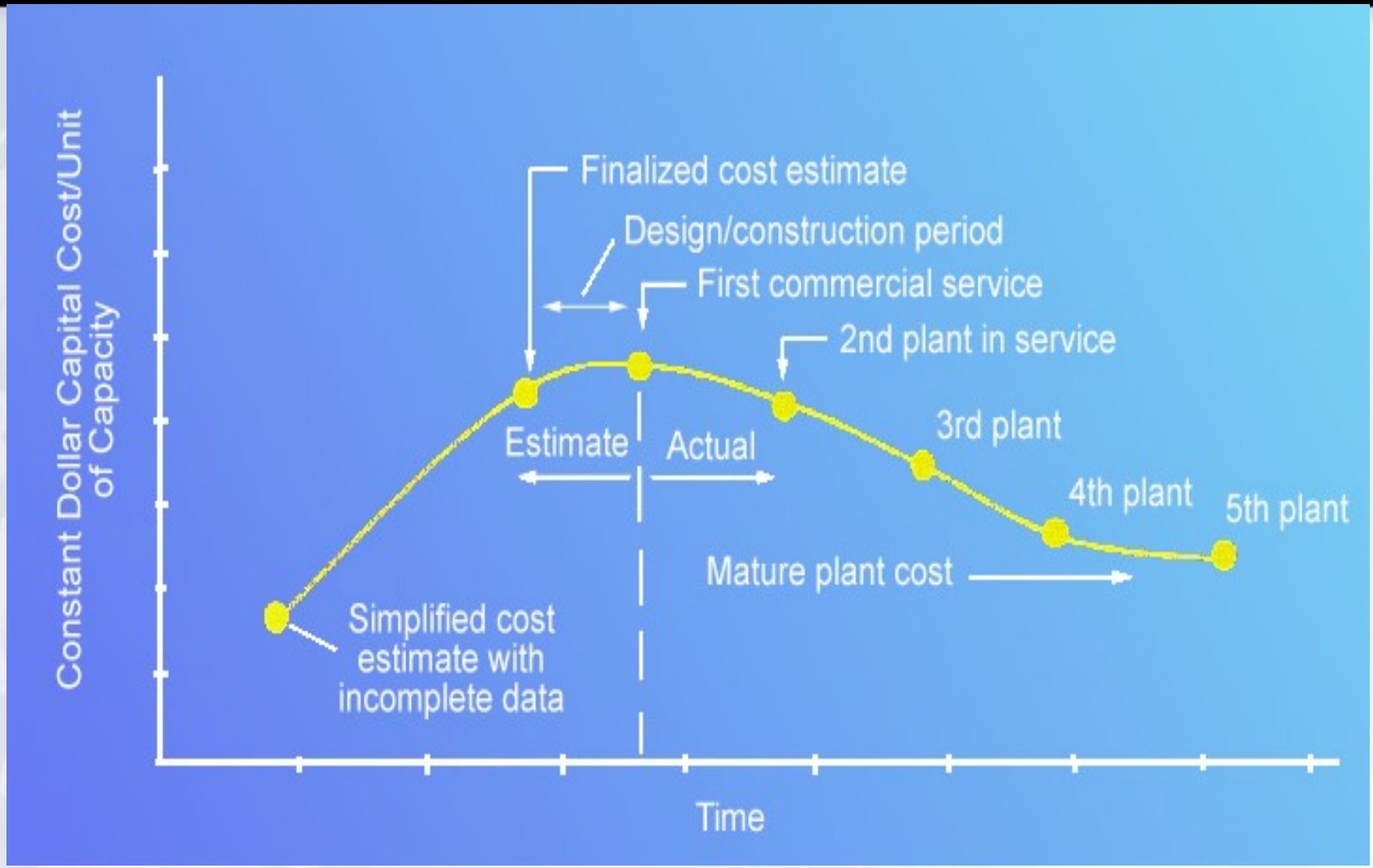

Wind Power

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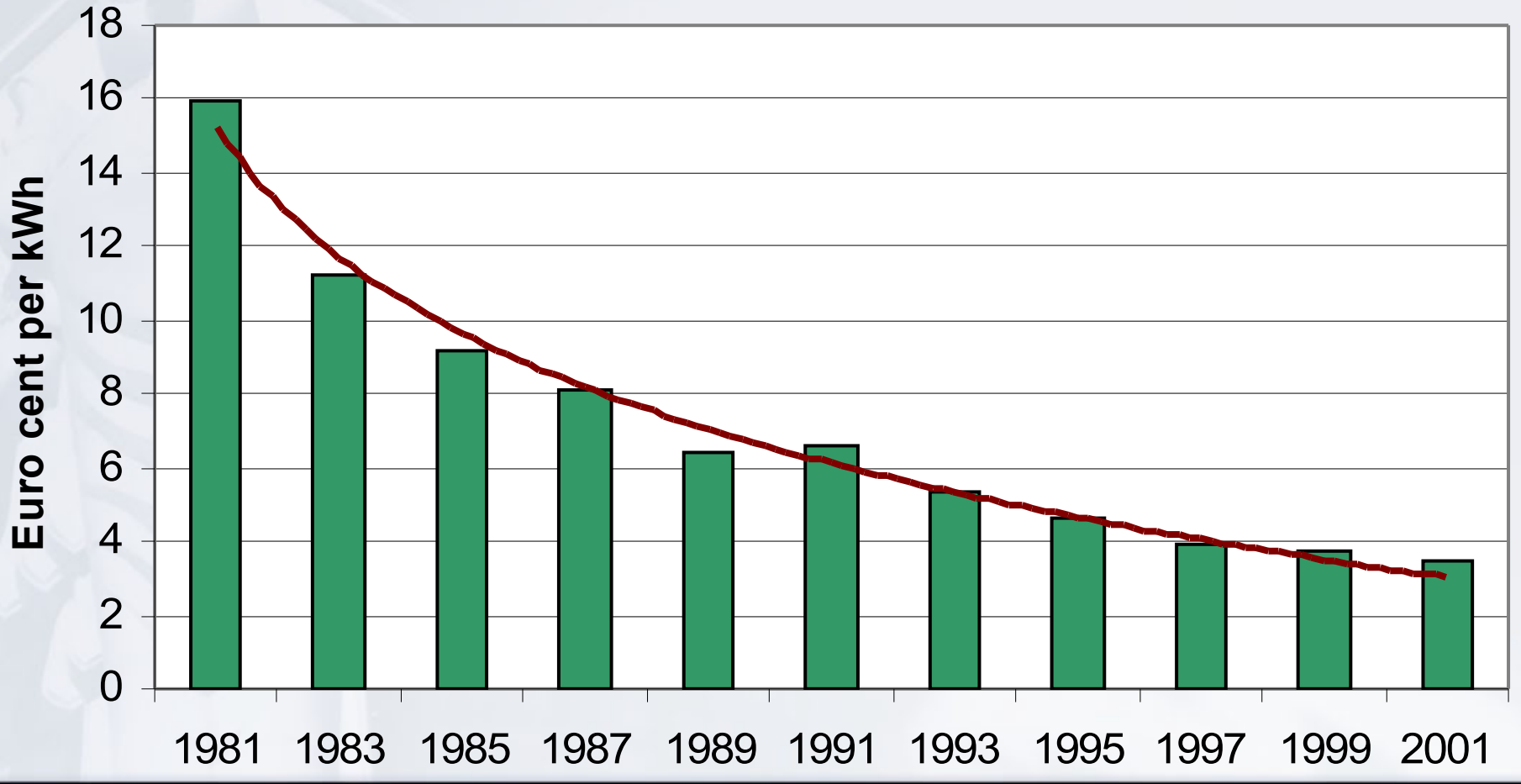

Costs pr. kWh reduced to ¼ (by 75 %) from 1973 to 2003

Classification of Gasifiers

Gasifiers can be classified as:

according to the gasification agent
- air-blown gasifiers
- oxygen gasifiers
- steam gasifiers

according to heat for gasification:
- autothermal gasifiers
- allothermal gasifiers

according to the design of fuel bed:
- fixed bed
- fluidised bed
- entrained flow gasifiers
- staged gasifiers

Gasification in Austria

- Research groups:
  - Graz University of Technology – Institute of Thermal Engineering
  - Graz University of Technology - Institute for Apparatus Design, Particle Technology and Combustion Technology
  - Joanneum Research Graz - Department of Energy Research
  - Vienna, University of Technology, Institute of Chemical Engineering
  - FJ-BLT Wieselburg (HBLFA)
  - Bioenergy 2020+ (Austrian Bioenergy Centre, Renet Austria)

- Implementation:
  - Biomass CHP Güssing
  - BioSNG Demonstration
  - Pyrotherm CHP Güssing
  - Biomass CHP Oberwart

Heat Pipe Refomer (TU Graz)

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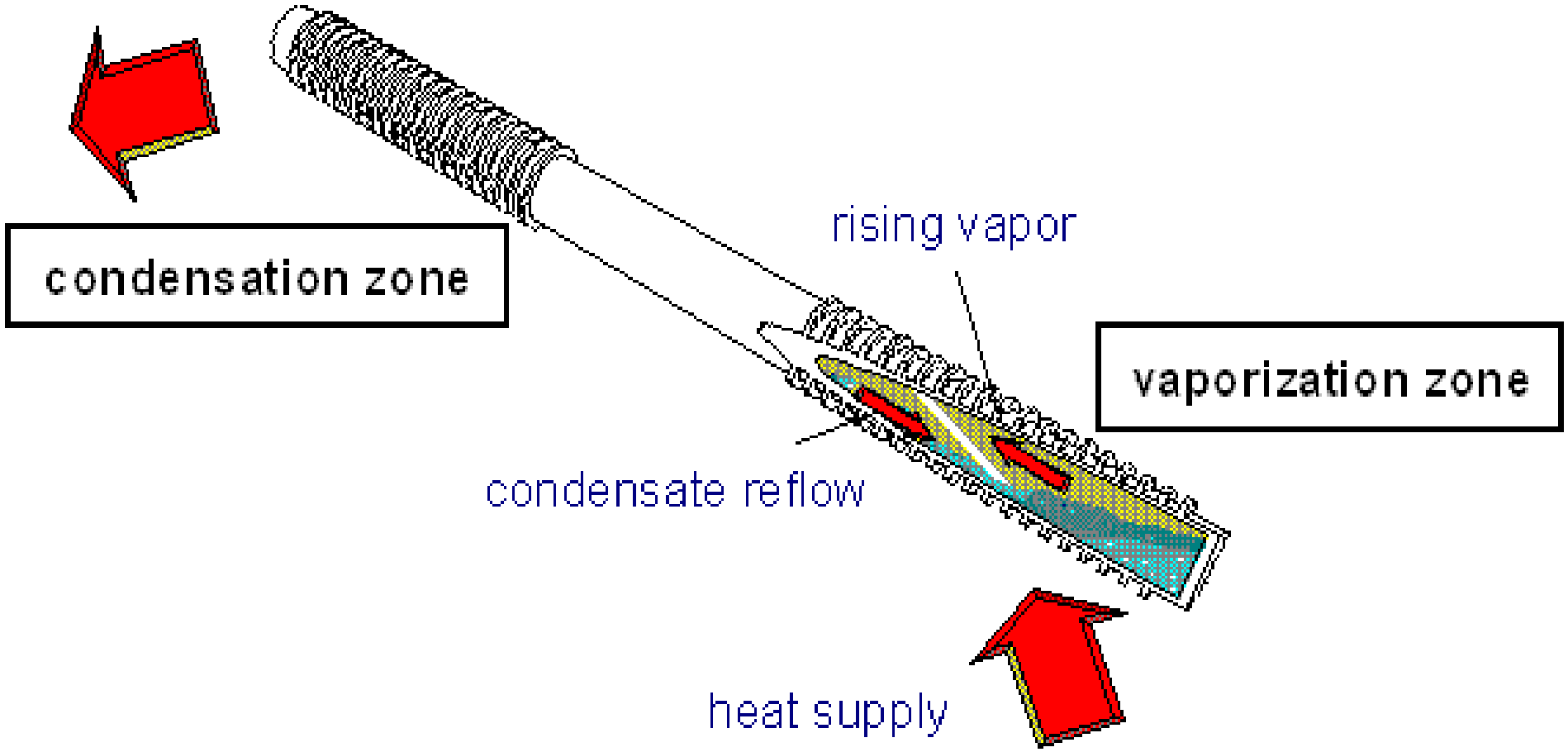

Dual fluidised bed steam gasification

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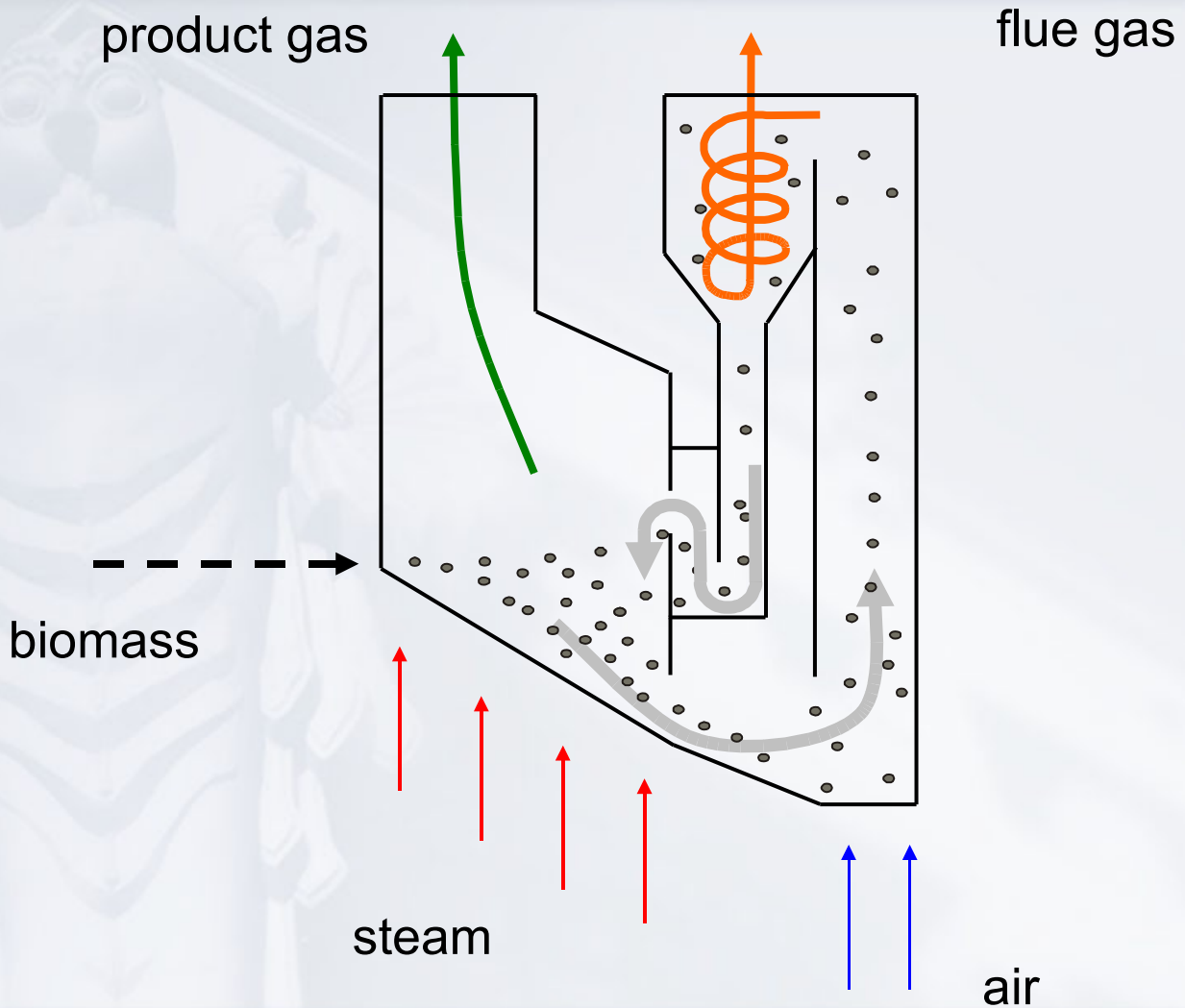

CHP-PLANT GÜSSING

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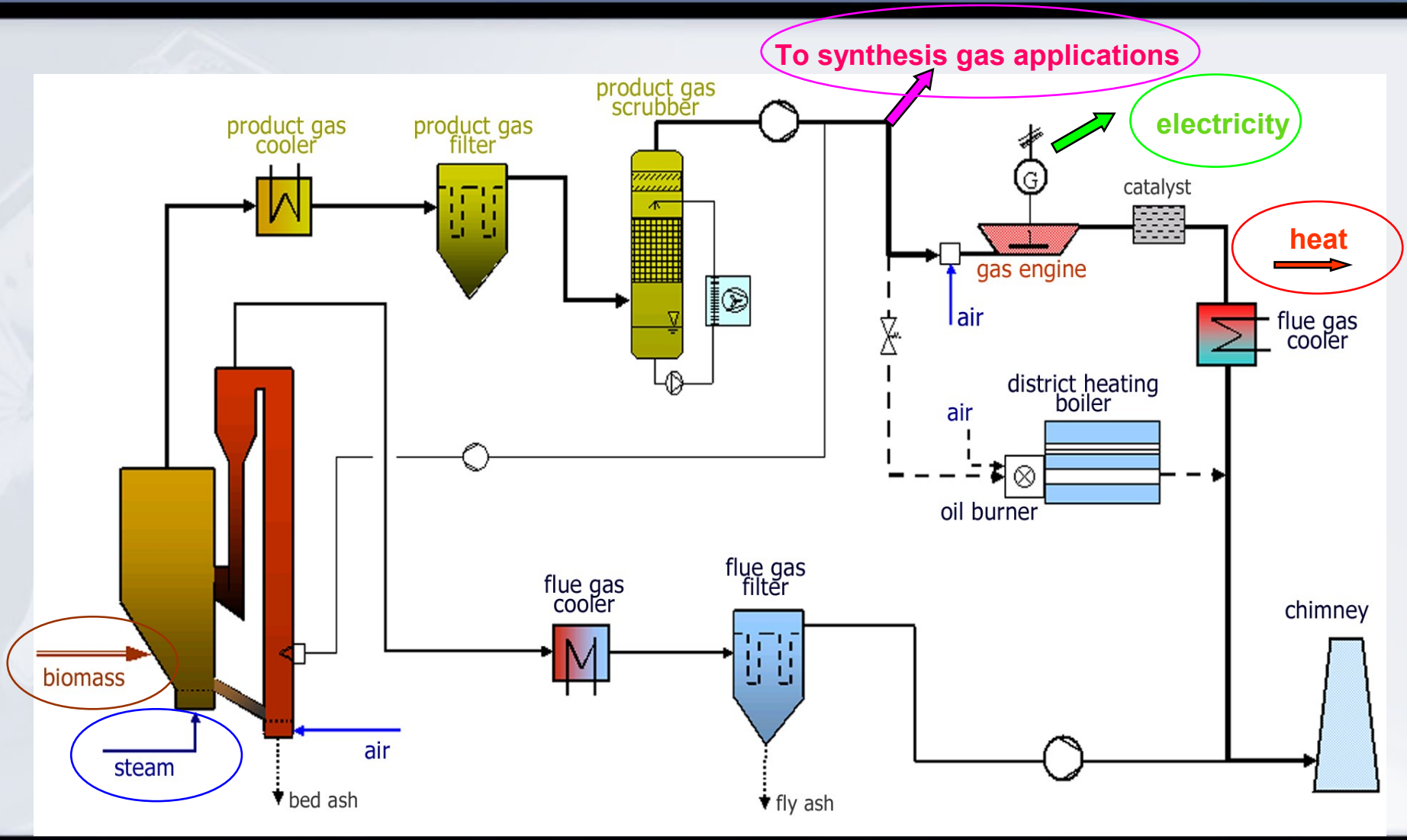

Gas Composition (after gas cleaning)

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Main Components		
H_2	%	35-45
CO	%	22-25
CH_4	%	~10
CO_2	%	20-25
Minor Components		
C_2H_4	%	2-3
C_2H_6	%	~0.5
C_3H_6	%	~0,4
O_2	%	< 0,1
N_2	%	1-3
C_6H_6	g/m^3	~8
C_7H_8	g/m^3	~0,5
$C_{10}H_8$	g/m^3	~2
TARS	mg/m^3	20-30

Possible poisons		
H_2S	mgS/Nm^3	~200
Mercaptans	mgS/Nm^3	~30
Thiophens	mgS/Nm^3	~7
HCl	ppm	~3
NH3	ppm	500-1000
Dust	mg/Nm^3	< 20

H_2:CO = from 1.5:1 to 2:1

Renewable liquid fuels

Fischer-Tropsch Syntheses

Theorie of FT Synthesis
Anderson Schulz Flory distribution by weight

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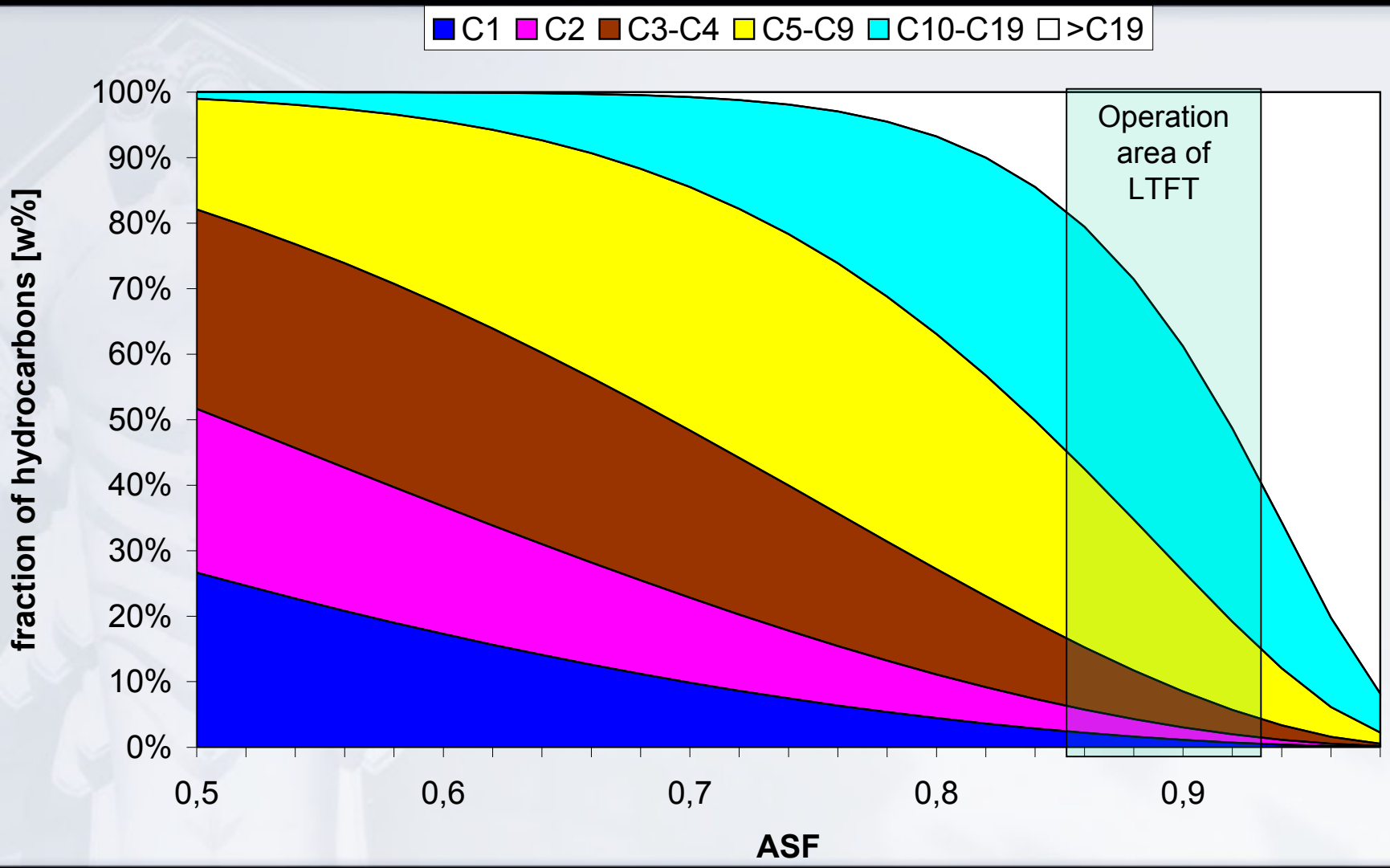

$$Log(W_n / n) = n \log \alpha + const.$$

Renewable natural gas

Synthetic natural gas (BioSNG)

BioSNG
BIOMASS-TO-SYNTHETIC-NATURAL-GAS

Schema BioSNG demonstration

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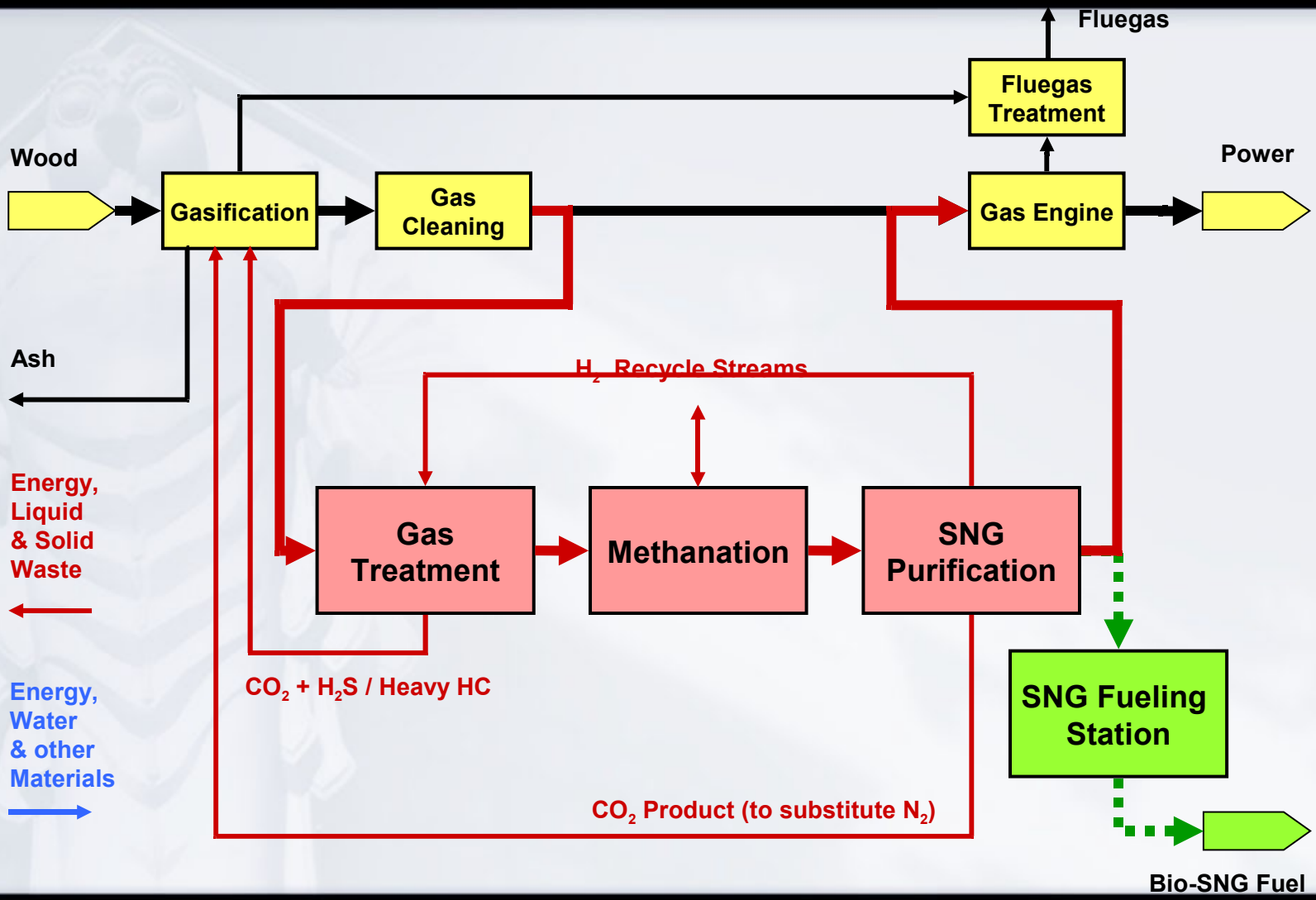

Current Status

- Participation in IEA Bioenergy Task33 is very important for know how transfer in the area of biomass gasification

- There is successful research and demonstration in Austria
  - Biomass CHP Güssing with
    - Demonstration for production of BioSNG
    - Research in 2nd generation liquid biofuels (Fischer Tropsch synthesis)
  - Research on heat pipe reforming at TU Graz
  - Implementation of fixed bed gasifiers, like Pyroforce

- Gasification gives high potential for production of electricity, district heat, biofuels and chemicals
  - BioSNG, experiments of demonstration plant are ongoing
  - BioFiT, research ongoing, ready for scale up