Topsoe Integrated gasoline Synthesis - TIGAS

RESEARCH | TECHNOLOGY | CATALYSTS

John Bøgild Hansen
HALDOR TOPSOE A/S

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Topsøe Group
– Key figures 2008

Headquarters, Lyngby, DK

- Turnover: DKK 5.0 bn (USD 920 MM)
- Result: DKK 533 MM (USD 97 MM)
- 2100 employees

Catalyst plant, Frederikssund, DK

Catalyst plant, Houston, Texas

Topsoe SynGas Technologies

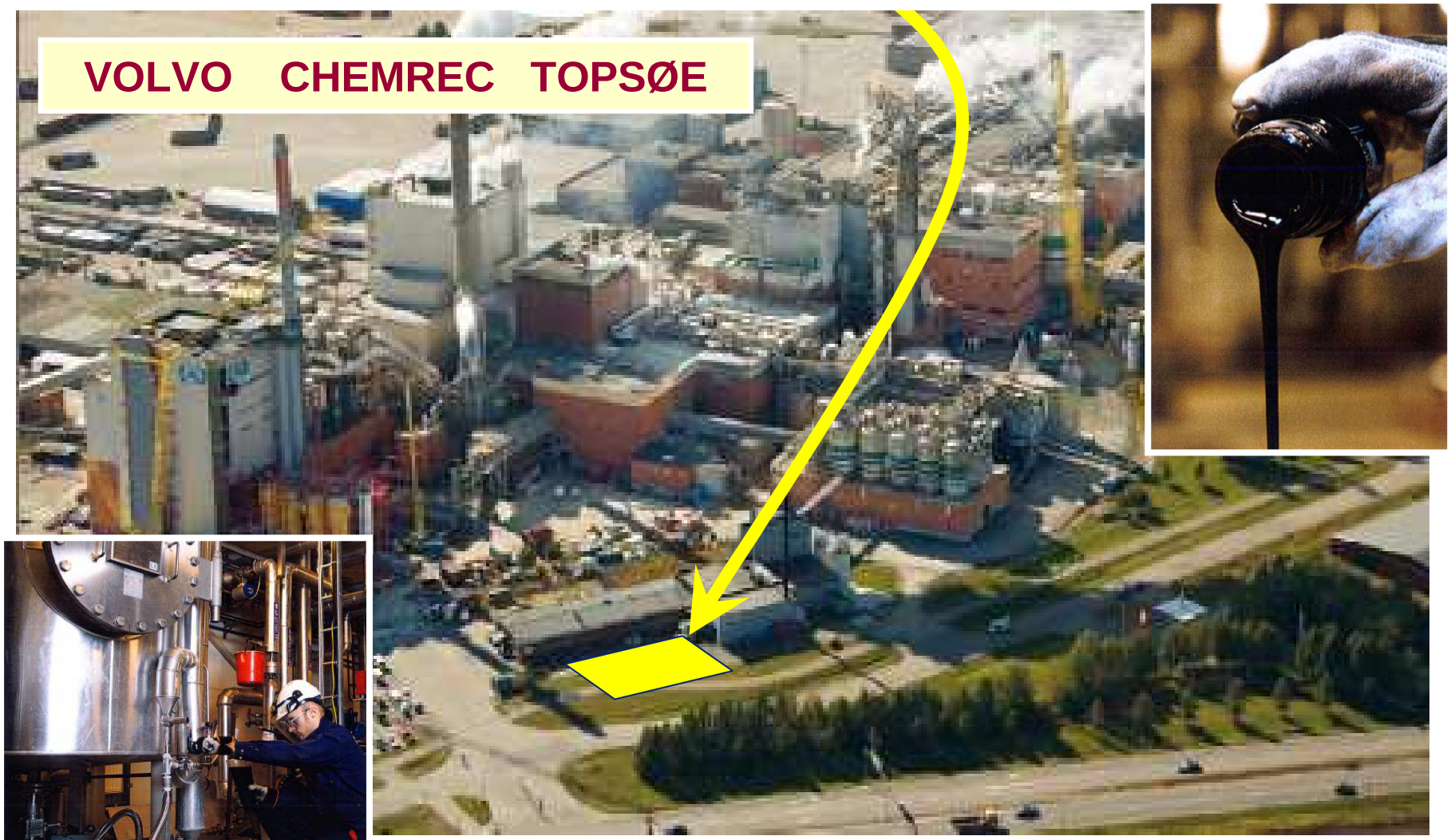
- Synthesis Gas
- Ammonia
- Hydrogen
- Carbon Monoxide
- Methanol
- Formaldehyde
- DME
- Gasoline - TIGAS
- SNG

Topsoe Methanol Plnats

- 10 Plants commisioned since 2010
- Combined capacity:

  13350 MTPD
- Feedstocks ranging from Coal to Natural Gas and Natural Gas plus CO_2

5 T/d DME from Black Liquor Pilot Plant, Piteå, Sweden



Synthesis Gas to Gasoline

Classic (**MTG**)

SynGas → MeOH ; MeOH → DME → Gasoline

Integrated (**TIGAS**)

SynGas → MeOH/DME → Gasoline

(Topsoe Integrated Gasoline Synthesis)

MeOH/DME Synthesis

– Low H_2/CO

– ΔH (kJ/mol)

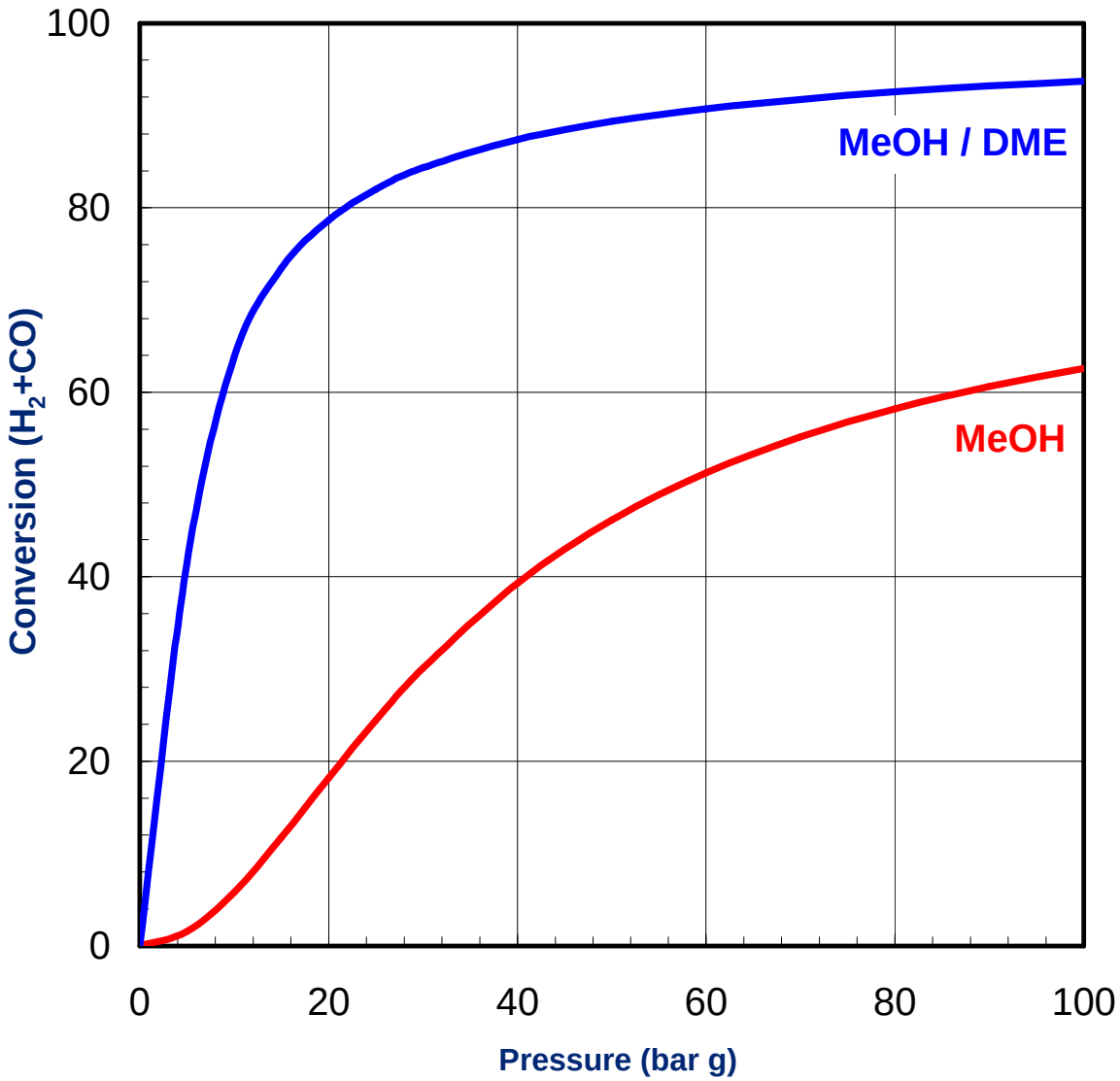
$$2H_2 + CO = CH_3OH \qquad 90.7$$

$$2CH_3OH = CH_3OCH_3 + H_2O \qquad 23.6$$

$$CO + H_2O = CO_2 + H_2 \qquad 41.1$$

$$3H_2 + 3CO = CH_3OCH_3 + CO_2$$

Syngas Eq. Conversion vs. Pressure
(H_2/CO = 1)

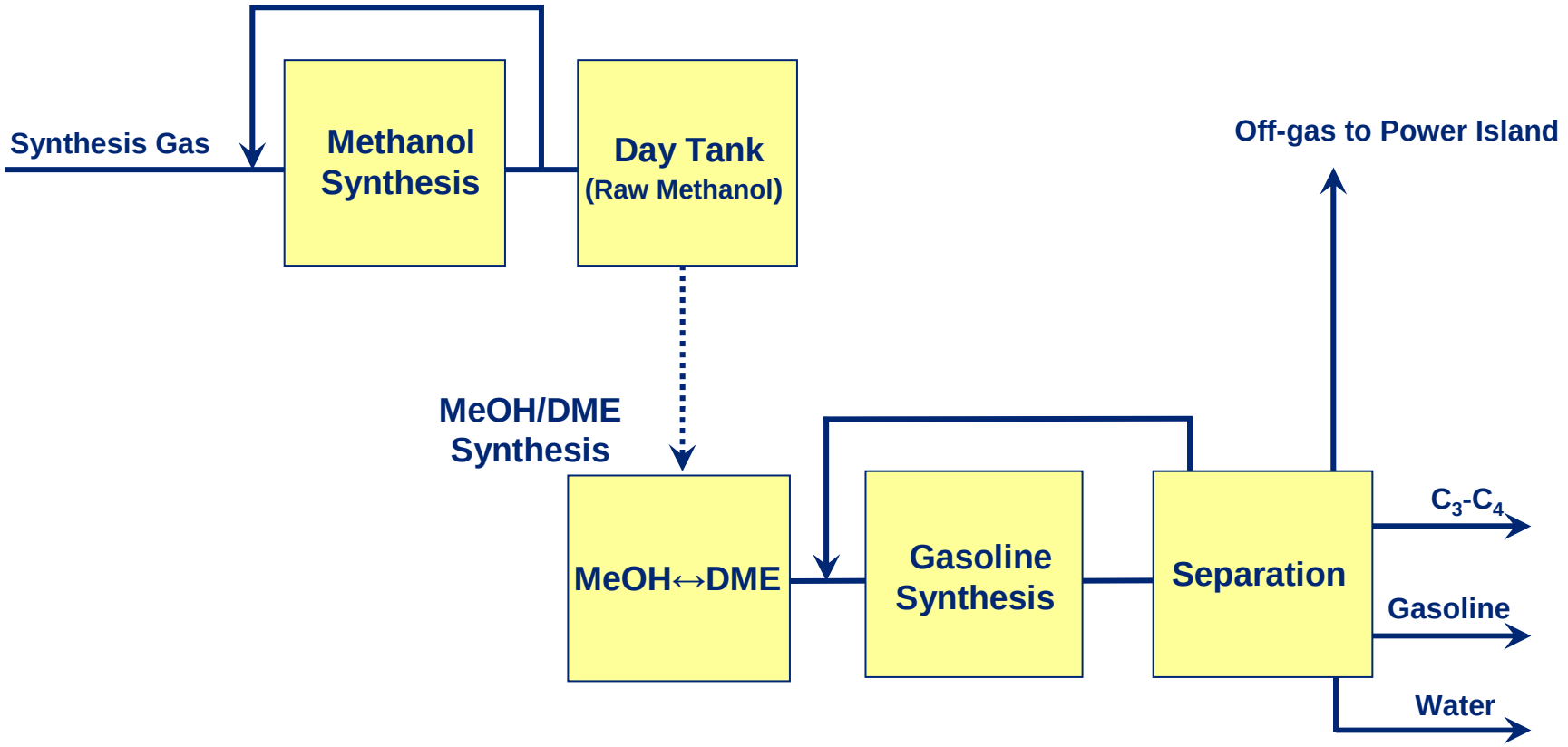


- **T = 250°C**
- **Feed Gas (mol%):**

H_2 = 51
CO = 48
CO_2 = 1

MTG

Methanol To Gasoline



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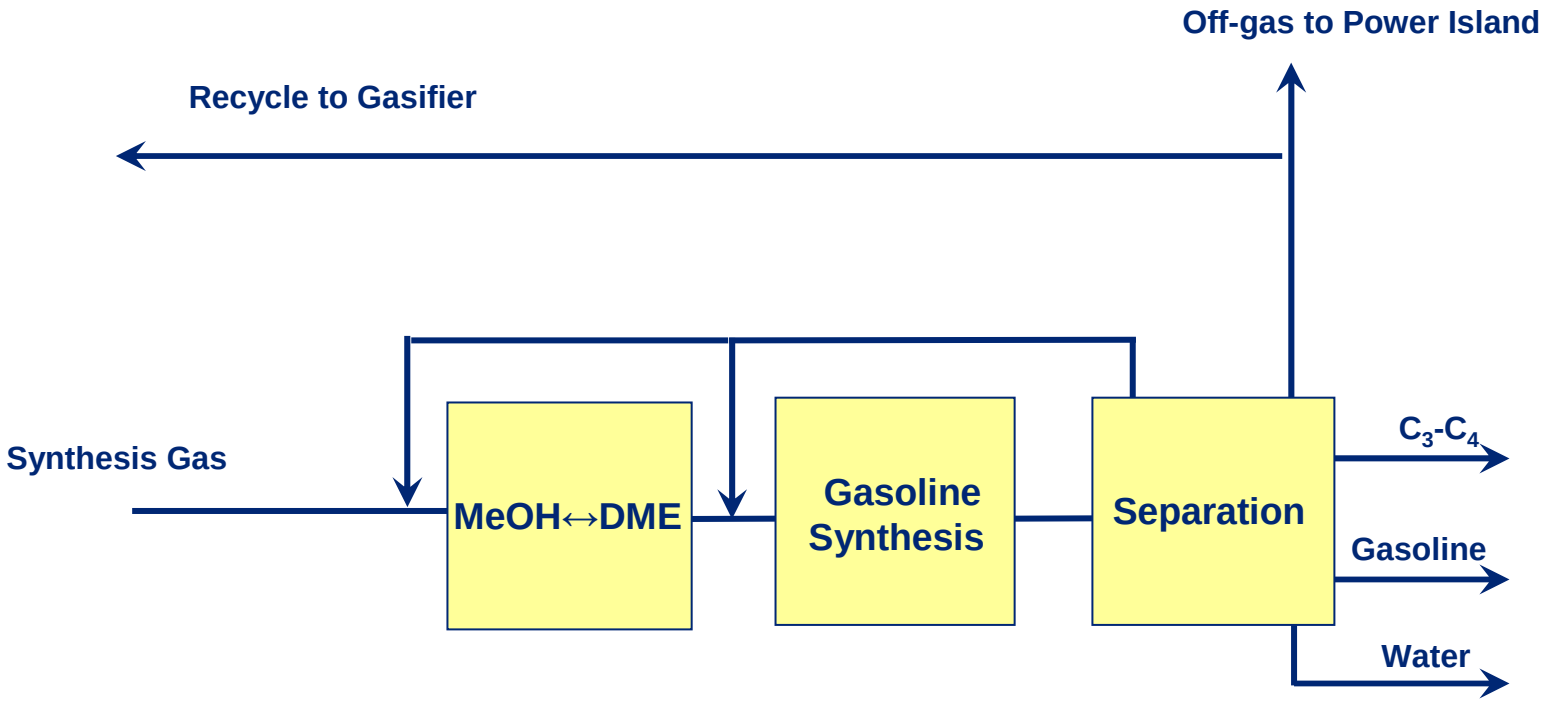
TIGAS

Topsøe Integrated Gasoline Synthesis

- 70-90% single-pass syngas conversion



Flexibility - Versatility

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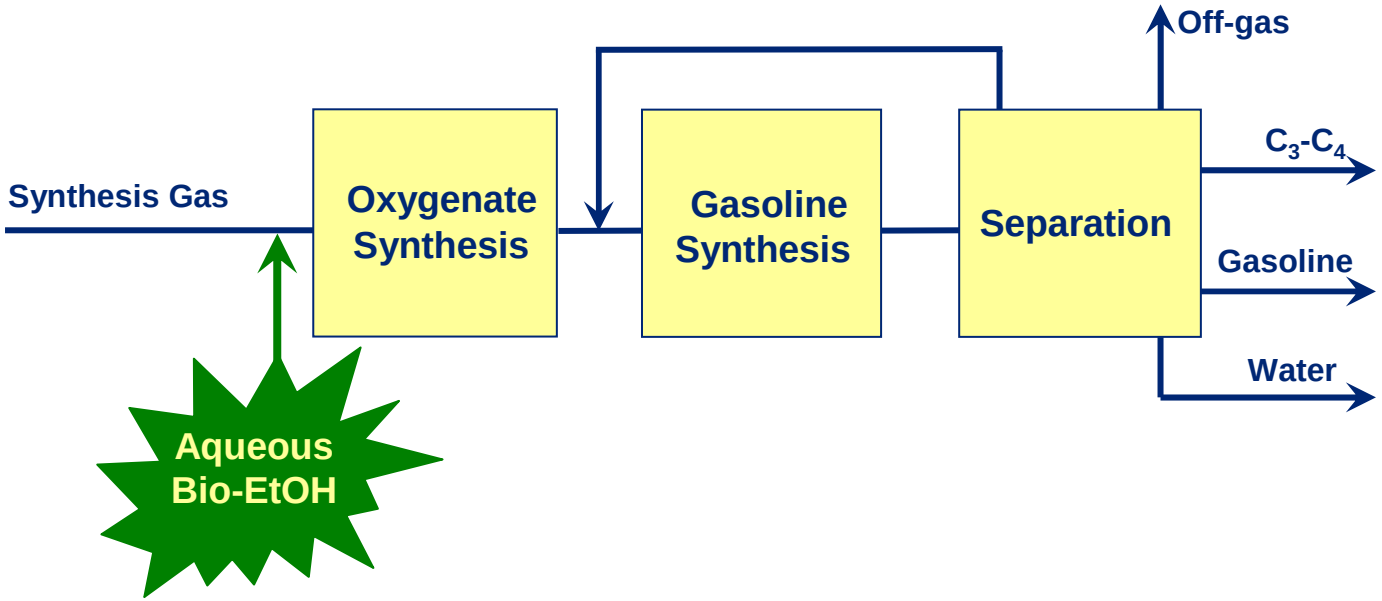
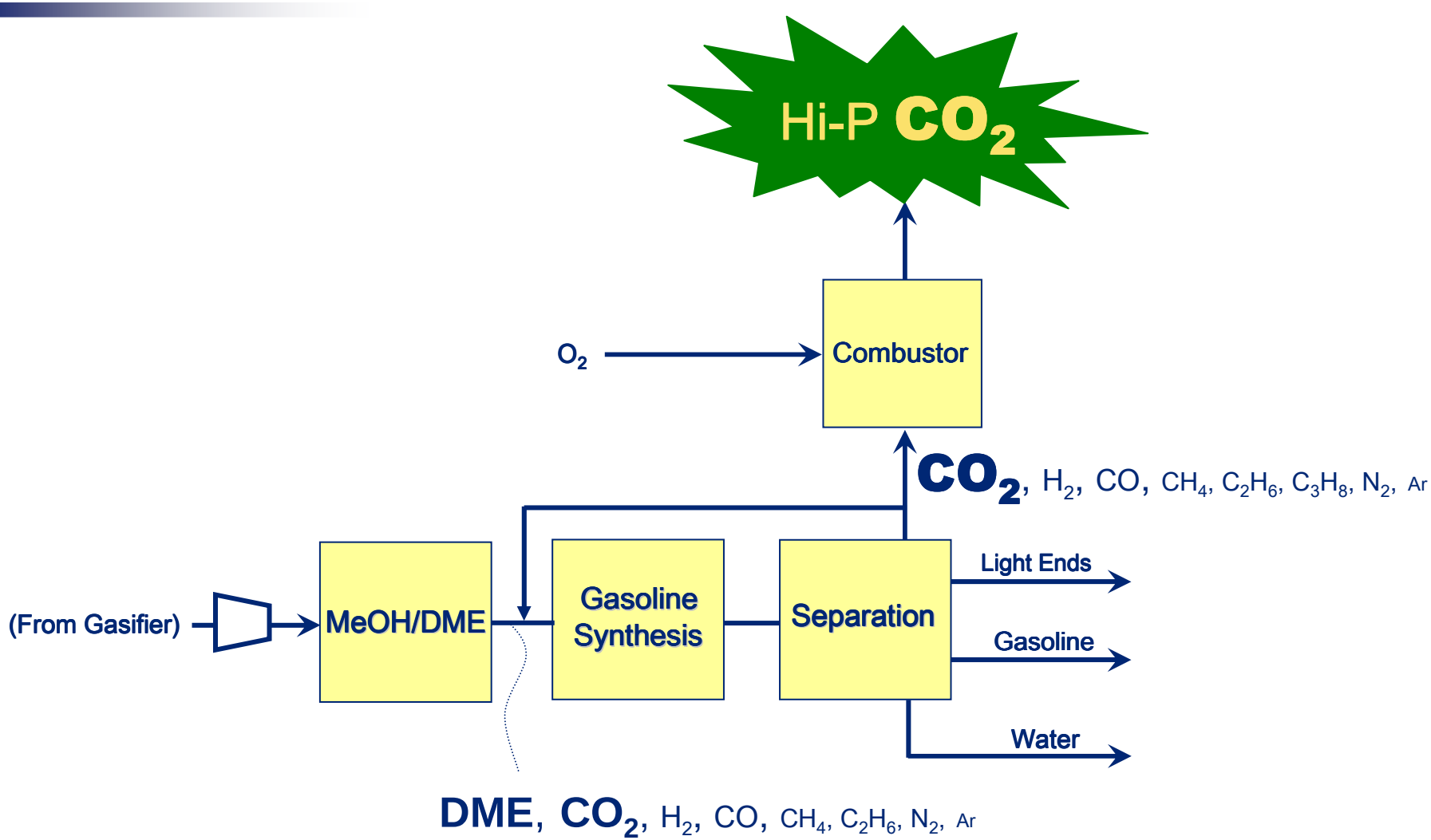
Bioethanol Co-conversion

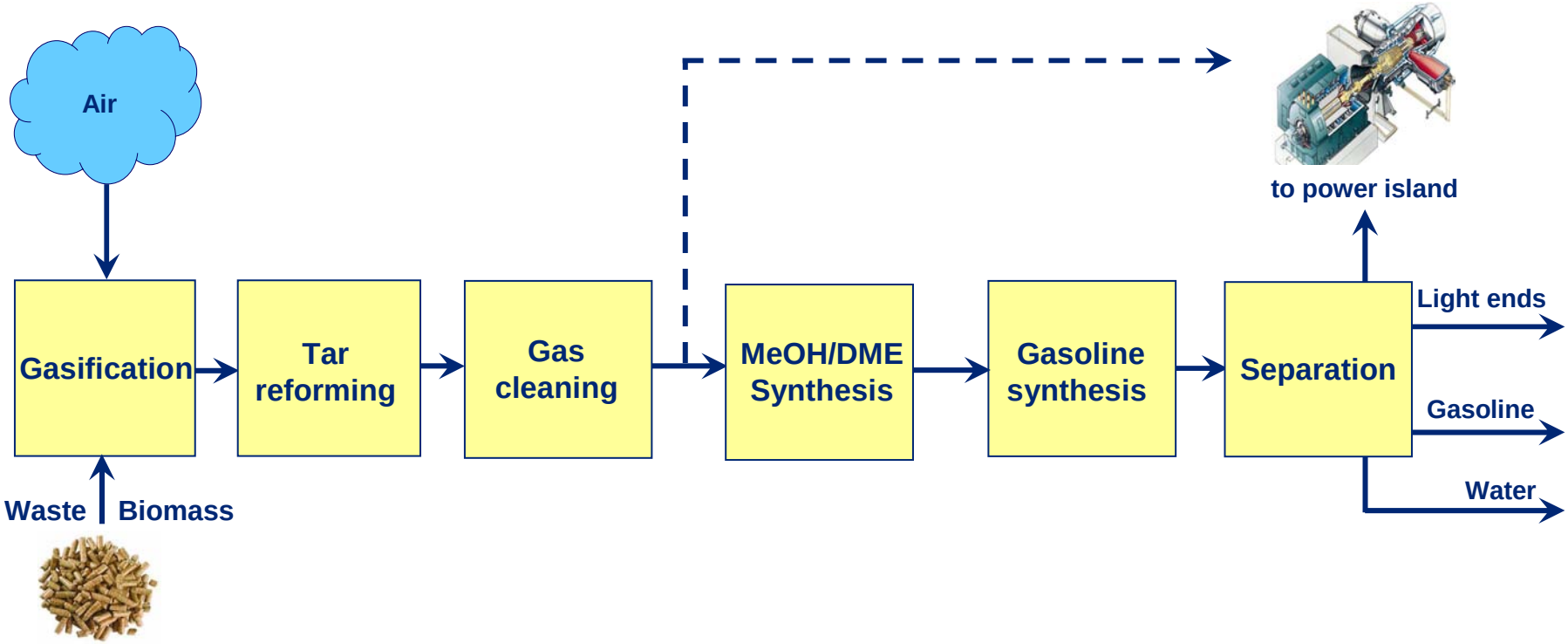


- Multiple catalytic functions in loop enable co-processing of other feed streams
- Direct co-feed of *aqueous* bioethanol – save ethanol distillation cost

TIGAS^{CCSR}


Hi-P CO_2
O_2
Combustor
CO_2, H_2, CO, CH_4, C_2H_6, C_3H_8, N_2, Ar
(From Gasifier)
MeOH/DME
Gasoline Synthesis
Separation
Light Ends
Gasoline
Water
DME, CO_2, H_2, CO, CH_4, C_2H_6, N_2, Ar

Air-Blown Synfuel Processes



TIGAS Demonstration Plant

1 T/d **8900 Runhours** **Houston,TX**

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TIGAS Product Breakdown

C	Total	Aromatics	P-O-N
1	1		
2	3		
3	6		
4	13		
5	16		16
6	18	< 0.1	18
7	15	1	13
8	13	6	7
9	8	7	1
10	7	7	0
11	< 0.1		0

Wood to Gasoline

DOE Project

Green Gasoline from Wood Using Carbona Gasification and Topsoe TIGAS Processes

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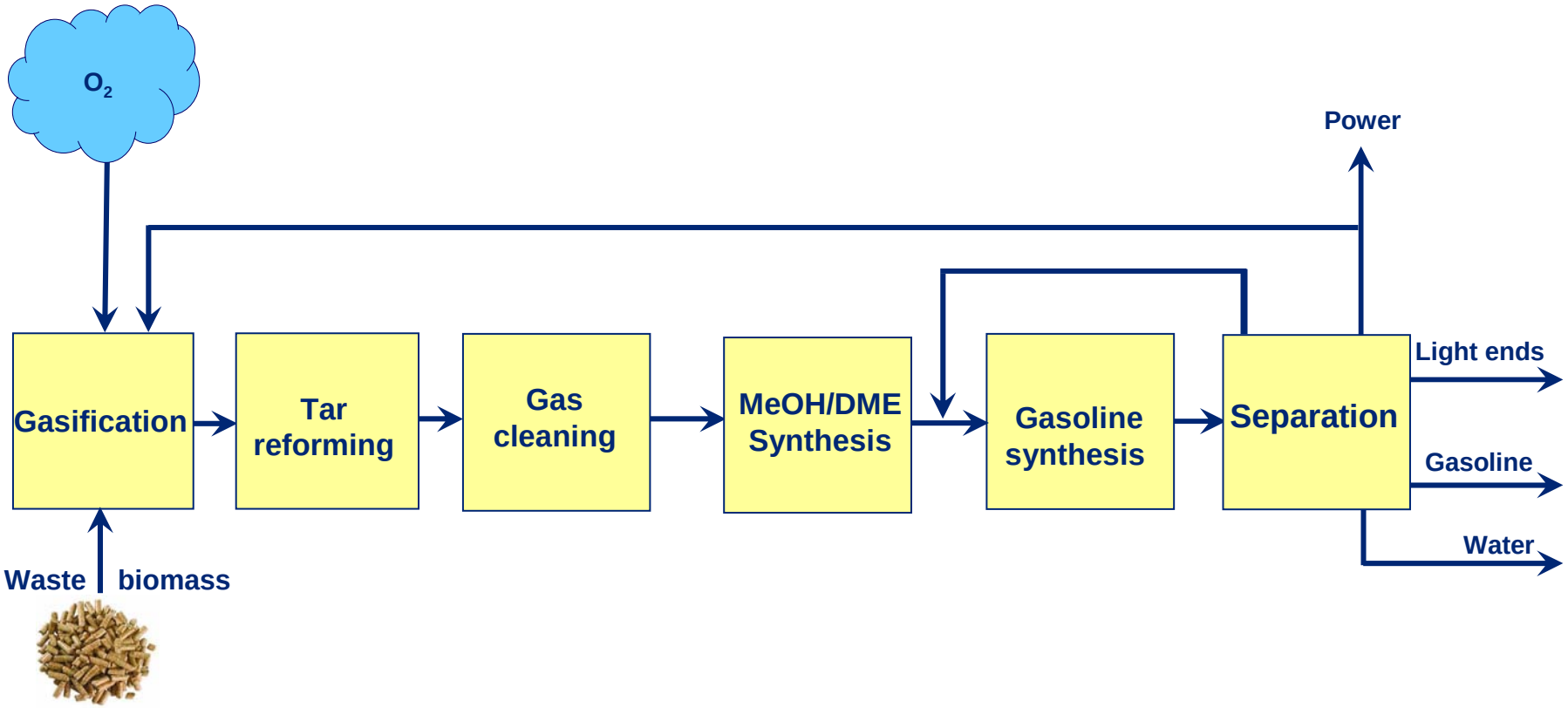
Wood to Gasoline DOE Project

Green Gasoline From Wood Using Carbona Gasification and Topsoe TIGAS Processes

http://www.energy.gov/news2009/releases.htm

TIGAS Process Layout (DOE)

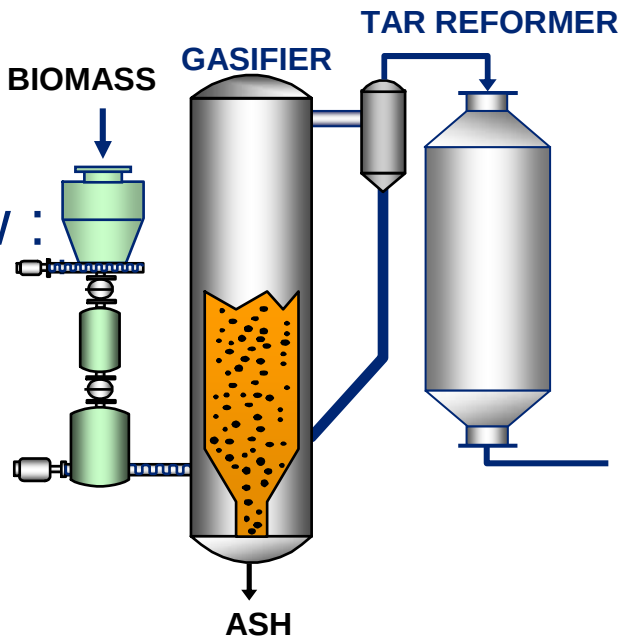


Tar Reforming

– Enabling Technology for Biomass Gasification

- Bio-syngas contains tars and contaminants
  - 2500 ppm tar (toluene, benzene, naphthalene)
  - 100 ppm S, particulates
  - 850-930℃, 1-30 bar g
  - Ammonia decomposition

- Topsoe Multidisciplinary know how :
  - Reformer design
  - In depth understanding of reforming
  - Catalyst formulation
  - High dust monolith operation



Summary

- **Process intensification by TIGAS scheme**
  - Cost reduction by process integration
  - High syngas conversion efficiency
- **Simple process scheme**
  - Also attractive for small-scale biomass-based plants
- **Flexible**: **Virtually any synthesis gas composition**
  - Base: natural gas (SMR & ATR) ; coal ; biomass ; waste
  - Tolerates high inert levels (enabling air-blown gasification)
- **Co-convert bio fuels**
  - Aqueous bioethanol
- **Attractive options for efficient co-generation layouts**
  - Low investment add-on for IGCC plants
- **TIGAS is CCS-ready**