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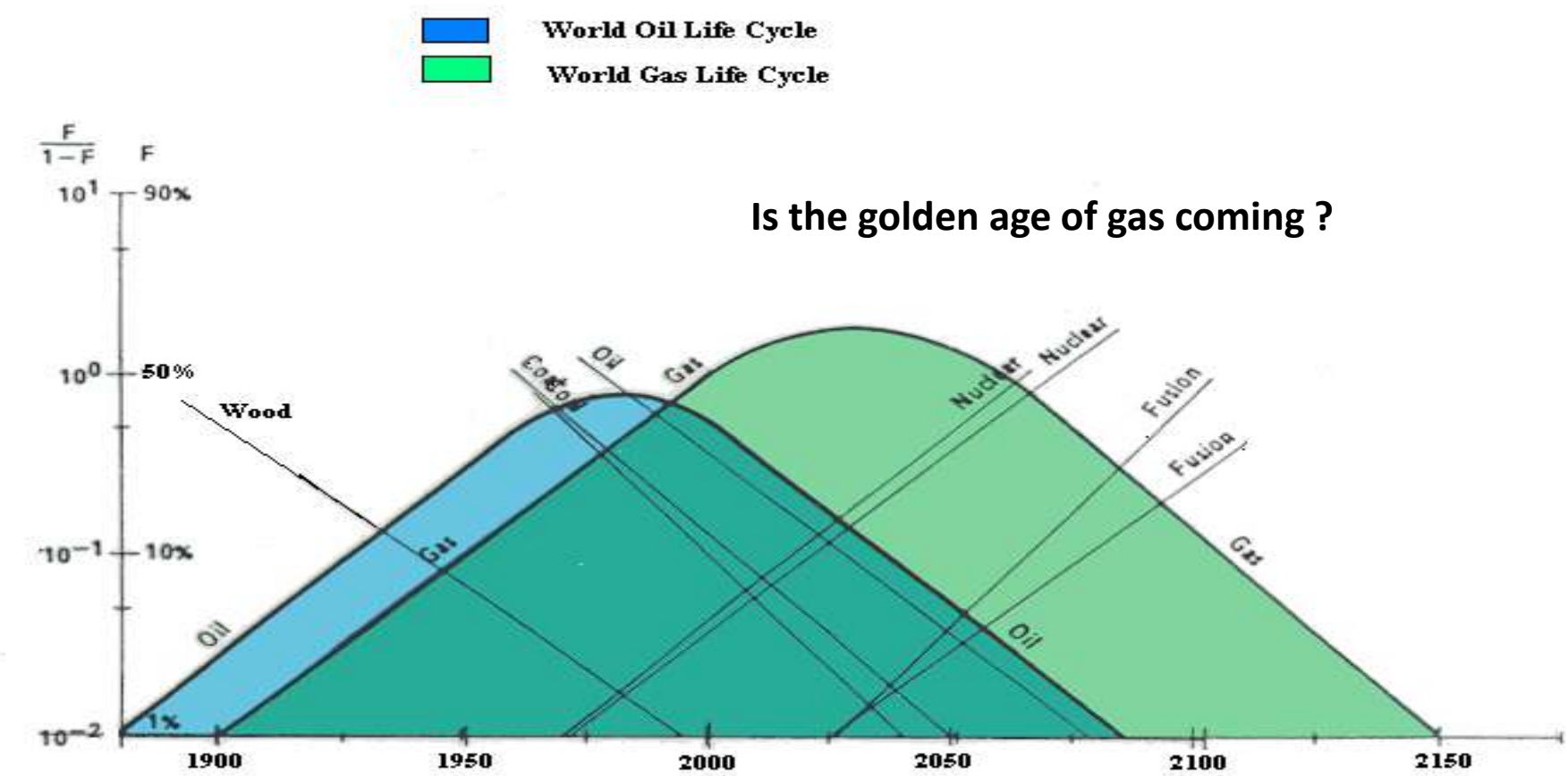
Chemicals and Fuels from (Natural) Gas

Alfred Ecker

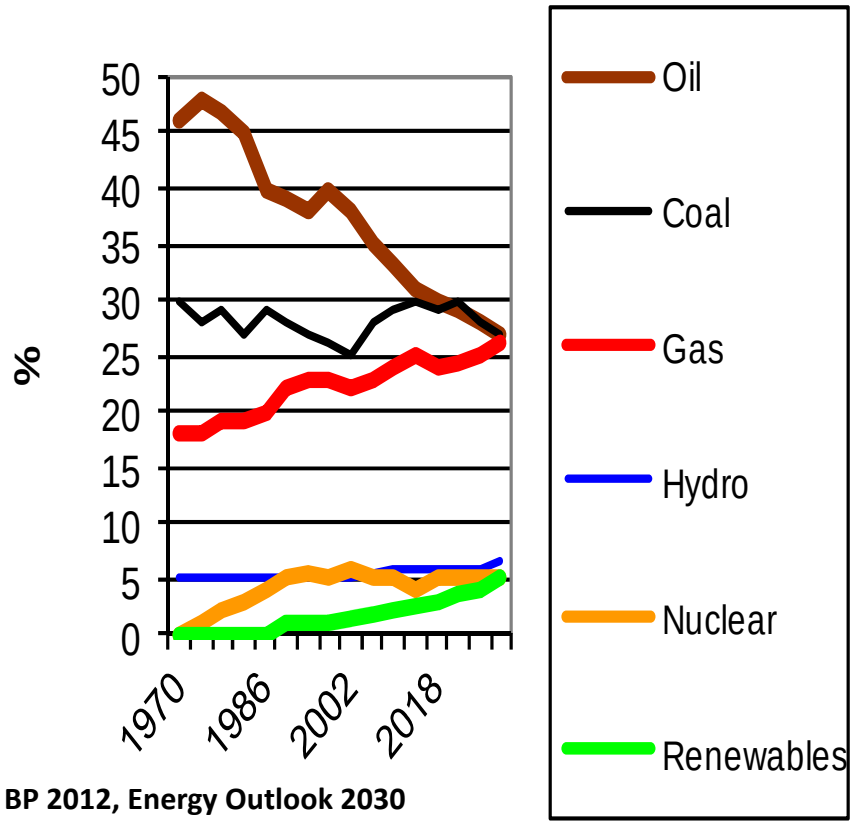
Life cycles of oil and gas



Is the golden age of gas coming ?

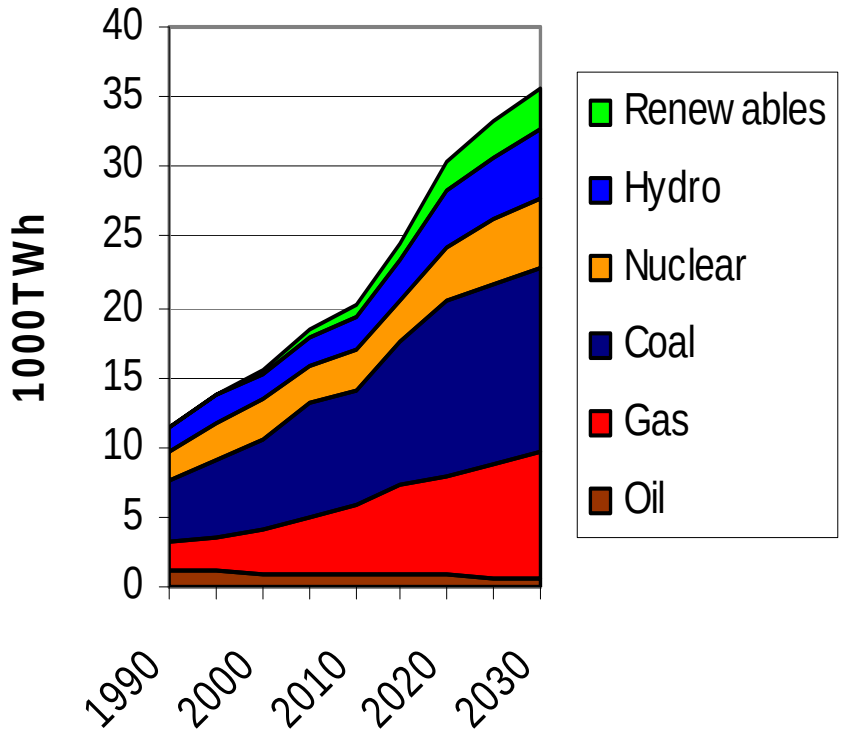
- Alternarive usage of gas
- Chemicals and Fuels from (Natural)gas

Shares of world primary energy



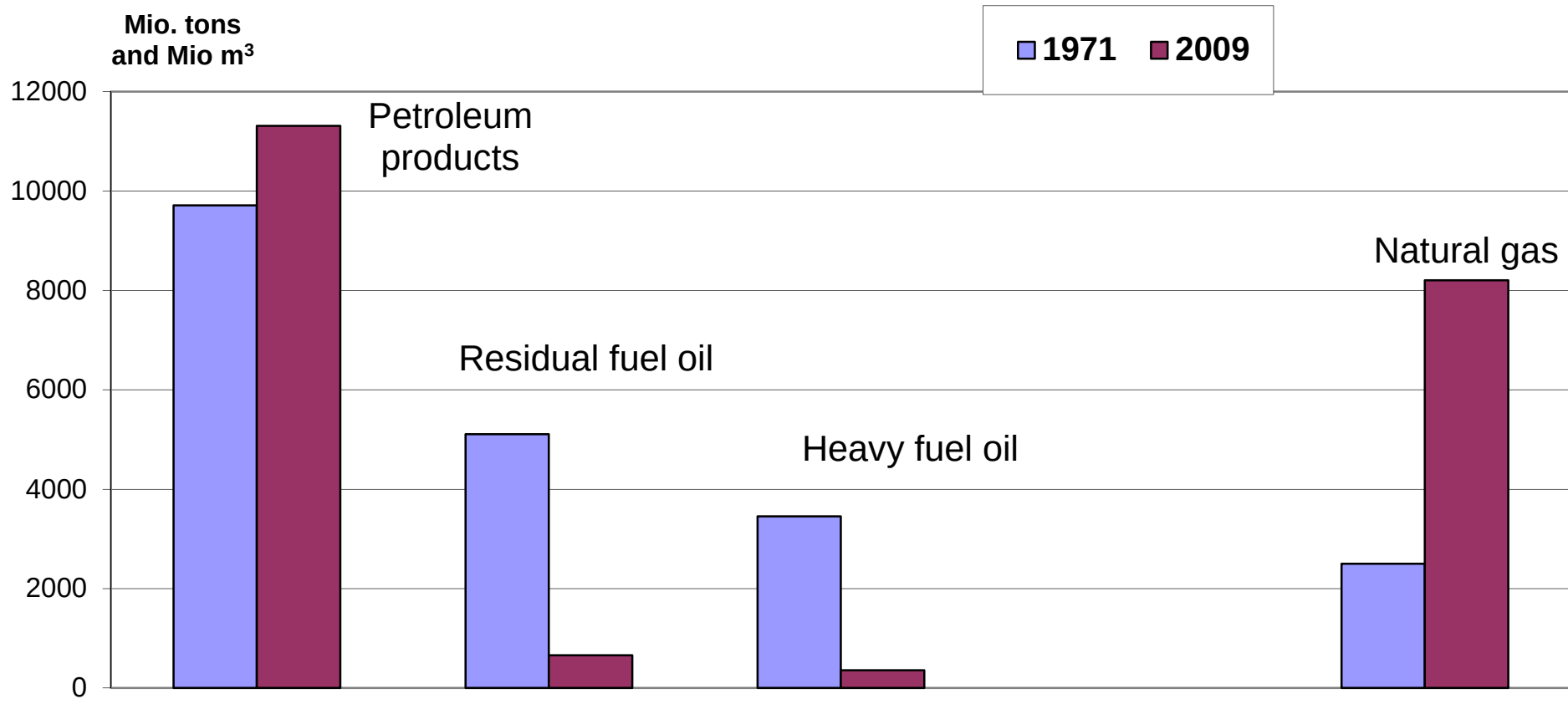
BP 2012, Energy Outlook 2030

World power generation



- Alternarive usage of gas
- Chemicals and Fuels from (Natural)gas

Petroleum products and natural gas consumption in Austria



- Alternarive usage of gas
- Chemicals and Fuels from (Natural)gas

Advantages and disadvantages of gas

Advantages

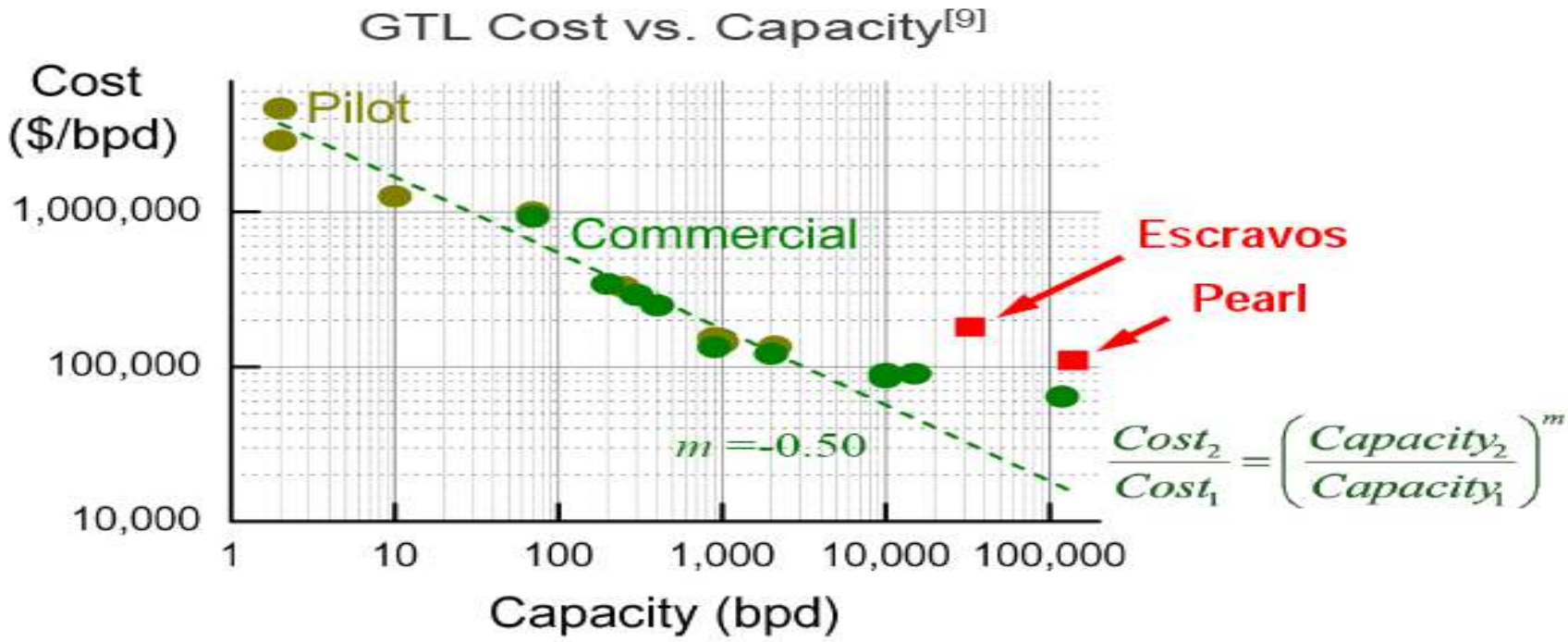
Minimum C and CO2
Maximum H
Cleaner tha coal and oil
Easily to convert
Scale up possible
Huge Resources

Disadvantages

Gaseous, low energy density (transport, storage)
Expensive building and operating a distribution system
Volatile- Green hous gas (CO_2 X 20)
No commercial direct route to liquid fuels
Not renewable

Fischer Tropsch

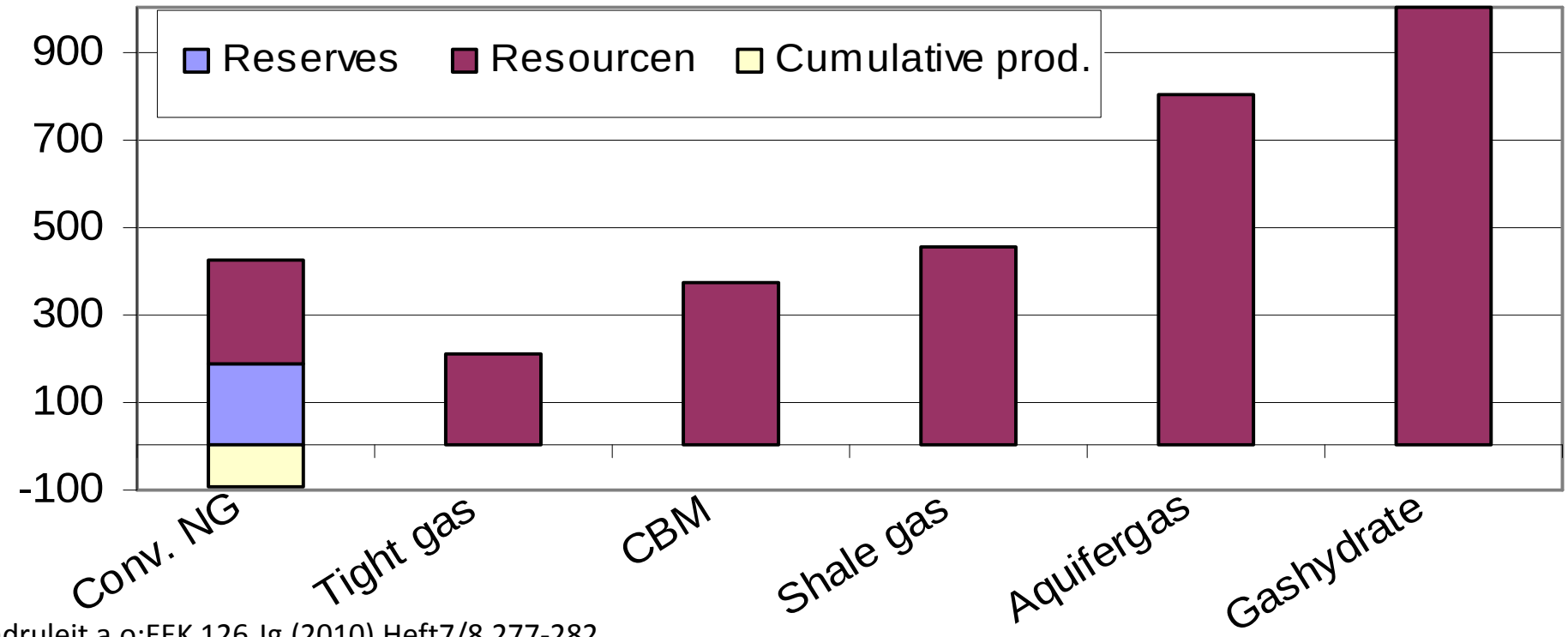
ECONOMIES OF SCALE



[9] PJA Tijm. *Gas to liquids, Fischer-Tropsch, advanced energy technology, future's pathway*. Feb 2010.

Natural gas

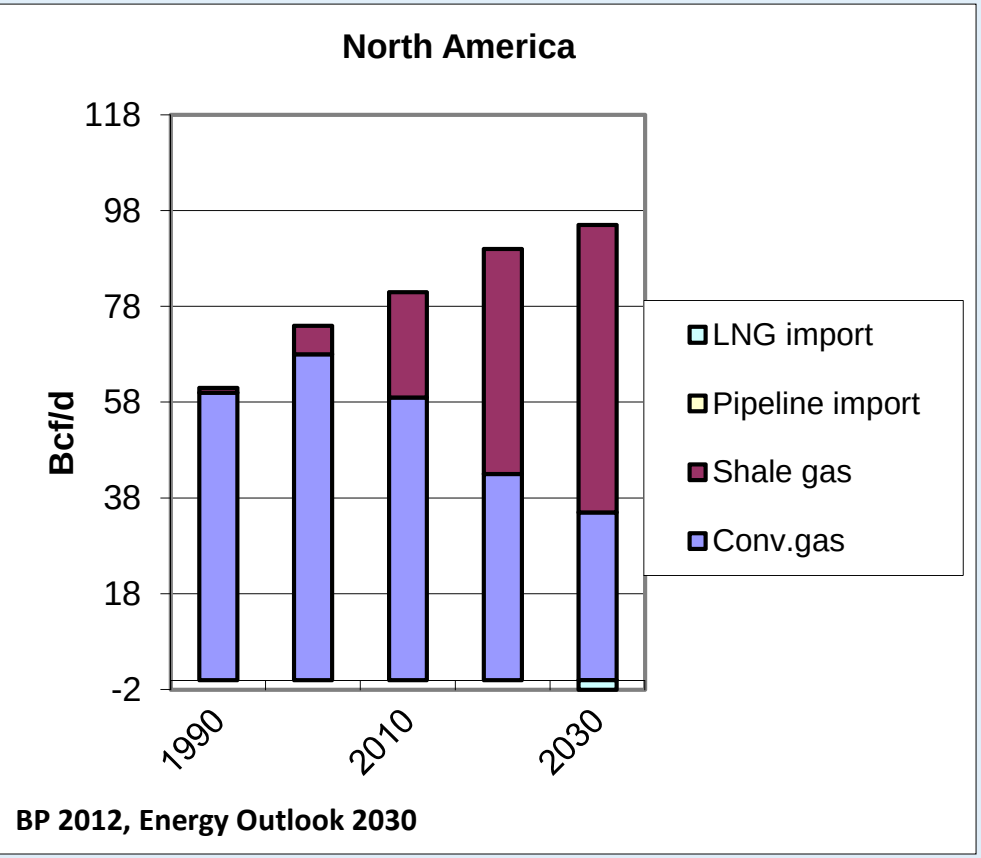
Reserves and Resources inTera (10^{12}) m^3



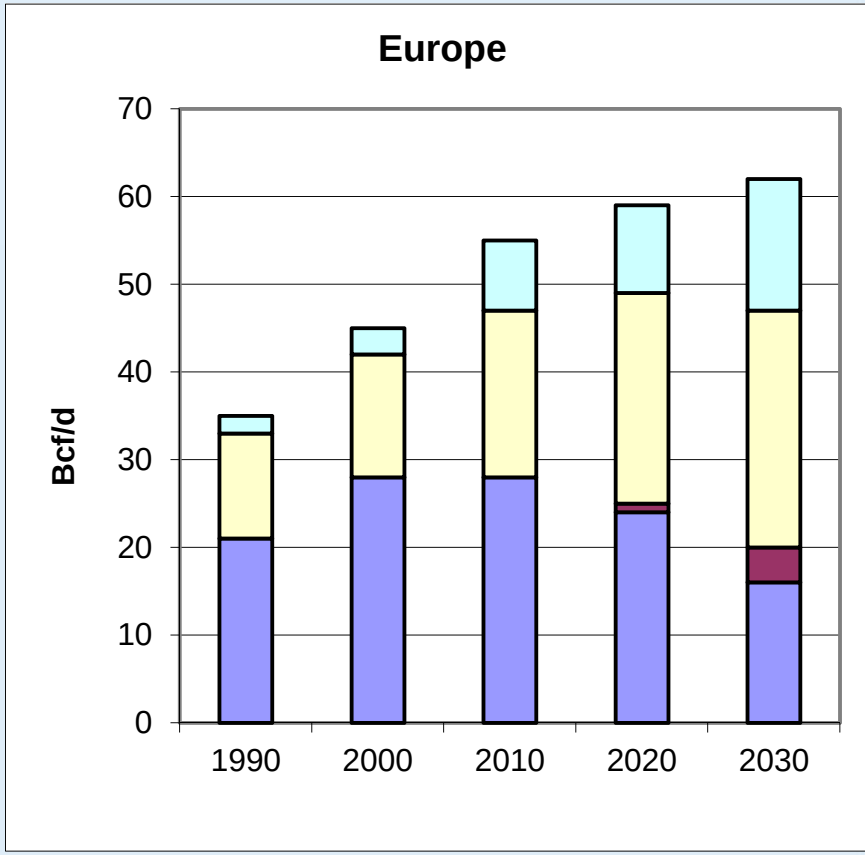
Andruleit a.o;EEK 126.Jg.(2010),Heft7/8,277-282

- Alternarive usage of gas
- Chemicals and Fuels from (Natural)gas

Sources of gas supply North America versus Europe



BP 2012, Energy Outlook 2030

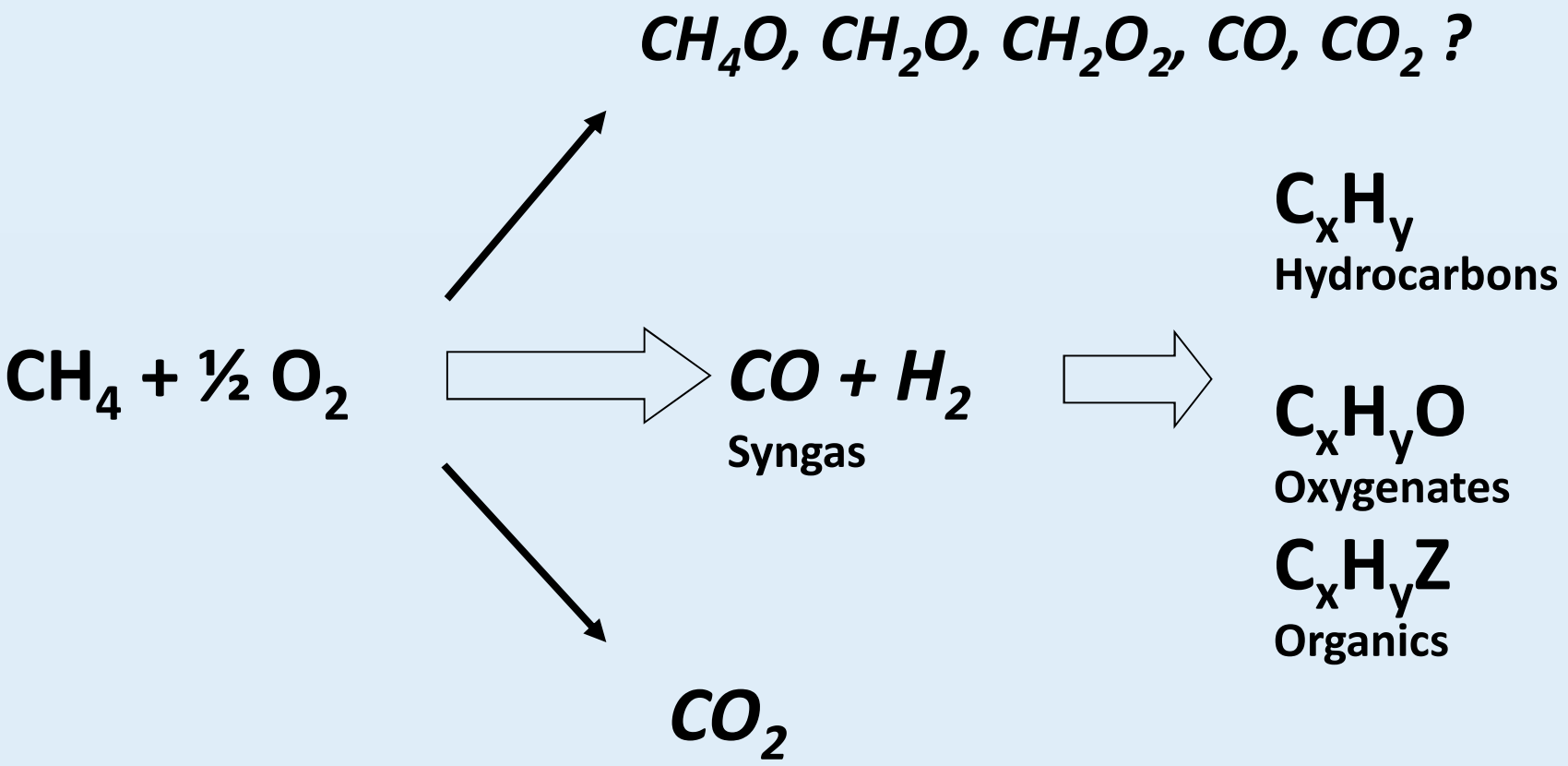


- Alternarive usage of gas
- Chemicals and Fuels from (Natural)gas

Natural Gas (Henry Hub) Chart in Dollar

- Alternarive usage of gas
- Chemicals and Fuels from (Natural)gas

Direct reactions of methane have no selectivity !!



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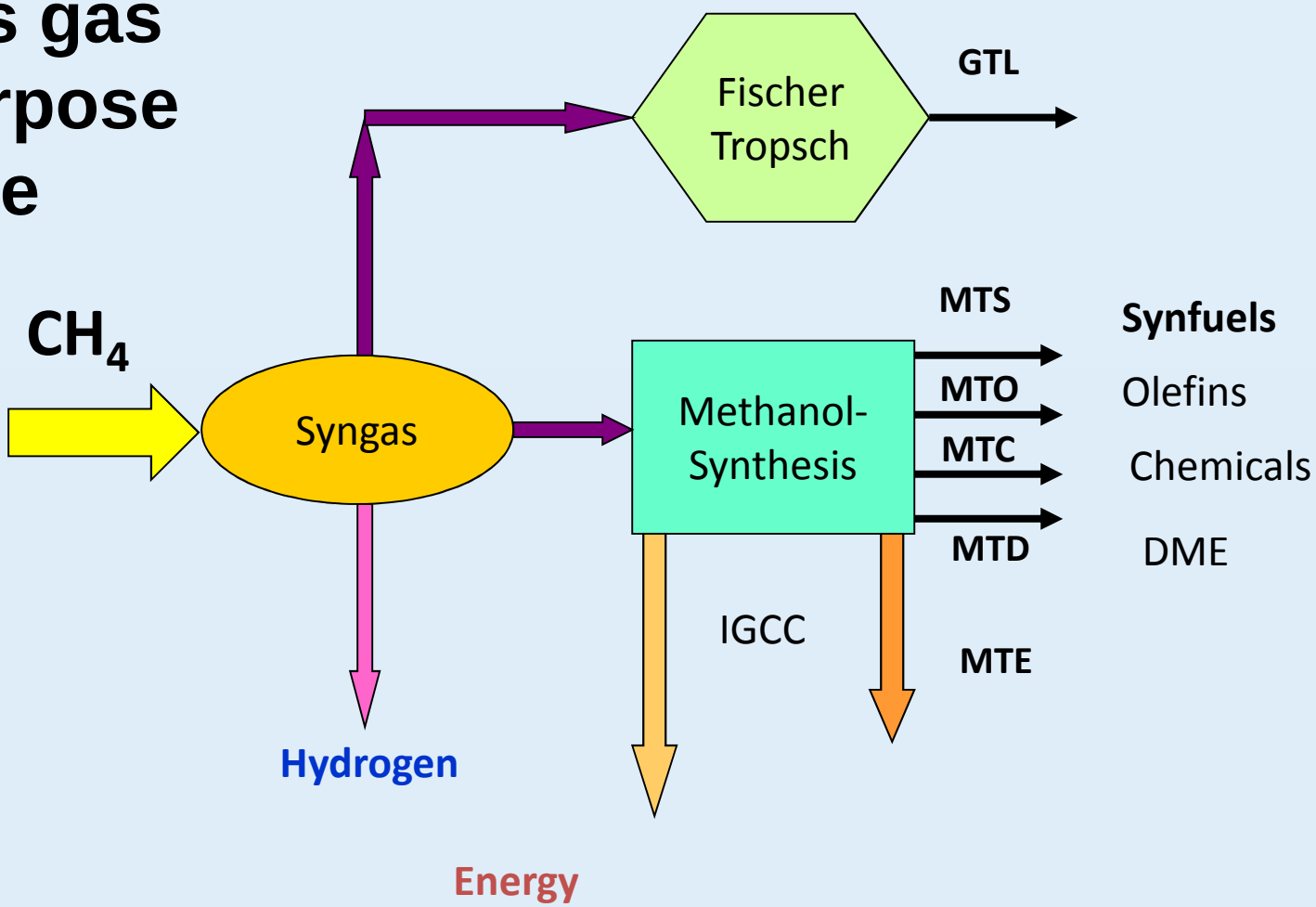
Synthesis gas a multipurpose source



- Alternarive usage of gas
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Reforming processes

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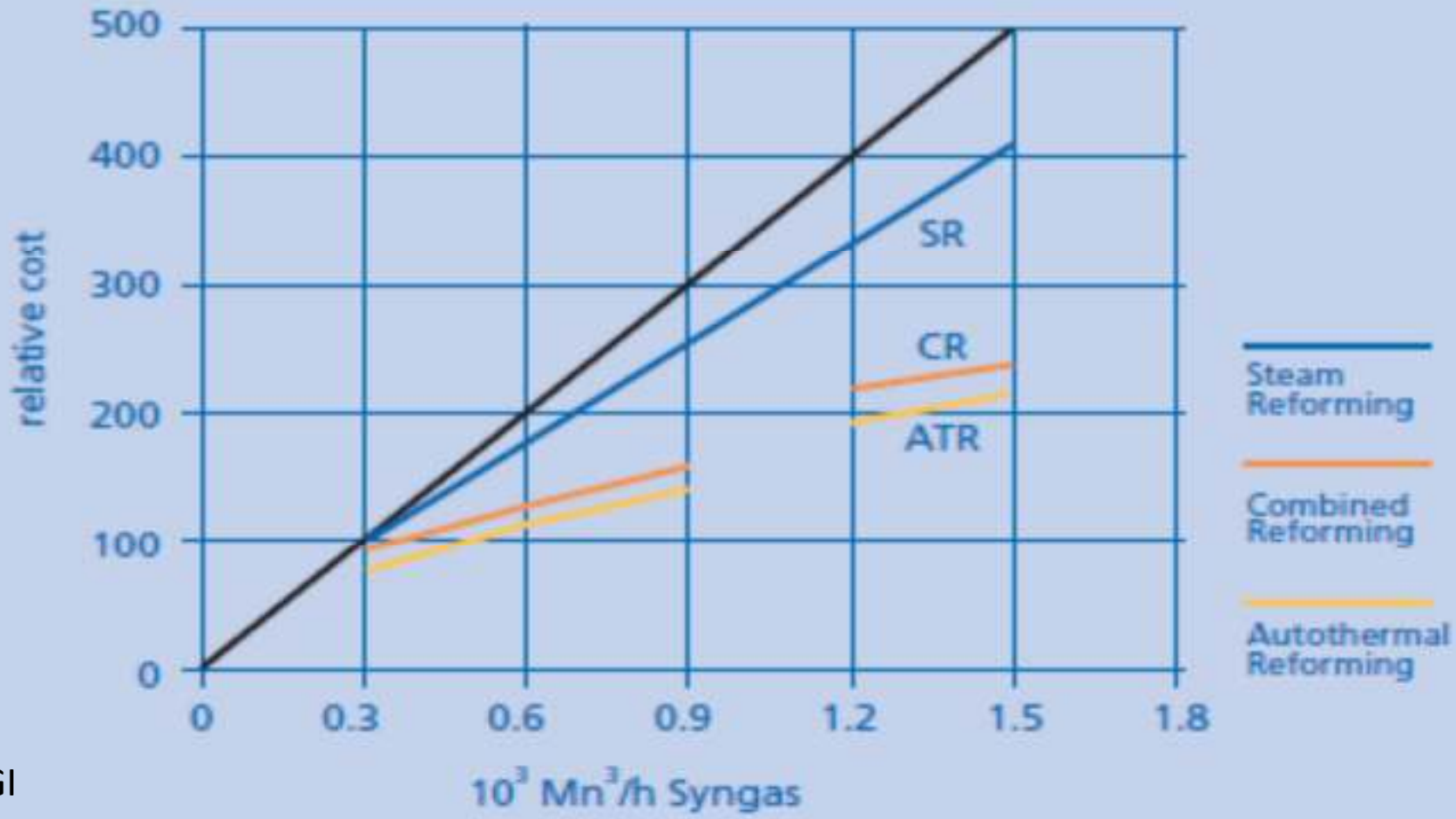

LURGI

- Alternarive usage of gas
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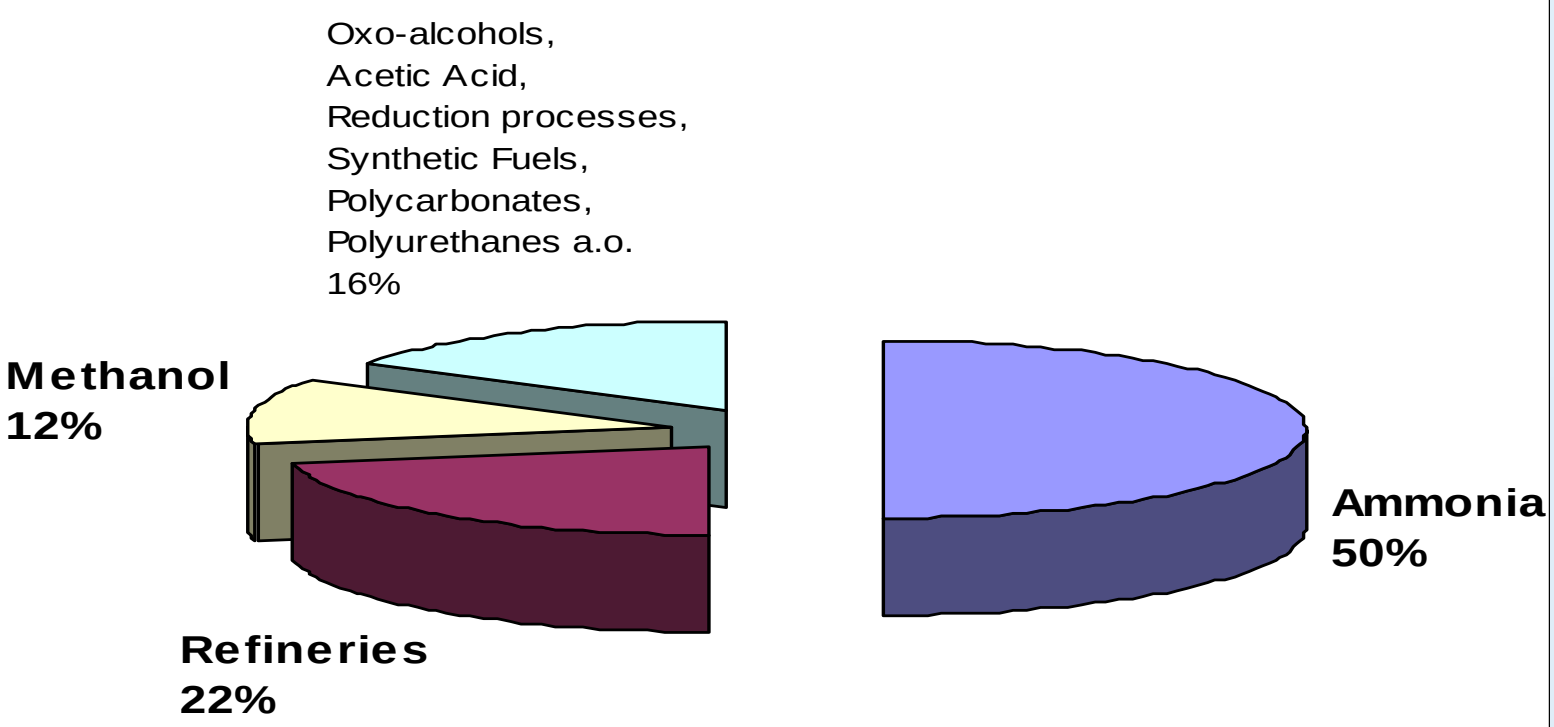
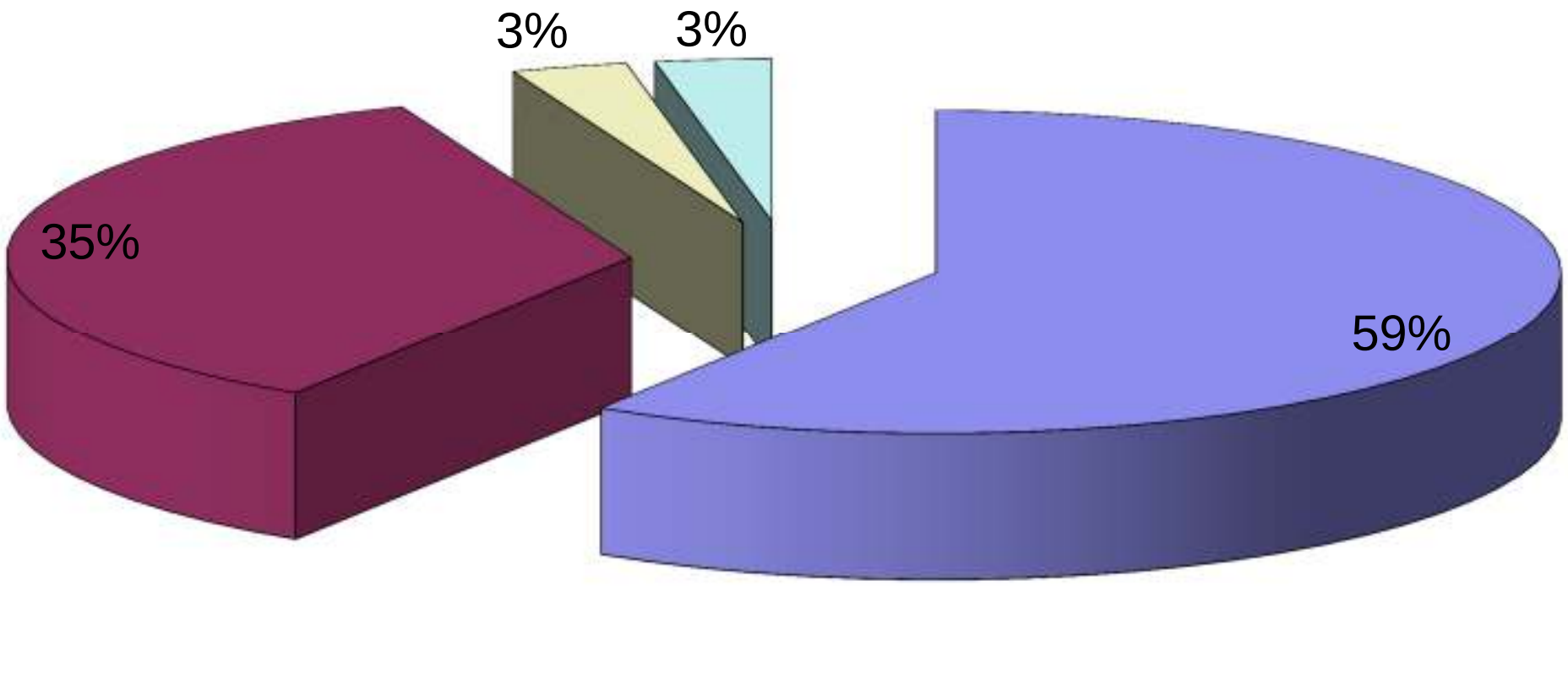


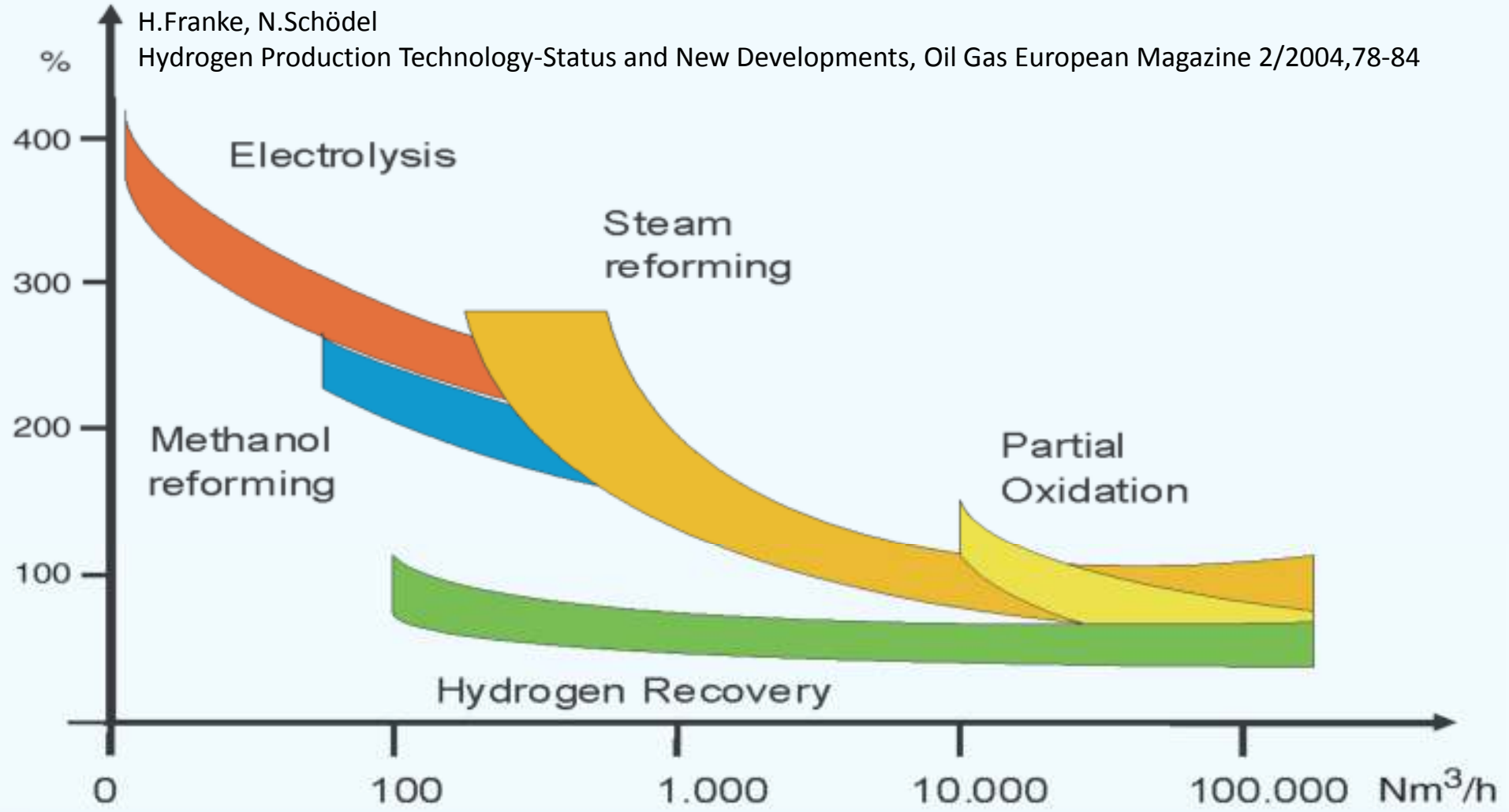
World consumption of Syngas

Hydrogen production in refineries



Hydrogen production costs

H.Franke, N.Schödel
Hydrogen Production Technology-Status and New Developments, Oil Gas European Magazine 2/2004,78-84



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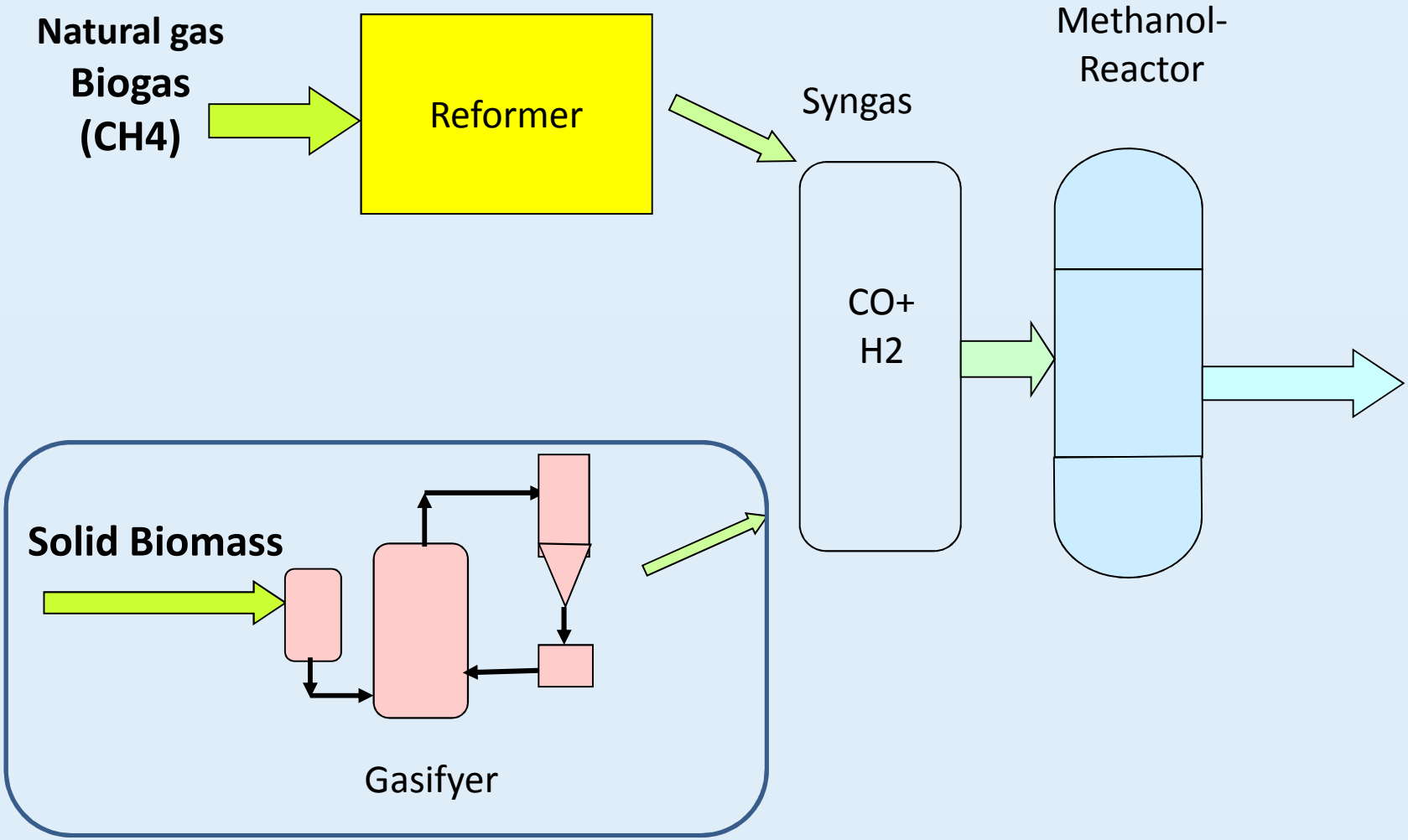
Methanol synthesis



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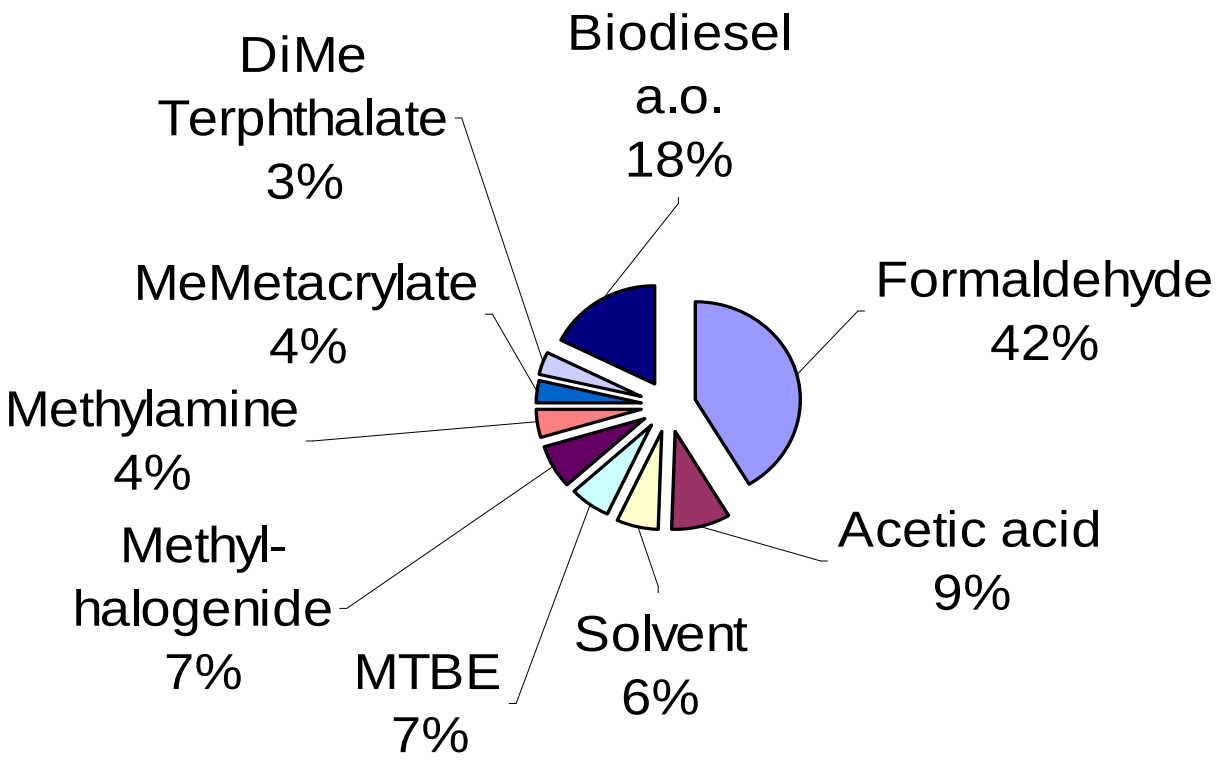
Chemical usage of Methanol



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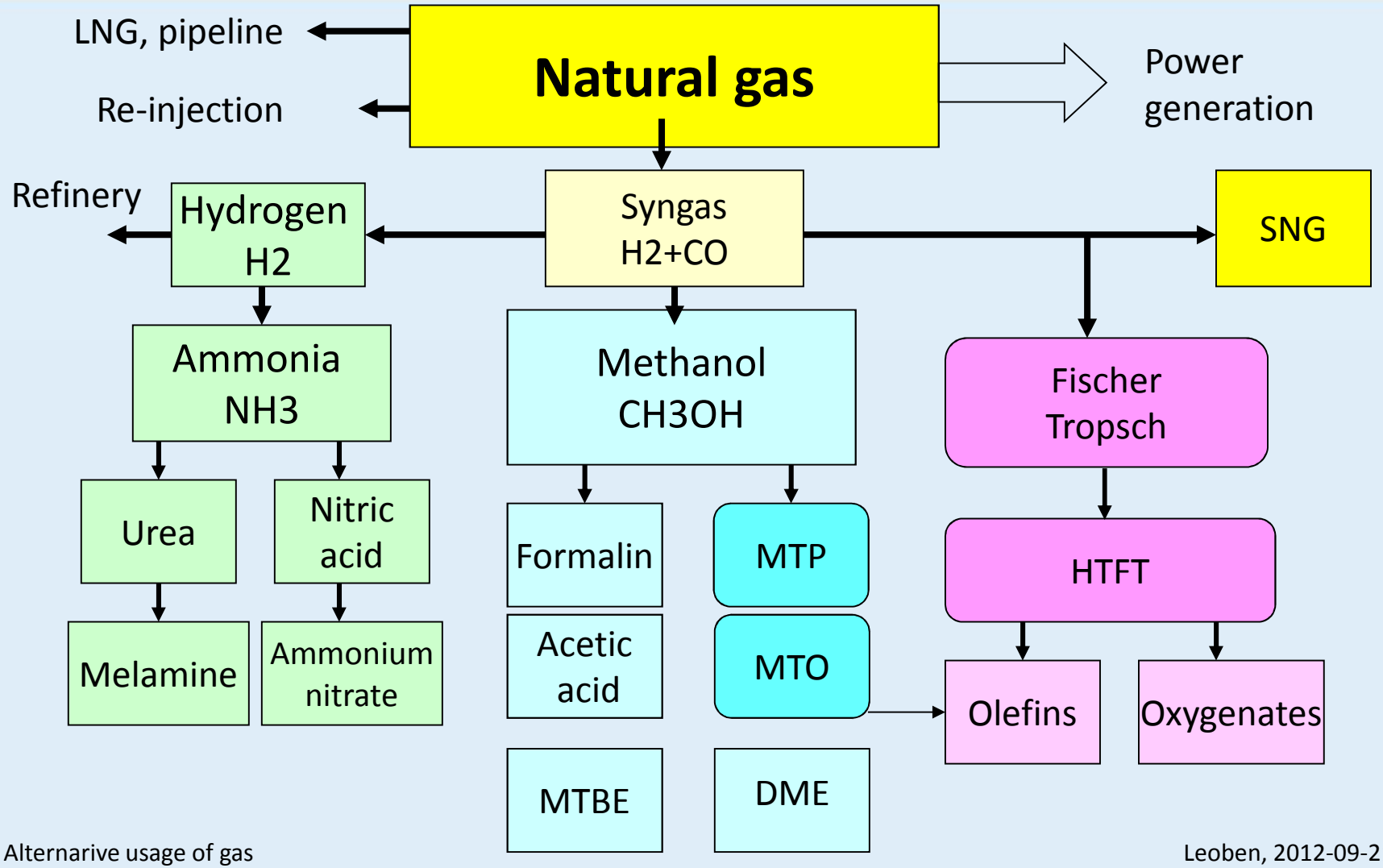
Chemical usage



- Alternarive usage of gas
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Syntheses routes to olefins and fuels
Feed: Syngas and Methanol

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MTD	250	15-30	Al2O3/Zeolite	Uhde, Lurgi, Haldor Topsoe, Toyo Eng.
MTO, MTP	400-450		Zeolite	UOP/Hydro, Lurgi
MTG	300-450	15-25		ExxonMobil, Uhde
MOGD, MTSyn	300-400		Zeolite	ExxonMobil, Lurgi
STD	250-280	30-70	Cu/Al2O3/Zeolite	HaldorTopdoe, AirProducts
STG (TIGAS)	240-420	40-60	Bifunct/Zeolite	HaldorTopsoe
FTTO	300-350			(BASF)
ATF, ATD, ATJ	400/280	1, 60	Al2O3/Zeolite	
TIGAS=Topsoe Integrated Gasoline Synthesis				

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Methanol to Synfuels

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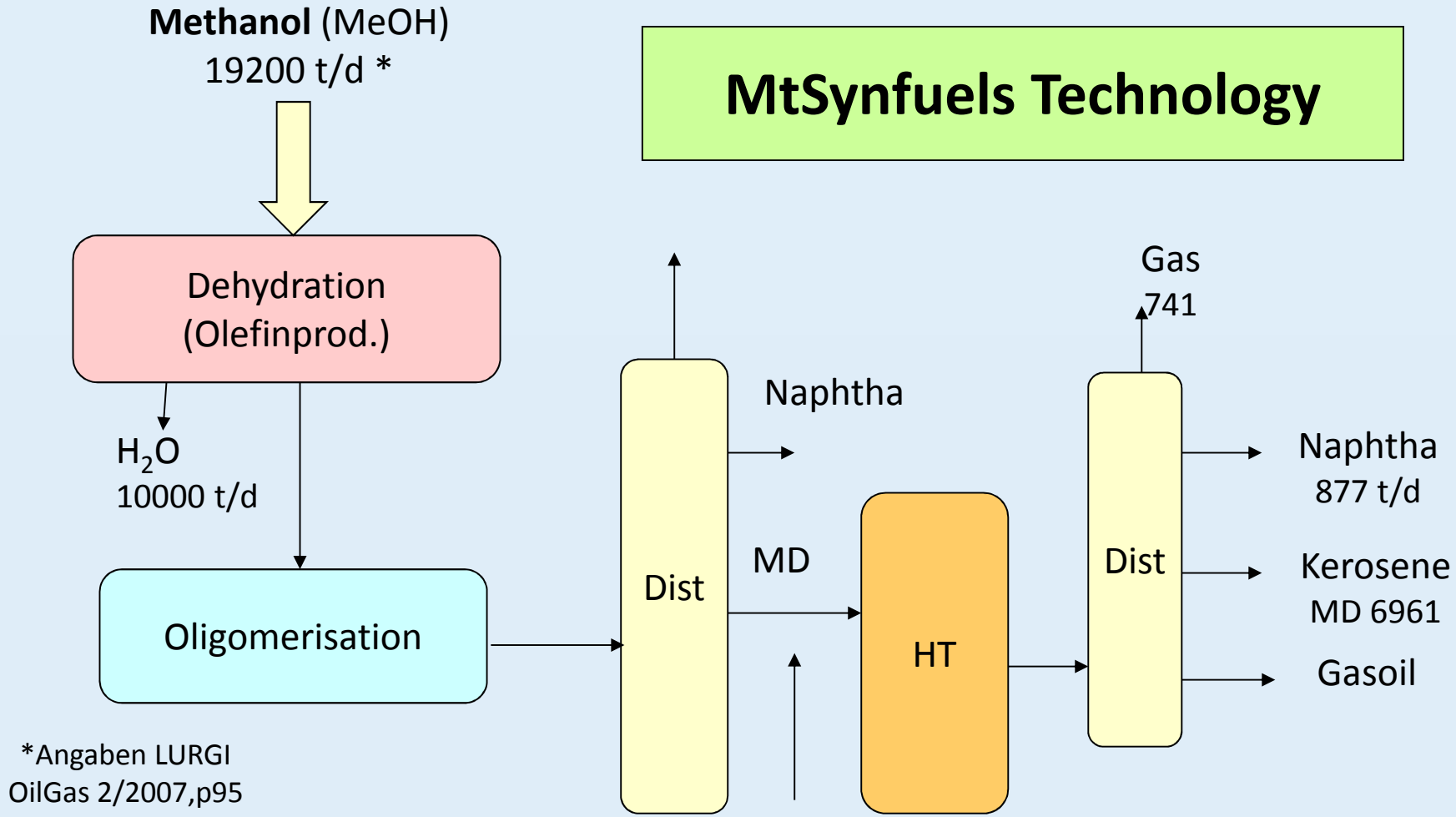

*Angaben LURGI
OilGas 2/2007,p95

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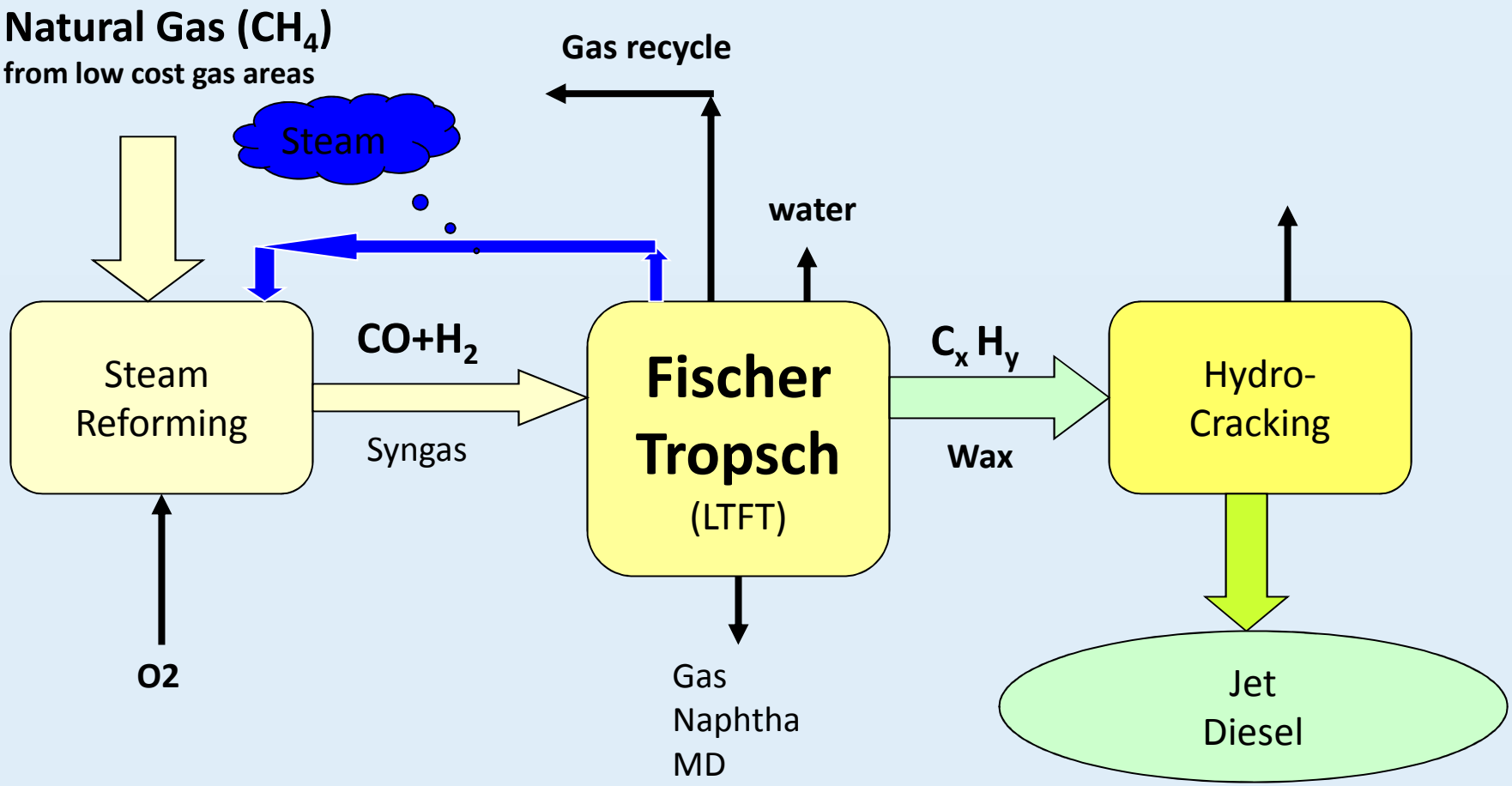
Leoben, 2012-09-21
A.Ecker

Fischer Tropsch process



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Commercial FT-processes

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Process	Catalyst	Reactor		Syncrude composition, %M			
HTFT				Olefin(a-Ol)	Paraffin	Aromatic	Oxygenate
SAS, Secunda	Fused Fe	Fluid.bed	Naphtha	70 (49)	13	5	12
(Sasol advanced Synthol)			Distillate	60 (34)	15	15	10
Synthol, PetroSA	Fused Fe	Fluid.bed					
LTFT							
SSBP, Sasolburg	Precip.Fe	Slurry bed	Naphtha	64 (61)	29	0	7
(Sasol slurry bed process)			Distillate	50 (47)	44	0	6
ARGE, Sasolburg	Precip.Fe	Fixed bed	Naphtha	32 (30)	60	0	8
(ARGE Ruhrchemie-Lurgi)			Distillate	26 (24)	66	0	11
SSBP, Qatar	Co-Al2O3	Slurry bed	Naphtha	35 (32)	54	0	11
			Distillate	15 (14)	80	0	5
SMDS, Bintulu	Co-SiO2	Fixed bed					

- Alternarive usage of gas
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GTL (CTL) capacities

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Shell MDS (1993/2000)	Malaysia	14000 bpd
PetroSA (1992)	Südafrika	23000(36000)
Sasol/Qatar Petroleum(2007)	Qatar	34000
Shell/Qatar (2012)	Qatar	70000 (140000)
NNPC/Chevron (2013)	Nigeria	34000
(Sasol (seit 1982)	Südafrika	150000,CTL)

Conventional FT Reactors among the largest in the world

Source: Sasol Web Site, Oryx reactor

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Transportation fuels synthesis routes

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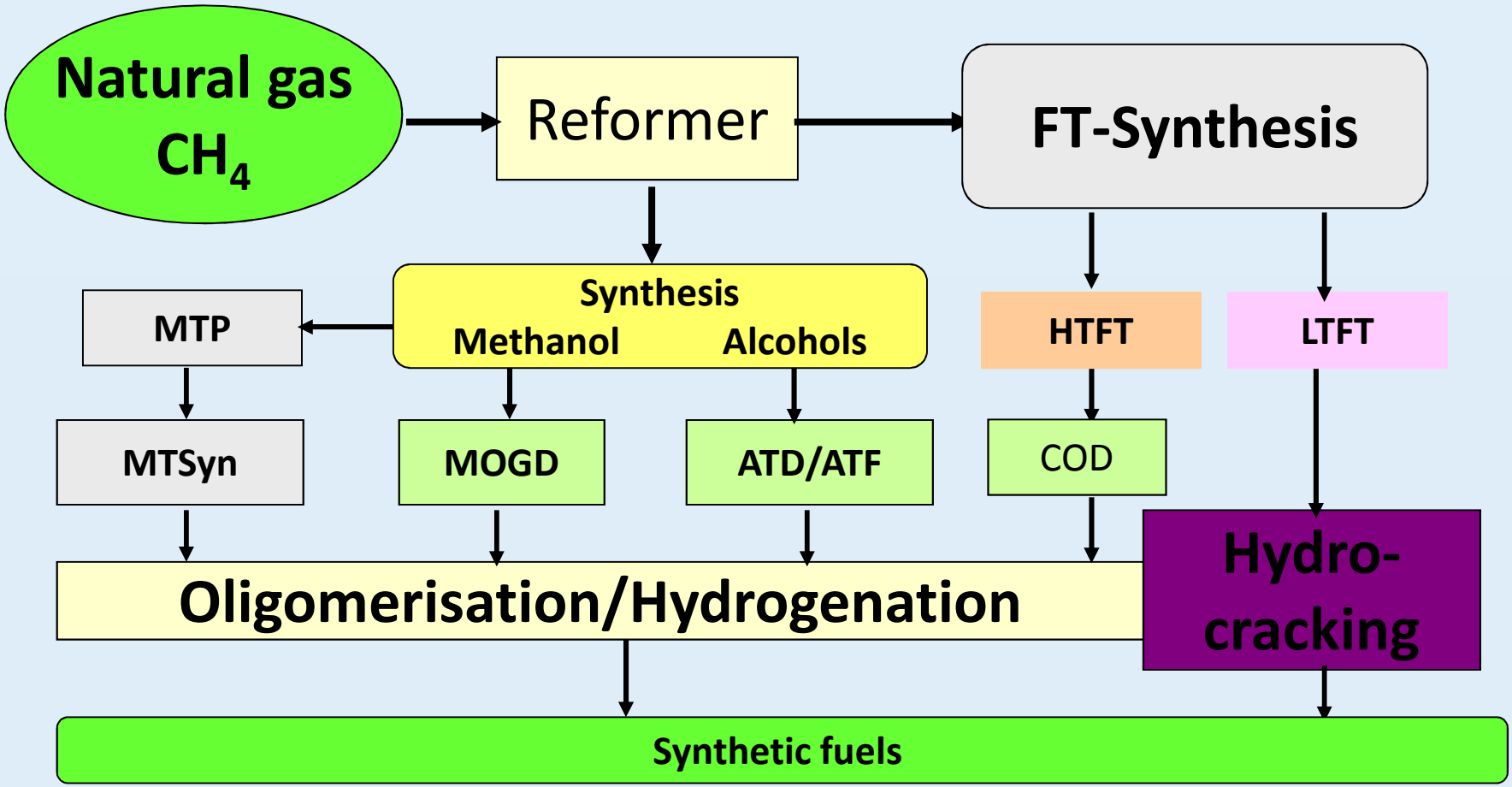

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Synthetic diesel fuels

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	Diesel (So)	FAME	NExBTL	GTL/FT	GTL/COD
Dichte/15°C	830-840	885	775…785	770…780	810
Flammpunkt	55…65	>100	>55…80	60…70	95
Viskosität/40°C	3…4	4…5	3…3,5	2,5…4	2,8
Cloudpoint	0…-5	0…-15	5 …- 30	5…-30	<-45
Cetanzahl	52	51	>80	80	55
Destillation10%Vol	230	350	200	210	235
50%Vol	270	350	290	270	250
90%Vol	330	350	300	300	330

- Alternarive usage of gas
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Why engage in advanced Jet fuels?

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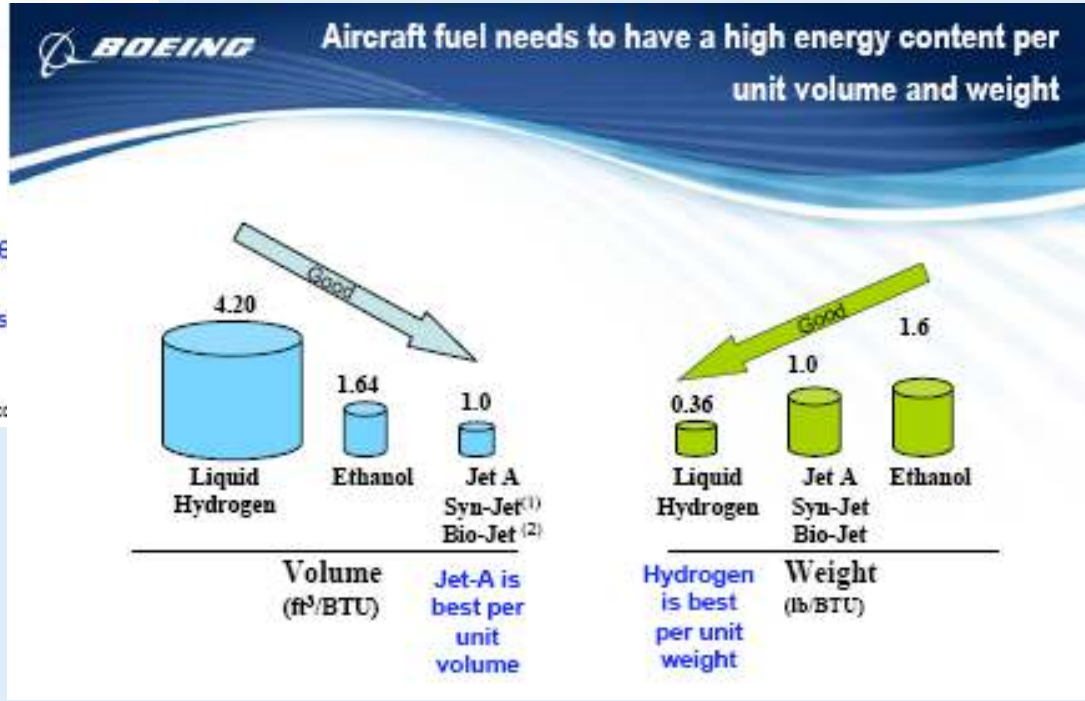
Alternative jet fuels must be produced (drop in fuels) to curtail future CO2 emission growth

Electric power, fuel cells, Hydrogen, alcohols, plant oils
are no practical solutions for propulsion

Future Jet fuels from gas and Biomass
are a *must* to meet aeronautical expectations

Hydrogen, Ethanol Aviation fuels ???



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Synthetic Aviation turbine fuels

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						Specifications	
	FT/HC	FT/IPK	FT/COD	Bio-SPK	Oligo-Jet	JP7	JP8
Density/15°C, kg/m3	756	760	779	753	781	779-806	775-840
Heating value, MJ/kg	44,1	43-44	>43	44	43,7	43,5	42,8
Hydrogen, %M	15	>14,5	>14,5	15	14,8	>14,4	>13,4
Paraffins (N+Iso), %M	100	100	>90	99	>90		
Aromatics, %M	<1	<1	3 bis 8	<1	3	>5	<25
Sulfur, ppm	<1	<1	<1	<1	<1	<1000	<3000
Flash Point, °C	45	42-57	69	42	74	>60	>38
Freezing Point, °C	-51	<-60	<-60	-63	-78	-43,3	<-47

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Summary

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The demand for more hydrogen, chemicals and fuels increases NG consumption

Hydrogenated petroleum products and synthetic fuels result less emissions

The dominant players in the oil and gas industry want to monetize natural gas (transport or conversion)

The current oil price and a low gas price are the greatest chance to building up a GTC- and GTF -industry