BIOKRAFTSTOFFE
BIOFUELS

A new way
to
AVIATION BIO-FUELS

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Aviation Fuels

AVGAS	Aviation Gasoline
AVTUR	Aviation Turbine Kerosene
AVDIESEL	Aviation Diesel fuel

Fuels
Properties

		Methane	Methanol	DME	Diesel
Formula		CH_4	CH_3OH	CH_3OCH_3	C_xH_y
Molmass		16	32	46	200
BoilingPoint	°C	-161	65	-25	150/350
Density	kg/m3	0,72	792	665	845
Heating value	MJ/kg	48	20	29	42

Not suitable as aviation fuels:

Methane , DME because of high volatility and low density

DME, Methanol because of low HV

Much Oxygen in product and feed is a problem !

		O-content,%Mol
Methanol	**CH4O**	**50**
Ethanol	**C2H6O**	**34,7**
Butanol	**C4H10O**	**21,6**
DME	**C2H6O**	**34,7**
Biodiesel	**C19H36O2**	**10,8**
CNG, Diesel	**CH4, CH1,9**	**0**
Wood	**CH1,6O0,7**	**45**
Sugar	**C6H12O6**	**53**

Oxygen reduces energy content, makes worse water tolerance, stability…

Important requirements on alternative (Bio)-Fuels

Infrastructure

- Must not demand a new infrastructure
- Must be blendable with conventional fuels
- Must be usable in existing engines

Sustainability

- Must not harm the environment
- Must not competitive to food
- Should create new jobs
- Should be competitive with other fuels

Assessment of Fuels

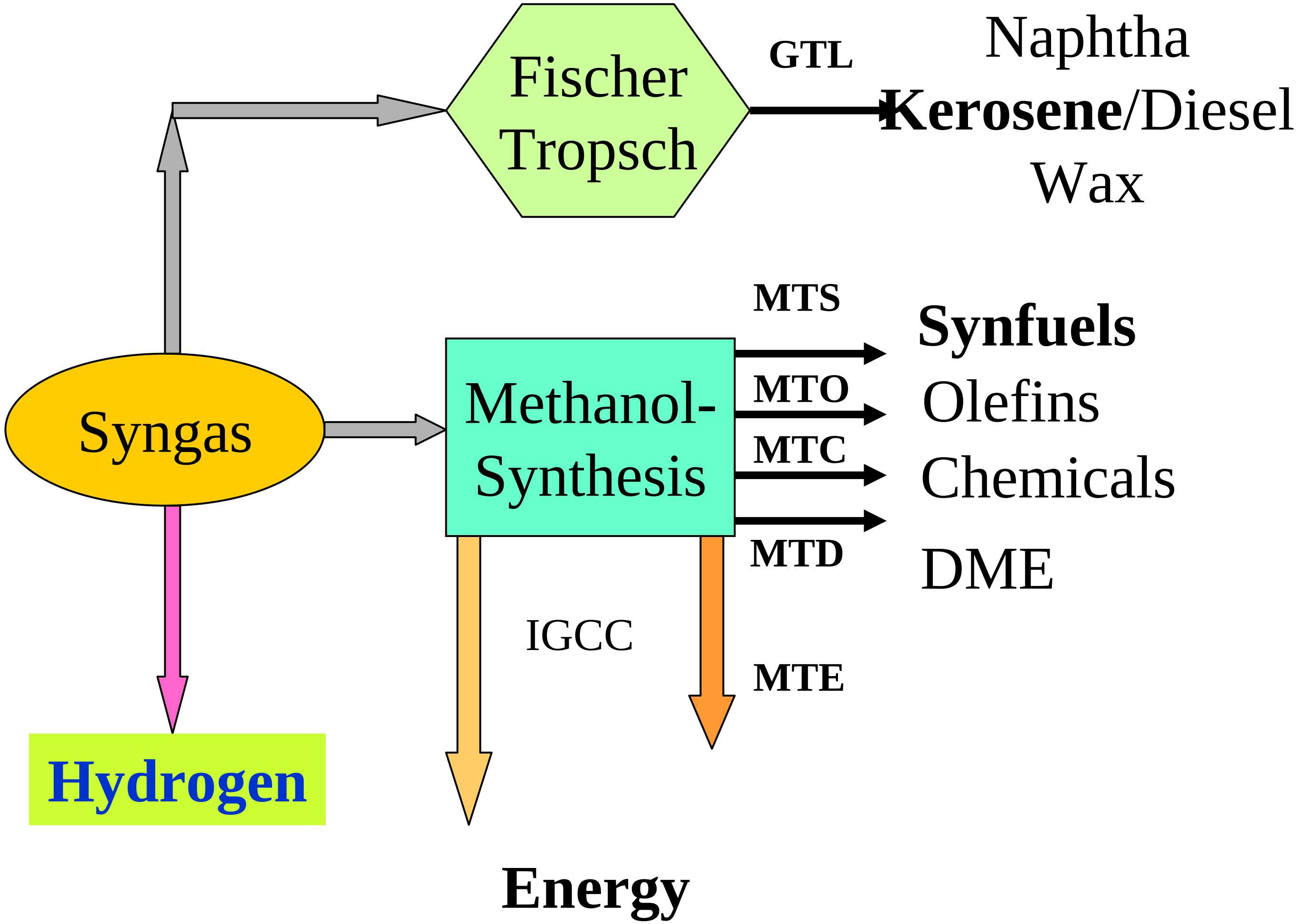
	H2	Biogas	DME	MeOH	Biosprit	FT-Diesel	Oligomerisat
Density, kg/m3	0,086	0,78	660	792	794	780	810
Heating value, MJ/kg	12	40	28	20	27	44	45
Liquid	no	no	no	yes	yes	yes	yes
Blendable with HC	no	no	no	partly	partly	yes	yes
Engine adapting necess.	yes	yes	yes	partly	partly	no	no
Infrastructure usable	no	no	no	partly	partly	yes	yes
Conv. Storage	no	no	no	yes	yes	yes	yes
Conv. Transport	no	no	no	yes	yes	yes	yes
No S, N, Metalle	yes	yes	yes	yes	yes	yes	yes
Max. H pro C		partly	no	no	no	yes	yes

What should biofuels consist of ?

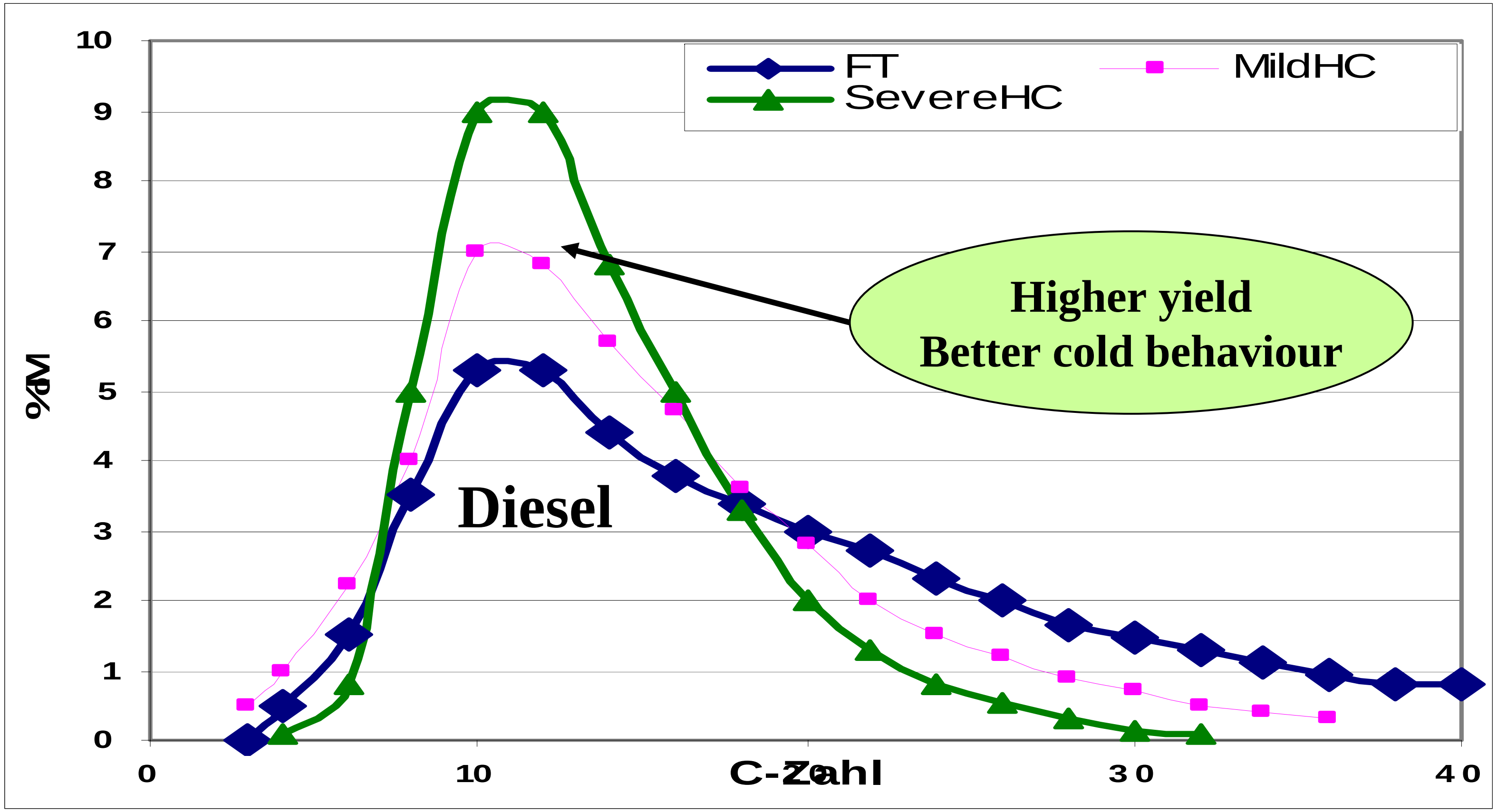
- ❖ No elements such as S,N,Metals, O?
- ❖ Consist only of C und H
- ❖ Contain Maximum H (for Minimum CO_2)

These reqirements are only met
by
Liquid Hydrocarbons (HC)
with a high portion of
(Iso)-Paraffins

Synthesis Gas
A multi purpose source for synthesis

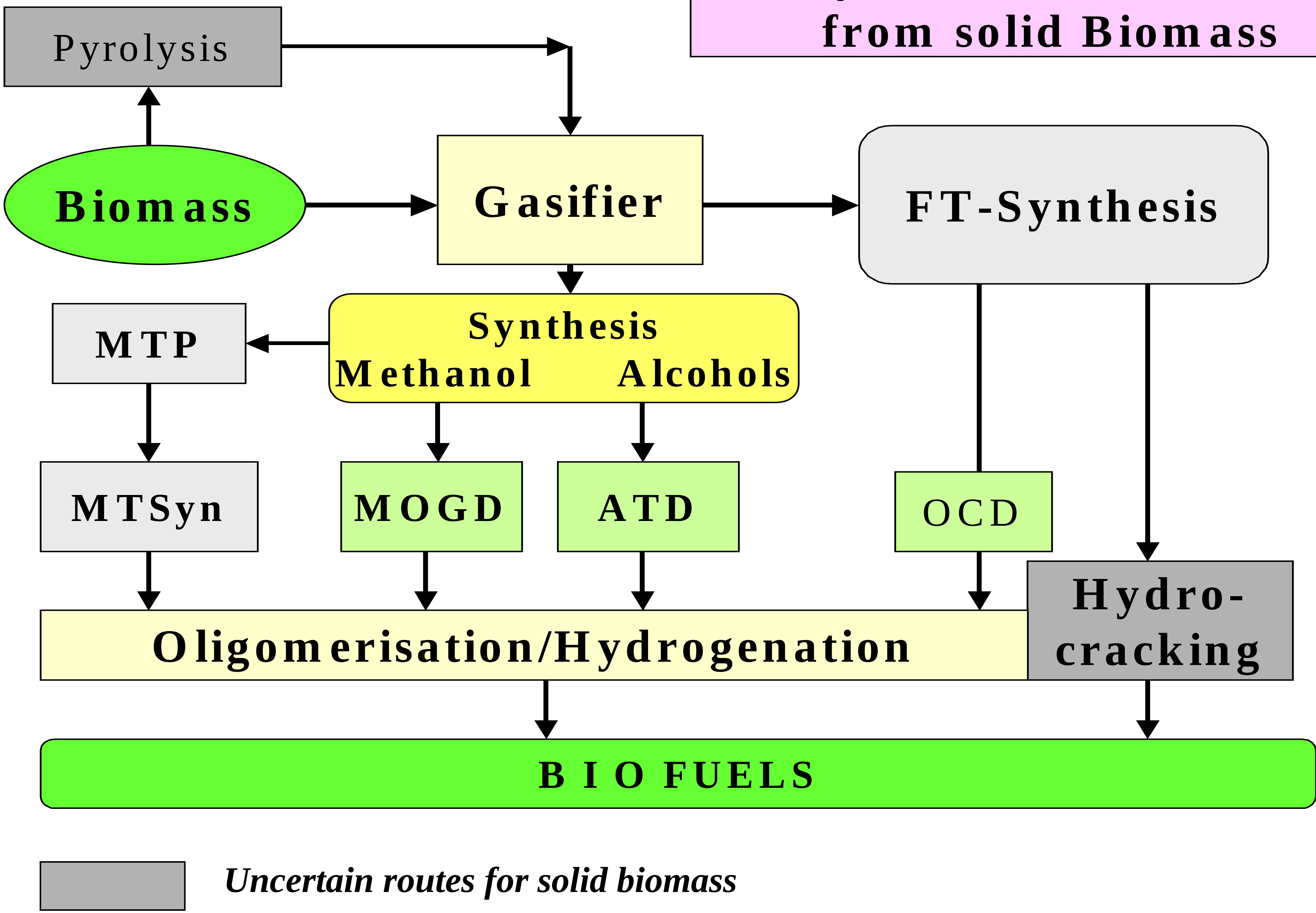


FT-Products
Bevor and after Hydrocracking



Hydrocracking produces more diesel fuel with better cold behaviour
Big plants are necessary for economical reasons -
But scale up is not possible for syngas from solid biomass

Synthesis of Biofuels from solid Biomass



Uncertain routes for solid biomass

Properties of Pyrolysis oil

Yield	**60-70%**
Water content	**20-30%**
pH	**2-3**
Density	**1,2 g/cm^3**
Viscosity/40°C	**40-100 cP**
Heating value	**17-19 MJ/kg**
Content C	**56%**
O	**37%**
H	**7%**

Pyrolysis oil

Pyrolysis coke (10-20%)

Pyrolysis oil Upgrading

	Pyrolysis oil	HDO
C, %M	54	63 -74
H	7	9 -10
O	39	28 -16
H_2O	25	16 - 2
HHV(MJ/kg)	17	25 -35

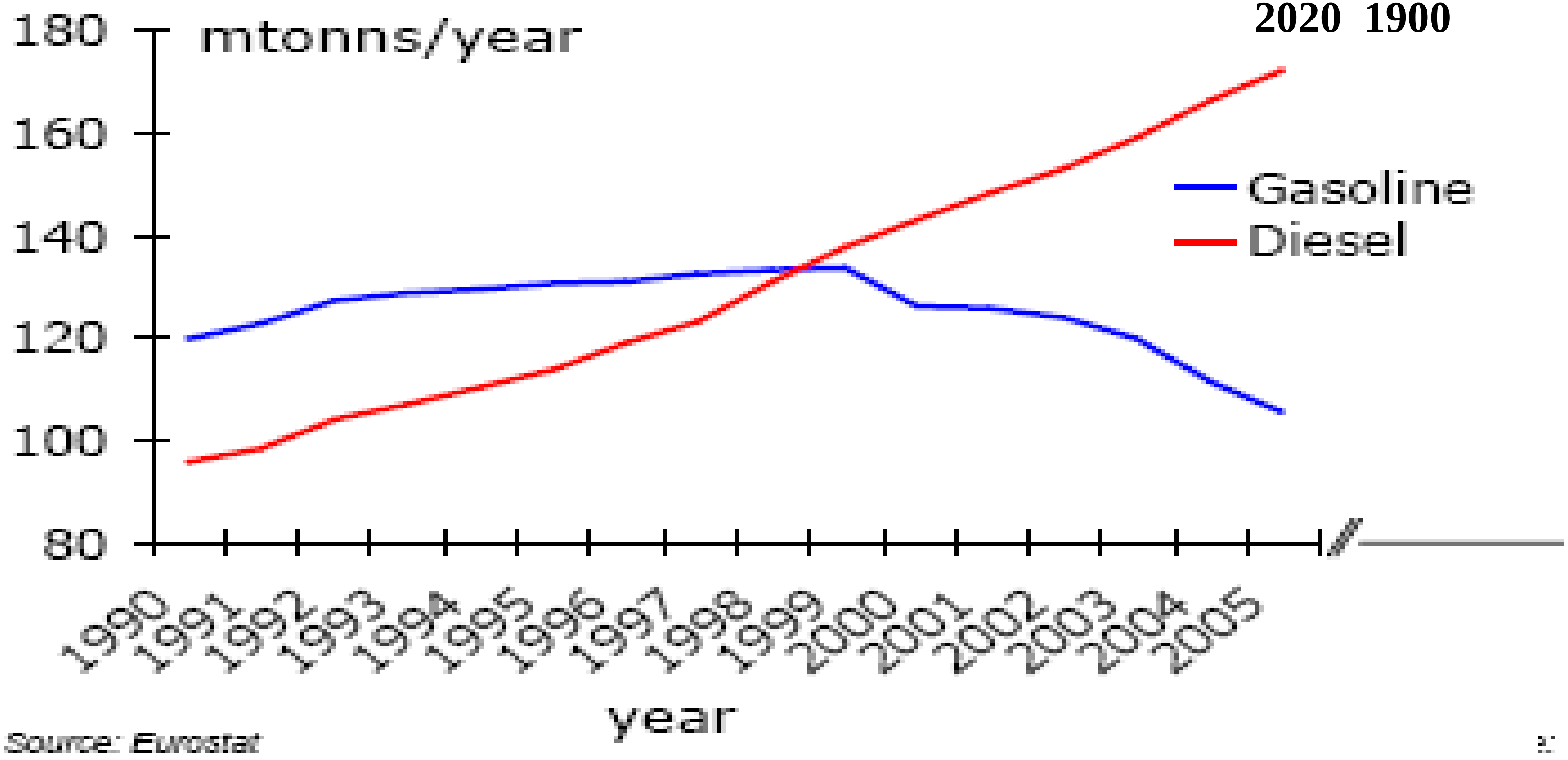
Biomass	Pyrolysis oil	HDO-Oil	FCC
100%	65	26	20

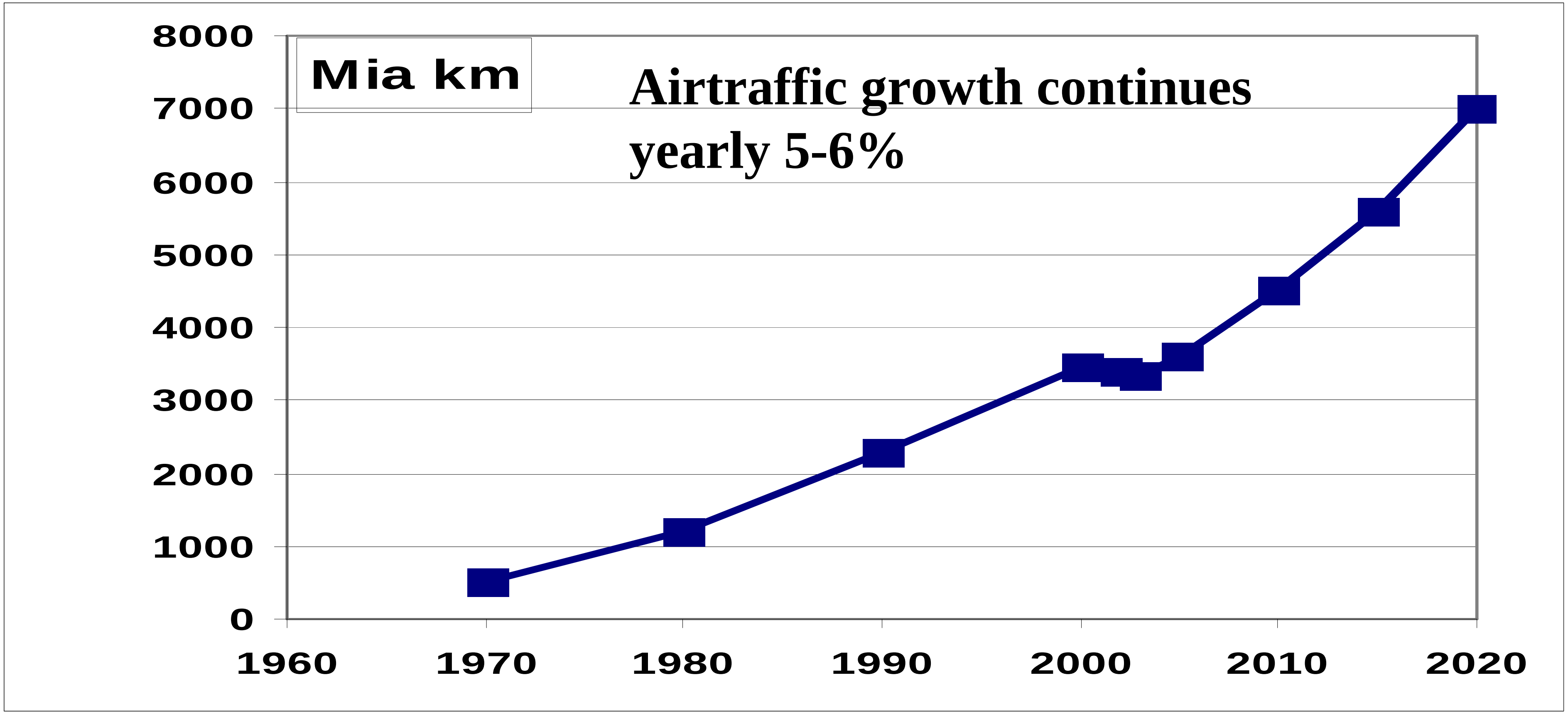
F.De M.Mercader et al, University Twente

Upgrading in FCC plant yields gasoline but no kerosene and gasoil of good quality

Which fuels do we need?
Consumption in EU

Consumption world OK+DK: 2005 1600 Mt/a
2020 1900





Consumption Jet A1

1990	1995	1998	2007	
158	168	178		Mio gal/d
174	185	196	220	Mio t/a
			276	Mio m3/a
2010-2020		>2000 Mio to		
		>6000 Mio to CO2		

Diesel- Fuels as Aviation diesel

	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

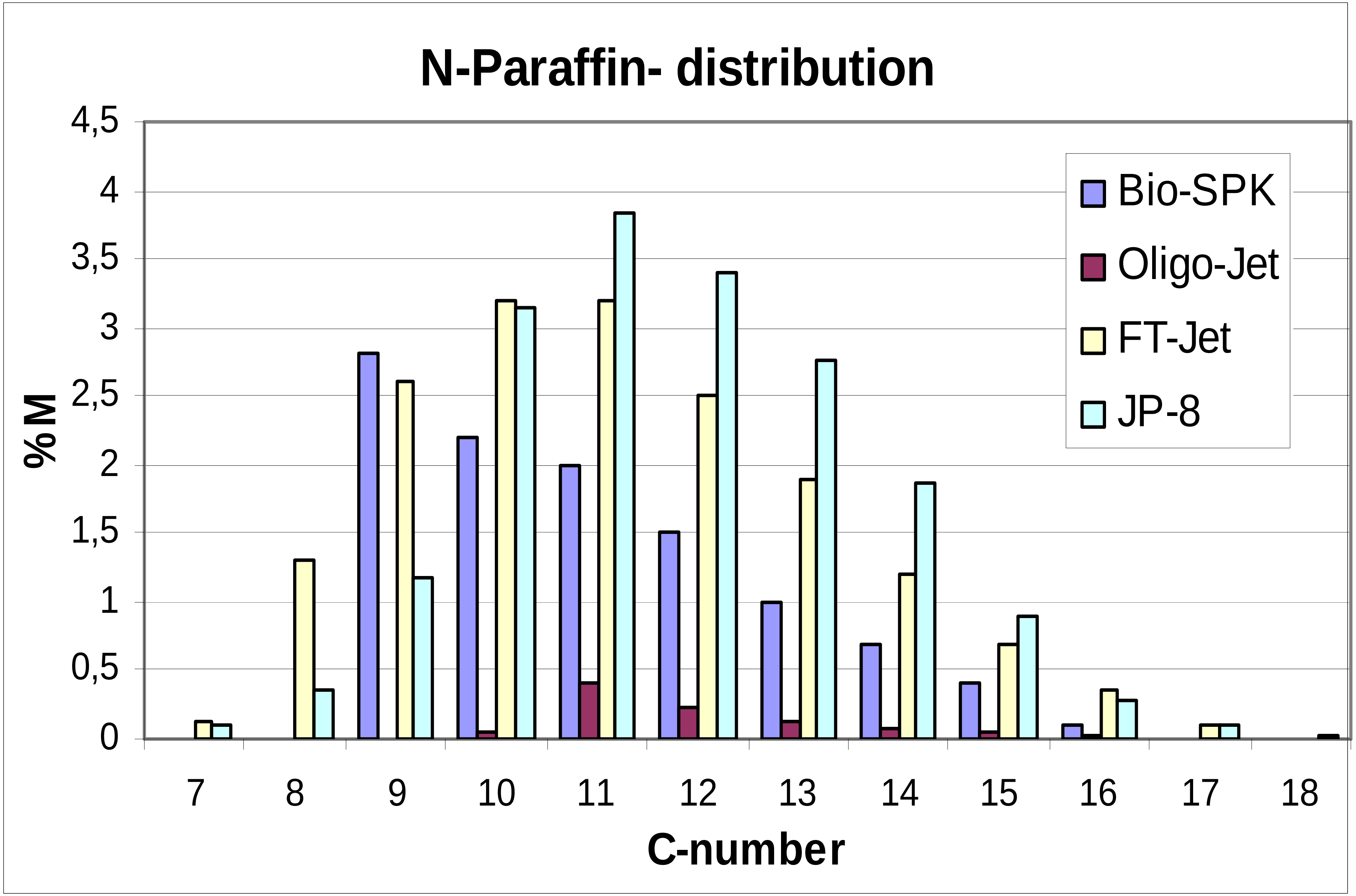
Oligo- Jet and Bio-SPK

in comparison to conv. JP-8/JetA1

	Oligo-Jet	Bio-SPK	JP-8/Jet A1
Specific Gravity/15°C	0,781	0,753	0,804
API/60°F	49,7		44,4
Flash Point, °C	74	42	51
Freezing Point, °C	-78	-63,5	-50
Viscosity/-20°C, cSt	7,2	3,34	4,9
Visciosity/-40°C, cSt	18,4		9,9
Smoke Point, mm	40		22
Existent Gum, mg/100 ml	<0,5	<1	0,4
Thermal Stability/260°C			
Tube Deposit Rating	1	1	1
Change Pressure, mm Hg	0		2
Copper Strip Corrosion	1a		1a
Total Acid Number, mg KOH/g	0,004	0,002	0,003
Hydrogen content, %m	14,8	15	13,8
Sulfur, %m	0	0	0,04
Distillation			
IBP, °C	194		159
10% recovered, °C	202	162	182
20% rec.,°C	206		189
50% rec.,°C	215	186	208
90% rec.,°C	257	226	244
FBP, °C	278	251	265
Cetane Index	61,8		46

Oligo-Jet from Syngas
FT-Olefins oligomerised/hydrogenated

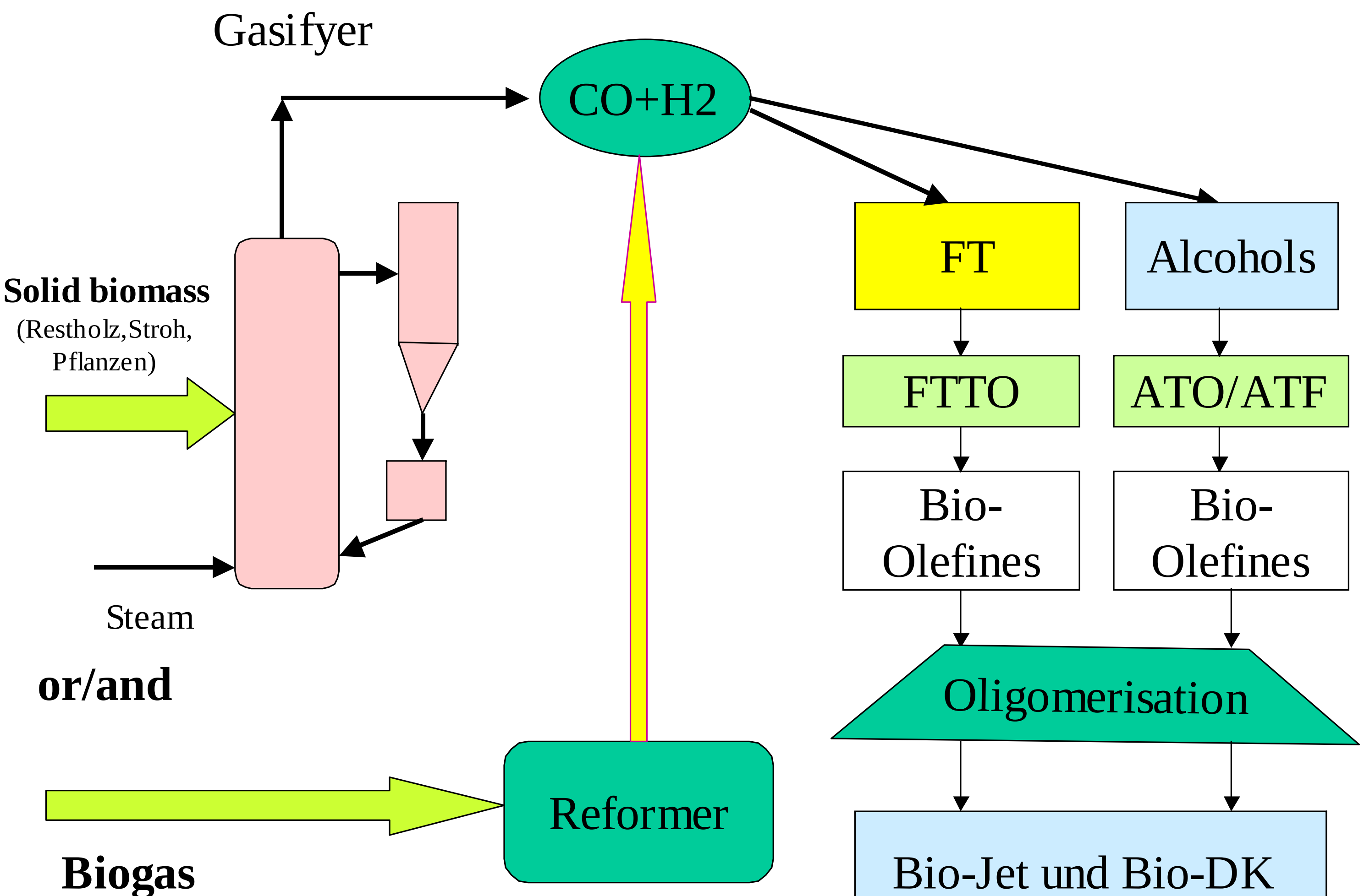
Bio-SPK from Camelina-Öl
hydrogenated and isomerised


N-Paraffin- distribution
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
% M
Bio-SPK
Oligo-Jet
FT-Jet
JP-8
7
8
9
10
11
12
13
14
15
16
17
18
C-number

Synth.Aviation turbine fuels
JP8/JetA1/JP7

						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

Alternative Processes to Biofuels



ATO(F/D)=Alcohols to Olefines (Fuels/Distillates)

Alternative Aviation Fuels