"Biodiesel – key trends and innovative developments"

prepared for the

COMPETE Meeting

Mauritius
21 June 2007

Werner Koerbitz
Austrian Biofuels Institute – Vienna, Austria

www.biodiesel.at

Gold rush mentality predominant

- **Austria:**
  - **4 new biodiesel plants** (100.000 t each) at river harbours getting on stream in 2007.
  - One of them to **expand to 400.000 t** by 2008 -- ?.
  - Risk of **overcapacity**.
- **Germany:**
  - **Overcapacity** has developed within a rather short time.
  - Price battles **decreasing profitability**.
  - Government reacts with **reduction of tax rebates**.
  - Nevertheless new plants are appearing like mushrooms.

Gold rush mentality predominant

- **United Kingdom :**
  - **Ineos Enterprises** plans for a 500.000 t plant to be in operation by 2008.
  - A 120.000 t/y biodiesel plant to be established in Scotland based on rapeseed oil.
- **Romania :**
  - The Portuguese company **Martifer** will finish construction of a 100.000 t biodiesel plant.
  - Competition for the best site within the harbour of **Constanza**.
  - **Rompetrol** as largest privately owned oil company to build a 60.000 t/y biodiesel plant based on multifeedstock.

A quiet place in South East Asia ……?

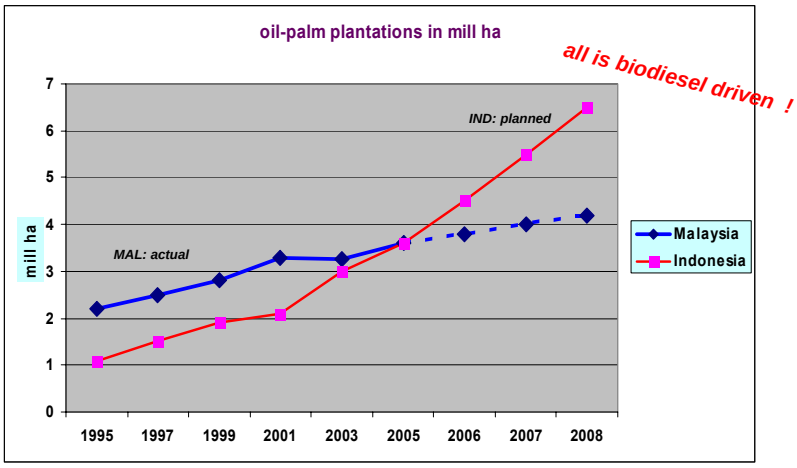
Gold rush mentality predominant

- **South Korea:**
  - **Golden Hope** (Malaysia) considering a 150.000 t/y plant.
- **Singapore:**
  - **Peter Cremer** establishing a 200.000 t / year plant for May 2007.
- **Thailand:**
  - Bangchak Petroleum considers a 80.000 t/y plant - not yet Cabinet approved.

Gold rush mentality predominant

- **Malaysia:**
  - FC biodiesel demand growth: 3.2 mill t now to 10.5 mill t biodiesel in 2020.
  - **capture 10 % of global biodiesel market** share by 2010.
  - 52 licences for biodiesel production, totalling 5 mill t/y.
- **Indonesia:**
  - state oil company **Pertamina** to produce 13 mill t by 2009.
  - is surpassing Malaysia in overall palm plantation acreage.

Indonesia to overtake Malaysia in palm oil acreage in 2006 !



Source: FAO, The Economist

Gold rush mentality predominant

- **Laos:**
  - **Koalo Group** of Korea investing € 25 mill in a biodiesel plant; - will plant non-food crop Jatropha on 100.000 ha
- **China:**
  - Intends to meet 10 % market share target by 2010
  - i.e.11 mill t biodiesel and then 15 mill t by 2020.
  - Austrian company BIOLUX invests into a 300.000 t biodiesel plant plus oil mill – investment is € 120 mio.

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Everywhere on this globe !

Gold rush mentality predominant

- **Argentina:**
  - Argentine company **BioDiesel** to build a 33.000 t/y capacity for export to Europe until Argentina biofuels obligation begins in 2008.
- **Brazil:**
  - **Petrobras** launched the "biggest biodiesel project in the world" to produce 144 mill lt biodiesel in 24 months.
  - **Incoa group** of the state of Parana is going to build a 140.000 t biodiesel plant to be ready by 2008.

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Think first – then invest wisely

Key criteria for an investor:

1. **Meet the top criteria for biodiesel fuel quality**
2. **Choose a high security level for multi - feedstock supply in volume and cost**
3. **Select high efficiency and flexibility in process technology**
4. **Secure 345 days of uninterrupted production**
5. **Identify profitable markets with secure conditions**
6. **Lobby for and take advantage of supportive legislation**
7. **Use all readily available information**

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Assured high biodiesel quality is “to be or not to be !”

The biodiesel standard development has come a long way:

- **Austria 1991:** **ON C 1190 for RME – first world-wide**
- **Austria 1997:** **ON C 1191 for FAME – first world-wide**
- **USA 2002:** **ASTM - D 6751-02 FAME**
- **Europe 2003:** **EN 14214 for FAME**
  (together with VW, DC, Peugeot, Bosch, Shell, Total, etc.)

- **Only accurate biodiesel quality assures market acceptance**
- **Easiest way is to adopt existing and accepted standards**
- **Be aware that fuel standards are getting tougher !**

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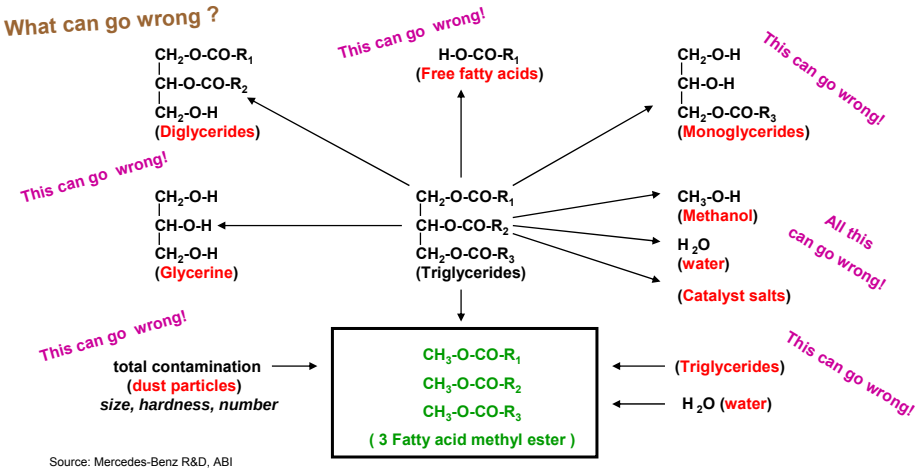
Biodiesel is derived from virgin or used oils and fats of vegetable or animal origin - it must have highest purity without any harmful contaminations



Source: Mercedes-Benz R&D, ABI

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selection criteria no. 1: quality

The biodiesel standard is complex and fine tuned

- triggered by ever growing demands in reducing exhaust emissions quality levels of any fuel have to be improved continuously
- - and process technology has to meet the new challenges

pr EN 14214 Fatty-acid-methyl-ester (FAME)		22.10.02
Parameter	Range	Unit
Ester content	≥96.5	%m/m
Density at 15°C	860 – 900	kg/m³
Viscosity at 40°C	3.5 – 5.0	mm²/s
Viscosity (-20°C)	≤ 48	mm²/s
Flash point	≥110	°C
CFPP →	see EN590	°C
Sulfur content	≤ 10.0	mg/kg
CCR / 10% distill. residue	≤ 0.30	%m/m
Cetane number	≥ 51.0	-
Sulfated ash	≤ 0.02	%m/m
Water content →	≤ 0.05	%m g/kg
Total contamination →	≤ 24	mg/kg
Copper corrosion (3h at 50°C)	class 1	rating
Oxidation stability	≥ 6.0	h
Thermal stability	?	h
Storage stability	-----	----
Acid number →	≤ 0.50	mg KOH/g
Iodine number →	≤ 120	-
Polyunsaturated methyl esters: C 18:4 +	≤ 1.0	%m/m
Linolenic acid methyl ester	≤ 12.0	%m/m
Methanol content	≤ 0.20	%m/m
Monoglyceride content →	≤ 0.80	%m/m
Diglyceride content →	≤ 0.20	%m/m
Triglyceride content →	≤ 0.20	%m/m
Free glycerol →	≤ 0.02	%m/m
Total glycerol →	≤ 0.25	%m/m
Group I metals (Na/K) →	≤ 5.0	mg/kg
Group II metals (Ca-Mg) →	≤ 5.0	mg/kg
Phosphorus content	≤ 10.0	mg/kg

→ further improvements are necessary and can be expected

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… and the biodiesel fuel standard is getting more strict!

Parameter	*Test*	*Unit*		*EN 14214*	*new plant*	*Optional*
acid value	**EN 14104**	**mg KOH/g**	**max.**	**0.50**	**0.213**	**0.213**
water content	**EN 12937**	**mg/kg**	**max.**	**500**	**260**	**145**
total contamination	**EN 12662**	**mg/kg**	**max.**	**24**	**10**	**5**
free glycerine	**EN 14105**	**%(m/m)**	**max.**	**0.02**	**0.01**	**0.001**
monoglycerides	**EN 14105**	**%(m/m)**	**max.**	**0.80**	**0.51**	**0.42**
diglycerides	**EN 14105**	**%(m/m)**	**max.**	**0.20**	**0.19**	**0.15**
triglycerides	**EN 14105**	**%(m/m)**	**max.**	**0.20**	**0.05**	**0.05**
total glycerine	**EN 14105**	**%(m/m)**	**max.**	**0.25**	**0.16**	**0.14**
Alkali content (Na+K)	**EN 14108(9)**	**mg/kg**	**max.**	**5**	**1.4**	**0.73***
Alkali content (Ca+Mg)	**prEN 14538**	**mg/kg**	**max.**	**5**	**< 0.5**	**< 0.93***

- **Further improvements can be reached by improved process technology**

Courtesy: Desmet Ballestra

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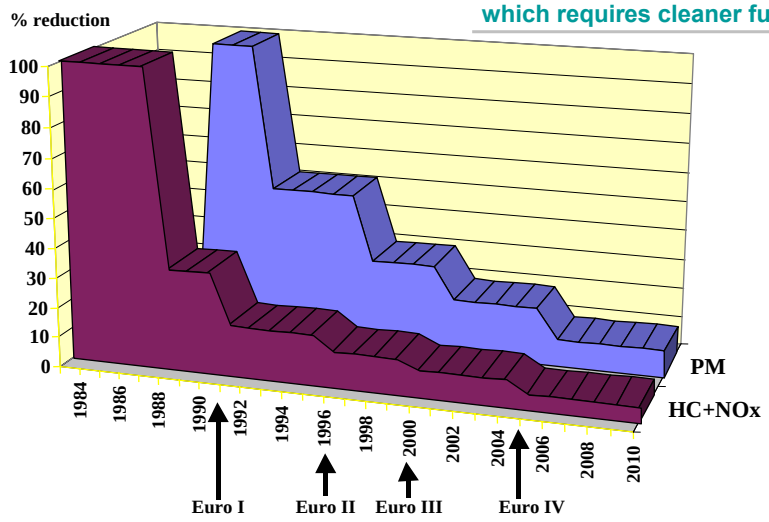
Europe requires emission reductions for diesel cars, which requires cleaner fuels



Source: European Commission

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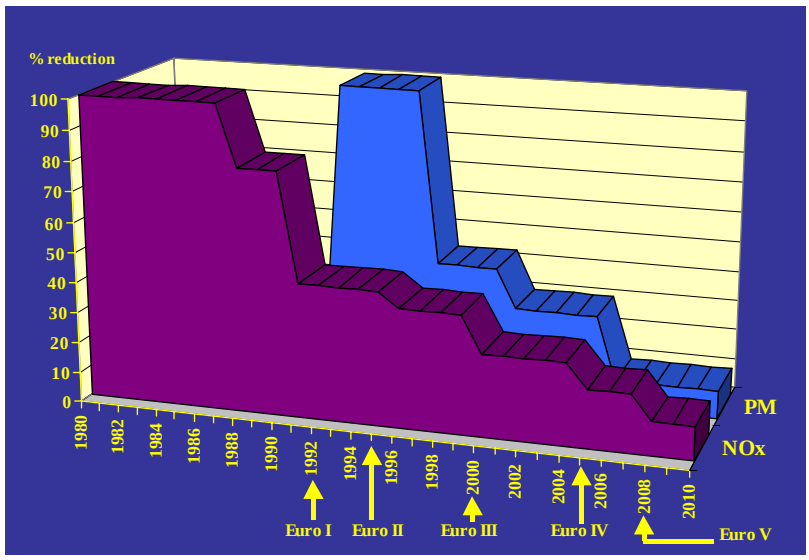
Europe requires emission reductions for heavy-duty diesel vehicles



Source: European Commission

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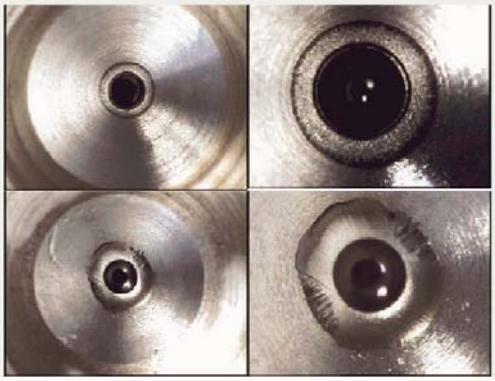
Further emission reduction: Biodiesel must reach highest levels of purity

Variable measured

Abrasion causes injector seat wear. The increased **injection return volume** is taken as a measure for wear.



little wear

← *Abrasion caused by water and finest particles leads to inefficient combustion and increase of emissions*

high wear

Courtesy: Ford

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Advanced vehicle fuel systems :

1. **Trends in vehicle fuel systems:**
   - * more precision,
   - * higher pressures,
   - * higher flow rates,
   - * smaller clearances, component sizes and tolerances
2. **leading to**
   - * higher fuel efficiency,
   - * lower fuel consumption and
   - * lower emission levels,
3. **requiring**
   - * cleanest, high quality fuels with reduced
     - * particles in hardness, size, number,
     - * free water content

Source: J. Bennett, Ford; R. Faucon, Renault

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Areas of improvement of Biodiesel :

1. **Improved fatty acid composition by**

   * targeted breeding for dedicated oilseed plants
   * appropriate blending of various oils

2. **Improved Biodiesel production process**

   * lowest water content levels
   * finest filtration for reduction of fuel contaminations with fine particles

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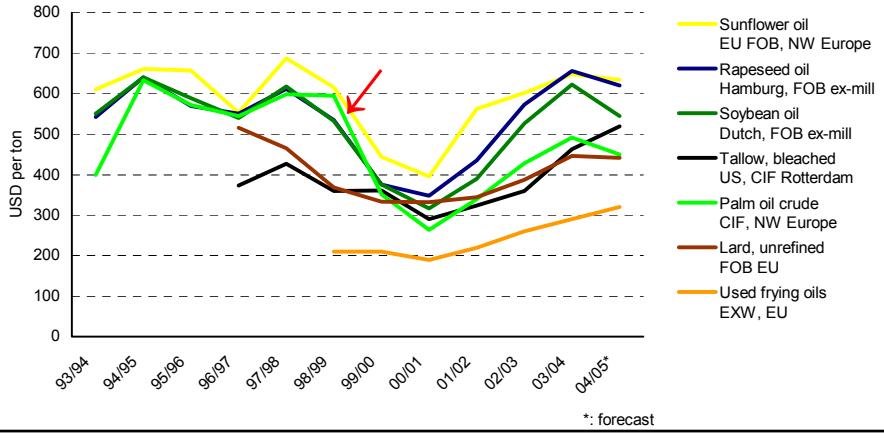
Ups and downs of edible oil prices have a strong influence on profitability

▶ **A flexible multi-feedstock concept will contribute to cost reduction**



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Broader basis + lower cost of feedstock

vegetable oils :

not the best, but that's what we have !

used today :	rapeseed (00), soy, palm,
new sources:	sunflower (HO), rapeseed (HO), Linola
non-food oils:	Acrocomia, Babaçu, Buriti, Cornus, Jatropha, Pongamia,

very promising for less developed countries, but needs further R&D !

recycling oils: "McDonalds option", trap grease

animal fats: beef tallow, lard, rendering fats

▶ **Sufficient supply of feedstock from food and non-food crops within international strategic partnerships**

▶ **Contributing to increased biodiversity**

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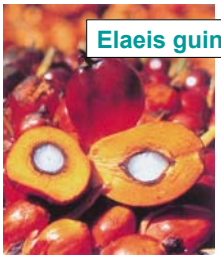
Palm oil may become the leading feedstock source for biodiesel production world-wide

highest oil yields / ha



Elaeis guineensis

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non-food oilseed crops – a new opportunity !

In India and Egypt, commercial plantations of Jatropha have been started in dry conditions and on marginal soils

Jatropha curcas

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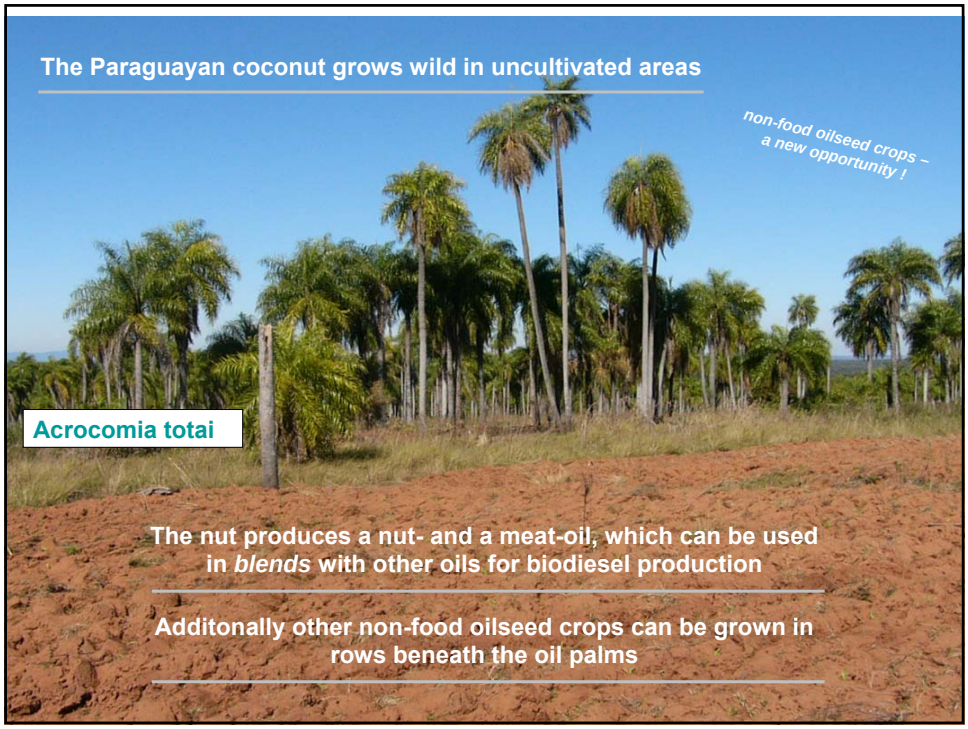
non-food oilseed crops – a new opportunity !

New non-food oilseed plants with highly suitable fatty acid profiles have been successfully investigated in China

Cornus wilsoniana - 光皮树

Camellia oleifera - 油茶



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what is the "ideal" biodiesel ?

Selection of blends needs careful consideration

Influencing criteria:

1. Chain length: Trade-off between energy and oxygen content

2. High level of unsaturation leads to high instability

Stability

Winter operability

Fatty Acid pattern - selected oilseeds:						
FA in %	00-rape	HO-sun	palm	coconut	jatropha	HEAR
8:0				6		
10:0				5		
12:0				49		
14:0			1	18		
16:0	4	3	42	9	13	3
18:0	2	4	5	3	6	1
18:1	60	91	41	7	38	18
18:2	21	3	11	2	42	13
18:3 →	11				0	6
20:1						9
22:1	1					49
total sat.	7	7	48	91	19	5
Iodine-no.	117	84	54	9	106	106
oxygen %	10,8	11	11,3	14,4	11	9,9
CFPP °C	- 7°		+ 11°			

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ranked by IV

all the world's oilseeds

Can we find the ideal fatty acid profile ?

FAME	Labornr:	C 8:0	C 10:0	C 12:0	C 14:0	C 16:0	C 18:0	C 20:0	C 22:0	C 24:0	C 18:1	C 22:1	C 18:2	C 18:3	Gesamt: [%]	Iodine Value [g of Iodine / 100g Fame]
Coconut Fat - ME	05-308	7,0%	5,7%	42,4%	18,1%	11,3%	4,2%				8,7%		2,5%		100,0%	11,8
Acrocomia Nut Oil - ME	04-358	5,4%	4,5%	38,2%	8,8%	8,2%	3,3%				27,9%		3,6%		100,0%	30,2
Palm Fat - ME	05-141				1,3%	44,7%	5,4%	0,5%			37,2%		10,8%		100,0%	50,8
Lard - ME	04-319			0,4%	2,3%	29,6%	20,0%				33,2%		13,1%	1,5%	100,0%	55,0
Animal Fat - ME	05-107				2,3%	29,8%	17,1%				37,7%		11,5%	1,7%	100,0%	56,8
HO Sunflower Oil - ME	05-102					5,2%	4,2%		2,0%		78,7%		10,0%		100,0%	84,9
Soy Oil - ME HighOleic	05-710					5,4%	4,1%				81,3%		3,8%	5,3%	100,0%	90,4
Jatropha Oil - ME	05-728					17,7%	7,9%				37,8%		36,6%		100,0%	95,9
Used Frying Oil - ME high visc.	05-344					16,5%	5,9%	0,9%	1,2%		40,9%		26,8%	7,9%	100,0%	102,1
Canola Oil - ME	05-693					5,6%	2,4%	1,0%	0,8%		63,6%		23,4%	3,2%	100,0%	103,6
Used Frying Oil - ME low visc.	05-339					14,3%	5,0%	1,0%	1,2%		41,6%	0,8%	27,4%	8,8%	100,0%	106,8
Soy Oil - ME MidOleic	05-709					11,1%	5,0%	0,6%	0,9%		43,7%		35,5%	3,1%	100,0%	107,1
Rapeseed Oil - ME	05-333					6,0%	2,4%	0,9%			59,3%		28,6%	2,7%	100,0%	107,8
Milk Thistle Oil - ME	05-178					10,0%	6,2%	4,1%	3,9%	1,2%	22,7%		50,7%	1,2%	100,0%	110,4
Rapeseed Oil - ME	05-330					6,9%	2,5%	1,0%	0,8%		58,0%		20,9%	9,8%	100,0%	111,8
HEAR OIL - ME	05-093					4,3%	1,2%	0,9%	1,0%		14,0%	47,2%	15,5%	15,8%	100,0%	114,4
Rapeseed Oil - ME	04-260					6,3%	2,3%	0,9%			57,9%		22,2%	10,4%	100,0%	115,4
Rapeseed Oil - ME	05-348					5,7%	2,3%	0,9%	0,7%		57,1%		22,7%	10,5%	100,0%	115,9
Soy Oil - ME LowLin	05-701					12,1%	6,1%	0,5%	0,7%		24,2%		54,9%	1,5%	100,0%	119,8
Sunflower Oil - ME	05-078					8,0%	4,7%		1,2%		28,9%		56,5%	0,7%	100,0%	124,6
Soy Oil - ME	05-314					13,0%	4,9%	0,5%	0,8%		23,9%		49,6%	7,3%	100,0%	125,5
Rapeseed Soy Oil-ME	05-108					12,3%	5,6%		0,7%		22,1%		52,1%	7,3%	100,0%	128,3
Soy Oil - ME Regular	05-700					12,5%	5,2%				22,3%		50,2%	9,8%	100,0%	131,8
Camelina Oil - ME	04-321					6,7%	3,0%	2,3%	0,7%		14,3%	6,5%	18,2%	48,4%	100,0%	175,0
Linseed Oil - ME	05-166					6,1%	4,6%				17,5%		15,9%	55,9%	100,0%	188,9

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balancing pros and cons

What are the selection criteria ?

Iodine number (IN): indication for *fuel stability*, negatively influenced by higher number of double-bonds in fatty acids (FA).

Net calorific value: indication for *energy content*, negatively influenced by higher content of oxygen e.g. in short-chain fatty acids.

Cold filter plugging point (CFPP): indication for *winter operability*, negatively influenced by higher content of saturated FA.

Cetane number: indication for *ignition behaviour*.

Distillation curve: indication for *smoothness of combustion*.

…... a clever blend of various oils can result in the "super-biodiesel"

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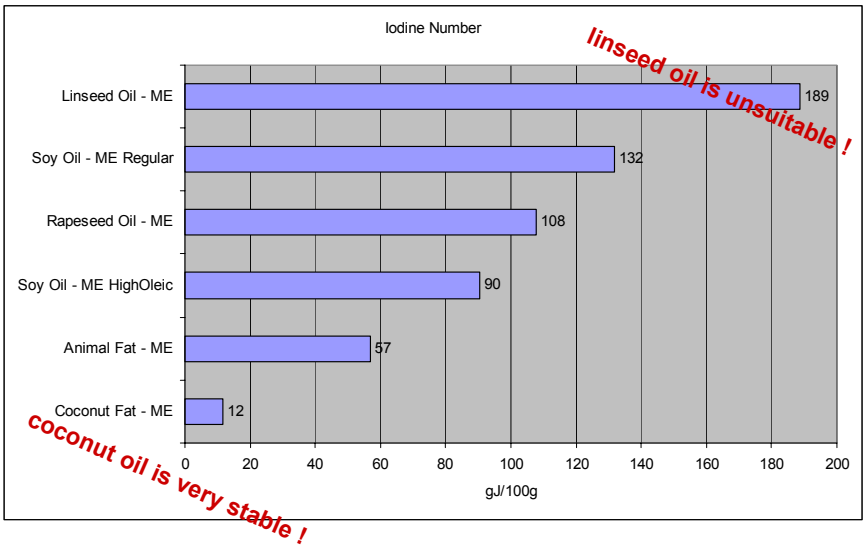
Iodine number (IN) – indication for stability



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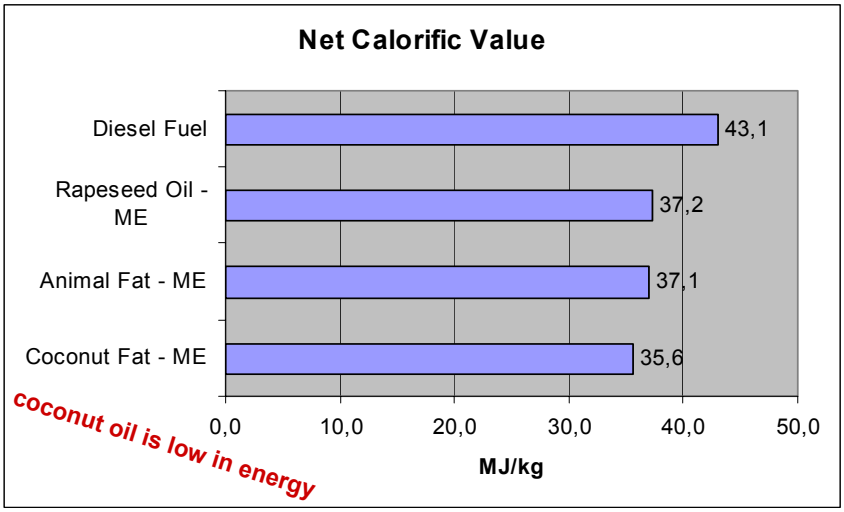
Net calorific value – energy content



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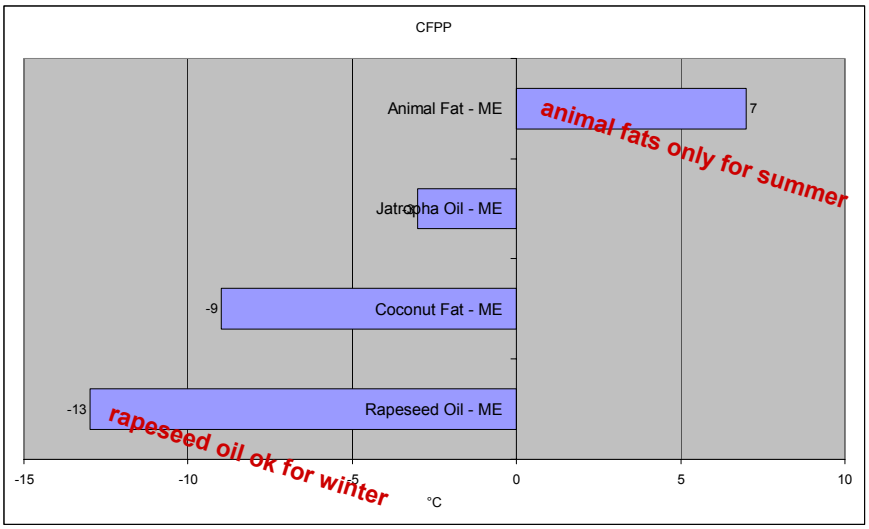
Cold filter plugging point – winter operability



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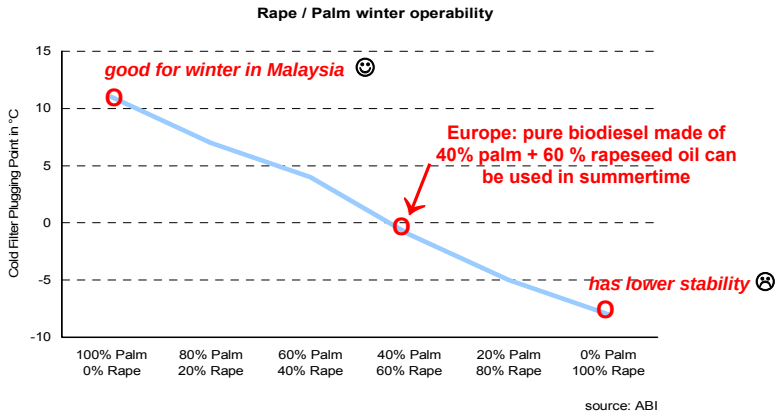
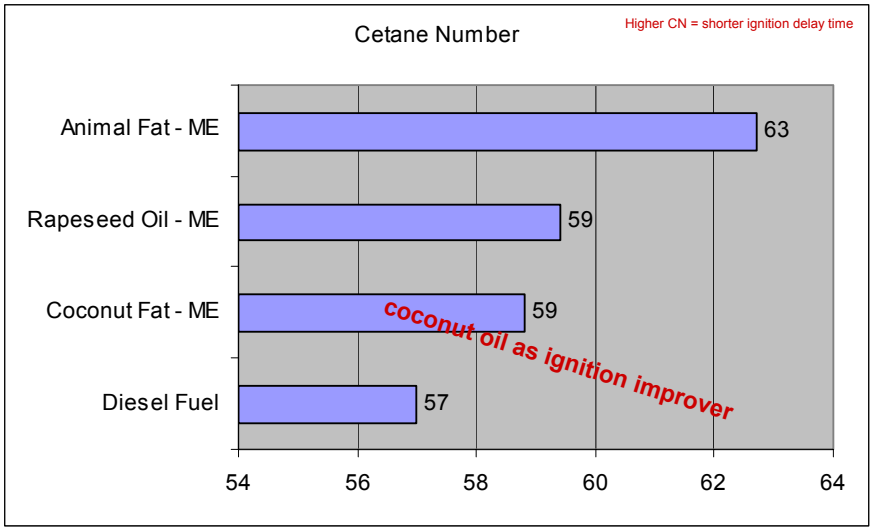
….. one can optimise feedstock cost by intelligent blending

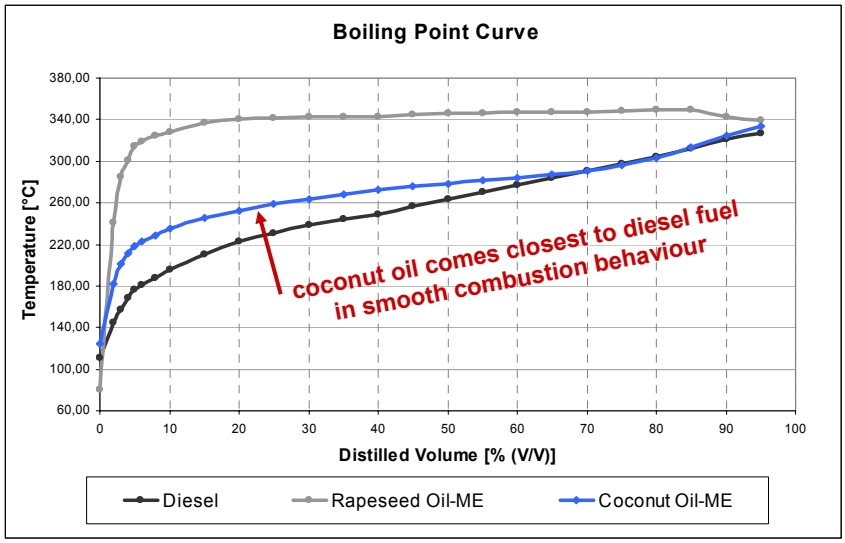


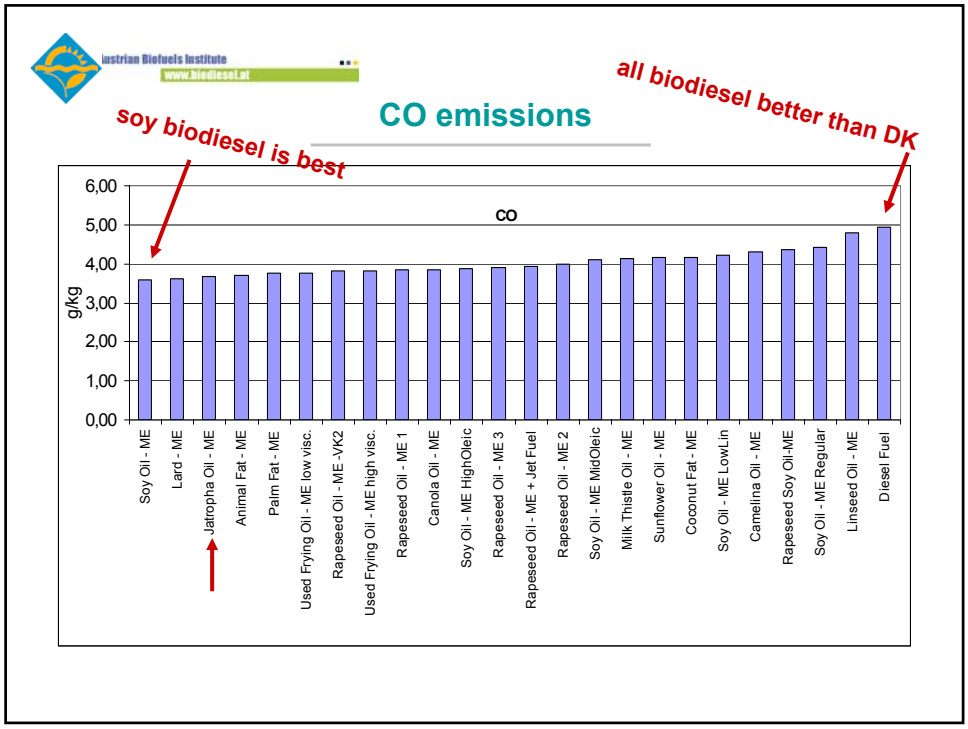
source: ABI

Cetane number



Distillation characteristics

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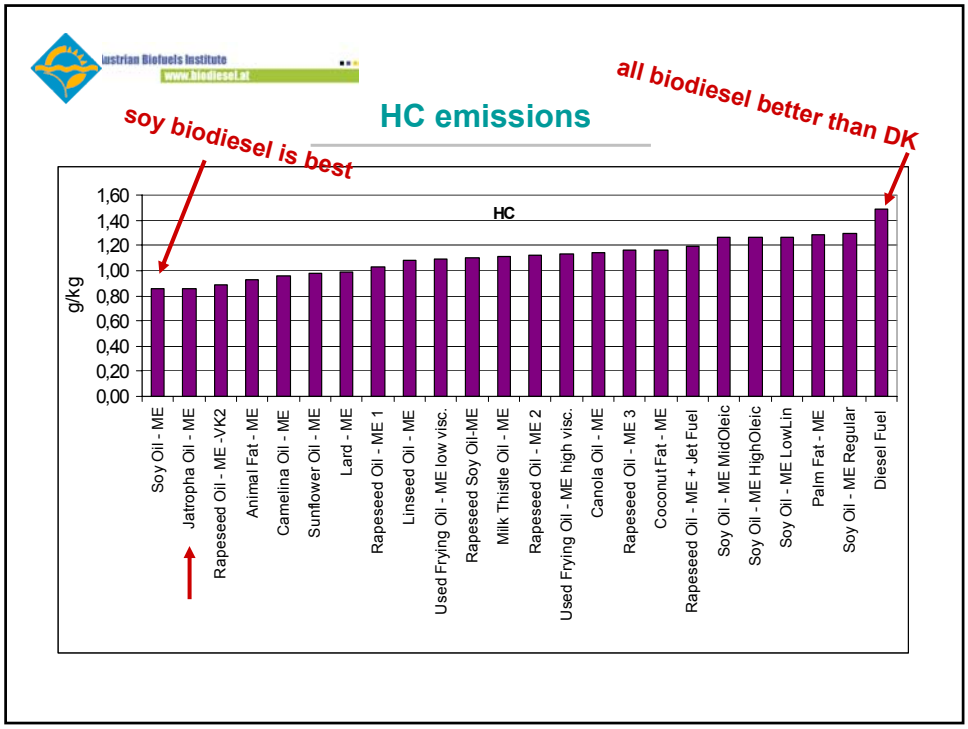
CO emissions
soy biodiesel is best
all biodiesel better than DK
CO
g/kg
6,00
5,00
4,00
3,00
2,00
1,00
0,00
Soy Oil - ME
Lard - ME
Jatropha Oil - ME
Animal Fat - ME
Palm Fat - ME
Used Frying Oil - ME low visc.
Rapeseed Oil - ME -VK2
Used Frying Oil - ME high visc.
Rapeseed Oil - ME 1
Canola Oil - ME
Soy Oil - ME HighOleic
Rapeseed Oil - ME 3
Rapeseed Oil - ME + Jet Fuel
Rapeseed Oil - ME 2
Soy Oil - ME MidOleic
Milk Thistle Oil - ME
Sunflower Oil - ME
Coconut Fat - ME
Soy Oil - ME LowLin
Camelina Oil - ME
Rapeseed Soy Oil-ME
Soy Oil - ME Regular
Linseed Oil - ME
Diesel Fuel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HC emissions
soy biodiesel is best
all biodiesel better than DK
HC
g/kg
1,60
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
Soy Oil - ME
Jatropha Oil - ME
Rapeseed Oil - ME -VK2
Animal Fat - ME
Camelina Oil - ME
Sunflower Oil - ME
Lard - ME
Rapeseed Oil - ME 1
Linseed Oil - ME
Used Frying Oil - ME low visc.
Rapeseed Soy Oil-ME
Milk Thistle Oil - ME
Rapeseed Oil - ME 2
Used Frying Oil - ME high visc.
Canola Oil - ME
Rapeseed Oil - ME 3
Coconut Fat - ME
Rapeseed Oil - ME + Jet Fuel
Soy Oil - ME MidOleic
Soy Oil - ME HighOleic
Soy Oil - ME LowLin
Palm Fat - ME
Soy Oil - ME Regular
Diesel Fuel

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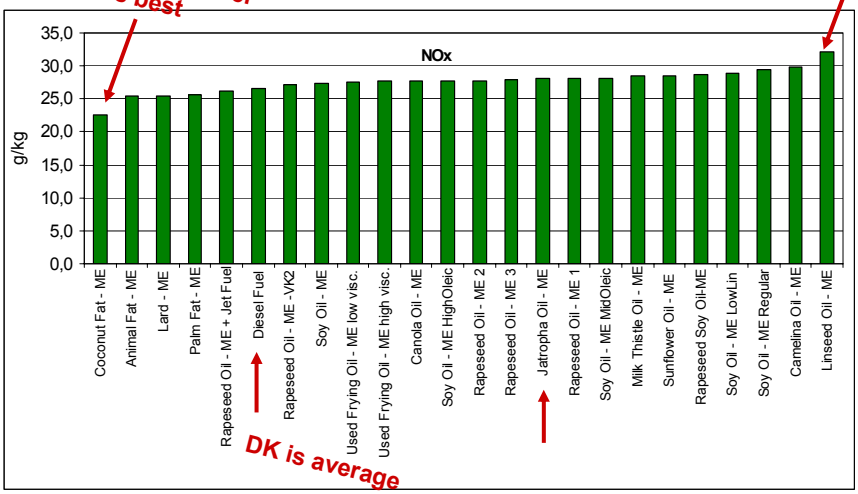
NO_x emissions

coconut biodiesel is best

linseed biodiesel is worst



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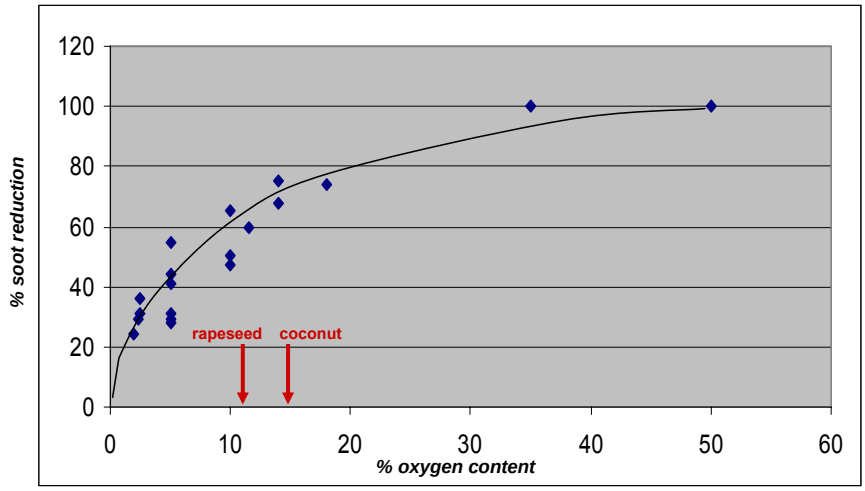
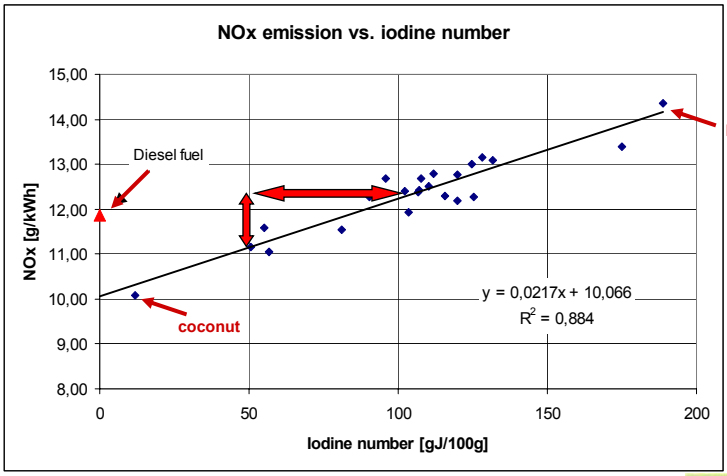
Correlation: the higher the oxygen content the lower the soot emissions



Source: TU Graz

Correlation: the lower the Iodine number the lower the NO_x emissions



BLT WIESELBURG

Biodiesel process technology has become very efficient

- Level of **yield** obtained by the process - **not less than 99%** .
- Reducing cost by flexibility to handle **multi-feedstock** oils and fats - including "dirty" high FFA feedstock.
- Utilising **flexible process control** and multi-feedstock recipe data bank.
- Installing a reliable **quality assurance** systems **(> EN14214)** able to produce higher quality.
- Produce at practically **no waste**.

▶ only the efficient and high quality biodiesel producer will succeed

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work in progress !

… there is plenty of choice among biodiesel process suppliers

Process technology company	Yield: % of triglycerides and FFA 1)	Ability to process feedstock with high ---------- low quality: 0 % Fully refined oil	< 1 % De-gummed oil	< 2	< 5 %	< 10 % Recycled oils and fats	> 10 % Render-ing fats	Reference plants in operation / firm orders approx.	Required acreage for 250.000 t unit in m²	Plant sizes built / ordered in 1.000 t / y
AT-Agrartechnik	96 - 97	yes	n.a.	n.a.	yes	no	no	4/26	n.a.	53 - 75/ 250
Axens	n.a.	yes	no	no	no	no	no	1/2	n.a.	160/ 165
BDI	99	yes	yes	yes	yes	yes	yes	9/11	n.a.	5 – 50/ 100
Christof MB	102 2)	yes	yes	yes	yes	yes	yes	4/5	n.a.	5 – 30/ 250
Crown	n.a.	yes	n.a.	n.a.	n.a.	no	no	n.a.	n.a.	n.a./ 250
Desmet Ballestra	n.a.	yes	n.a	n.a	n.a	n.a	no	7/38	n.a.	100/ 250
Energea	99	yes	yes	yes	yes	yes	yes	3/ n.a.	1.190	40 - 250
Lurgi	95 - 97	yes	yes	yes	yes	n.a	n.a	7/14	n.a.	40 - 100/ 200
Westfalia	95 - 97	yes	n.a.	n.a.	no	no	no	3/ n.a.	n.a.	100 – 120/ 350

1) Basis: chemically degummed oil 2) Starting with water degummed oil

Source: technology company interviews, published information, ABI analysis

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Beside process technology **site** selection is crucial

- Extent in exploiting synergies of existing industrial activities:
  - Chemical industry park (methanol, service)
  - Oilseed crushing plant
  - Shared personnel and maintenance cost
  - Oil refinery for direct blending
- best logistic and low transport cost locations:
  - Deep sea or river harbour
  - Train connections

site matters !

▶ **Biodiesel production sites with synergies have an advantage**

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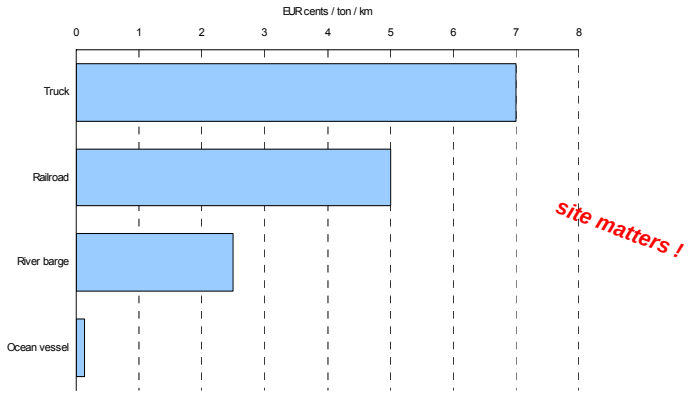
Transportation by water is more efficient than by land

Costs by mode of transportation



Source: Vienna University of Economics, Institute for Transportation and Logistics

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Biodiesel production development is strongly increasing

► **Small is beautiful (?) but not efficient and not at all economic !**

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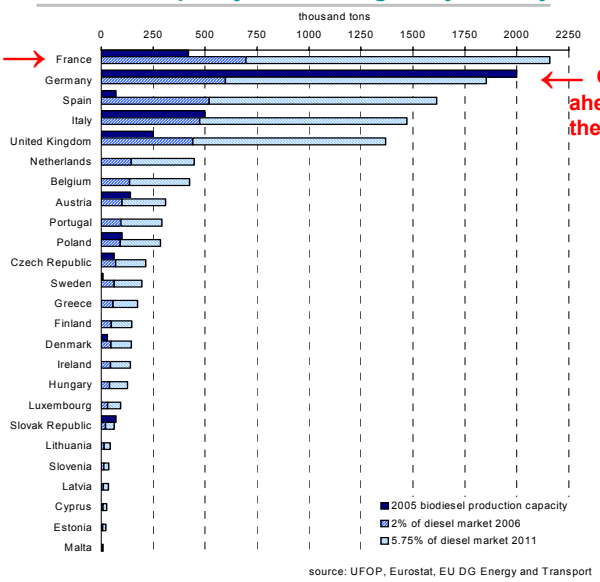
Biodiesel capacity and EU targets by country

France is the largest diesel fuel consumer

Germany is far ahead and leading the biodiesel pack



source: UFOP, Eurostat, EU DG Energy and Transport

hatched

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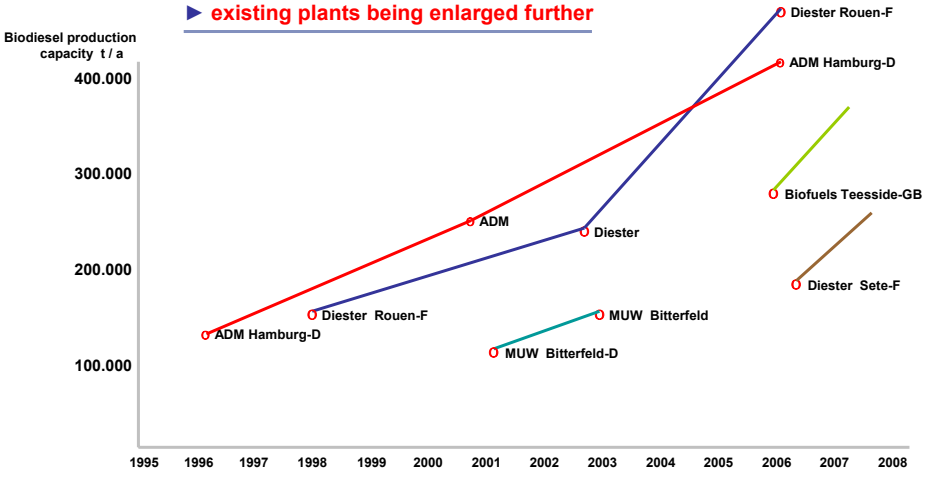
Challenge for process technology providers: dramatic increase in production capacity :

- new plants starting with sizeable volumes
- existing plants being enlarged further



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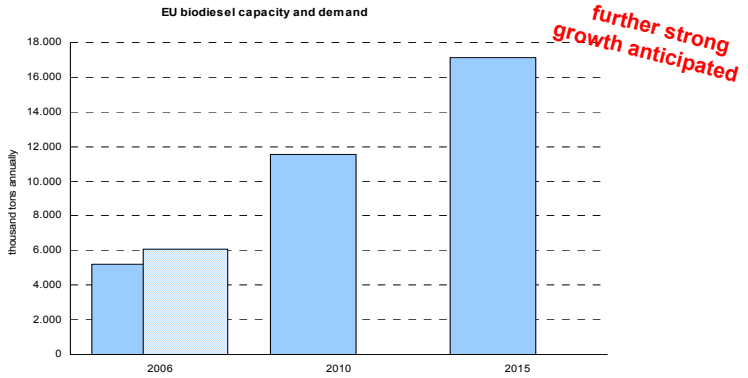
EU Biodiesel targets need additional biodiesel capacity

EU25 installed capacity	2006	2010	2015
Installed capacity EU25 mid 2006	6.069		
Targeted / expected EU25 demand	5.187	11.544	17.133



source: EBB, Eurostat, EU DG Transport and Energy, Total

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France: Diester & Bunge / Grand Couronne – expanding from 250.000 t to 500.000 t

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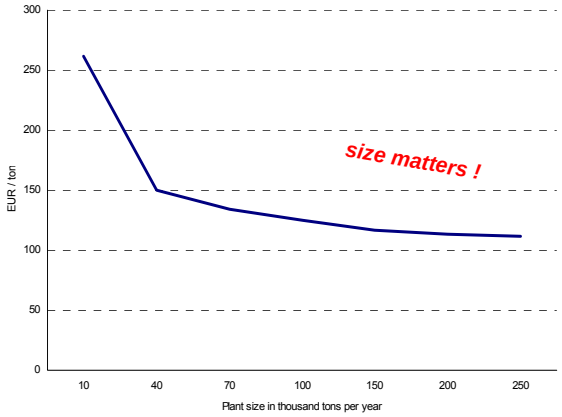
The larger the plant, the lower the cost per liter

Estimated production cost per ton of biodiesel vs. plant capacity



Note

- Fully loaded production cost excluding feedstock oil cost. The feedstock oil price must be added to the production cost to determine the breakeven sales price for biodiesel per ton.
- As facility size increases, less fixed costs such as depreciation and interest are spread over each ton of product, so total production costs per ton approach the variable costs per ton.
- The kink from 10,000 to 40,000 tons capacity is due to the low number of plant offers ABI has seen at these sizes. If more offers were received, the curve would be smoother.

Source: Plant manufacturer offers, ABI analysis

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Marketing strategies are changing

► Biodiesel is / was sold as the cheap fuel at the public fuel pumps in Austria and Germany so far

→

← ←

► Biodiesel is no longer differentiated as the environmentally friendly fuel

► **Switch in positioning from marketing as pure, environmentally friendly fuel to an optimised blending component for fossil diesel fuel in refineries**

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A remaining visible market segment ? - may be the city bus fleet

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European Directives have set a strong impulse for fast expansion !

Supportive legislative framework for Europe

- **EC Directive for the Promotion of Liquid Biofuels:**
  Semi-obligatory market shares :
  - **2 % by 2005**
  - **5,75 % by 2010**
  - **10 % as intended target for 2020**
- **EC Directive for the Quality of Fuels**
- **EC Directive on Taxation of Fuels**

► **European legislation is pushing the markets thus creating export opportunities for many non-European countries with feedstock potential**

► **Intelligent national legislation can create attractive market conditions**

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The triggers for the biofuels legislation are …

1. ***Reduction of greenhouse gas emissions* as caused by the transport sector**
2. ***Assurance of energy supply security* for the transport sector (mobility)**
3. ***Create economic value added* by energy production within the European Union** ***(the same motive applies for any other country as well)***

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… one driving force: impact on reducing the greenhouse gas effect

Production of CO_{2eq} per 1 kg DFE (Diesel Fuel Equivalent = 42,7 MJ):

- ***Biodiesel produces:*** ***0,73 kg CO_{2eq} / 1 kg DFE***
- ***fossil Diesel produces:*** ***3,63 kg CO_{2eq} / 1 kg DFE***
- ***reduction of*** ***2,90 kg CO_{2eq} - emissions / 1 kg Biodiesel***
- ***Avoiding cost of US$ 0,64 per 1 kg Biodiesel in average.***

Average costs for industrialised countries per ton of avoided CO_{2eq} is US$ 220

Source: Frauenhofer Institute, Germany; 1993

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… another trigger: reducing strategic cost to assure energy supply

- ***Generating and sustaining US military forces in peacetime in the Persian Gulf causes expenses of***
- ***US $ 60 billion, which is related to US imports of 6,2 billion barrels oil (1992)***
- ***US national security cost of US$ 9,70 / barrel mineral oil***
- ***Avoiding cost of US$ 9,70 per barrel mineral oil.***

Source:
Ravenal, The National Security Cost of Petroleum, US Governors' Ethanol Coalition;
June 1994

… and what are Mr. Putin's ideas about secured energy supply ?

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… but do we have enough land for all that Biodiesel ?

FAO has calculated that today
….. 41,88 million km² land are available for agriculture
….. although just 15,06 mill km² are in use;
….. 0,11 million km² are used for biofuels production today,
….. which is no more than 1 % of that area

FAO estimates that in 2030
….. 0,325 million km² will be used for biofuels production
….. this is no more than 2 % of total agricultural land use

Source: FAO – April 2007 / Dr. Josef Schmidhuber / Lourens Gengler (NL)
1 km² = 100 ha =1,000.000 m²

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Information availability has increased significantly

Recent studies published by the Austrian Biofuels Institute :

1. "Best Case Studies of Biodiesel Production Plants in Europe"
2. "Review on Biodiesel Standardisation World-wide" CD-ROM
3. "World-wide Review of Biodiesel Production" CD-ROM
4. "Biodiesel Process Technology Survey – Europe" *... in completion !*
5. "Clean Transport for Modern Cities" – DVD *... in 6 languages*

- Easy access to a wide field of biodiesel know-how
- Overcoming barriers: broad communication - e.g. our meeting