

# Microalgae as a Future Energy Source

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“Transport Biofuels Research in Austria”  
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*Our future. Clean energy.*

# BIODIESEL

## BioDiesel – Fattyacidmethylester, FAME

Environmentally friendly, high-quality, alternative fuel for diesel engines

produced from renewable feedstock like e.g

⇒ **Vegetable oils**

Rapeseed oil, Soybean oil,  
Palm oil, Linseed oil,  
Sunflower oil, Jatropha oil, ...

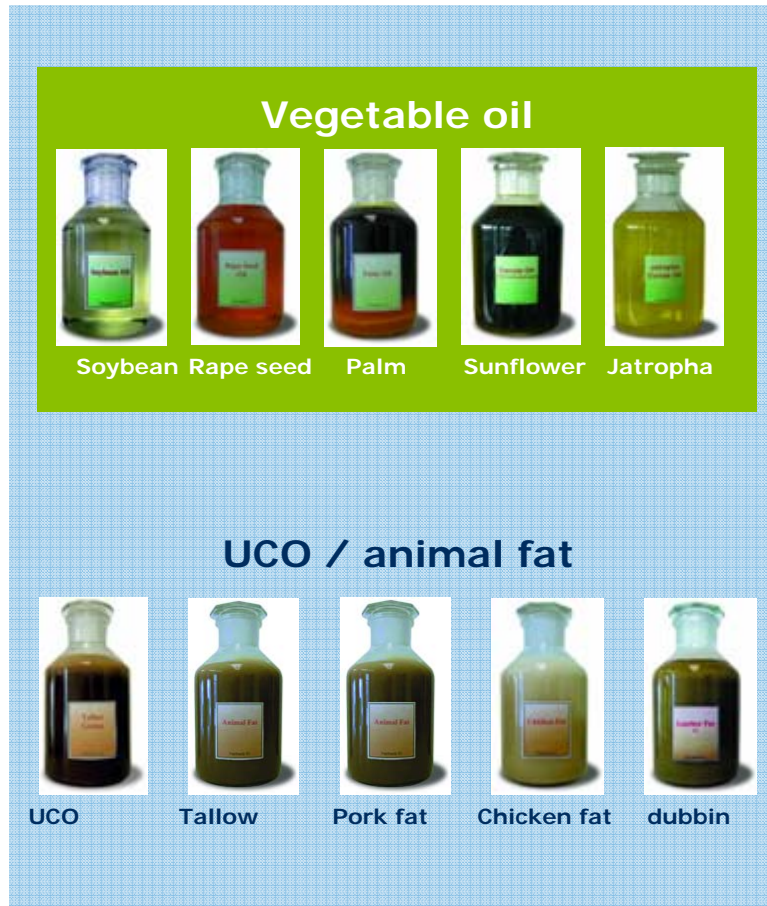
⇒ **Used cooking oil**

⇒ **Animal fat**



# BIODIESEL

## Single- Multi-Feedstock



Single-Feedstock

Multi-Feedstock

## USP of BDI

Highest raw material flexibility

Maximum yield

Proven technology, own patents

Numerous references

More than 15 years experience with BioDiesel



# REFERENCES

1991 / A



Nr. 1

1991 / A



Nr. 2

1992 / A



Nr. 3

1994 / Cz



Nr. 4

1998 / US



Nr. 5

2001 / D



Nr. 6

2002 / E



Nr. 7

2002 / D



Nr. 8

2003 / A



Nr. 9

2005 / Uk



Nr. 10

2006 / A



Nr. 11

2006 / E



Nr. 12

2006 / E



Nr. 13

2006 / D



Nr. 14

2007 / Lv



Nr. 15

2007 / AUS



Nr. 16

2006 / LIT



Nr. 17

2007 / E



Nr. 18

2007 / E



Nr. 19

2007 / D



Nr. 20

2007 / A



Nr. 21

2007 / Pt



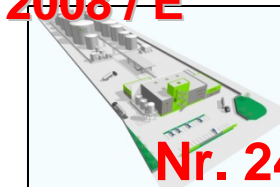
Nr. 22

2007 / Dk



Nr. 23

2008 / E



Nr. 24

2008 / E



Nr. 25

2008 / E



Nr. 26

2008 / Ir



Nr. 27

2008 / N



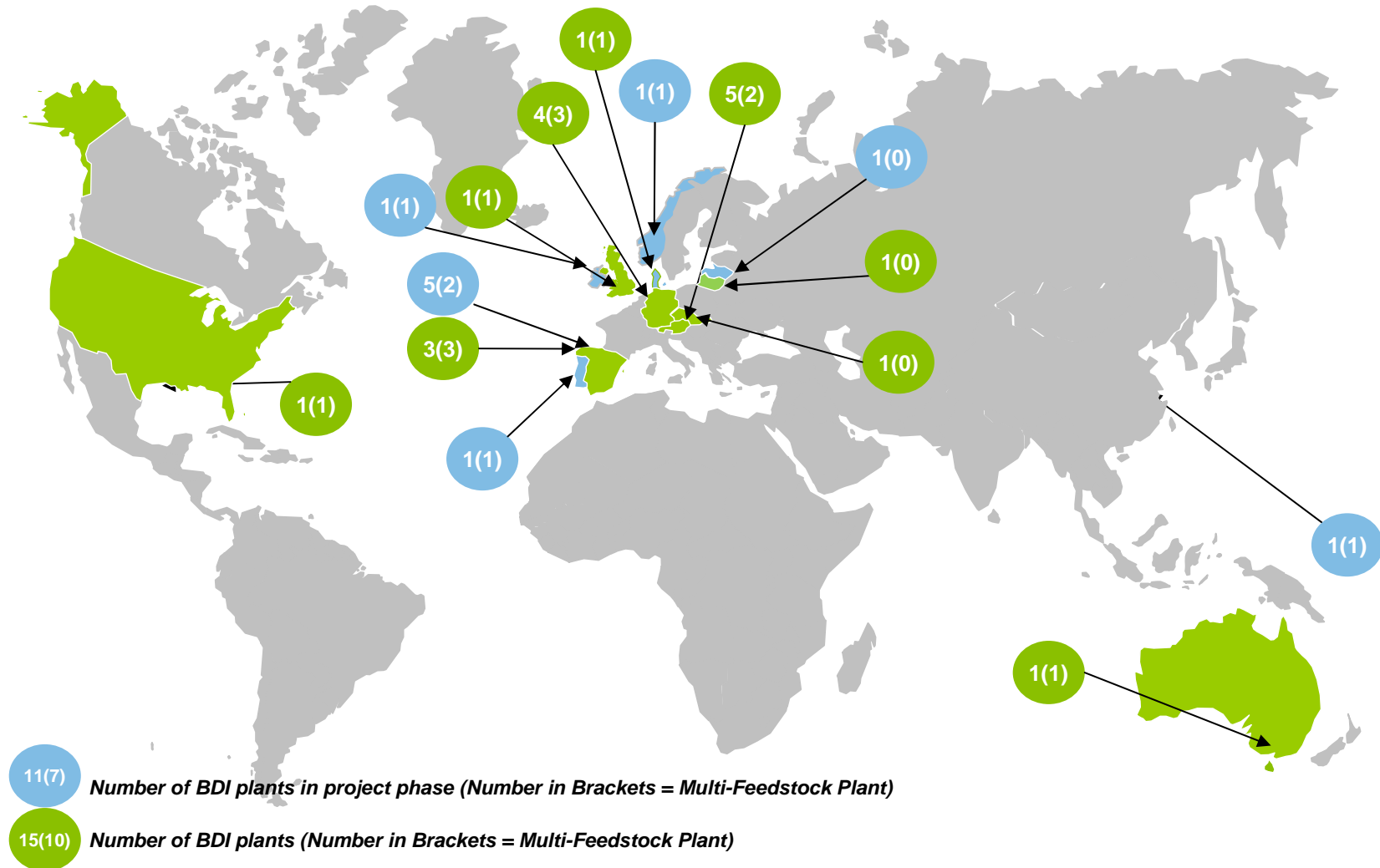
Nr. 28

2009 / HK



Nr. 29

# REFERENCES



# BIOFUEL TARGET

	2005	2010
Mengenziel	2 %	5,75 %
Dieselmotorenverbrauch <sup>1</sup>	158,6 Mio. t	165,0 Mio. t <sup>4</sup>
Biodieselbedarf <sup>2</sup>	3,69 Mio. t	11,0 Mio. t
Flächenbedarf <sup>3</sup>	2,63 Mio. ha	7,88 Mio. ha
Ottomotorenverbrauch <sup>1</sup>	124,8 Mio. t	113,6 Mio. t <sup>4</sup>
Ethanolbedarf <sup>2</sup>	3,7 Mio. t	9,7 Mio. t
Flächenbedarf <sup>3</sup>	1,85 Mio. ha	4,84 Mio. ha
Gesamtfläche	4,48 Mio. ha	12,72 Mio. ha

Quelle: **Biofuels in the European Union**

A VISION FOR 2030 AND BEYOND

**Arable land EU-25: 100 Mio. ha**

# CO<sub>2</sub> MITIGATION

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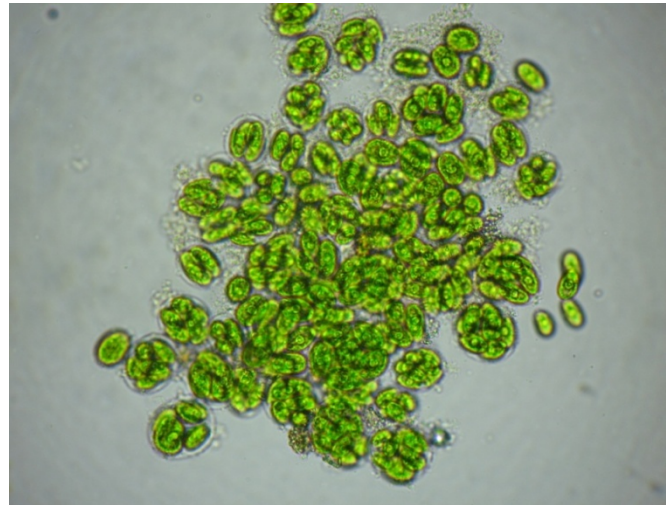


**Trading of CO<sub>2</sub>-Emissions contribution to decrease the greenhouse effect**

**CO<sub>2</sub> Certificate Trading from 2006 to 2007 nearly doubled:  
increased to 40 billion Euro  
2,7 billion tons CO<sub>2</sub>**

Institute Point Carbon (Oslo)

# ALGAE



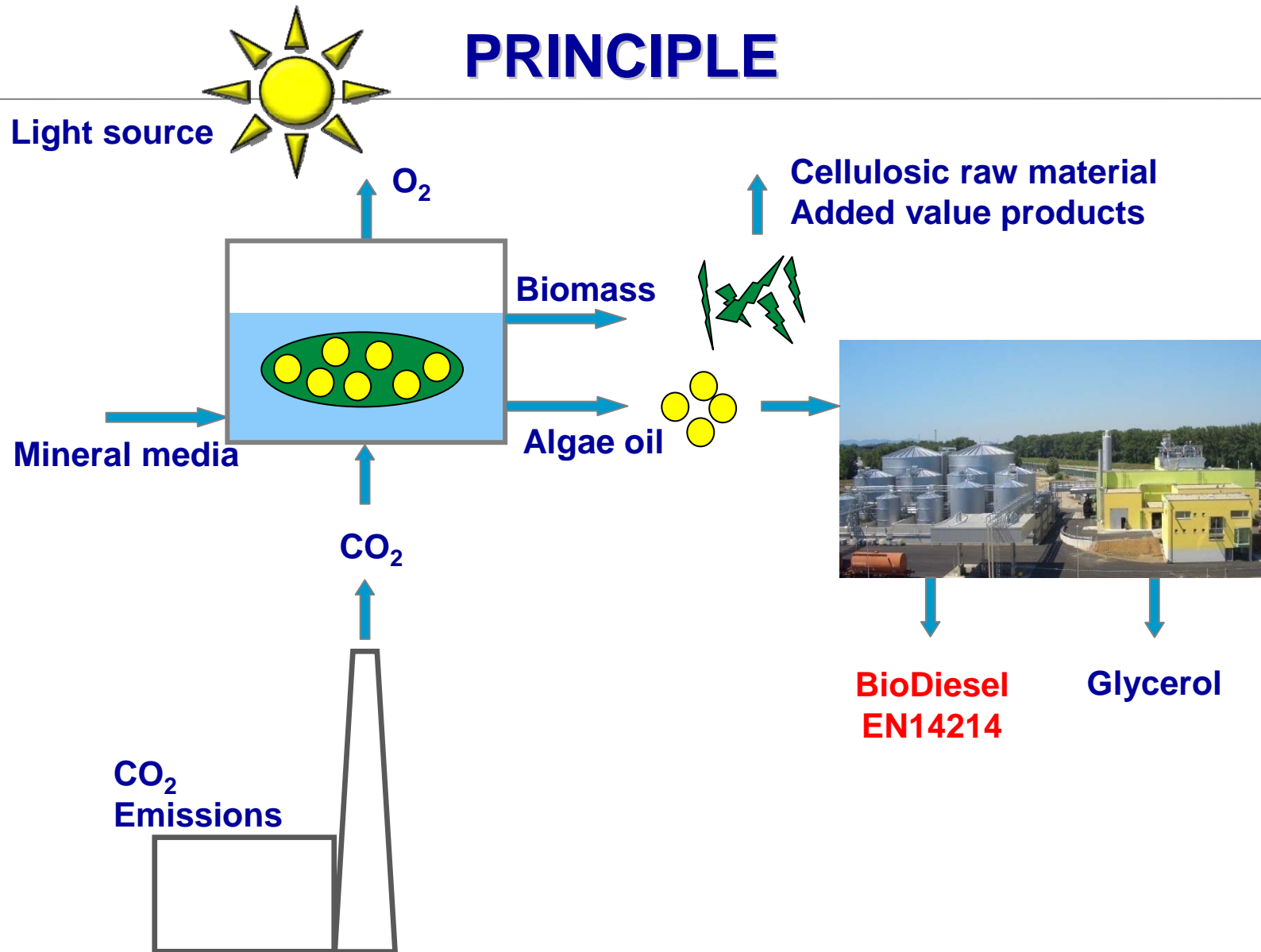
**2 t CO<sub>2</sub>  $\longrightarrow$  1 t algae biomass**

**Market: pharmaceuticals  
platform chemicals**

**Market value: 5000 t/year  
1 billion US\$**



# PRINCIPLE



# POTENTIAL

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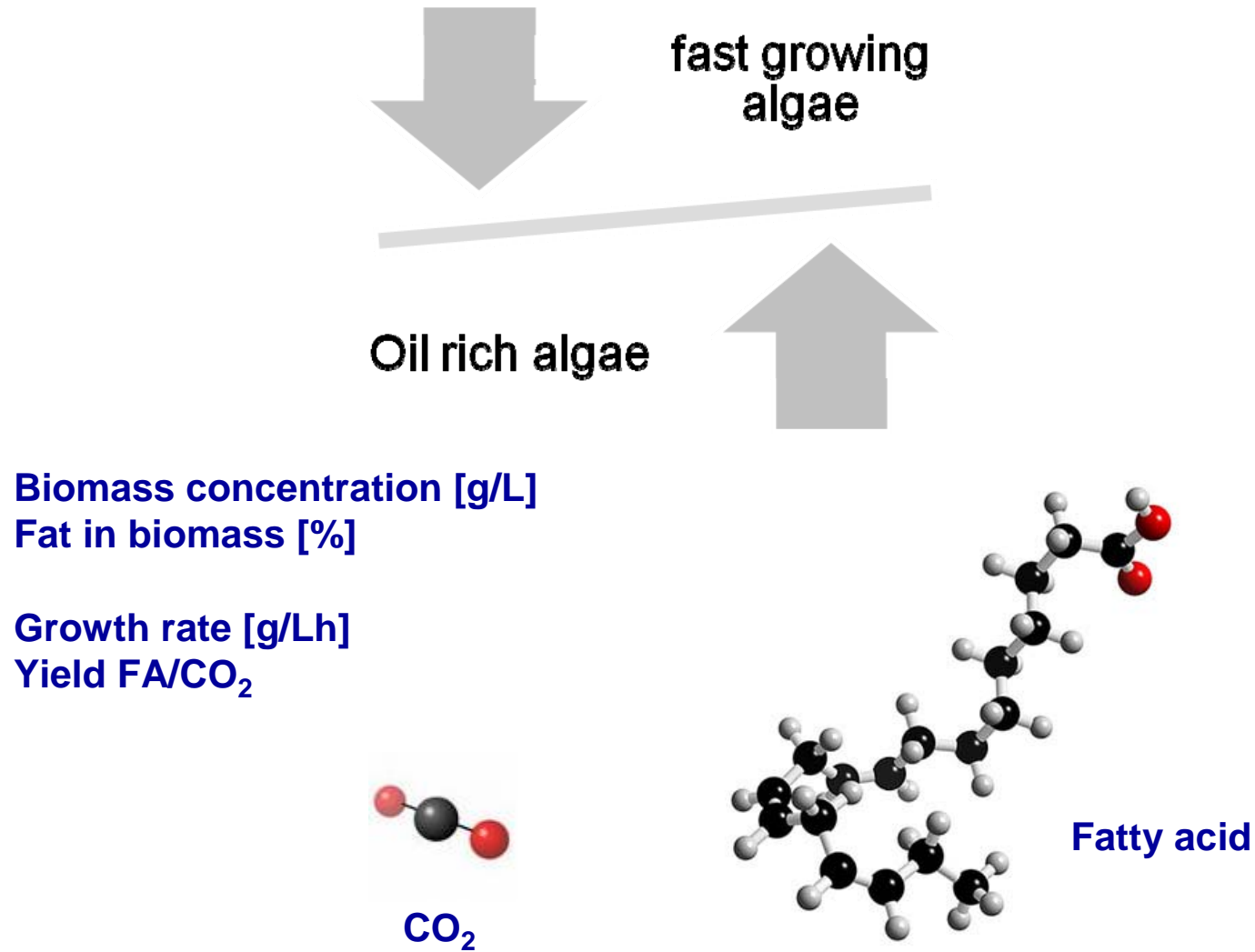
.....annual production of 150 t/ha biomass.....

- Full scale plant performance is extrapolated from pilot scale data
- Mechanisms of photosynthesis are ignored: 45% of sunlight has the suitable wavelength (400-700nm) to drive photosynthesis

Mario Tredici, Oil from microalgae, International symposium on Microalgae and Seaweed Products in Agriculture, Mosonmagyar, 2008

**Realistic estimation: 50-88 t biomass/ha**

# Relevant Processing Data



# PROCESS

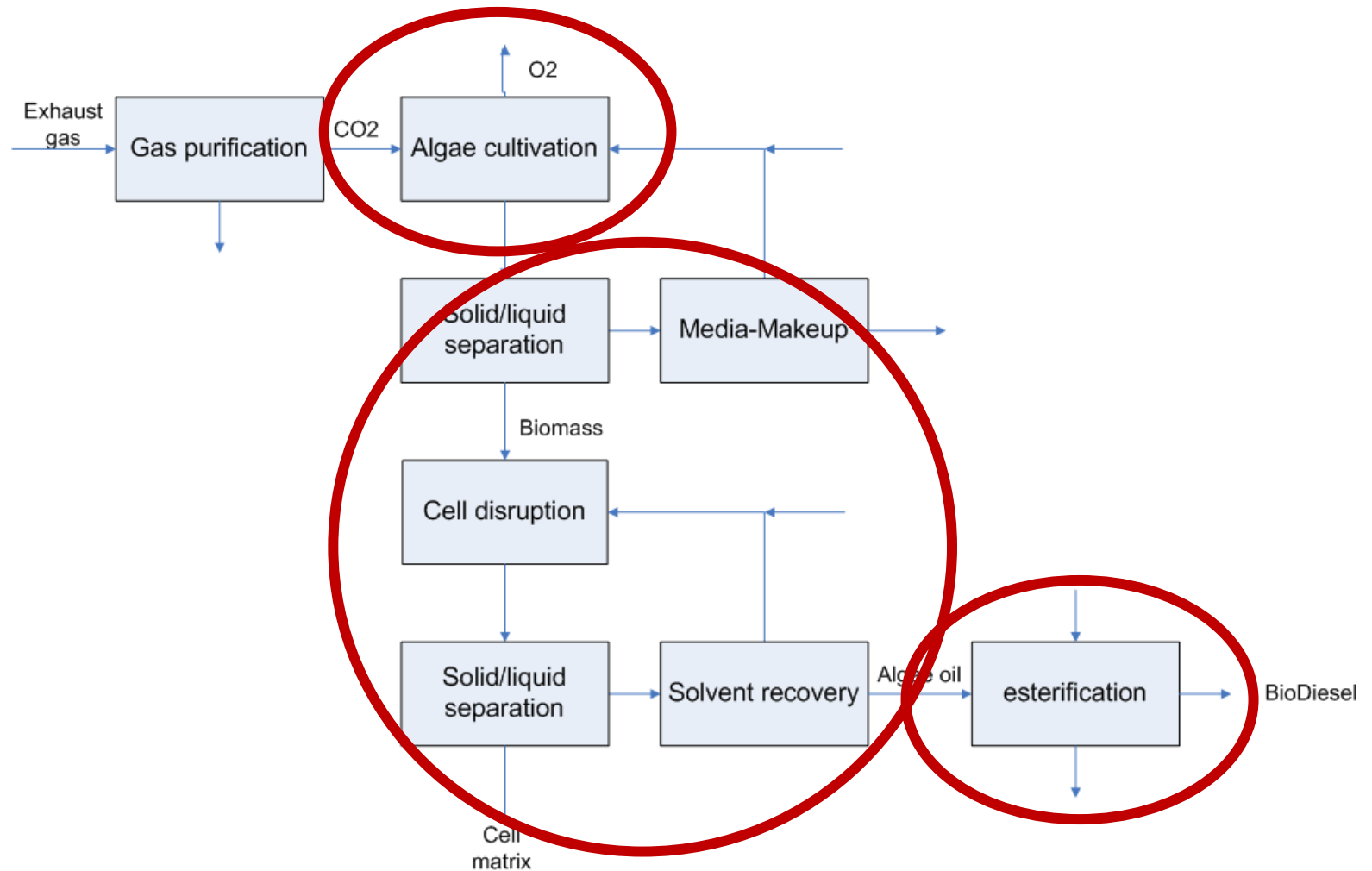


Organism  
 cooperation  
cultivation BDI  
 Lab scale  
 Lab reactor

solid/ liquid separation  
 Filtration  
 Centrifugation  
oil out of biomass  
 solvent Extraction  
 scCO<sub>2</sub> Extraction  
 mechanical process

**BDI Knowledge**

# PROCESS

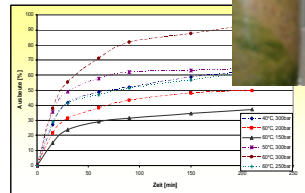
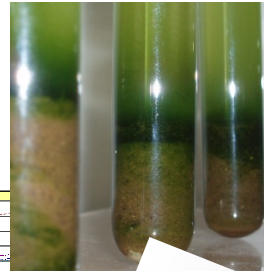




# PROCESS



**Selection of  
experimental  
procedure**



**Experimental data**

**Modelling of  
processes for  
Scale up**



# COLD PROPERTIES

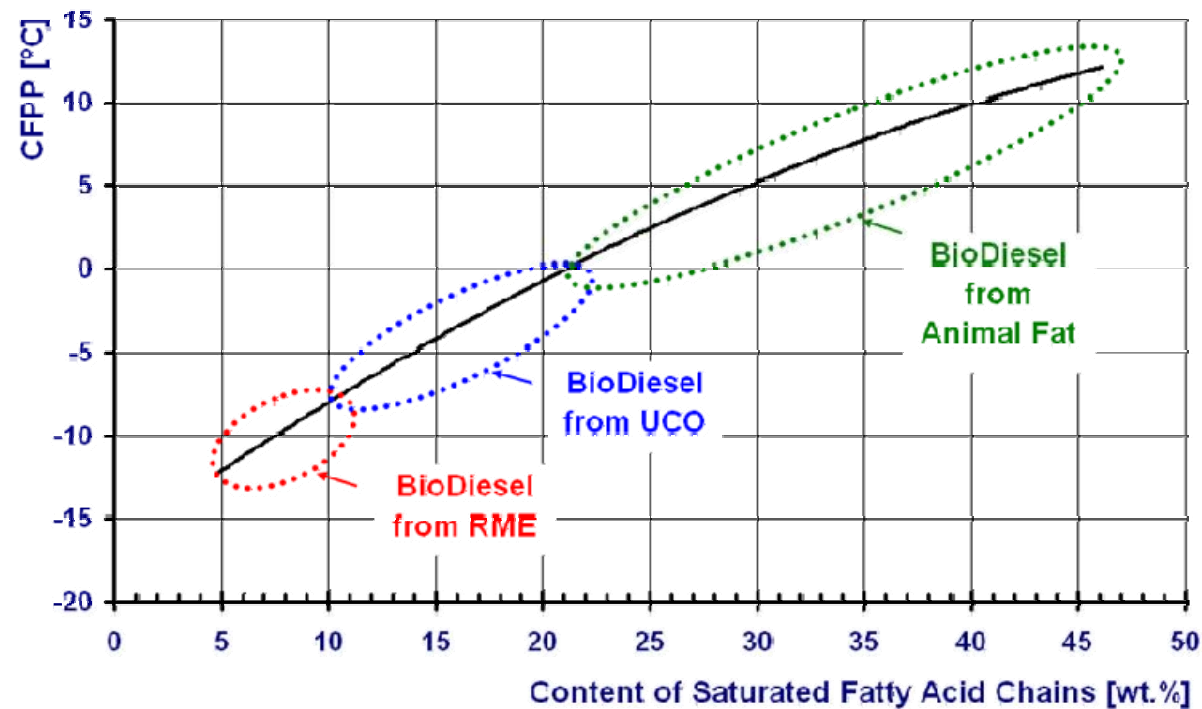
## CFPP value

Quality criterion

Partial solidification, may cause blockage of fuel line and filters

Indicators for operability limits

Algae CFPP 6-11°C



# PROPERTIES

## Iodine number

Measure of total unsaturation

Limited to  $<120\text{g I}_2/100\text{g}$

Linked with oxidation stability

Raw material source	Iodine number BioDiesel
Sun flower	130-145
Rape seed	95-120
Tallow	35-50
Algae	73-90

# COOPERATION

**University of  
Technology  
Graz/Austria**



**Prof. Dr. Matthäus Siebenhofer**  
Institute of Chemical Engineering and  
Environmental Technology



## Research

- Gas purification
- Downstream processing



# COOPERATION



**Prof. Dr. Michael Schagerl**  
Department of Marine Biology



## Research

- Cultivation of microalgae
- Organism screening





# COOPERATION



**Prof. Dr. Martin Mittelbach**  
Institute of Chemistry



**Research**  
Biodiesel from  
Alternative Feedstock



# SUMMARY

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## STRENGTH

- No need of arable land
- Carbon from flue gas
- No pesticides
- Higher oil yield than traditional crops

## WEAKNESS

- High investment costs
- High production costs in cultivation/ harvesting

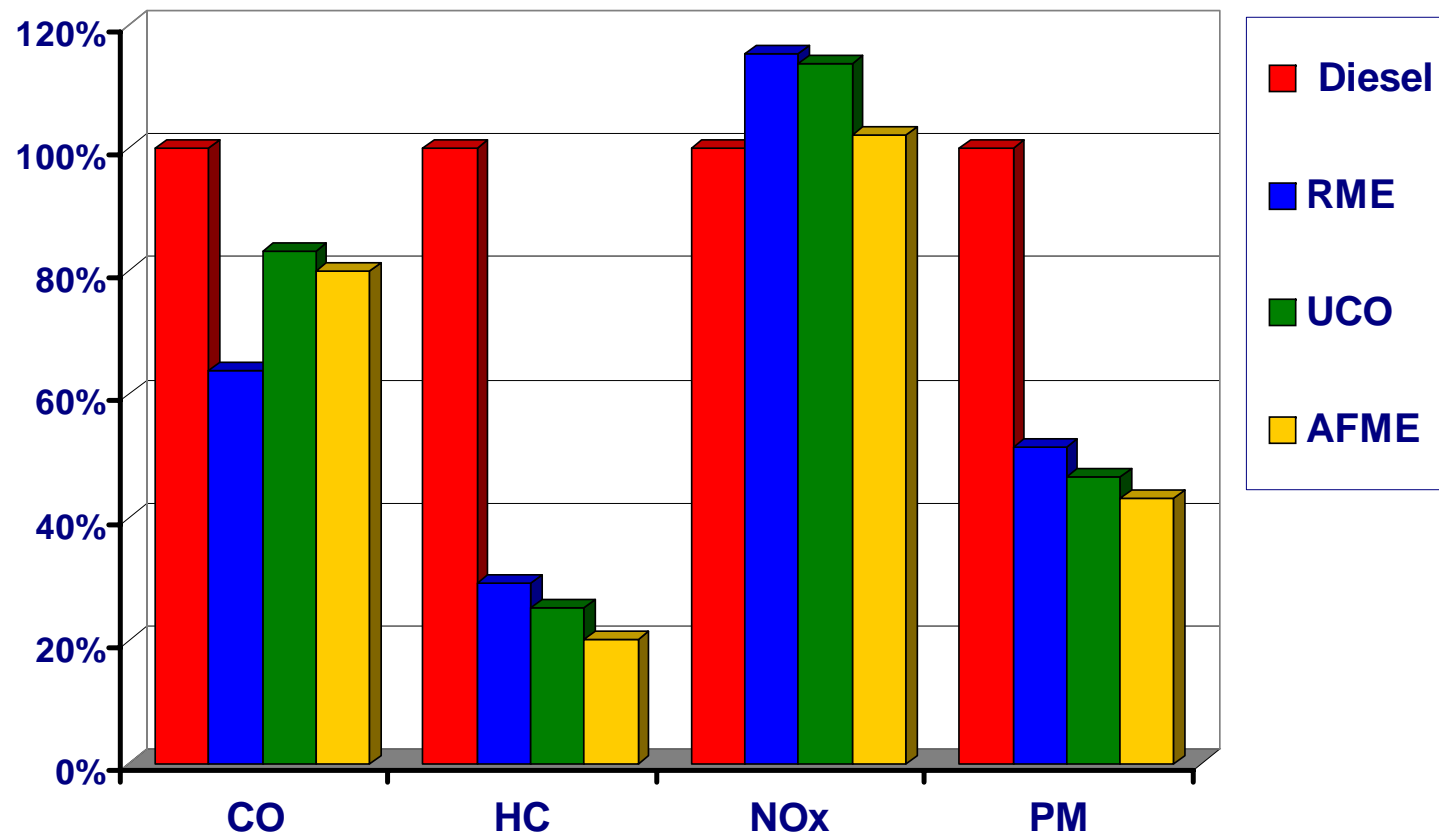
➤ **Process optimization**

➤ **Added value products**



Our future. Clean energy.

# BIODIESEL PROPERTIES



Quelle: Truck test; real-world conditions; courtesy by VKM, TU Graz, 2004.