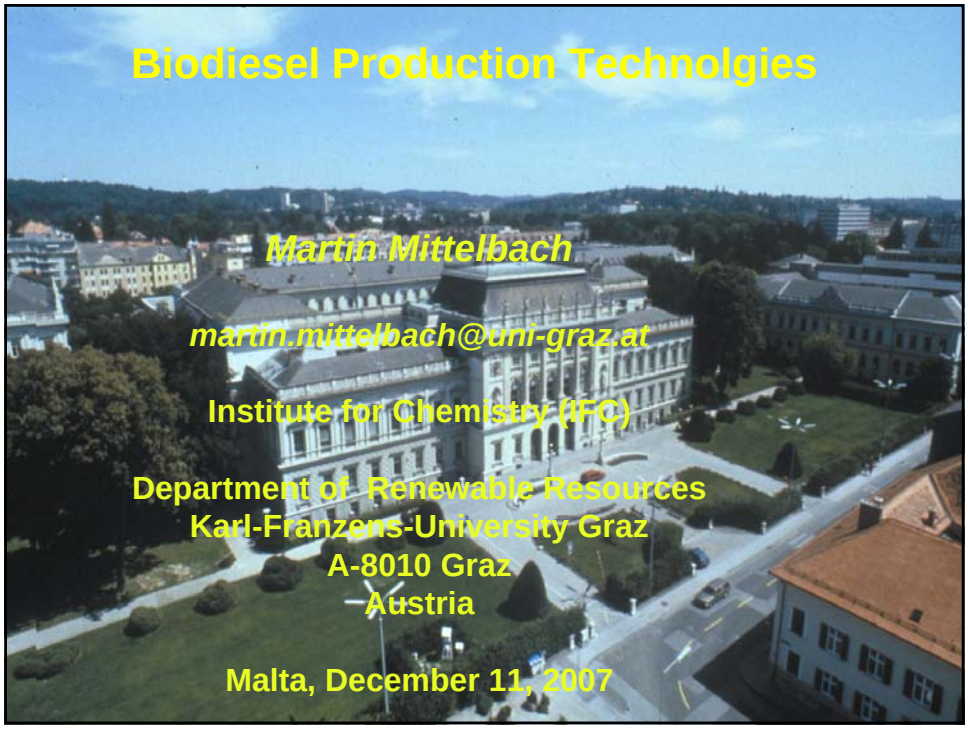
Biodiesel Production Technolgies



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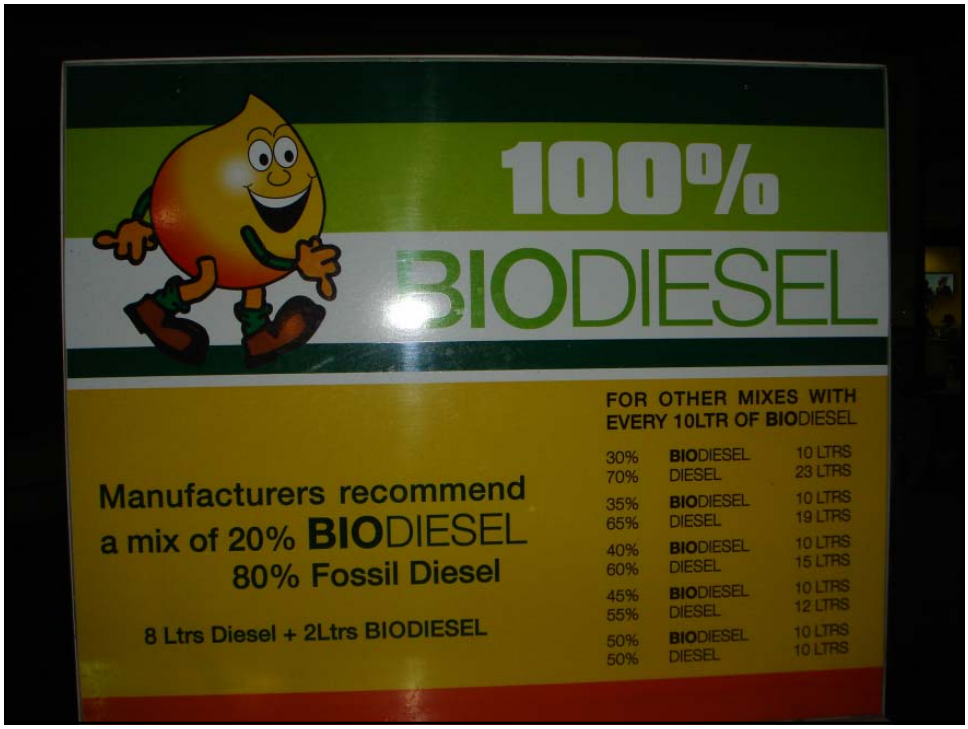


Biofuels Activities of IFC, Uni Graz
Department of Renewable Resources

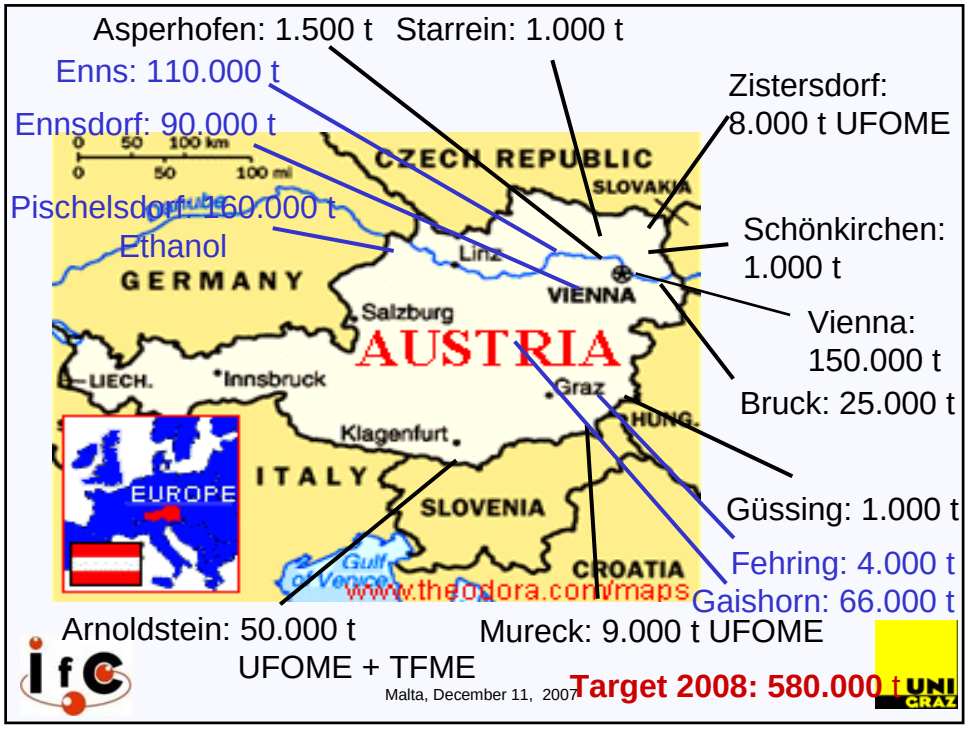
- Development of biodiesel process technologies
- Alternative feedstocks for biodiesel production
- Alternative uses for biodiesel and side products
- Research on analysis and characterization of fats and oil derivatives
- Development of specifications
- Training and seminars on biodiesel analysis and quality management
- Research on second generation biofuels: BTL, biomethanol, …

First Laboratory Experiments 1981

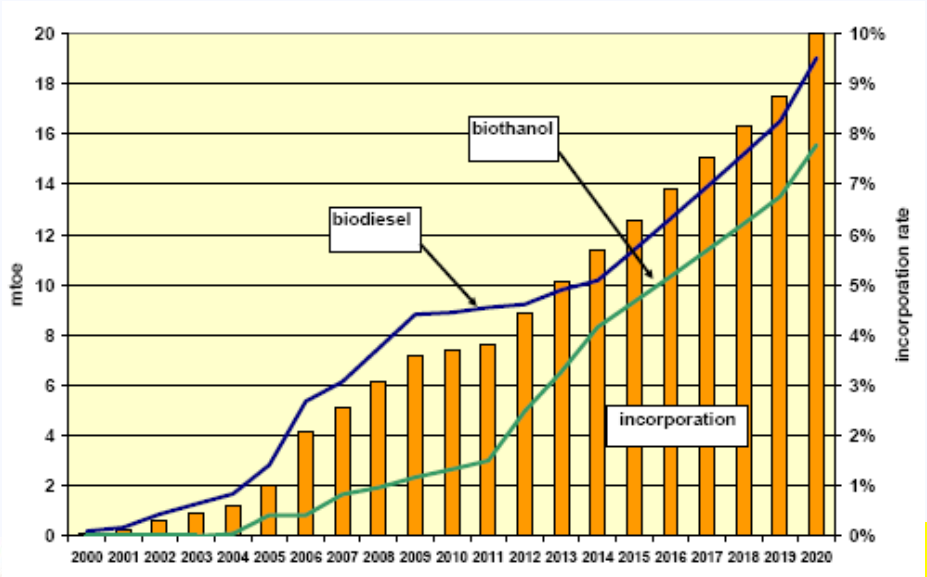
IFC: Over 25 Years Experience in Biodiesel

1987: 1st pilot plant worldwide for Biodiesel: Silberberg, Styria, Austria

1st Biodiesel Plant in a European Capital, BDV Vienna, 2006



Biofuels Roadmap until 2020



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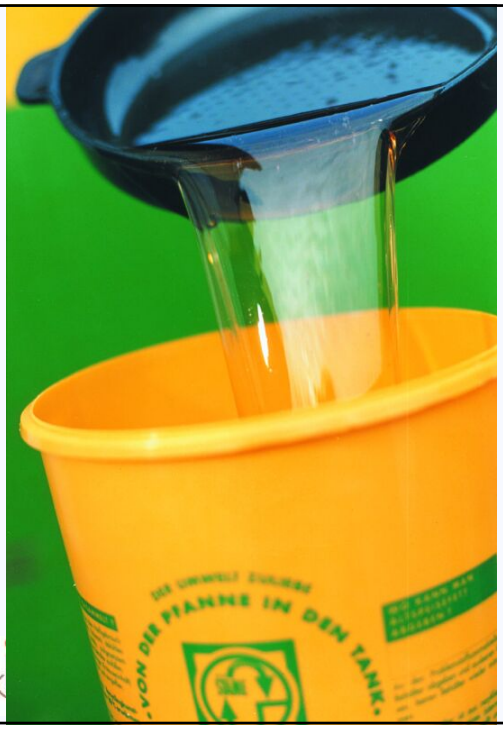
EC, 2007

New Feedstocks

- Vegetable food oils: palm, soybean, sunflower
- „New“ seed oils: cuphea, crambe.....
- Single cell oils: yeast, funghi, algae
- Genetically modified seed oils
- Non-edible seed oils
  - Jatropha curcas, Castor oil
  - Used frying oil
- Animal fat: tallow, grease
- Waste oils and fat, soap stock, trap grease



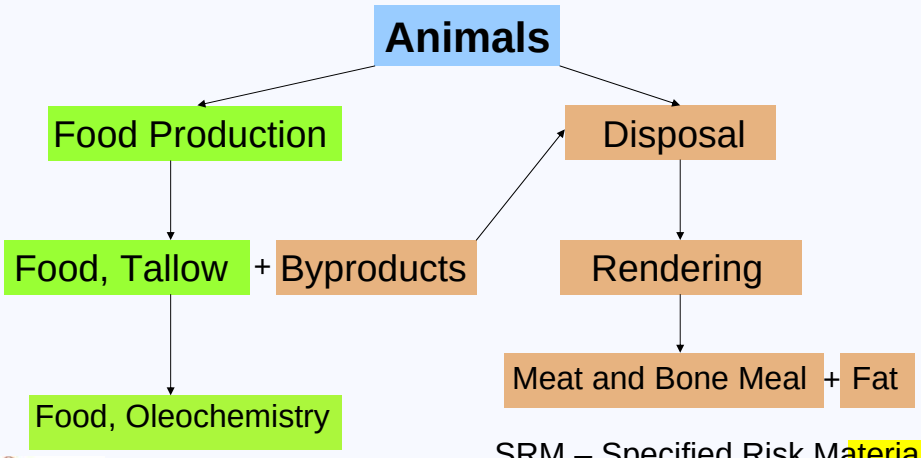
1983:

First Experiments With Used Frying Oil

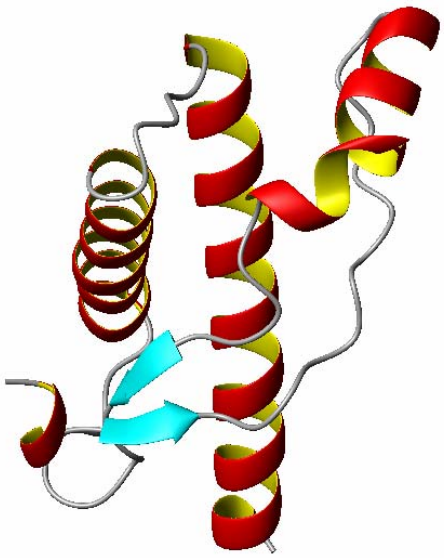

KEIN
MINERALÖL


All 150 City Buses in Graz are running with
100 % Biodiesel from Used Frying Oil
ÖKODRIVE®
ÖKODIESEL - von der Pfanne in den Tank
ÖKODRIVE
mit Ökodiesel
CLIMATE STAR
GRAZ
DIE VERBUND LINIE
64
G 744 BT
World Climate Star 2002
Osmose Award 2006

Animal Byproducts as Feedstock



SRM – Specified Risk Material



Prion protein responsible for BSE disease:

Destruction during Biodiesel process?

European Food Safety Authority (EFSA)

The Scientific Panel on Biological Hazards concludes that the Biodiesel process as described (BDI) is considered as safe for treatment and use of ABP of category 1

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Algae for Biodiesel Production

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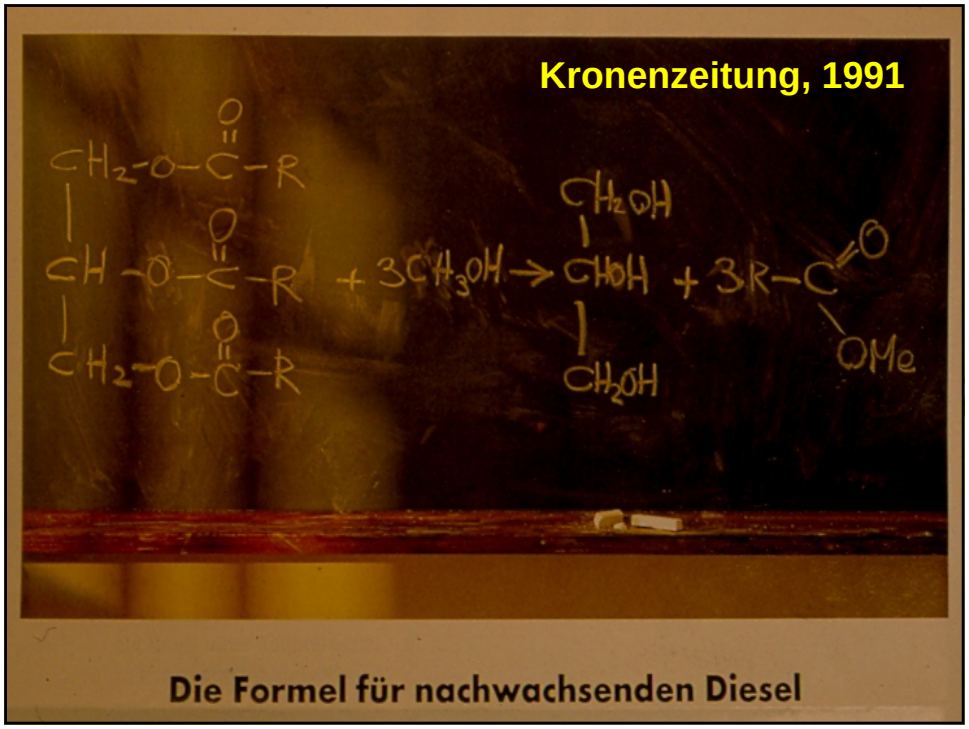


History of Alcoholysis of Triacylglycerols

1852 *P.Duffy: Alcoholysis of fats: J.Chem.Soc.*

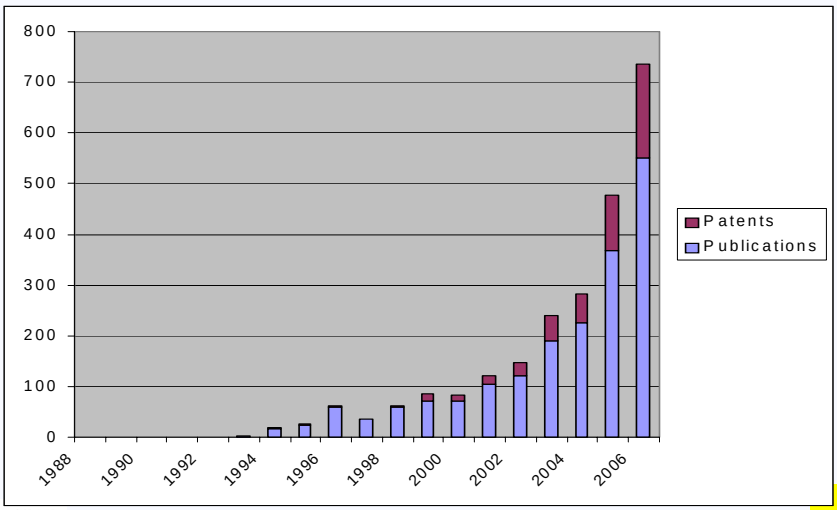
1944 *G.B.Bradshaw: US 2,360,844*
preparation of pure glycerol: 2-step reaction

1950 ff Fatty alcohol production for nonionic detergents
high temperature and pressure process
240°C; 100 bar; $NaOCH_3$; distillation

1986 *Mittelbach et al. AT 386.222*
low temperature and pressure process for biodiesel production: KOH; purification with IER

1990 ff over 200 patents on biodiesel production

Citations in Chemical Abstracts „Biodiesel“



Biodiesel Production Technologies

1) Single Feedstock Technologies

Feedstock	→	Fully refined vegetable oils, FFA < 1 %
Catalyst	→	$NaOCH_3$, NaOH, KOH
Reaction conditions	→	40-100°C, batch or continous
Purification ME-Ester	→	water washing, drying, no distillation
Glycerol treatment	→	removal H_2O+MeOH, opt.: distillation
Capacity	→	500 t – 250.000 t/a

Biodiesel Production Technologies

2) Multi Feedstock Technologies

		FFA: up to 100 %
Feedstock	→	Crude vegetable oils, animal fat, waste oils
Catalyst	→	Preesterif.: H^+; Transesterif.: KOH
Reaction conditions	→	40-60°C, batch or continous
Purification ME-Ester	→	water washing, drying, distillation
Glycerol treatment	→	acidification, salt separation: crude glycerol
Capacity	→	5.000 t – 50.000 t/a

Homogenous Catalysts for Transesterification

Type of Catalyst	Comments
Sodium hydroxide	Cheap, disposal of residual salts necessary
Potassium hydroxide	Reuse as fertilizer possible, fast reaction rate, better separation of glycerol
Sodium methoxide	No dissolution of catalyst necessary, disposal of salts necessary disposal
Potassium methoxide	No dissolution of catalyst necessary, fertilizer, better separation of glycerol, high price

Acidic Catalysts for Esterification

Type of Catalyst	Comments
Conc. sulphuric acid	Cheap, decomposition products, corrosion
p-Toluene-sulphonic acid	High price, recycling necessary
Acidic ion exchange resins	High price, continuous reaction possible, low stability

New Trends: Heterogenous Catalysts

Metal oxides (Mg, Ca, Al, Fe)
- Carbonates: $CaCO_3$
- Ion exchange resins (acidic, alkaline)
- Enzymes
- Silicates

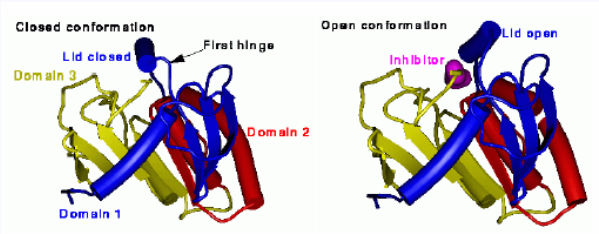
\+ easy separation, reusable
pure glycerol, no side products (salts)
first industrial application 2006

\- high temperature and pressure, high investment costs

New Trends: Enzymes as Catalysts

Lipases (Triacylglycerolhydrolases)

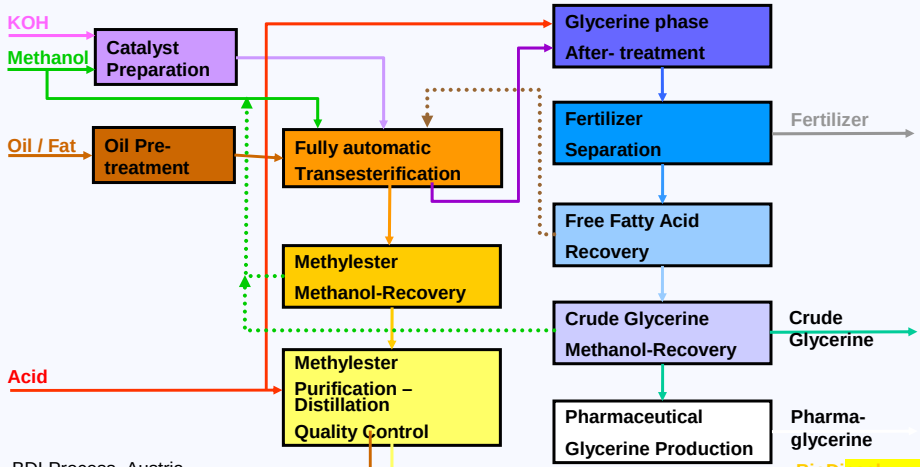
main task: lipid hydrolysis
in organic solvents:
esterification, transesterification
Alcoholysis of sunflower oil with MeOH, EtOH
Mittelbach et al., 1990



Enzymes as Catalysts: Main Advantages

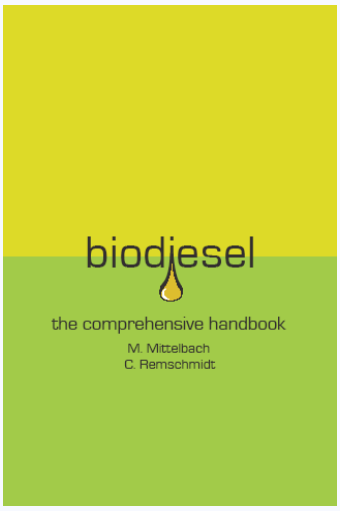
- Heterogenous catalysts, immobilization, reusable
- Saving of chemicals
- Easy purification of glycerol
- Catalysis of esterification as well as transesterification
- Mild reaction conditions

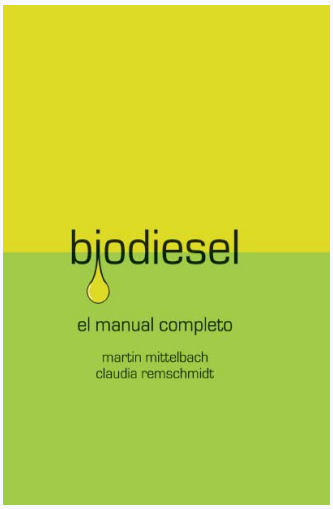
Multi-Feedstock Production Scheme (simplified)



BDI Process, Austria

Thank You for Your Attention !





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