

ALLGAS

Large scale algae cultures for biofuel production

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Symposium
Energieinnovationen

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Our future. Clean energy.

- **Introduction BDI**
- **Algae Production Processes**
- **BioDiesel from Algae**
- **Allgas Project**

BDI Headquarter



BDI - BioEnergy International AG

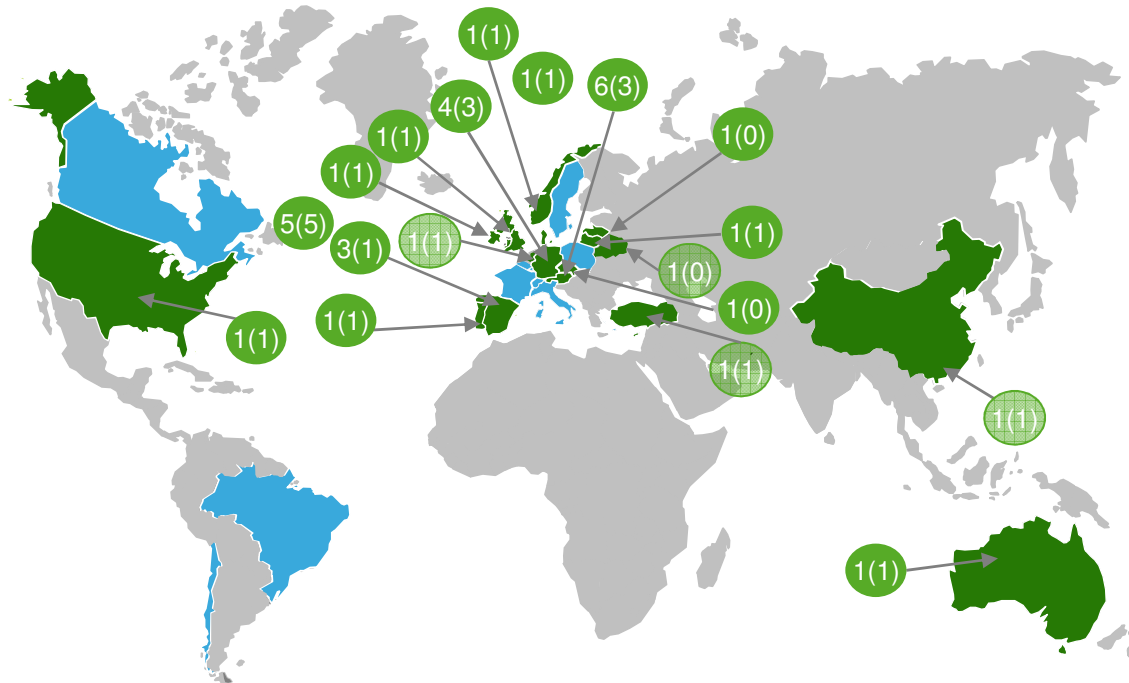
Parkring 18

A-8074 Grambach/Graz

Austria/Europe




www.bdi-bioenergy.com

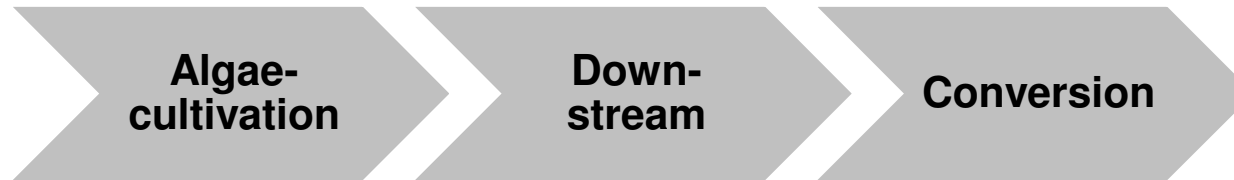
Diversified international customer base



Customers

- Fat and Meat Processing Industry
- Waste Disposal Companies
- Agriculture/Farmers
- Food Industry
- Brewing Industry
- Fresh Oil Producers (Vegetable Oil)
- Financial Investors
- Mineral Oil industry

-  Number of plants ordered in the respective countries (figures in brackets denote number of Multi-Feedstock plants)
-  Number of plants completed in the respective countries (figures in brackets denote number of Multi-Feedstock plants)
-  Target markets



**Lab scale reactors
PCS**

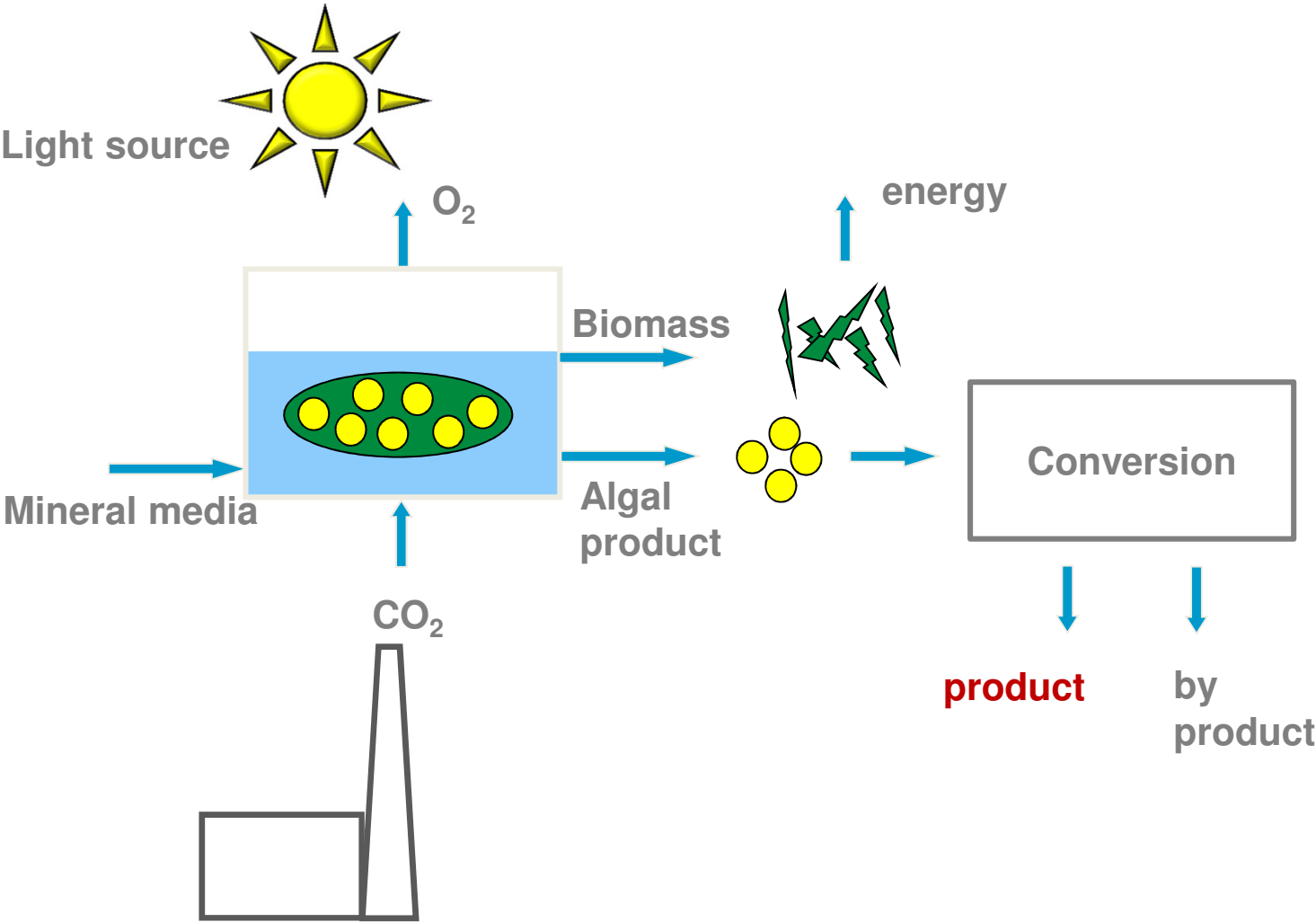
**Oil extraction/
purification**

**Synergies to production of
BioDiesel from difficult raw
materials**



Algae Production Processes

Principle



Reactor design

Open cultivation

Open ponds



Sapphire Energy, San Diego

Klötze, Subitec, Germany

Closed cultivation

Horizontal tubes



Airlift reactors



Novel concepts



NASA, US

Energy balance

		Open Ponds	Flat Panel PBR	Tubular PBR
Volumetric Productivity	[kg/m ³ .d]	0,035	0,27	0,56
Biomass Concentration	[kg/m ³]	0,35	2,7	1,02
Energy Consumption	[W/m ³]	3,72	53	2500

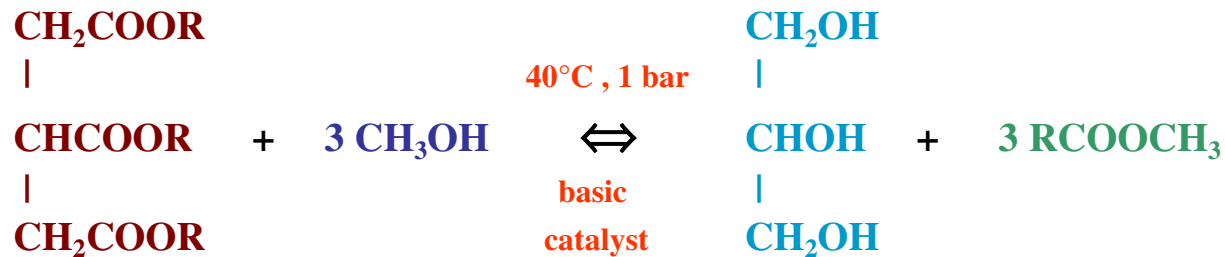
$$Net_energy_ratio = \frac{\Sigma energy_produced}{\Sigma energy_requirements}$$

		Open Ponds	Flat Panel PBR	Tubular PBR
NER for Oil	[-]	3,05	1,65	0,07
NER for Biomass	[-]	8,34	4,51	0,2

O. Jorquera, A. Kiperstock Comparative energy LCA of microalgal biomass production in open ponds and PBR, Bioresource Technology, 2009
Evodos centrifuges: Evodos Algae Harvester 1000

BioDiesel from Algae

Transesterification

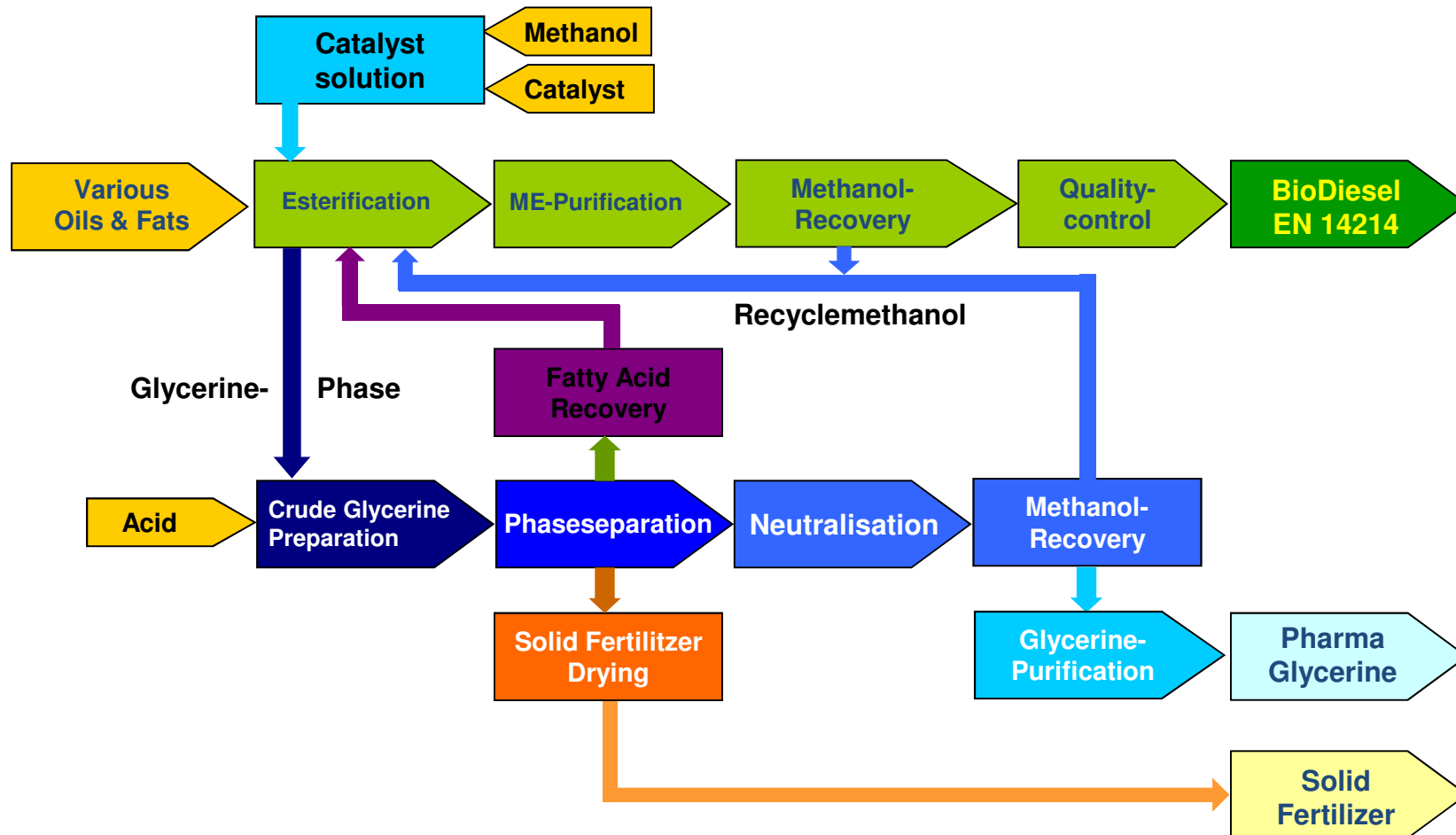


R = fatty acid chain

Esterification

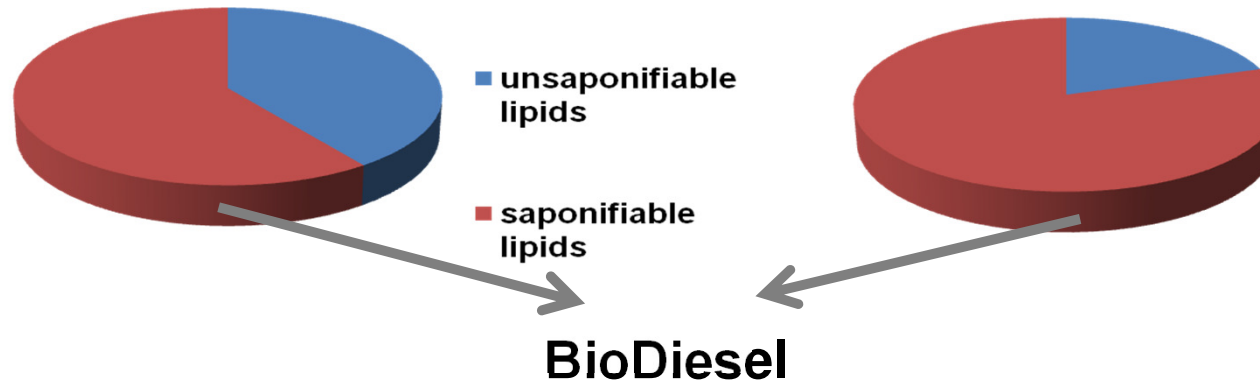


BDI-Process – Flow chart



Algae oil composition

**Possible raw material for BioDiesel production:
Mono-, Di-, Triglycerides
Fatty acids**



Impurities: solids, water, unsaponifiables, polymers, sulfur, phospholipids, phosphatides

characteristics: free fatty acid content, fatty acid composition

Raw Material specification

Crude algae oils are off spec in various parameters

impurities

Unsaponifiable
Total fatty acids
Free fatty acid
Water
Insoluble substances
Phosphorous
Sulphur
Polymerised triglycerides
Polyethylene type plastics

fatty acid profil

Iodine number
Linolenic acid
Polyunsaturated fatty acid (≥ 4 double bonds)

Parameters used in specification for raw material entering the BDI BioDiesel process

Fatty acid composition

fatty acid profil

- influence on BioDiesel quality, cold behaviour
- oxidation stability, iodine number
- content of polyunsaturated, linoleic acid

	rape seed	animal fat	palm oil	algae oil (Chlor.)	algae oil (Diatom)	algae oil (Choryc.)
C14:0		4	1	4	4	
C16:0	6	27	44	16	20	27
C16:1	1	4		6	20	
C16:2-4				10		
C18:0	4	20	5	16	2	3
C18:1	54	41	40	14	14	
C18:2	26	3	10	6	6	45
C18:3	8	1		8	16	19
C20:1						
>C20:n				4	2	6

Comparison with different raw materials

Context

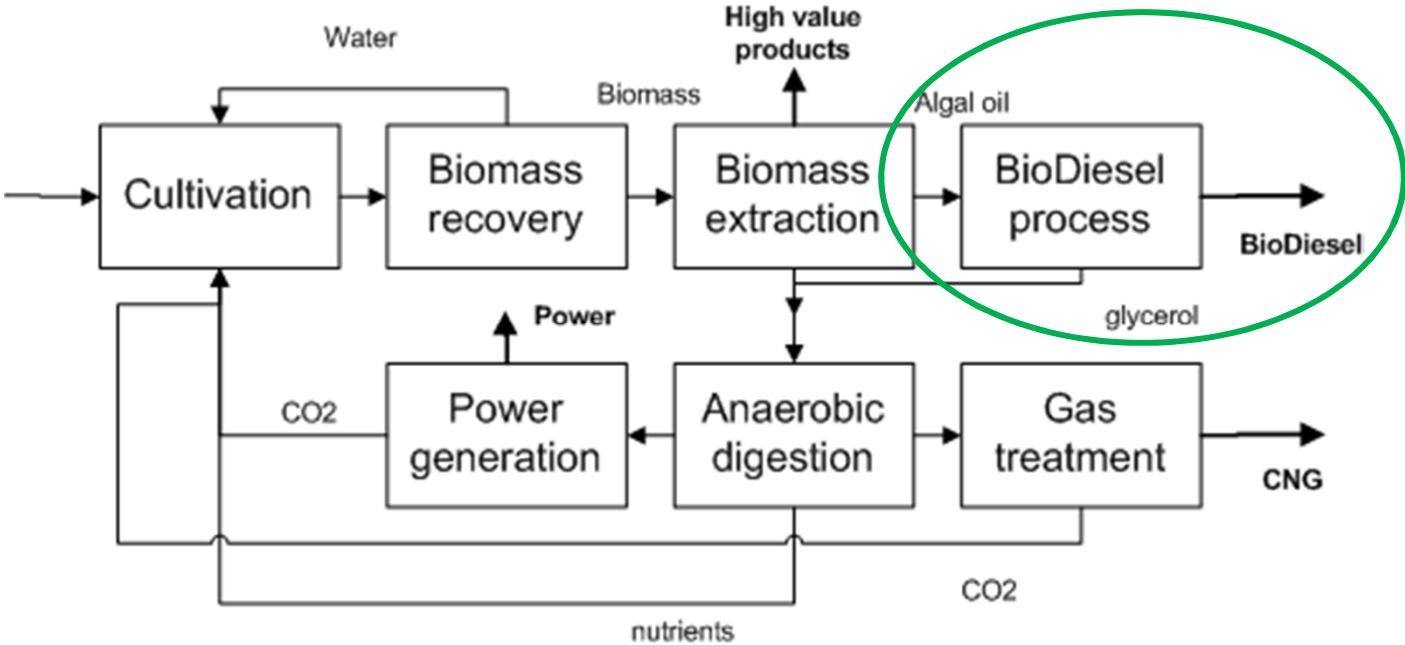
Collaborative project
Grant agreement no: 268208
Duration : 60 months
Topic ENERGY.2010.3.4-1: Biofuels from algae

Coordinator: Aqualia, Frank Rogalla

Project start 01.05.2011



Overall process



Consortium

Participant no.	Participant organization name	Role	Country
1 (coordinator)	Aqualia Gestión Integral del Agua S.A.	Wastewater	Spain
2	Feyecon/ Clean Algae S.L	Cultivation, Extraction	Netherlands /Spain
4	BDI - BioEnergy International AG	Oil conversion	Austria
5	Hygear B.V	Biogas refinement	Netherlands
6	MTD Alternative Energies	Cultivation	Turkey
7	University of Southampton	Cultivation, Biogas	UK
8	Fraunhofer Umsicht	Analytics	Germany



Algae cultivation site



Technical Experience

> 300 Wastewater Treatment Plants: 500 M m³/a

Nitrogen 50 mg/L = 25 000 t/a

Energy Consumption 0.5 kWh/m³ = 250 MWh/a

Energy in Nitrogen Fertilizer 15 kWh/kg N = 375 MWh/a

Phosphorus 10 mg/L = 5000 t/a

20 Anaerobic Digestion Plants

Biosolid Production: 125 M t/a

Biogas Production from Biomass

2.2 M m³ CH₄/a

@ 10 kWh/m³ = 22 MWh/a



Algae cultivation



Algae cultivation on 10 ha

AllGas Oil - Workpackages

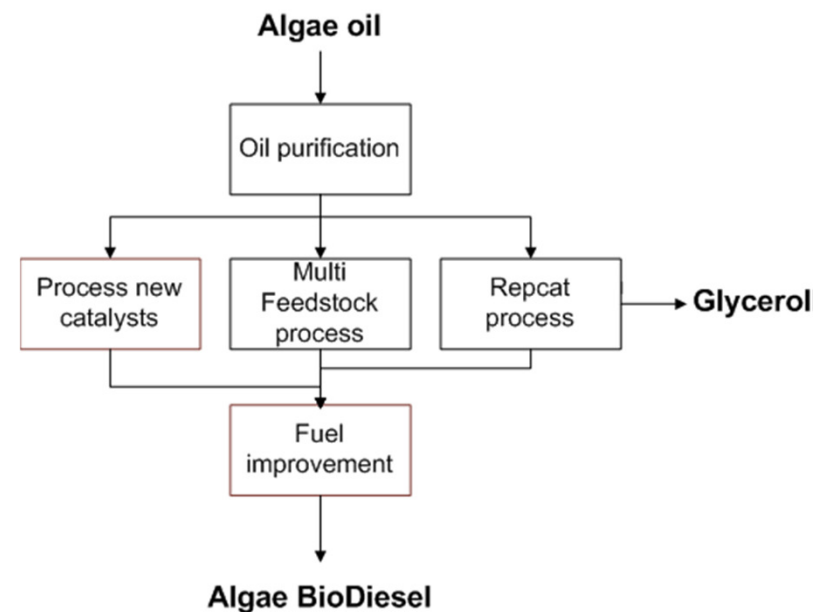
WP Number ⁶³	WP Title	Type of activity ⁶⁴
WP 1	Project Management	MGT
WP 2	Biomass Plant	RTD
WP 3	Biomass Plant Demo	DEM
WP 4	Algae Growth and Harvest	RTD
WP 5	Algae Growth and Harvest Demo	DEM
WP 6	Product Extraction	RTD
WP 7	Product Extraction Demo	DEM
WP 8	Biodiesel production	RTD
WP 9	Biodiesel production Demo	DEM
WP 10	Gas Processing: Separation & upgrading and Fuel Station	RTD
WP 11	Gas Processing: Separation & upgrading and Fuel Station Demo	DEM
WP 12	Fleet Demo	DEM
WP 13	Sustainability Analysis	OTHER
WP 14	Diffusion	OTHER

Process requirements

PILOT tests of algae oil in 3 different BioDiesel production processes

- New catalysts FhG
- Multifeedstock BDI
- Repcat BDI

- Mass and energy balance
- Identification of challenges
- Assessment of process requirements

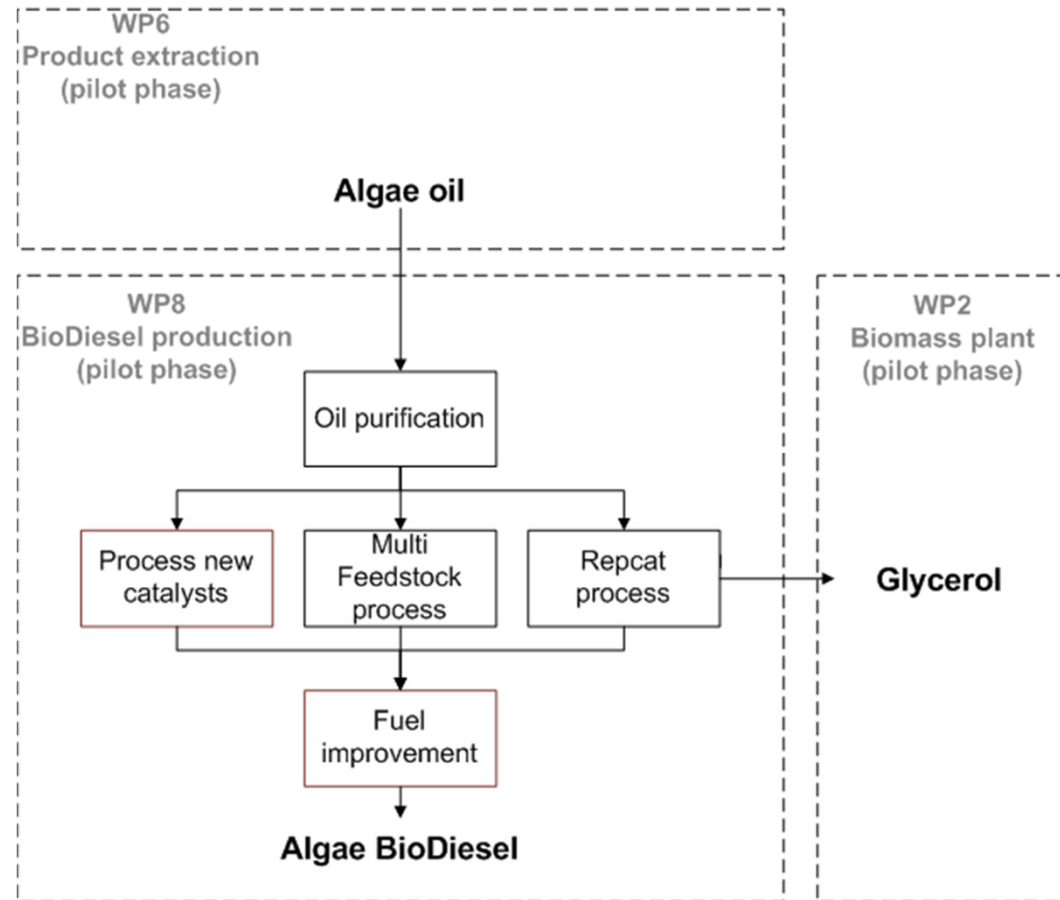


DEMO in industrial scale Multifeedstock or Repcat in BDI plant

Workpackage 8

Pilot Scale experiments

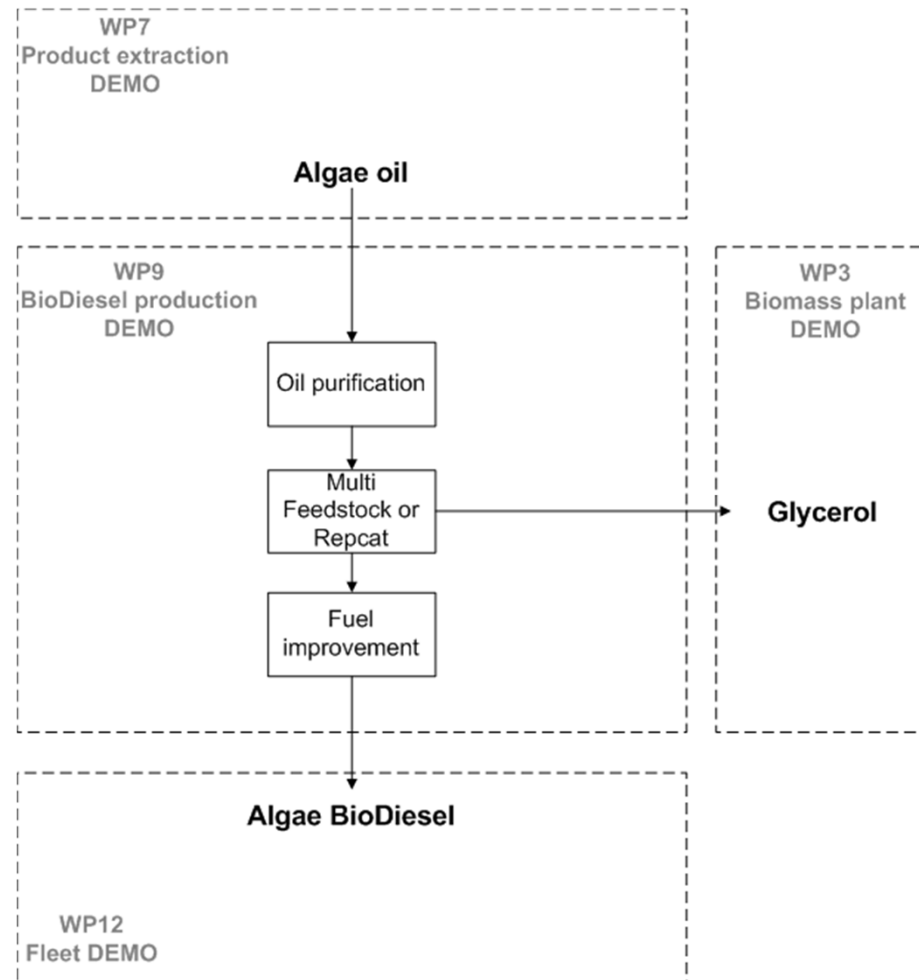
Pilot facility at BDI



Workpackage 9

Demo experiments

beginning Sep. 2013



BDI BioDiesel Plants worldwide



Summary

AIM

Demonstration of sustainable production of biofuels based on low-cost microalgae cultures on large scale

GOALS

- Full chain of processes
- Algal ponds: 10 ha site
- Biomass separation
- Processing for oil
- Biofuel production
- Use in vehicles

MEANS

Wastewater influent and nutrients will be re-used to stimulate algae growth. The extracted oils will be processed at an existing biodiesel plant.





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