



bioenergy2020+

# Produkte aus Mikroalgen – österreichische Aktivitäten

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BIOENERGY 2020+

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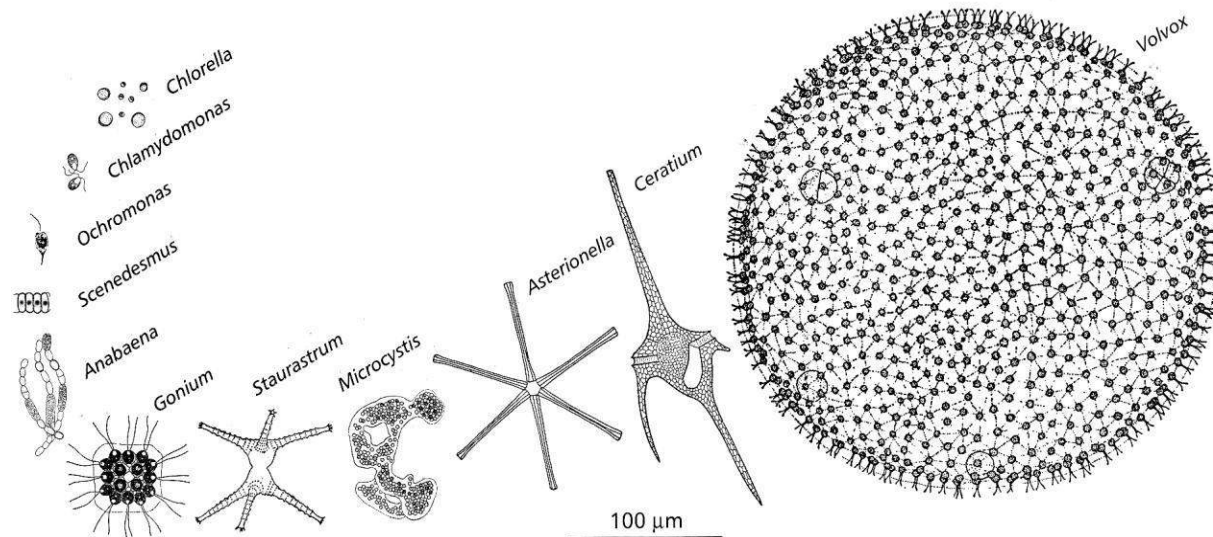


# ALGENBASICS



# Was sind Mikroalgen?

- Wassergebundene Mikroorganismen, Photosynthese
- Vorläufer der höheren Landpflanzen
- Extrem diverse Gruppe (100.000 – 10 Mio Arten)



# Algenarten



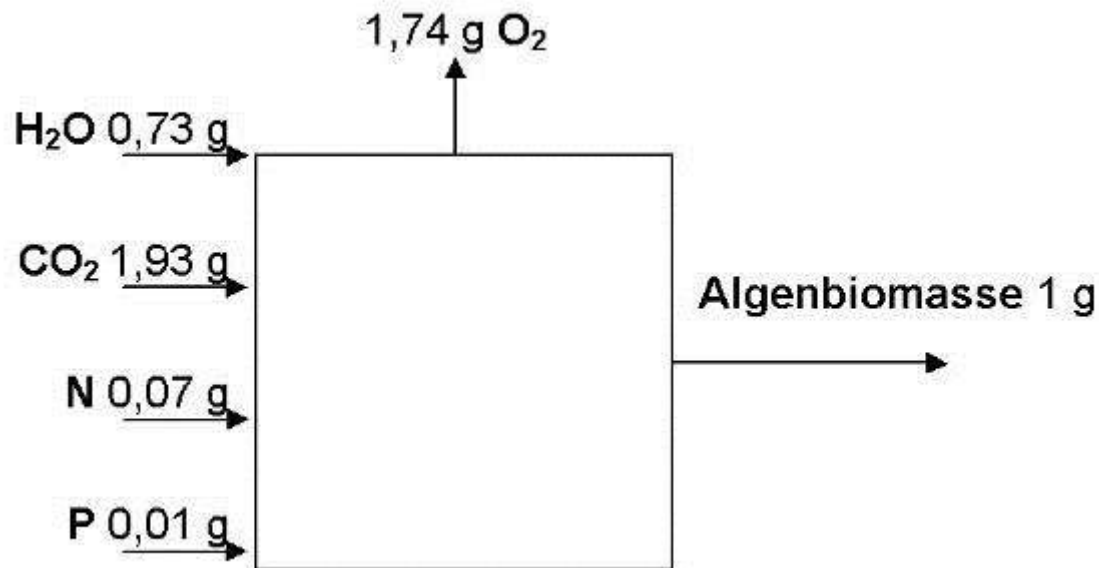
***Chlorella* sp.**



***Scenedesmus* sp.**

# Umwandlung von CO<sub>2</sub> in Biomasse

- durchschnittliche molekulare Formel: CO<sub>0,48</sub>H<sub>1,83</sub>N<sub>0,11</sub>P<sub>0,01</sub>
- Ca. 38 % des eingesetzten CO<sub>2</sub> werden aufgenommen
- Nährstoffe müssen im Überschuss zugegeben werden



Eigene Darstellung



# Algenöl für Biotreibstoffe?

## Hoher Ölgehalt

Table 2  
Oil content of some microalgae

Microalga	Oil content (% dry wt)
<i>Botryococcus braunii</i>	25–75
<i>Chlorella</i> sp.	28–32
<i>Cryptocodinium cohnii</i>	20
<i>Cylindrotheca</i> sp.	16–37
<i>Dunaliella primolecta</i>	23
<i>Isochrysis</i> sp.	25–33
<i>Monallanthus salina</i>	>20
<i>Nannochloris</i> sp.	20–35
<i>Nannochloropsis</i> sp.	31–68
<i>Neochloris oleoabundans</i>	35–54
<i>Nitzschia</i> sp.	45–47
<i>Phaeodactylum tricornutum</i>	20–30
<i>Schizochytrium</i> sp.	50–77
<i>Tetraselmis sueica</i>	15–23

Quelle: Chisti 2007

## Hoher Flächenertrag

Comparison of some sources of biodiesel

Crop	Oil yield (L/ha)	Land area needed (M ha) <sup>a</sup>	Percent of existing US cropping area <sup>a</sup>
Com	172	1540	846
Soybean	446	594	326
Canola	1190	223	122
Jatropha	1892	140	77
Coconut	2689	99	54
Oil palm	5950	45	24
Microalgae <sup>b</sup>	136,900	2	1.1
Microalgae <sup>c</sup>	58,700	4.5	2.5

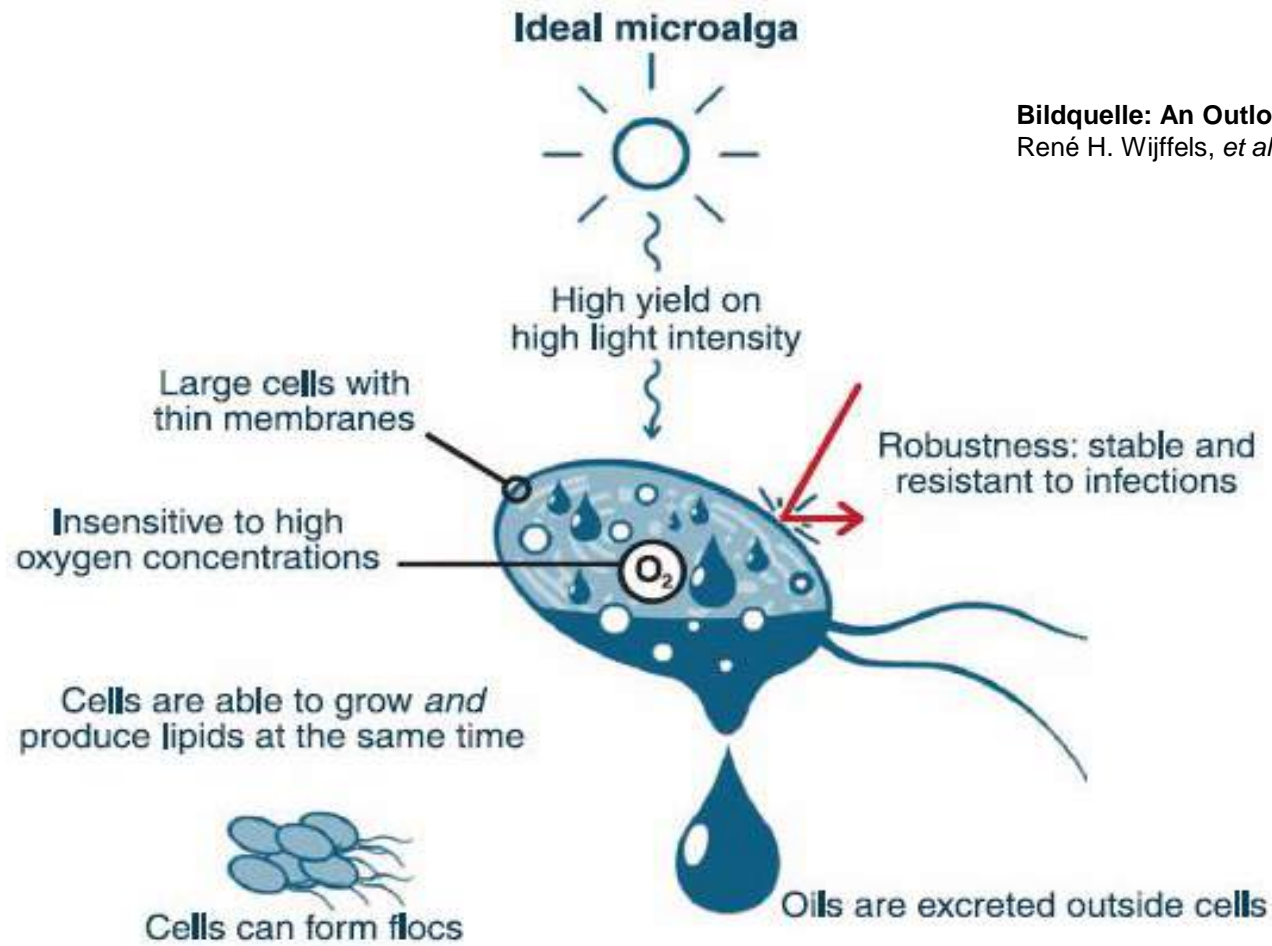
<sup>a</sup> For meeting 50% of all transport fuel needs of the United States.

<sup>b</sup> 70% oil (by wt) in biomass.

<sup>c</sup> 30% oil (by wt) in biomass.

Quelle: Chisti 2007

# Die ideale Alge

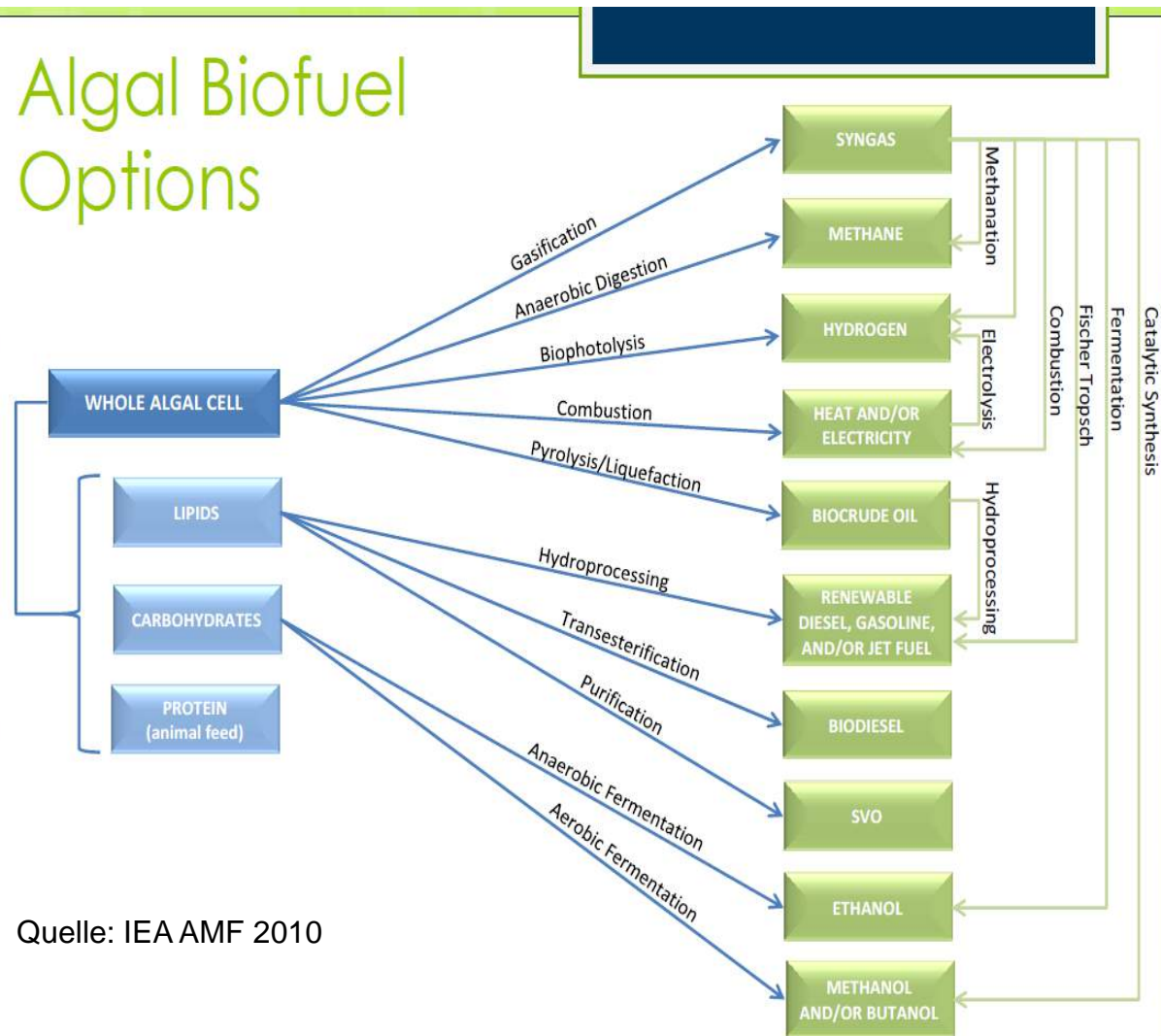


Bildquelle: An Outlook on Microalgal Biofuels, René H. Wijffels, *et al.*, *Science* **329**, 796 (2010);

# Alternativen zu Biodiesel



## Algal Biofuel Options



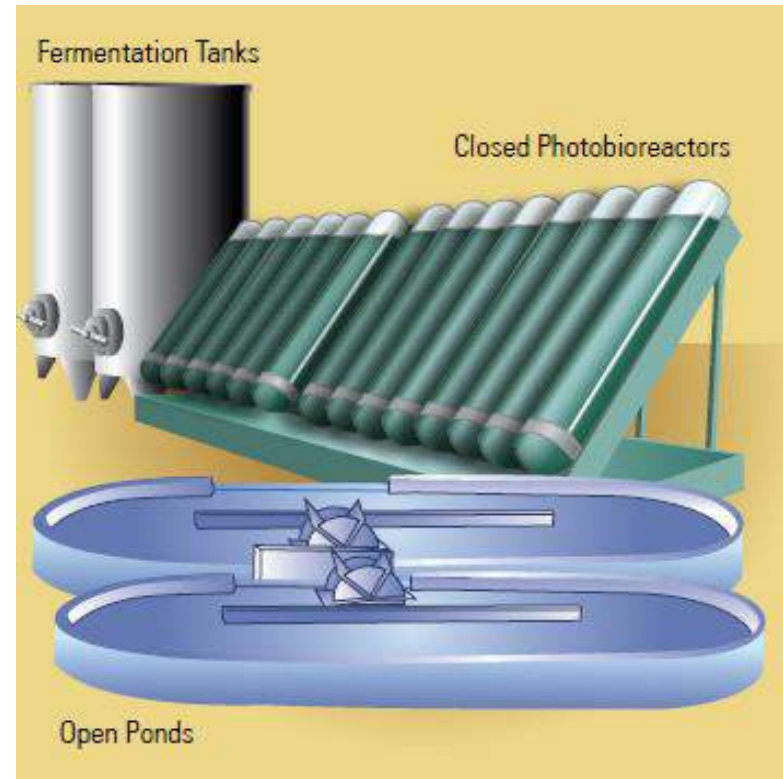


# Algenkultivierung



Metabolismus: Photoautotroph – Heterotroph – Mixotroph

- Offene Systeme
- Photobioreaktoren
- Fermentoren
  
- Hybrid Systeme
- Integrierte Systeme



Source: U.S. DOE 2010. **National Algal Biofuels Technology Roadmap**. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Biomass Program.



# Offene Systeme

- Extensive ponds
- Raceway ponds
- Circular ponds
- Tanks
- Cascade system



Source: **Current Status and Potential for Algal Biofuels Production**, Al Darzins et al., IEA Bioenergy Task 39, 2010

# Photobioreaktoren

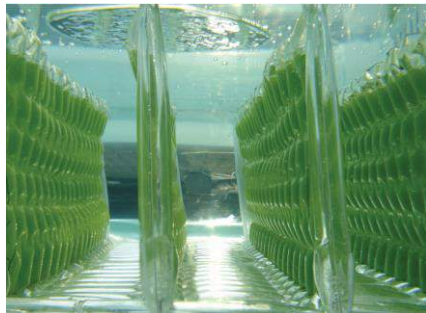
- Tubuläre PBR
- Flat Plate PBR
- Big bag system
- Columns



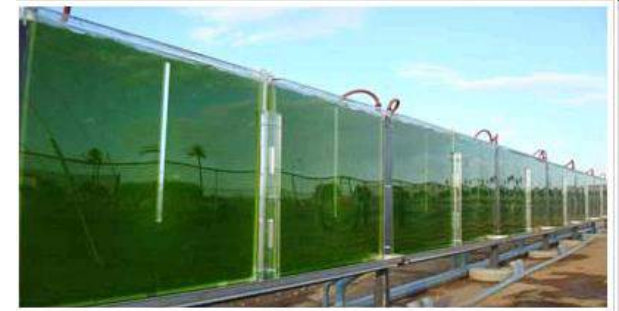
<http://brae.calpoly.edu/CEAE/images/menupicture.jpg>



[http://www.mvm.kit.edu/img/bio/rohrreaktor\\_neu.jpg](http://www.mvm.kit.edu/img/bio/rohrreaktor_neu.jpg)



<http://www.bpe.wur.nl/NR/rdonlyres/05ADDB3D-91DC-4D12-20F1-5F9B045F01/84007/fig2.JPG>



<http://biofuels.asu.edu/images/biomaterials-figure1.jpg>



Algenworkshop Graz,  
Beitrag Martin Mohr

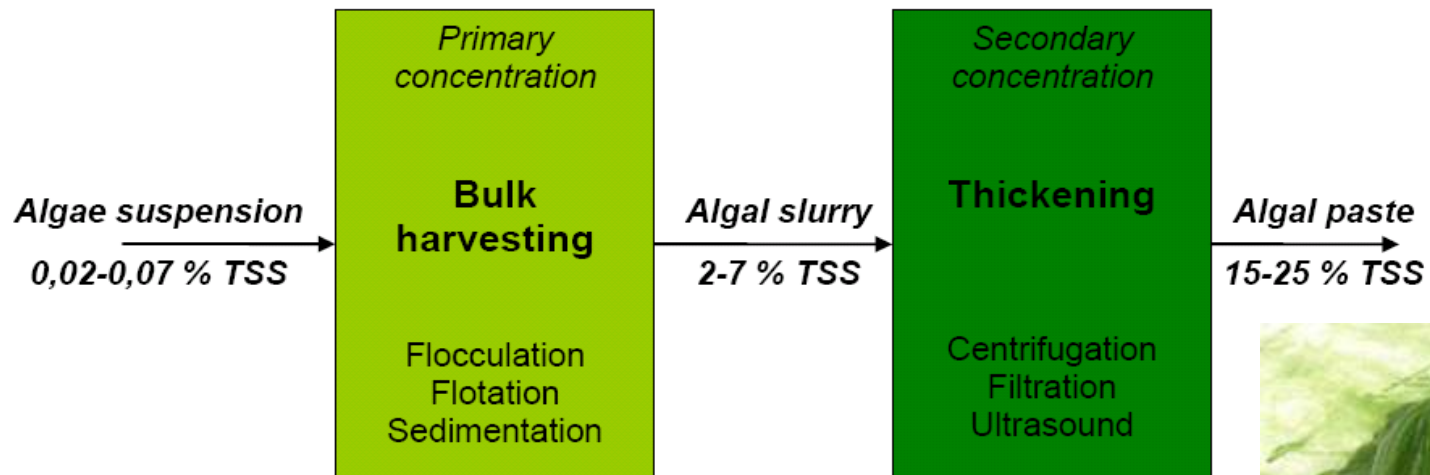
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Source: An Outlook on Microalgal Biofuels,  
René H. Wijffels, et al., Science 329, 796 (2010);

Stakeholderdialog BBI, 16.11.2015, Wien

# Ernte



Eigene Darstellung basierend auf Uduman et al. 2010



Dewatered algal paste

Credit: Idaho National Laboratory



# Vorbehandlung

## ■ Trocknung → 90 %

- Solare Trocknung
- Trommeltrockner
- Gefriertrocknung
- Sprühtrocknung
- Rotationstrockner



[www.world-of-algae.com/images/PileOfDryAlgae.jpg](http://www.world-of-algae.com/images/PileOfDryAlgae.jpg)

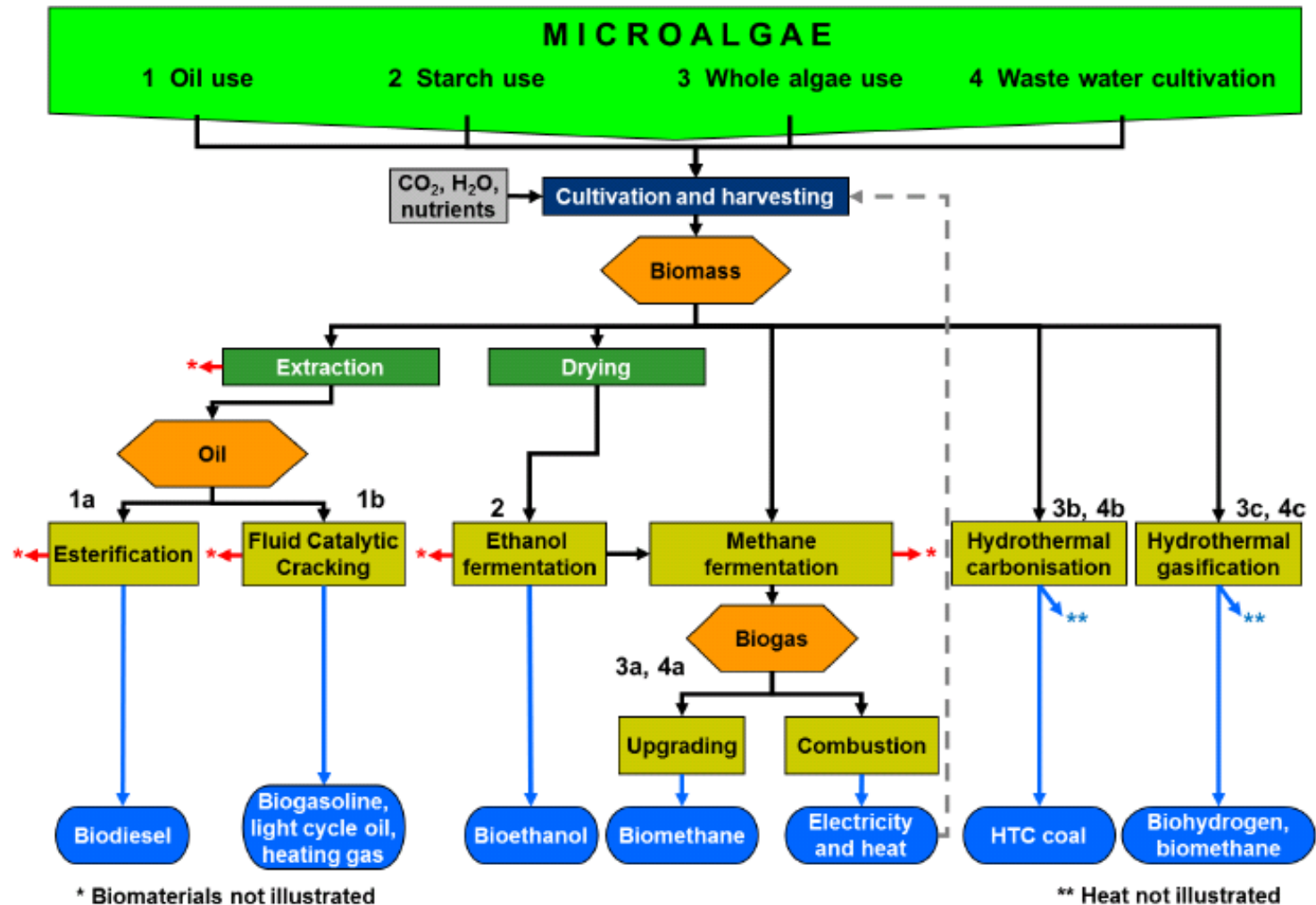
## ■ Ölextraktion:

- Mechanisches Pressen
- Flüssig-Flüssig Extraktion
- Extraktion mit superkritischem CO<sub>2</sub>
- Ultraschalltechnik
- Osmotischer Schock
- Biologische Extraktion



<http://www.neilpeterson.com/wp-content/uploads/2008/12/green-oil.jpg>

# Übersicht über Wertschöpfungsketten Mikroalgen zu Biotreibstoffen



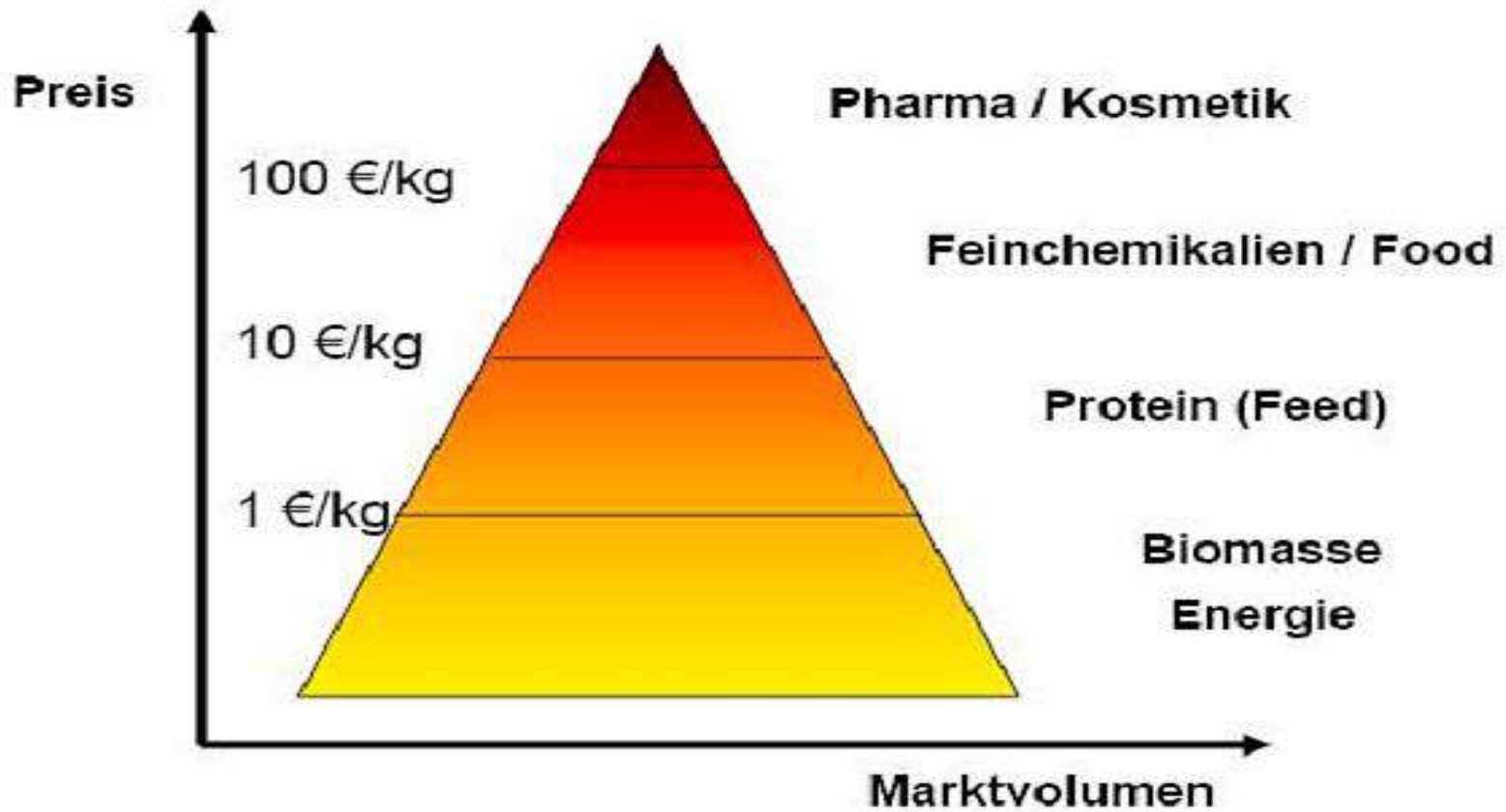
\* Biomaterials not illustrated

\*\* Heat not illustrated

Source: Hingsamer, Maria; Gerfried, Jungmeier, Kurt; Könighofer, Johanna; Pucker : Biorefineries for Transportation Biofuels, Austrian Stakeholder Workshop of IEA Bioenergy Task 42 „Biorefining“ October 24, 2013, Graz

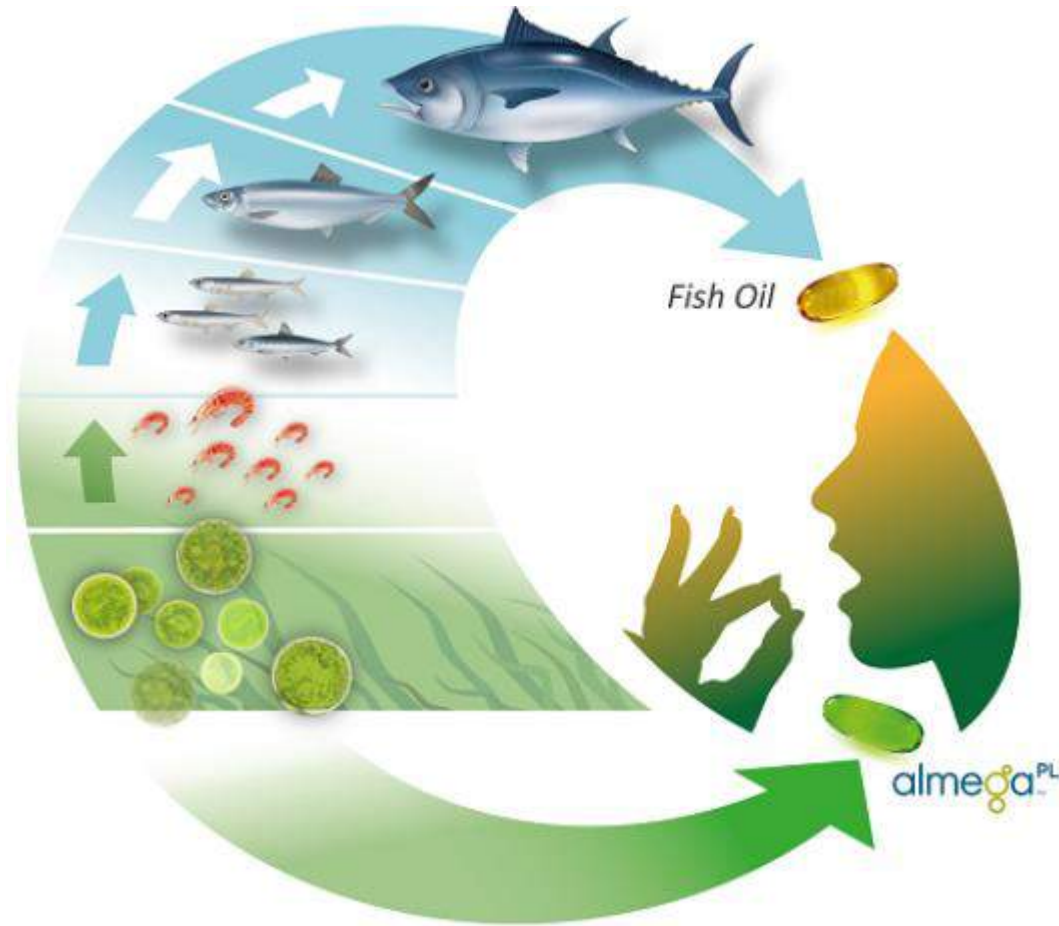


# Marktwert



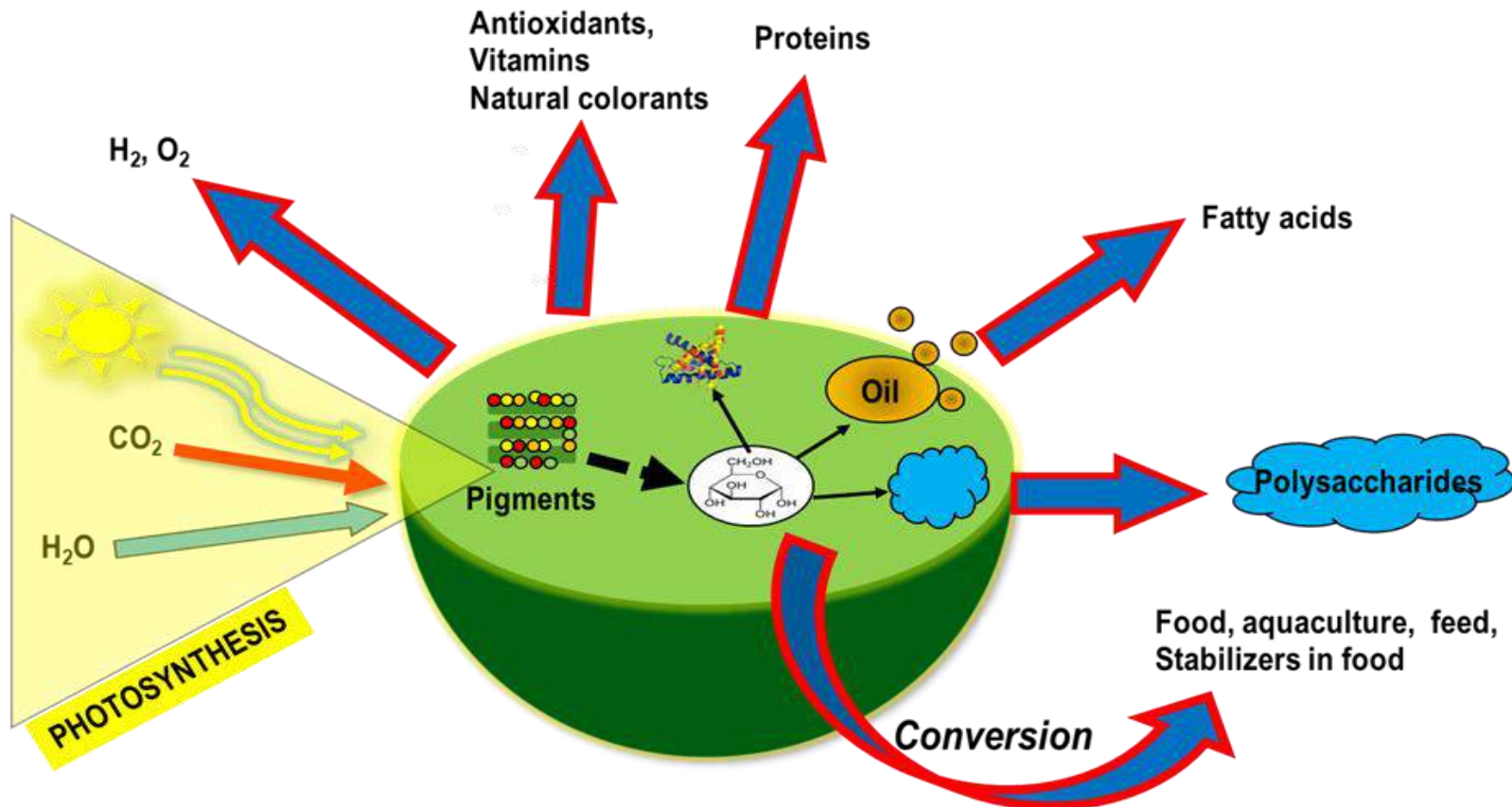
Quelle: Ripplinger, Subitec

# PUFA aus Algen





# Mikroalgen Bioraffinerie

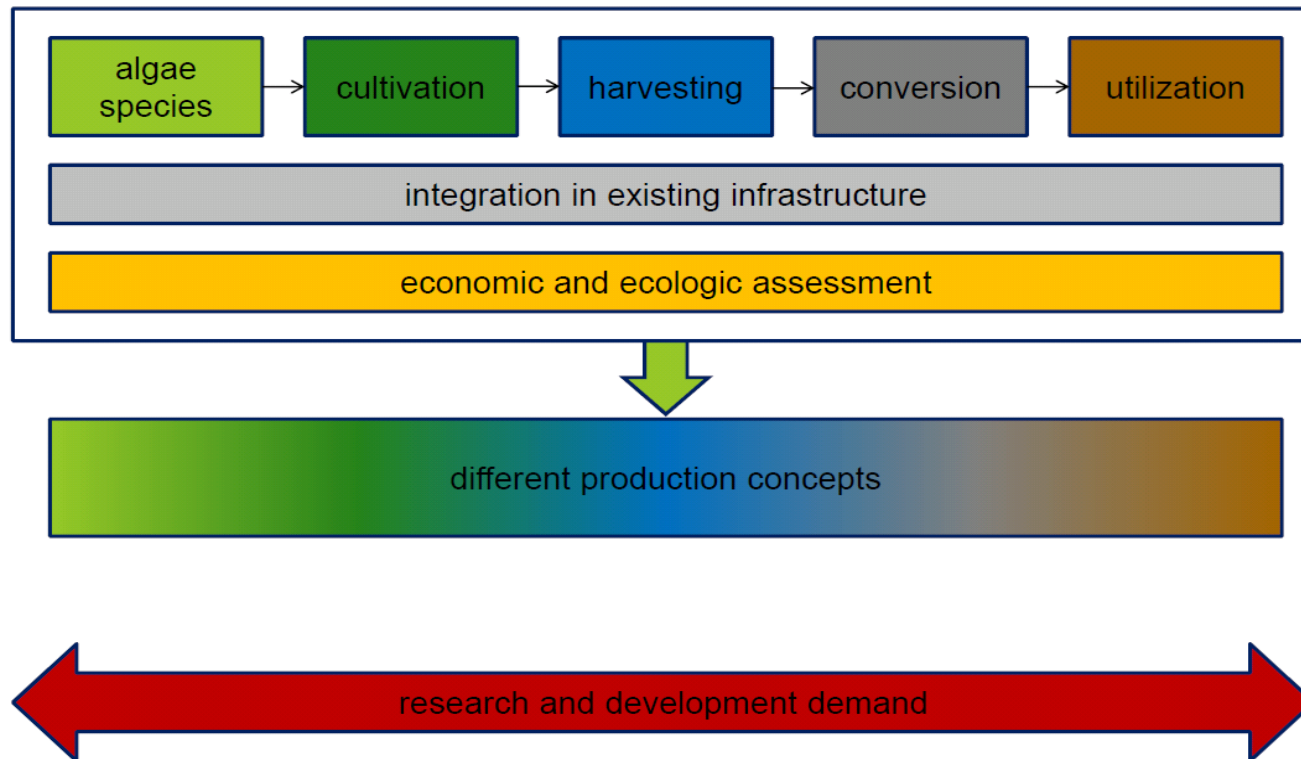


Nur die Reststoffe energetisch verwerten



# Relevante Themen im Bereich der Algenforschung in Österreich

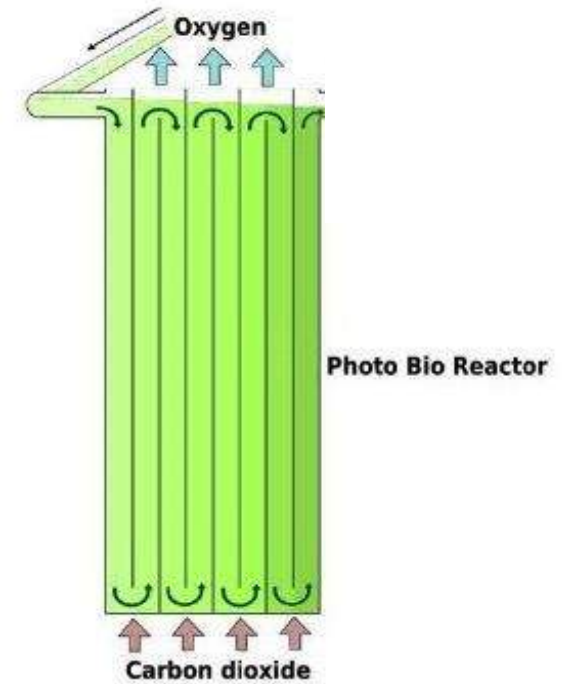
F&E Bedarf entlang der gesamten Produktionskette





# ÖSTERREICHISCHE AKTIVITÄTEN

# Ecoduna Technologie zur Algenkultivierung



ecoduna

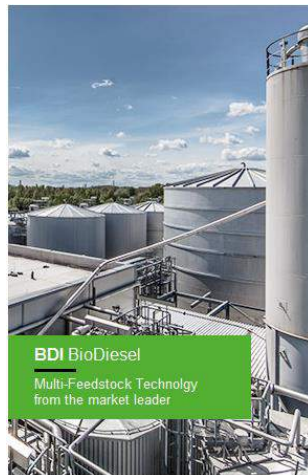
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# BDI

## Technologie zur Umwandlung schwieriger Rohstoffe in Biodiesel



NEU: Technologie zur Produktion von Astaxanthin

### ALLGAS (Spanish pronunciation for algae)

Biofuels from algae  
Project Number: 268208

Total funds of the European Union: 7.1 M€

Project start 01.05.2011

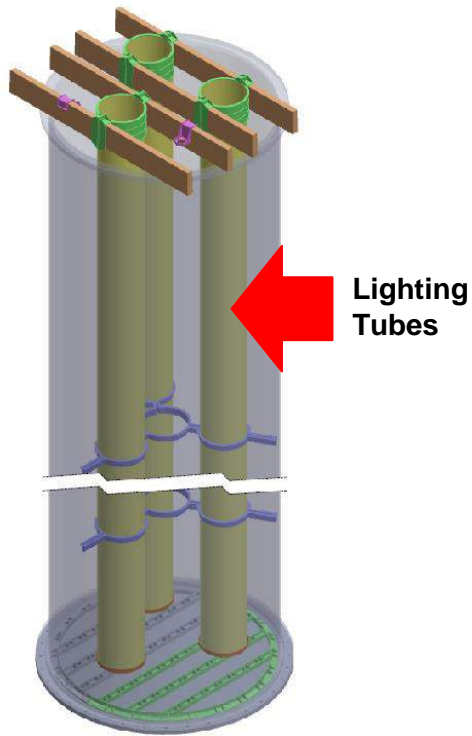
Part of BDI's RetroFit program: prepare BioDiesel plants for the future  
→ use of algae oil in an existing BioDiesel plant



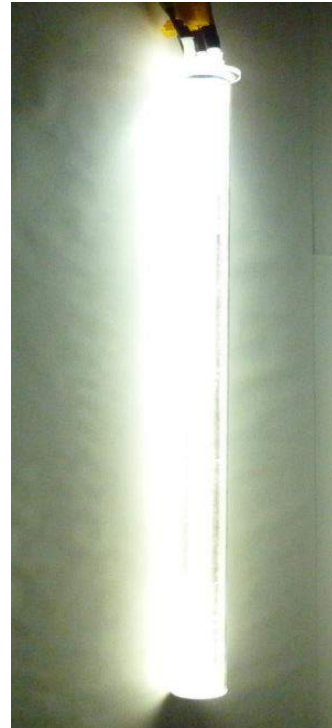


# SUN Algae Technology

## Technologie zur mixotrophen Kultivierung von Algen und Ölextraktion



Sunlight Distribution inside PBR



Sollektor sunlight feed into tubes

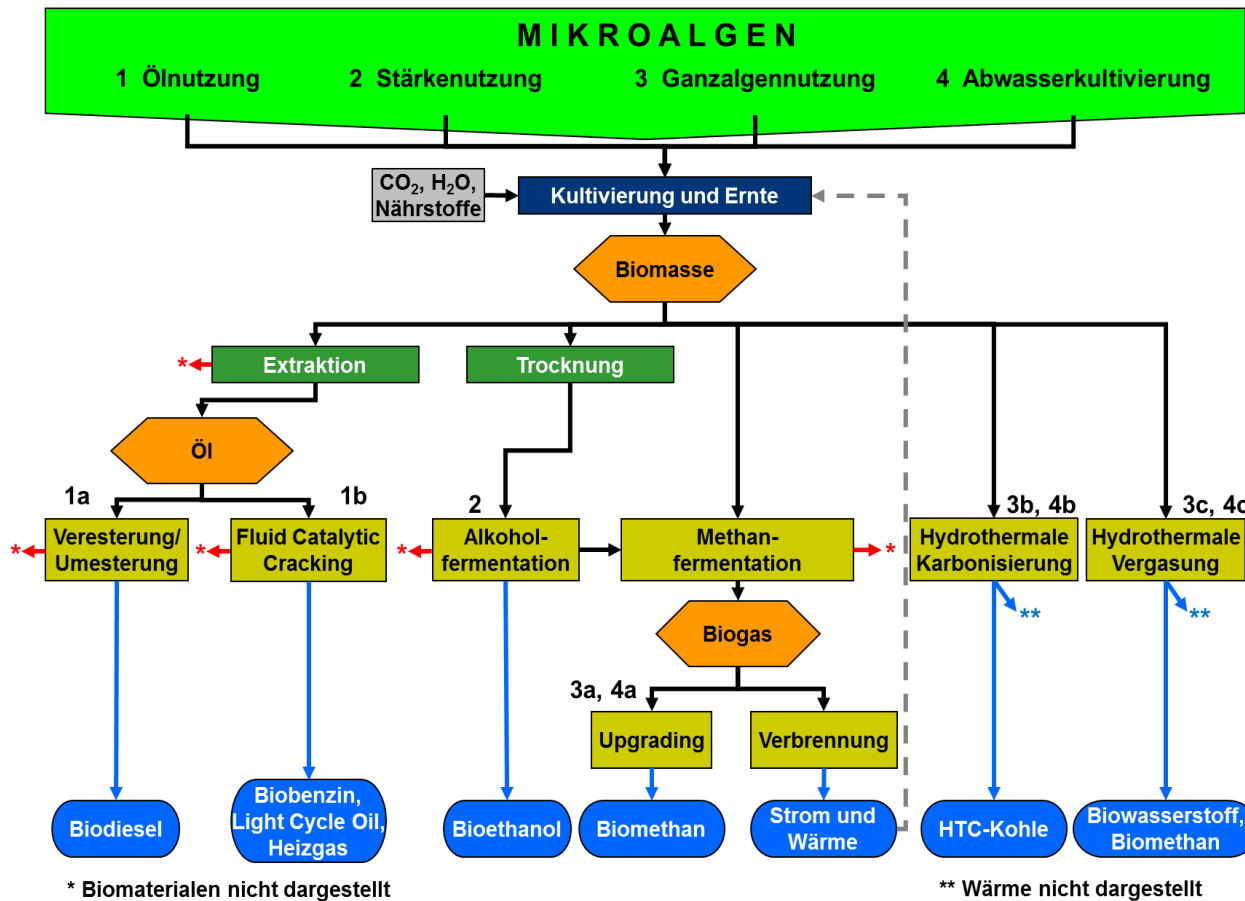


Microalgae and 14% Astaxanthin Concentrate (compared to 7% reached by solvent extraction)



# Algae&Energy:Austria

## Algen – eine zukünftige erneuerbare Energiequelle?



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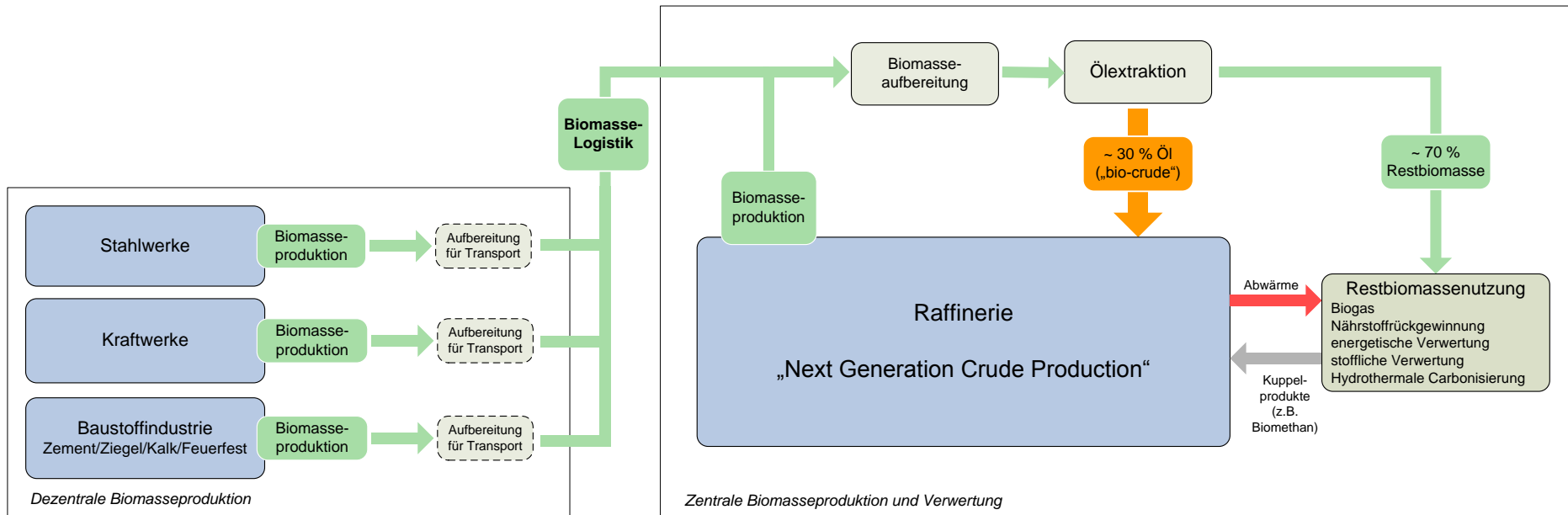


# Montanuni Leoben

## Studie zur industriellen Ölproduktion aus Algen

Projekt Next Generation Crude Production

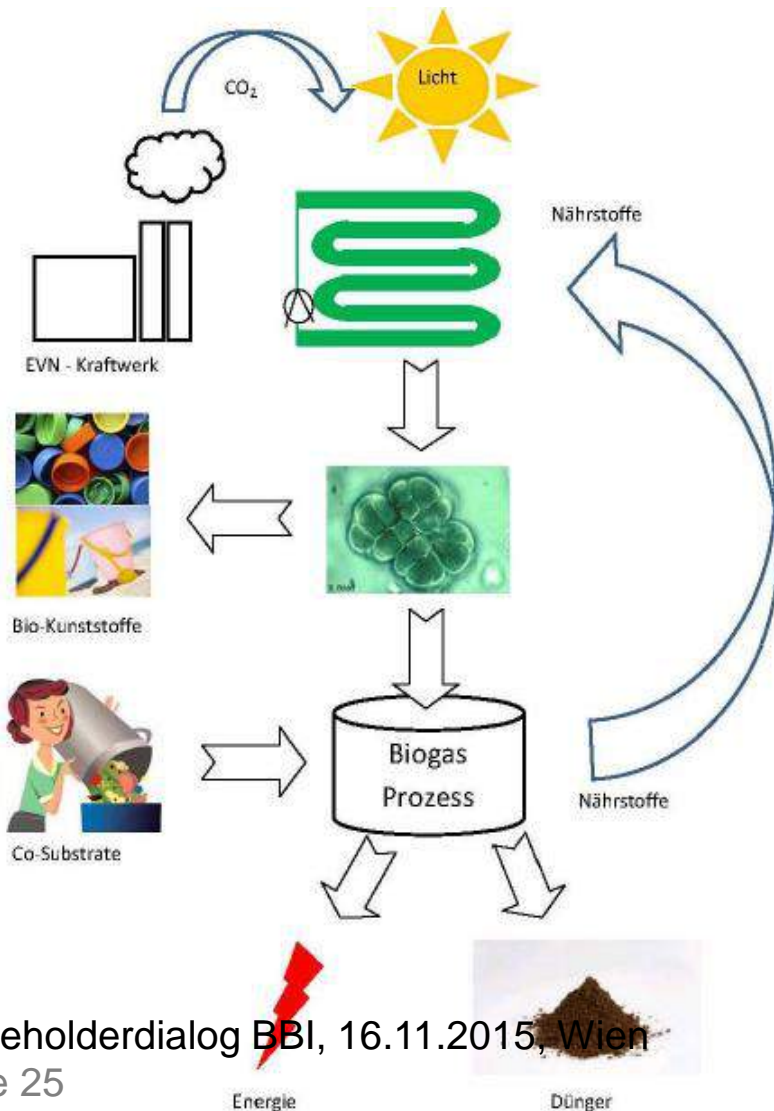
Nutzung von CO<sub>2</sub> aus Rauchgas zur Produktion von Algenöl zur Verwertung in der Raffinerie





# BOKU – EVN – Andritz

## Nutzung von CO<sub>2</sub> zur Produktion von Bio-PHB



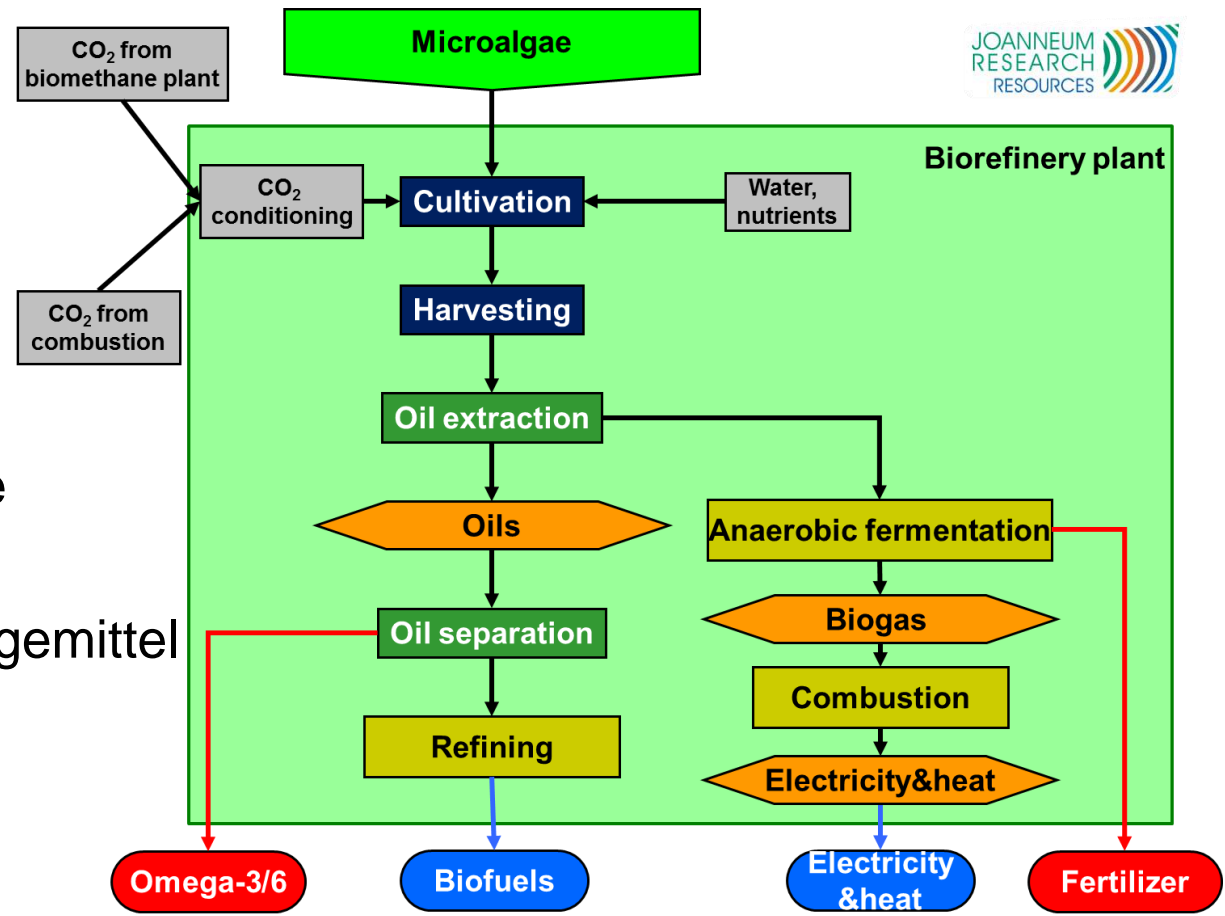
### PHB = Polyhydroxybuttersäure

- biologisch abbaubares Biopolymer
- ungiftig, unlöslich in Wasser, resistent gegen UV-Strahlung
- gute O<sub>2</sub>-Durchlässigkeit,
- Thermoplast,
- ähnliche Eigenschaften wie Polypropylen



# Joanneum Research Ökologische Bewertung

- Bewertung von
  - THG-Emissionen
  - Energiebedarf
- Im Vergleich zu
  - Fischöl
  - Fossile Treibstoffe
  - Erdgas
  - Synthetische Düngemittel

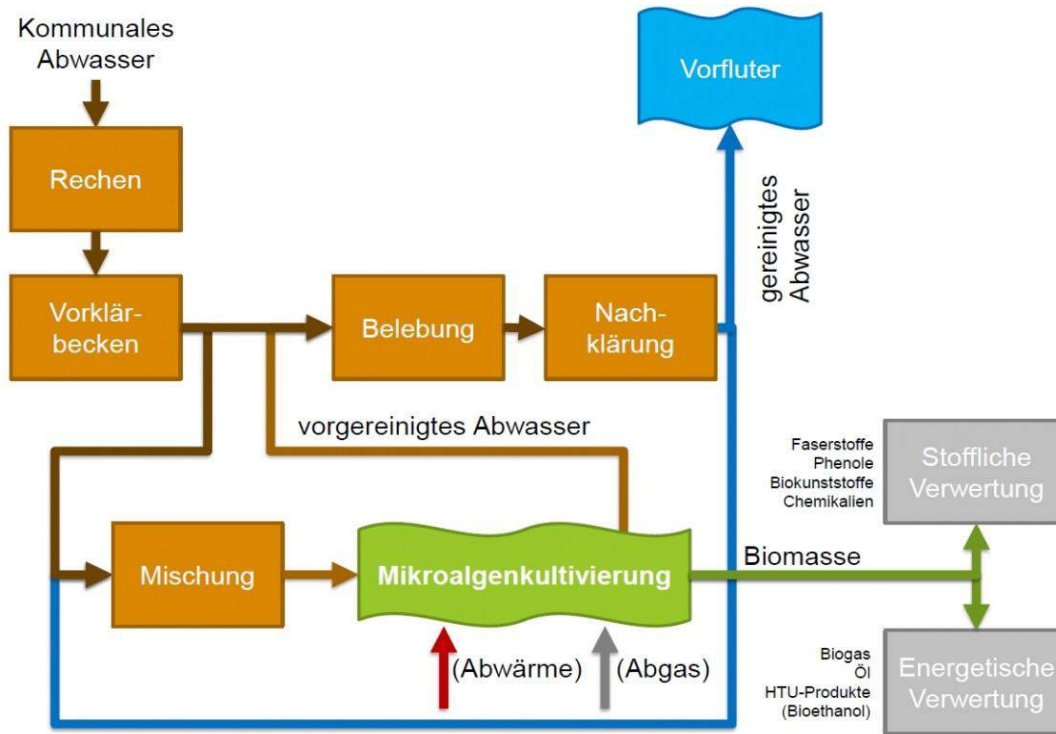


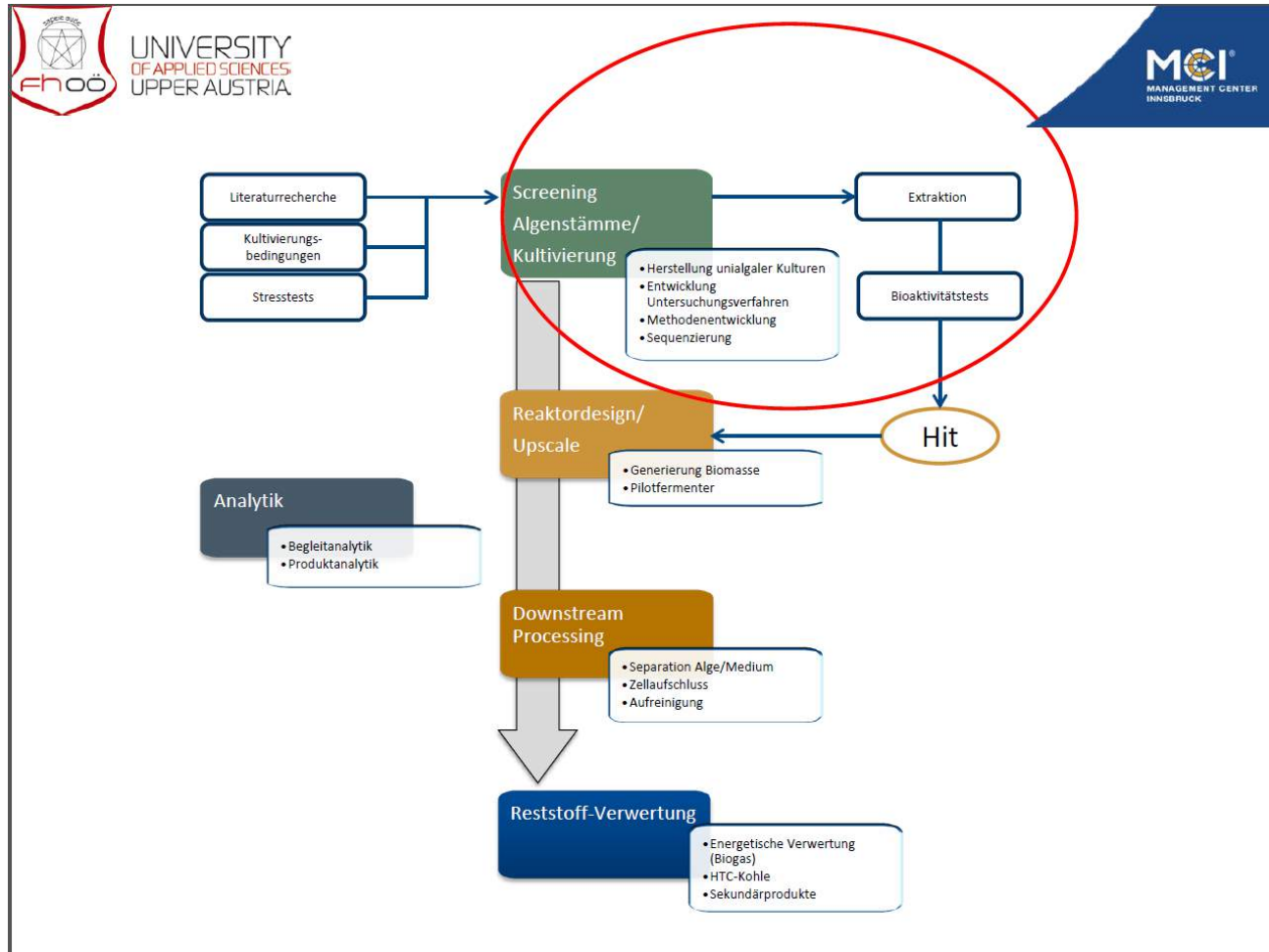


# BIOENERGY 2020+

## Mikroalgenkultivierung und Abwasserreinigung

### Algenbiomasse als Additiv in der Anaerobfermentation





UNIVERSITY OF APPLIED SCIENCES UPPER AUSTRIA



# Uni Wien, Institut für Limnologie Algenbiologie

