

ALGAE, A NEW GOLD RUSH?

DAS Conference 17 November 2011

Dr. Monique A. Schoondorp
Lector New Business Development

Hanze University of Applied Sciences





CONTENT

next 30 minutes

Oil versus Algae

Algae, some facts

Algae, the business

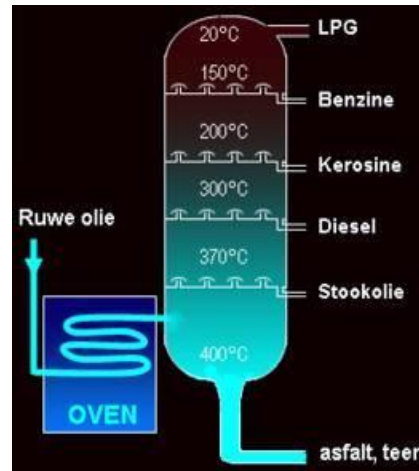
Algae and applied research

CRUDE OIL VERSUS ALGAE

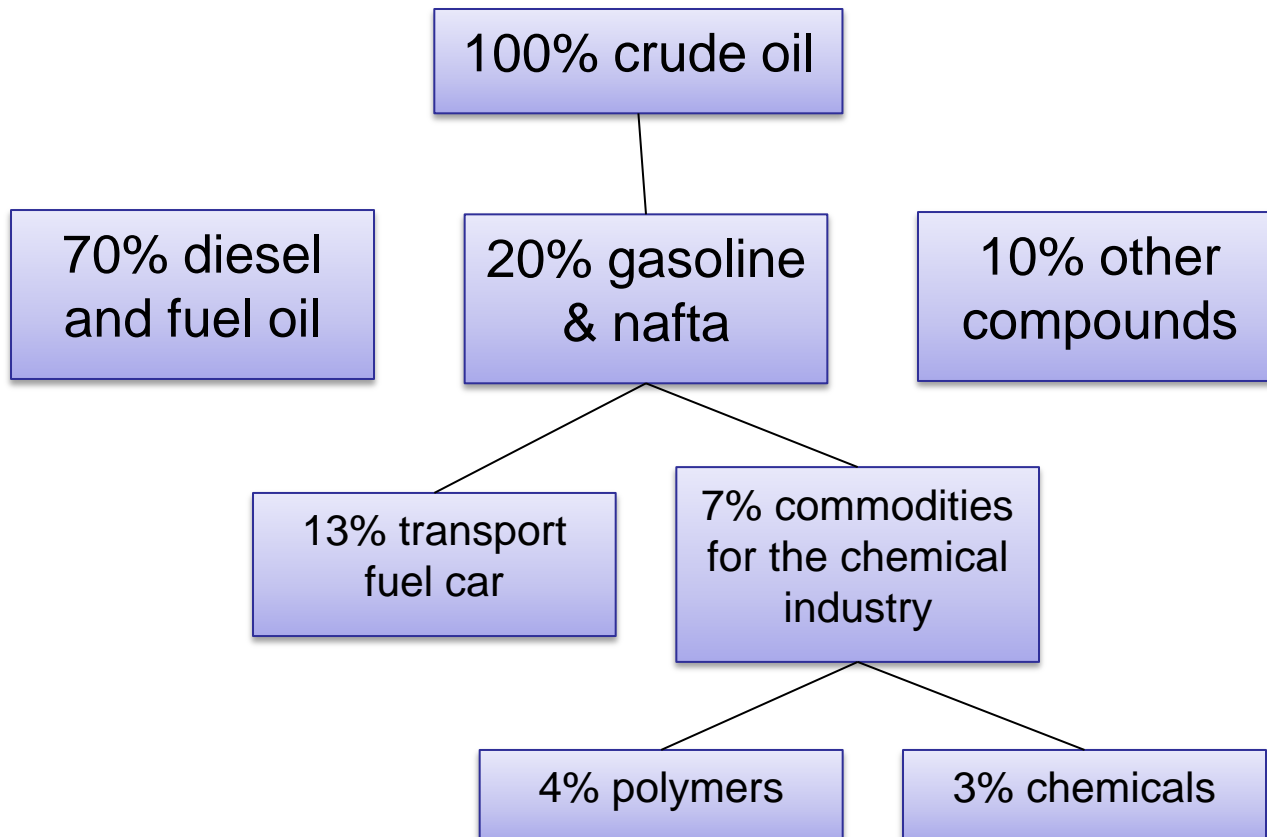
Crude oil, gas and coal are formed 100 to 300 million years ago from plants, microbes and algae, resulting in a complex liquid consisting out of 10.000 compounds

Main compounds

Alkanens $C_x H_y$
Cycloalkanes
Aromates



The refinery of crude oil



PRODUCTS

FROM CRUDE OIL



benzine, diesel, kerosine, antivries, schoonmaakmiddelen, medicijnen, aspirine, verf, autolak, luiervloeistof, insecticiden, kunstmest, oplosmiddelen, remvloeistof, verpakkingsmateriaal, kogelvrijevesten, textiel, cd/dvd, flessen, airbags, computerkasten, buizen, leidingen, boten, auto-onderdelen, sportartikelen, zuignappen, (auto)banden

transport fuel, cleaning agents, pharmaceuticals, paint, solvents, packaging materials, textiles, CD/DVD, Bleu ray, bottles, tubes, car parts, boats, computer housing, furniture, tires



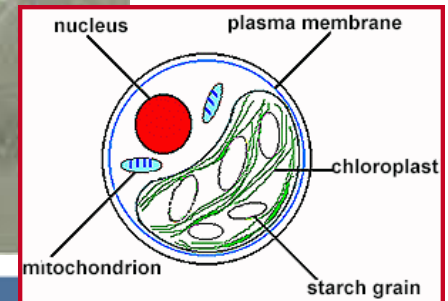
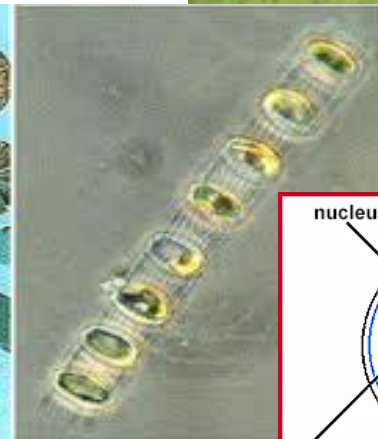
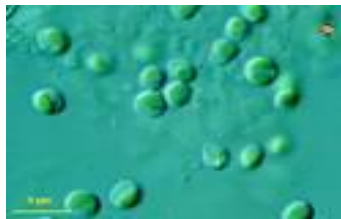
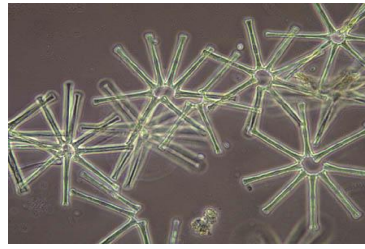
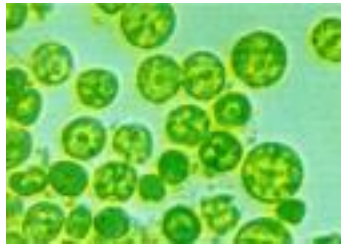
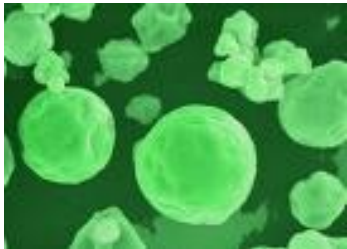
Turnover of the world largest companies

nr	COMPANY	turnover 2010 (billion \$)	turnover 2009 (billion \$)
1	Wal-Mart	408	415
2	Shell	285	458
3	ExxonMobil	284	442
4	BP	246	367
5	Toyota	204	

Figures from Fortune 500, CNN)

Algae

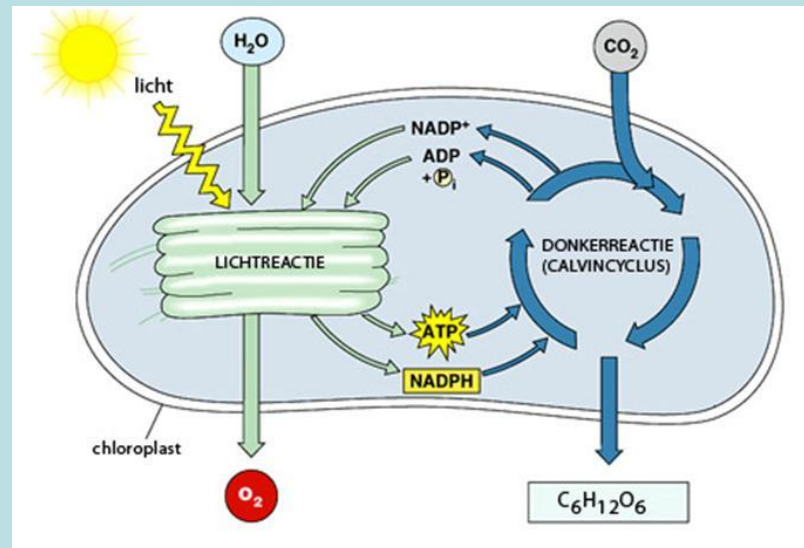
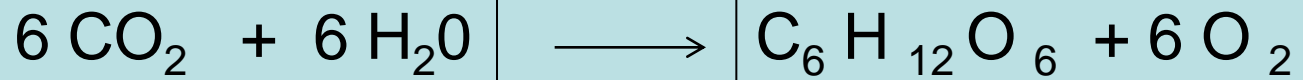
Algae are a large and diverse group of simple, typically autotrophic organism, ranging from uni-cellular to multicellular forms, typically 2 tot 20 microns. They are photosynthetic like plants and simple because their tissues are not organized into many distinct organs.



ALGAE AND CRUDE OIL



Photo synthesis



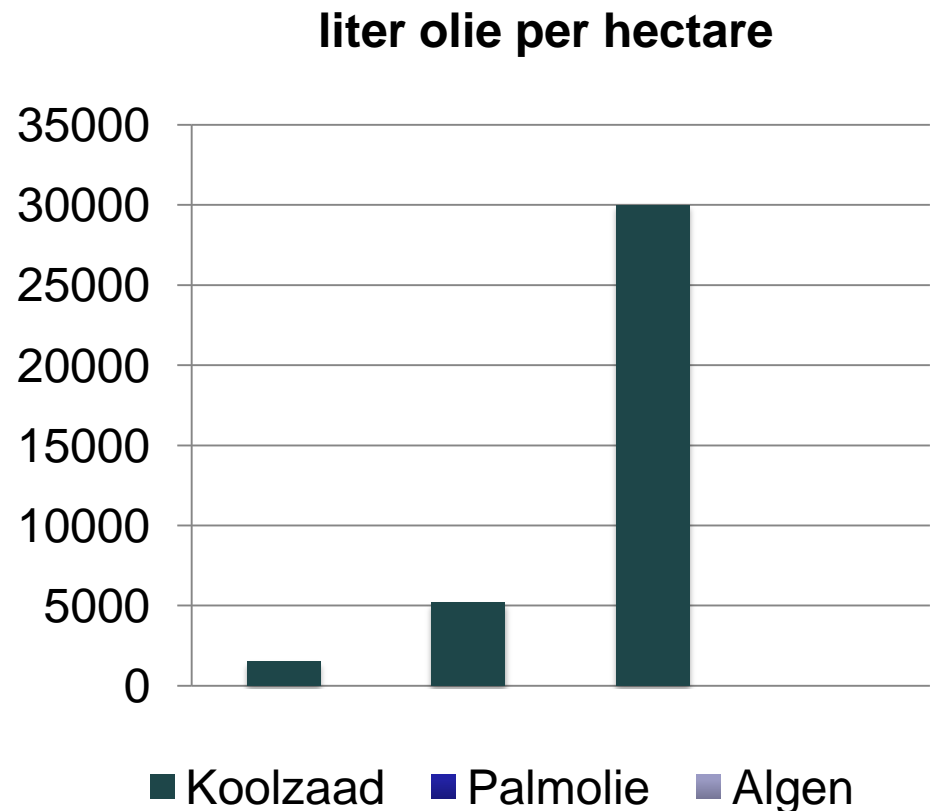
Compounds within algae

Composition of different algae (% of dry mass)

Alga	Protein	Carbohydrates	Lipids
Anabaena cylindrica	43-56	25-30	4-7
Aphanizomenon flos-aquae	62	23	3
Chlamydomonas reinhardtii	48	17	21
Chlorella pyrenoidosa	57	26	2
Chlorella vulgaris	51-58	12-17	14-22
Dunaliella salina	57	32	6
Euglena gracilis	39-61	14-18	14-20
Porphyridium cruentum	28-39	40-57	9-14
Scenedesmus obliquus	50-56	10-17	12-14
Scenedesmus dimorphus	8-18	21-52	16-40
Spirogyra sp.	6-20	33-64	11-21
Arthrospira maxima	60-71	13-16	6-7
Spirulina platensis	46-63	8-14	4-9
Synechococcus sp	63	15	11

Algae biomass in comparison with other crops

Crops	ton/ha/jr (dry weight)
Algae	20-100
Palmoil	10
Rapeseed	3
Soya	1 – 2,5
Jathropa	7-10
Sunflower	3-5



**Grow of 1kg algae
sequesters 2 kg CO₂**

**1 ha sequesters
between 100 en 150
ton CO₂**

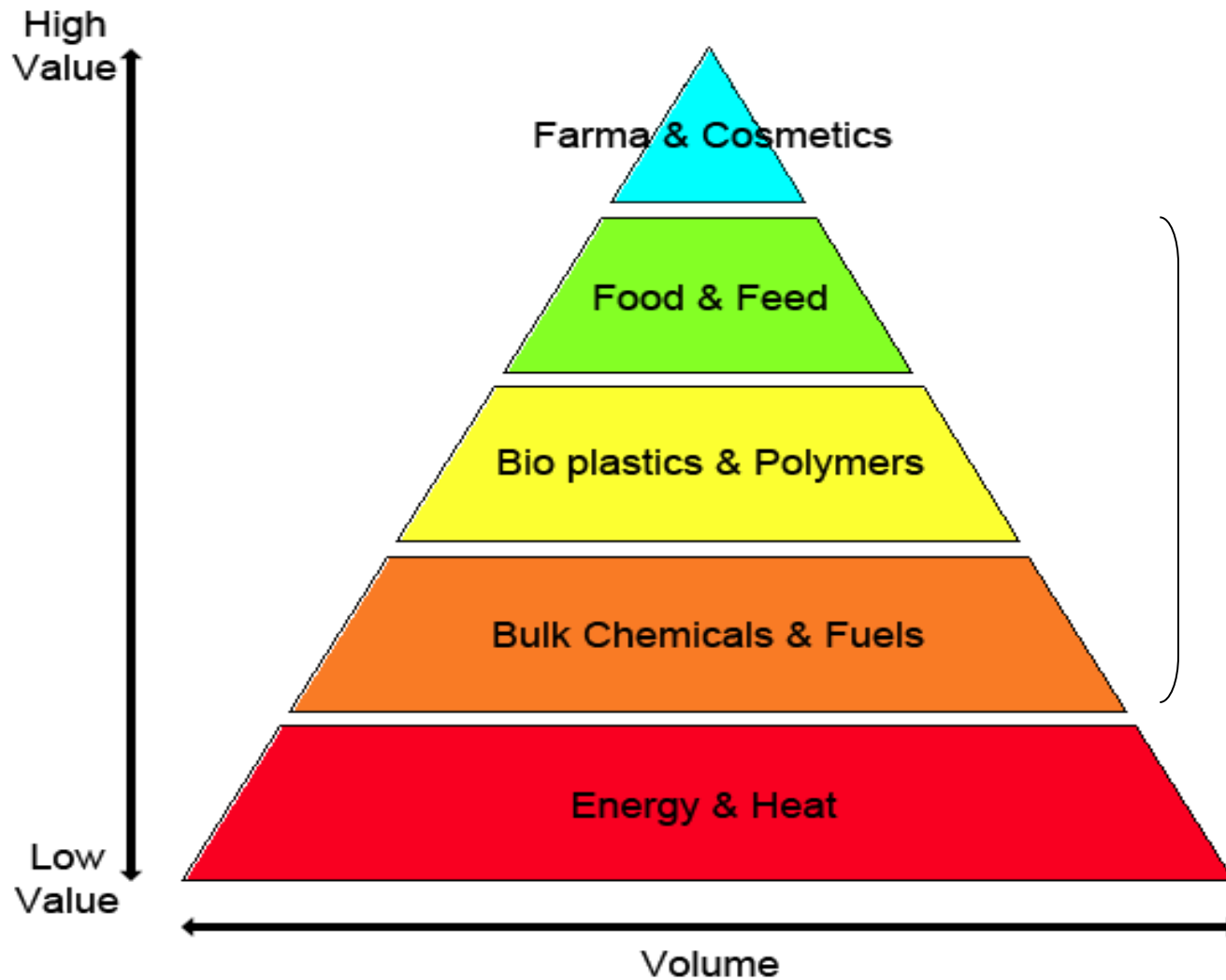
**This is much more
effective than all other
crops**

The Earth



Total natural algae population sequesters 450 billion tons CO₂ (estimate) and is responsible for 50% of the total oxygen production, the other half is produced by trees and green plants.

De value pyramide



Algae market



Algae products	Value (€ / ton)	Size World market / jaar (€)
Neutraceuticals	10.000-100.000	60 – 100 milion
Fish- and feed	500 - 5000	3 - 4 billion
Bulk materials	500 - 1200	10- 50 billion
Transport fuels Energy	< 500	> triljard
CO₂ credits	In development	



One big difference

oil and algae business

Crude oil / natural gas
was and still is available in large quantities

Algae (and other biomass) have to be produced

Start of applied research



Oil crisis 1970

Rise of the Aquatic Species Program in the US

Biodiesel from algae (1978-1996)

Several European countries developed expertise in several laboratories

Japan concentrated on offshore bio-reactors

In the Netherlands

2000 - 2003 EET (Energie, Ecologie en Technologie) project, expertise within different institutes WUR/ECN/ UvA

The yields are dissapointing regarding the theoretical expectations

The costs are higher than expected

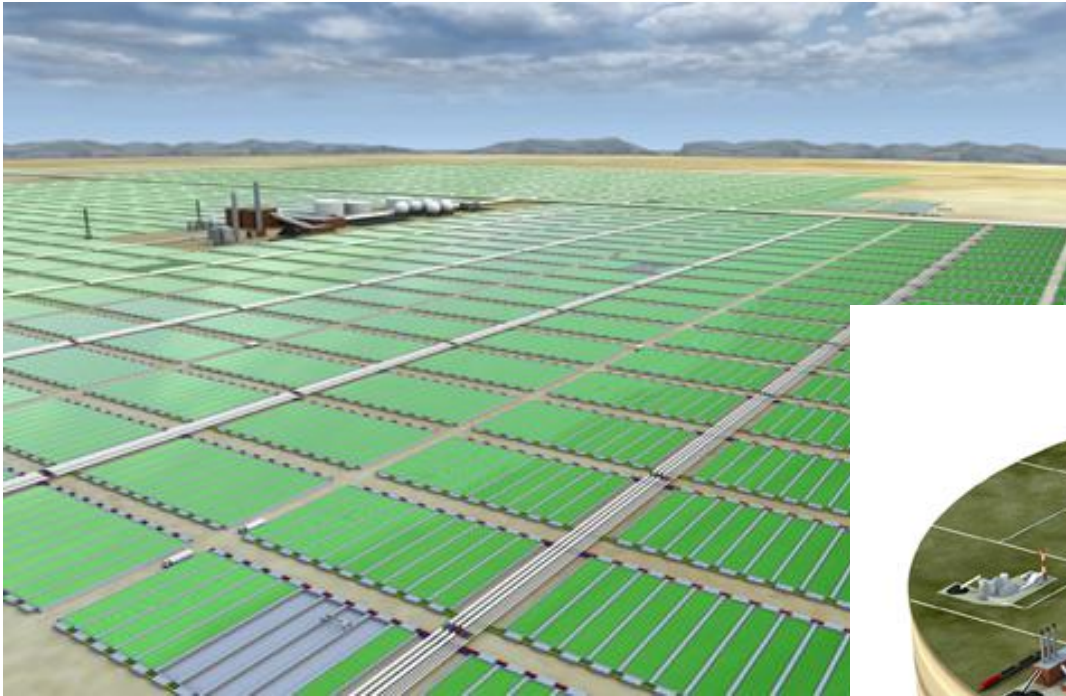
The growing of algae is possible in open ponds and the optimal climate conditions are known.

3000 algae species have been evaluated and the top 300 has been stored in an algae databank hosted by the University of Hawaii and is still available

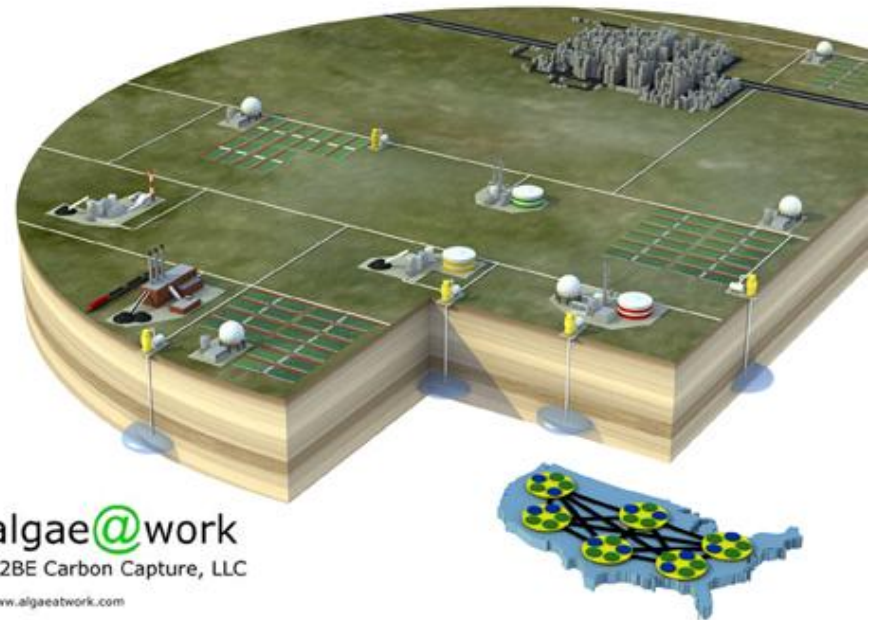
US and Europa
same knowledge background

Different approaches to develop the algae
business

THE AMERICAN DREAM



Solix Biofuels



algae@work
A2BE Carbon Capture, LLC
www.algaeatwork.com



FIGURES

TO SUPPORT THE DREAM

An area as big/small as Idaho can supply all algae to replace the crude oil demand of the US.

An area as big/small as Portugal is able to supply the demands of Europe

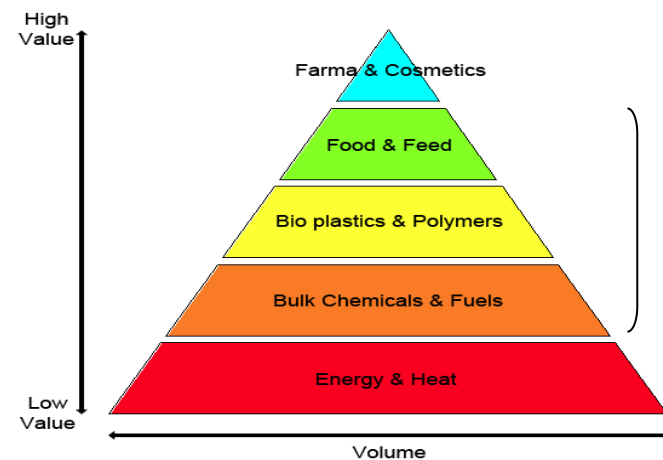
3% of the total ocean area is able to provide the crude oil demand of the whole world.

EUROPEAN DREAM

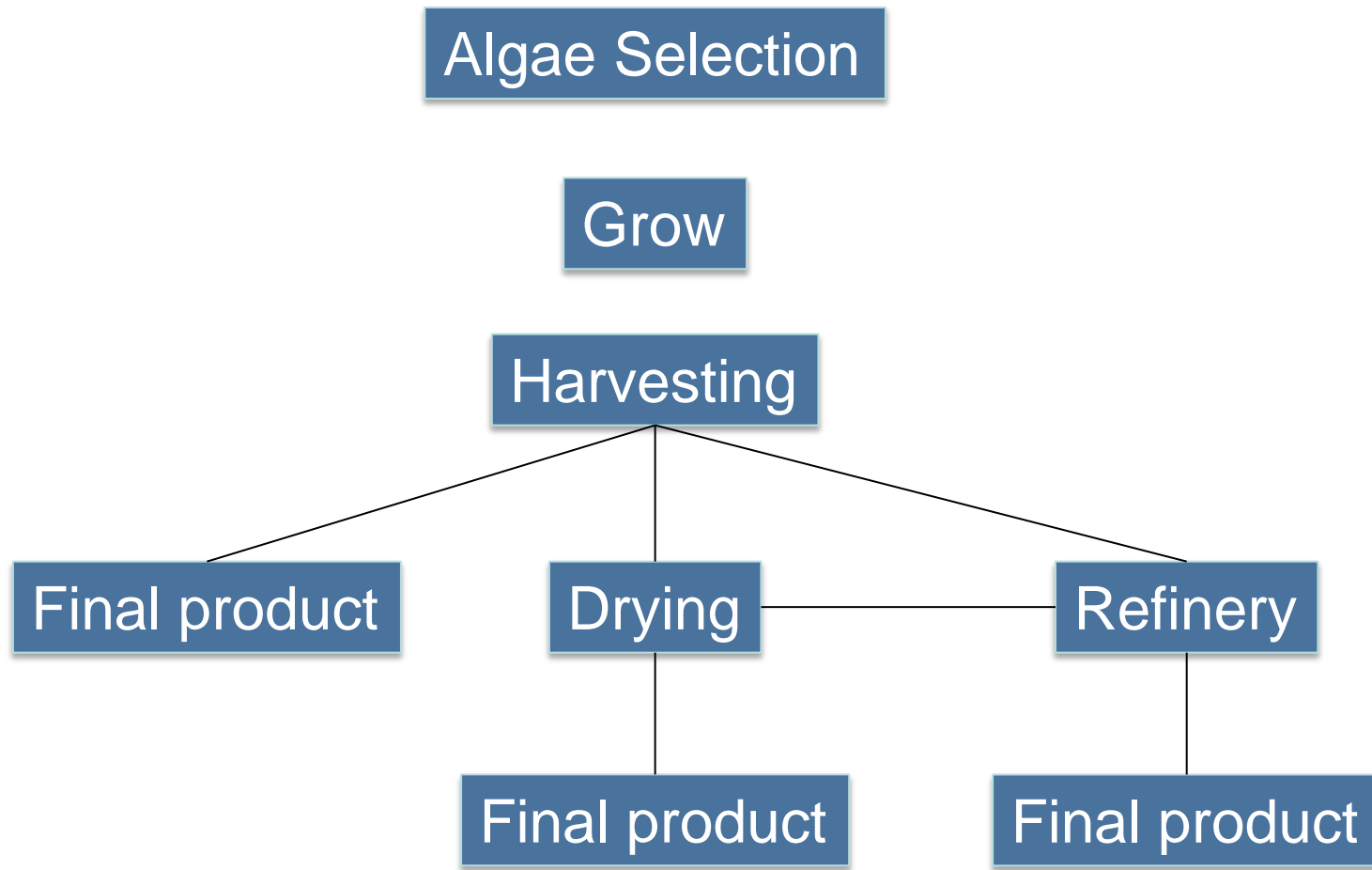
More divers

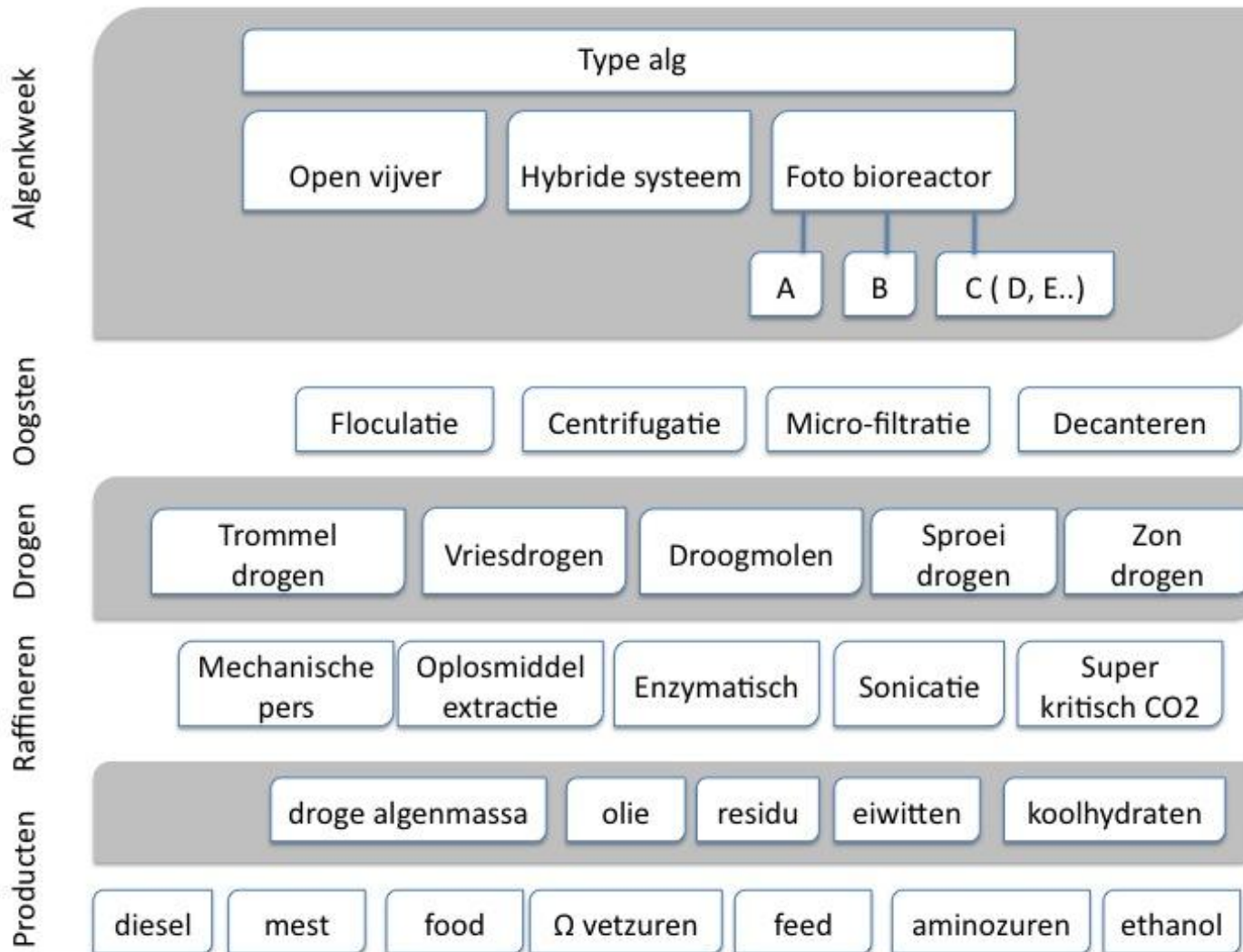
Pharmaceutical products
Cosmetics
Fish feed / feed
Bio plastics
Water treatment
Cradle to cradle

Bio diesel, Kerosine
Green Gas
Ethanol



Production Process





Growing systems



Open Systems



“ Raceway ponds “



Closed Systems



Examples of closed systems

Companies

Profitable



Mera pharmaceuticals, Hawaii, specific patented process, β carotene, divers.

Earthrise VS, spirulina, food supplements

Algatech, Israel, asthaxathin

Cognis, Australia, β carotene

Seambiotic, Israël, asthaxathin, β carotene

BleuBioTech GmbH, production location China, products spirulina, food supplements, cosmetics.

Overview Companies I

Company	Grow system	Weast streams	Dessert	Water	Capital
A2BE Carbon Capture	reactors	+	+	sweet/salt	
Algaewheel	ponds	+			
XL Renewables	ponds	+	+	salt	Union of farmers Venture
Algenol Biofuels	reactors				Venture
Cellana	hybride			salt	o.a. Shell for sale
Petrosun	ponds		+	salt	Bedrijf
Greenfuel Technology	reactors	+	±	±	Early venture bankrupt cy

Overview companies II

Company	Grow system	Waste stream	Dessert	Water	Capital
Solix Biofuels	Reactors in water	±		sweet	venture
Greenstar	divers			salt	venture
Sapphire Energy	Special reactor		+		Venture Bill Gates
Solazyme	dark reactor sugar input			sweet	large (oil) companies
Martek	dark reactor sugar input				Sold to DSM
Aurora Biofuels	hybride			sweet	Venture, DARPA
Blue Marble Energy	harvesting the sea	+		salt	Venture

The Netherlands

Netherlands	AlgaeLink B.V.	reactors
	Aquaphyto B.V.	ponds
	Ingrepro B.V.	ponds
	L gem B.V.	reactors
	AFF B.V.	reactors
	Procede B.V.	reserach
	Algaecom VOF	reactors
Belgium	Proviron B.V.	developing reactors
	SBAE Industrie	Bankruptcy 2011 (venture)

Rest of the world

Australia
New Zealand

Large projects, 80 ha
Aquaflow Bionomic Corporation

Germany

Novagreen GmbH
Subitec GmbH, Fraunhofer
Phytolutions GmbH, Jacobs Universiteit Bremen

Italy, Spain en
Portugal,
Tsjechië

University spin offs

Asia

China, aqua culture , production spirulina
Japan, research
India, start of many different activities, bio diesel

Project “ Algen voor een schoner wad ”

Largest pilotplant in the Netherlands in symbiose with a chemical plant

Cooperation Zeolyst NV, Waterbedrijf Groningen Algaecom and BN Algen



low cost reactor

outdoor

innovative
harvesting system

waste streams

testing the process in
winter conditions

Algaecom specializes in world wide knowledge about available algae technology

Algaecom develops a protein algae market focussing on the Netherlands and Germany

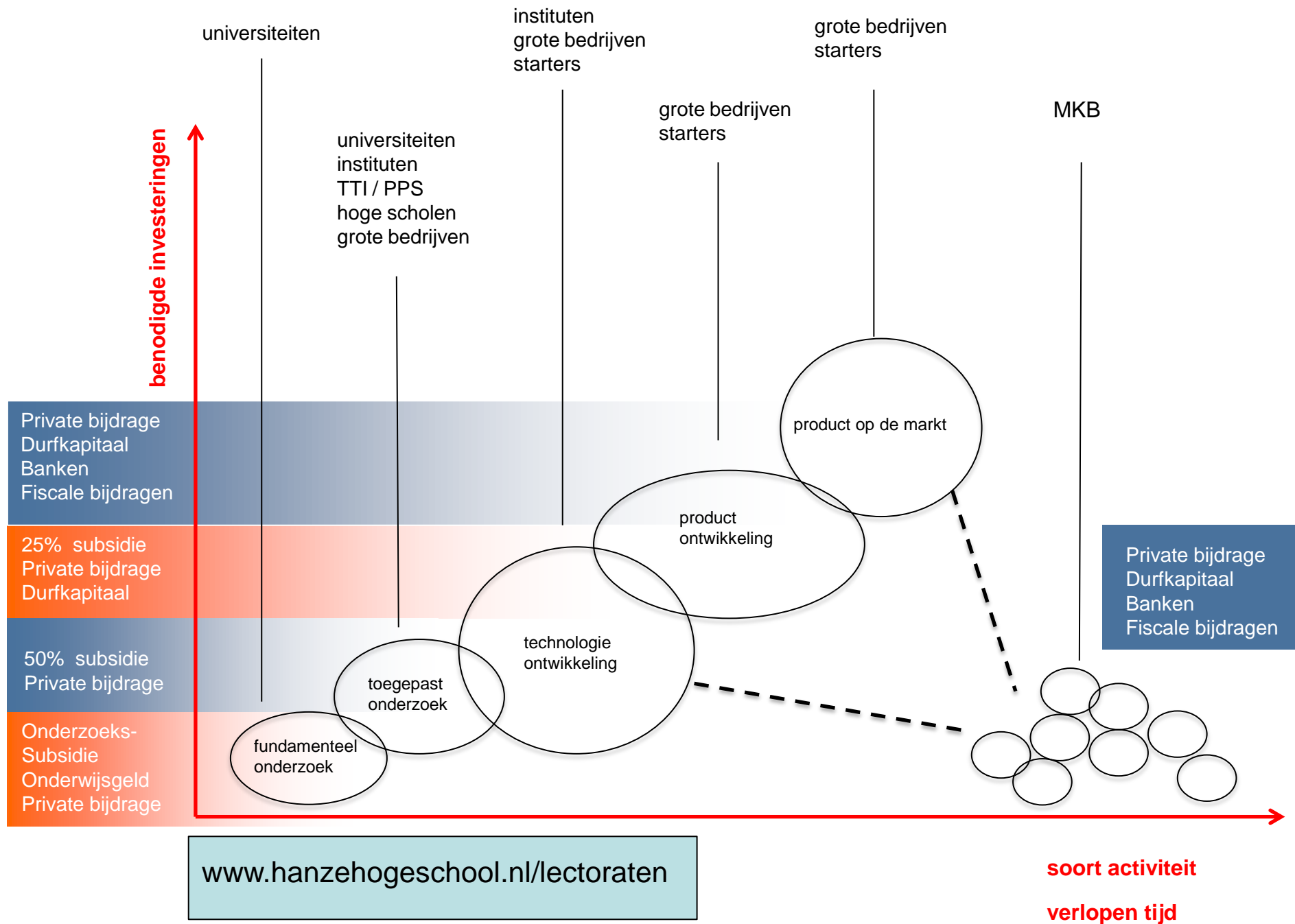
Algaecom develops state of the art pilot projects based on waste streams



Contribution of applied universities

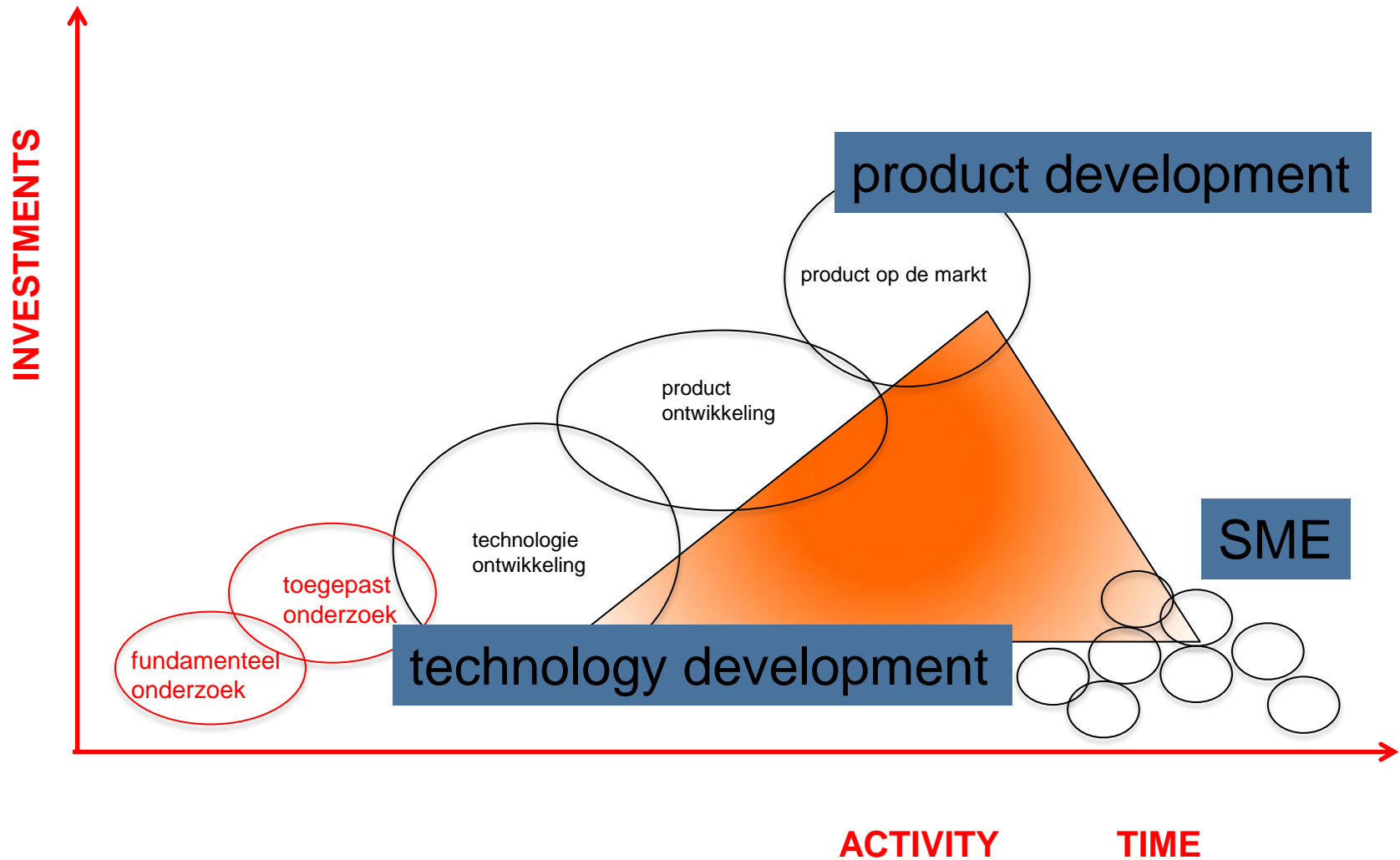
to the green gold

**Depends on the vision how innovation works
and how “praktijkgericht” research is interpreted**





PLATINUM TRI ANGLE



NEW BUSINESS DEVELOPMENT



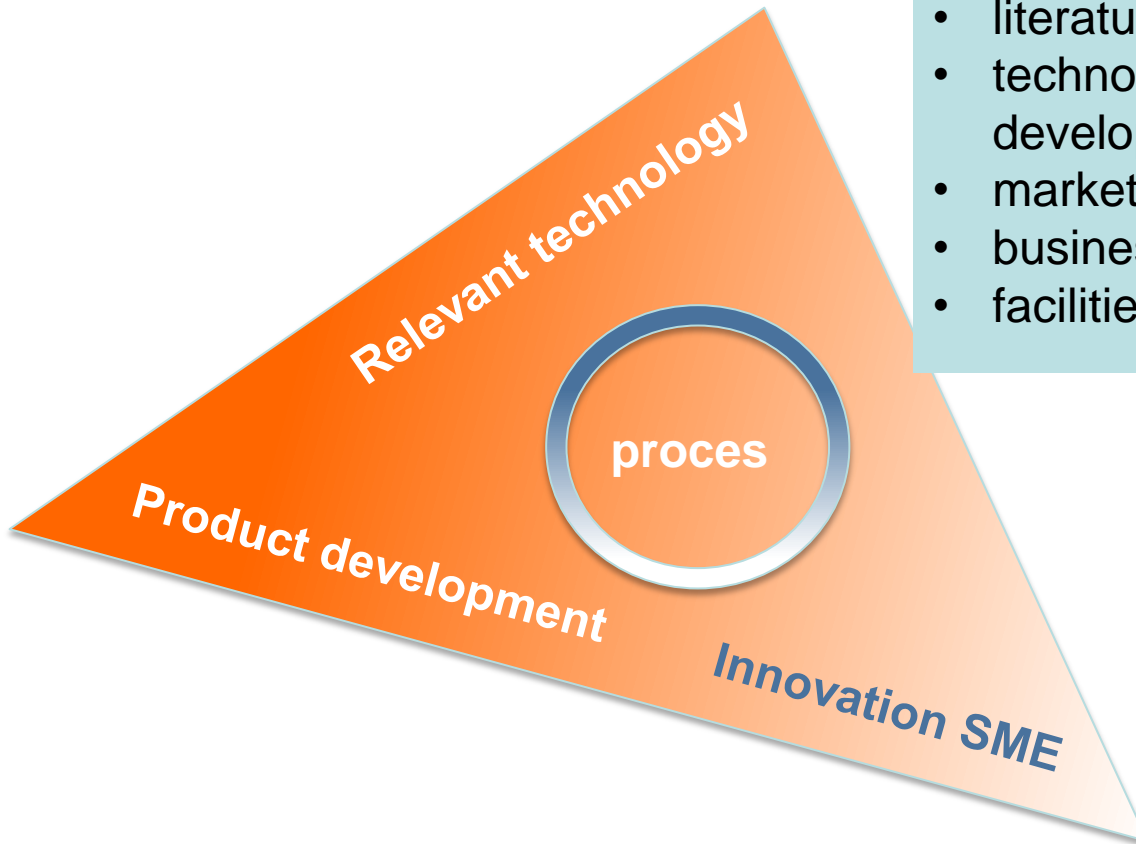
Hanzhogeschool Groningen

Kenniscentrum
Ondernemerschap

	technologie	product ontwikkeling	markt	organisatie	financiën	netwerk	regelgeving
Idea phase	✓	✓	✓				
Development Phase	✓	✓	✓		✓		✓
Demonstration Phase			✓	✓	✓	✓	✓
Market Introduction			✓	✓	✓	✓	
Promotion Phase				✓	✓	✓	
Stabie situation			✓	✓	✓		✓



ROLE OF APPLIED UNIVERSITIES



- idea generation
- literature searches
- technology development
- market analysis
- business models
- facilities

- Publications
- Knowledge transfer
- Implementation higher education
- New companies



“ALGAE BUSINESS” OPPORTUNITIES

Waste management

Sequestering CO₂

- Carbon credits
- Green image



Water treatment

- Reduction of nitrates and fosfates
- Reduction of heavy metals



Production of valuable compounds

Bulk products

- bio fuel
- feed/fish feed
- proteïnes



Fine chemicals

- Carotenoids
- Omega fatty acids
- Amino acids



THE END

Final Conclusion or Message,

There are so many interesting subjects to develop regarding the bio based economy
So, just start and cooperate in open innovation programs to transfer algae, but also other biomass, into green gold

Aiming for a new generation people thinking
“green”