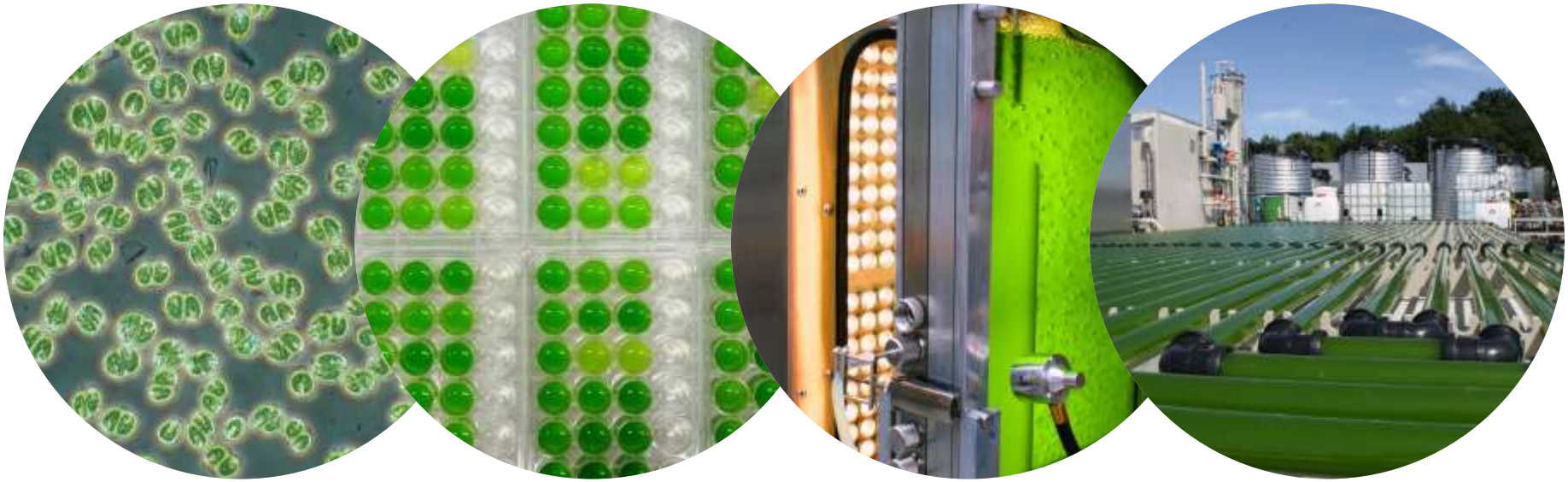
AlgaePARC

Algae Production And Research Center

Young Algaeneer symposium, 15 June 2012

Rouke Bosma
Maria Barbosa
Dorinde Kleinegris
René Wijffels



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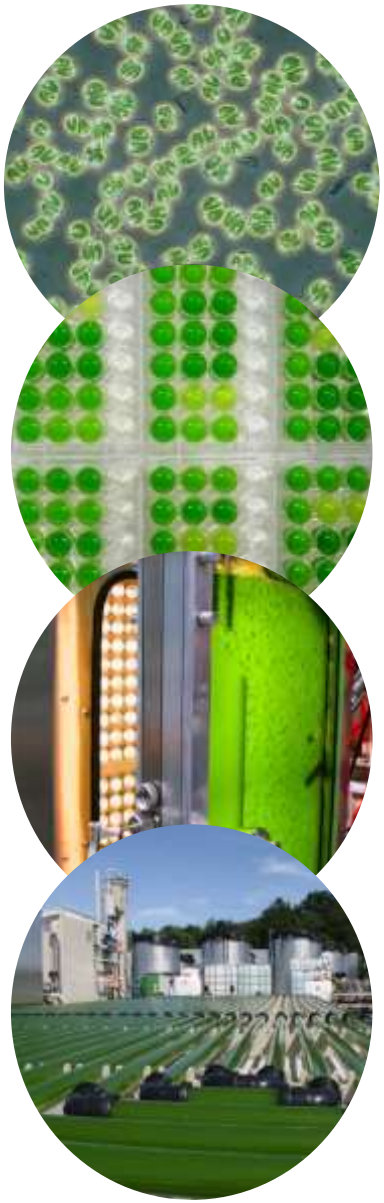
Overview presentation

- From craft to industrial Process
- How to decrease production costs
- Why AlgaePARC ?
- AlgaePARC
  - Objectives
  - Building
  - Cultivation systems
  - Funding
  - Research
  - Team
- Tours



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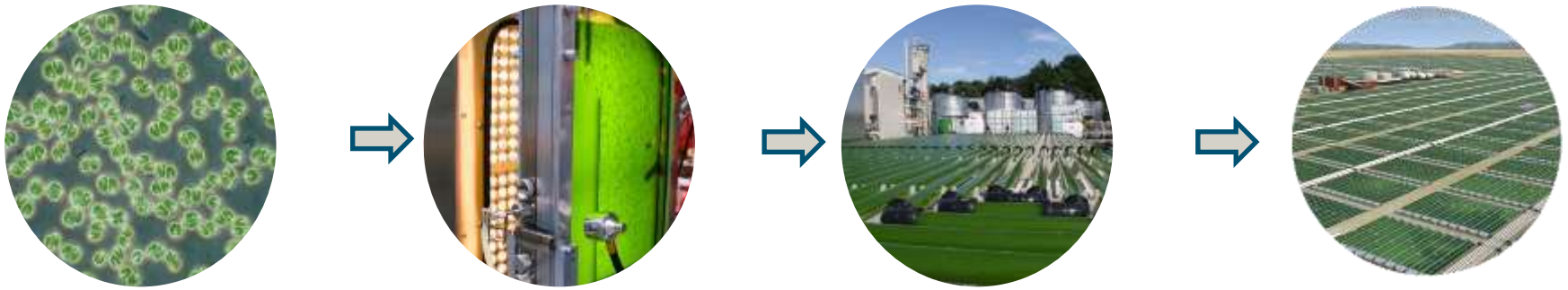
From a craft to an industrial process…

- Current worldwide microalgal manufacturing infrastructure ~5000 tons of dry algal biomass
- High value products such as carotenoids and ω-3 fatty acids used for food and feed ingredients.
- Total market volume is €1.25 billion
  (average market price of €250/kg dry biomass)
- World production of palm oil is nearly 40 million tons, with a market value of ~0.50 €/kg



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Wijffels R.H., Barbosa M.J. (2010) An outlook on microalgal biofuels. ***Science*** 329: 796-799

How to decrease production costs?

- At 1 ha scale today : 10 €/kg
- At 100 ha scale today : 4 €/kg
- What will be possible : 0.50 €/kg

- Increasing photosynthetic efficiency
- Integrating processes (free nutrients)
- Decreasing mixing
- Developing cheaper and less energy consuming harvesting technologies
- Choosing locations with higher irradiations

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*Norsker et al. (2011) Microalgal production- a close look at economics, *Biotechnology Advances* **29**: 24-27

Why AlgaePARC ?

Example, photosynthetic efficiency

- At lab scale a photosynthetic efficiency of 6% seems to be within reach

What about

- Pilot scale 10 – 100 m^2
- Extended time > 1 yr

And how to design/operate even larger (1-100 ha plants) ?

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MANY SCATTERED ACTIVITIES

- Different locations
- Different designs
- Different measurements
- How to compare systems?
- How to learn from this process?

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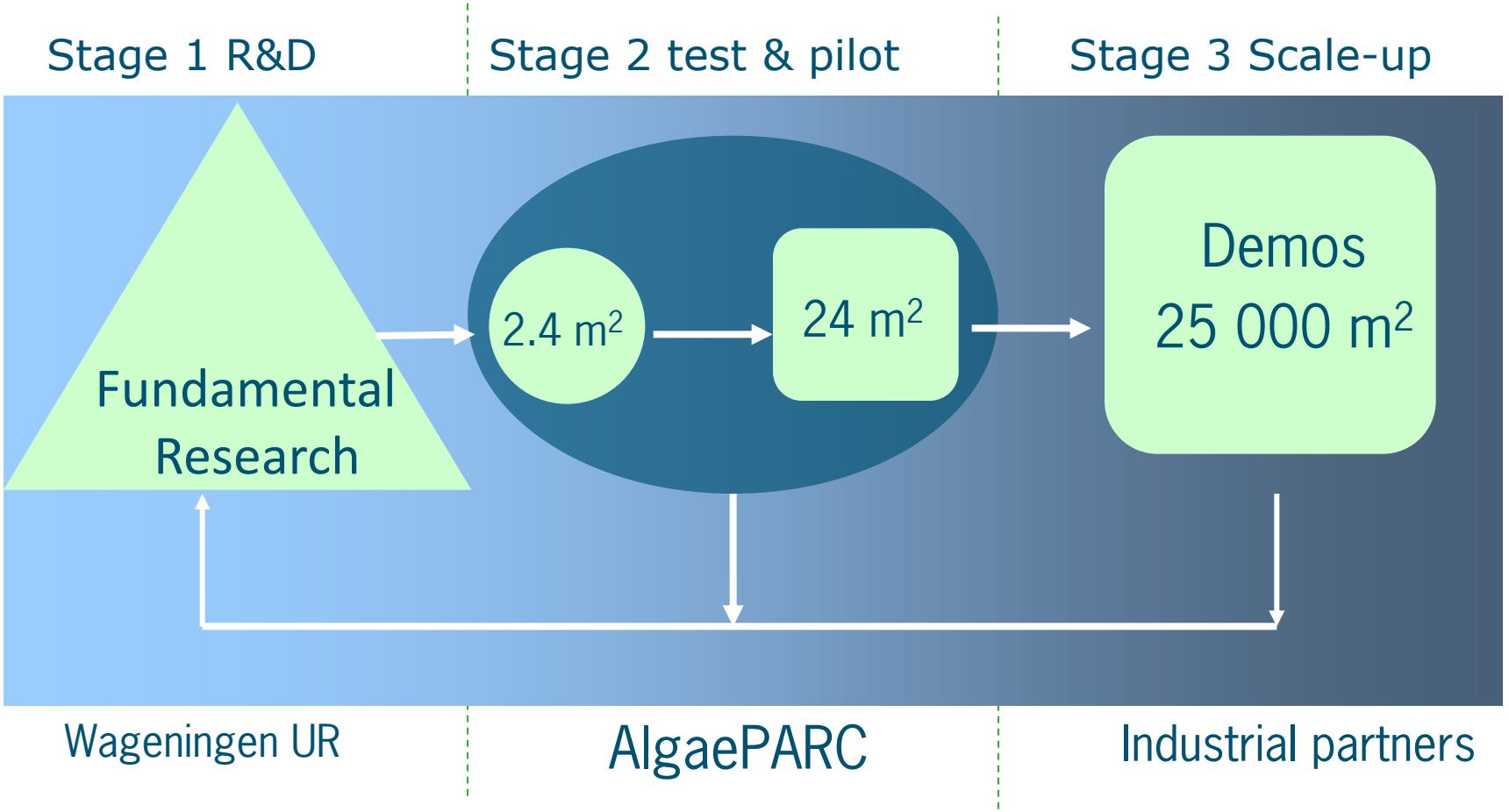
Translate research towards applications



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AlgaePARC

The main focus of AlgaePARC is to develop knowledge, technology and processes strategies to *scale up* microalgae facilities *under industrial settings* and to optimize product productivities under stress and controlled conditions outdoors.

AlgaePARC objectives

- International center of applied research
- Intermediate between basic research and applications
- Development of competitive technology (economics, sustainability)
- Acquire information for full scale plants
- Algal biomass for food, feed, chemicals and fuels

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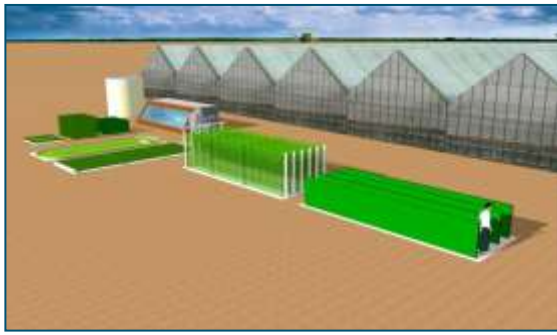
Timeline and status building

Status 1 April 2010

Available: 3.3 M€

Wanted:
Four demo photobioreactors
Three pilot photobioreactors

Still needed
- Technical specifications
- Permits
- Facilities (electricity, water, air)



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Official opening of AlgaePARC 17 June 2011

Production systems at AlgaePARC

Raceway pond

Horizontal tubular reactor

Flat panels

Vertical stacked tubular reactor

Systems at AlgaePARC

24 m^2 systems

- Long time performance (1 year)
- High level of measurement and control
- Representative productivities for full scale
- Information for design of full scale plants

2.4 m^2 systems

- Phase between lab and pilot
- Short term experiments
- Different strains
- Different feed stocks
- Adaptations in design and process
- If successful
  → To 24 m^2 scale
- If not successful
  → More experiments
  → Reject

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AlgaePARC

Main Features

Uniqueness - 4 different systems that can run in parallel

Fundamental aspects for successful operation and scale up of photobioreactors to commercial plants

Control Units: accurate online measurements and control of a wide range of metabolic and environmental parameters

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Funding AlgaePARC

Facility financed by

- Ministry EL&I
- Province Gelderland
- Wageningen UR

Ministerie van Economische Zaken, Landbouw en Innovatie

provincie Gelderland

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Research program financed by

BioSolar Cells

BASF The Chemical Company

BioOils energy

DSM

Drie Wilgen Development

ExxonMobil Research and Engineering

GEA Westfalia Separator Group

seliae

NESTE OIL

nijhuis WATER TECHNOLOGY

PAQUES

pdx EXCEPTIONAL EFFICIENCIES

Proviron

ROQUETTE Offering the best of nature

sabic

Simris Alg FOOD & FUEL FROM THE SEA

STAATSOLIE

SYNTHETIC GENOMICS

TOTAL

Unilever

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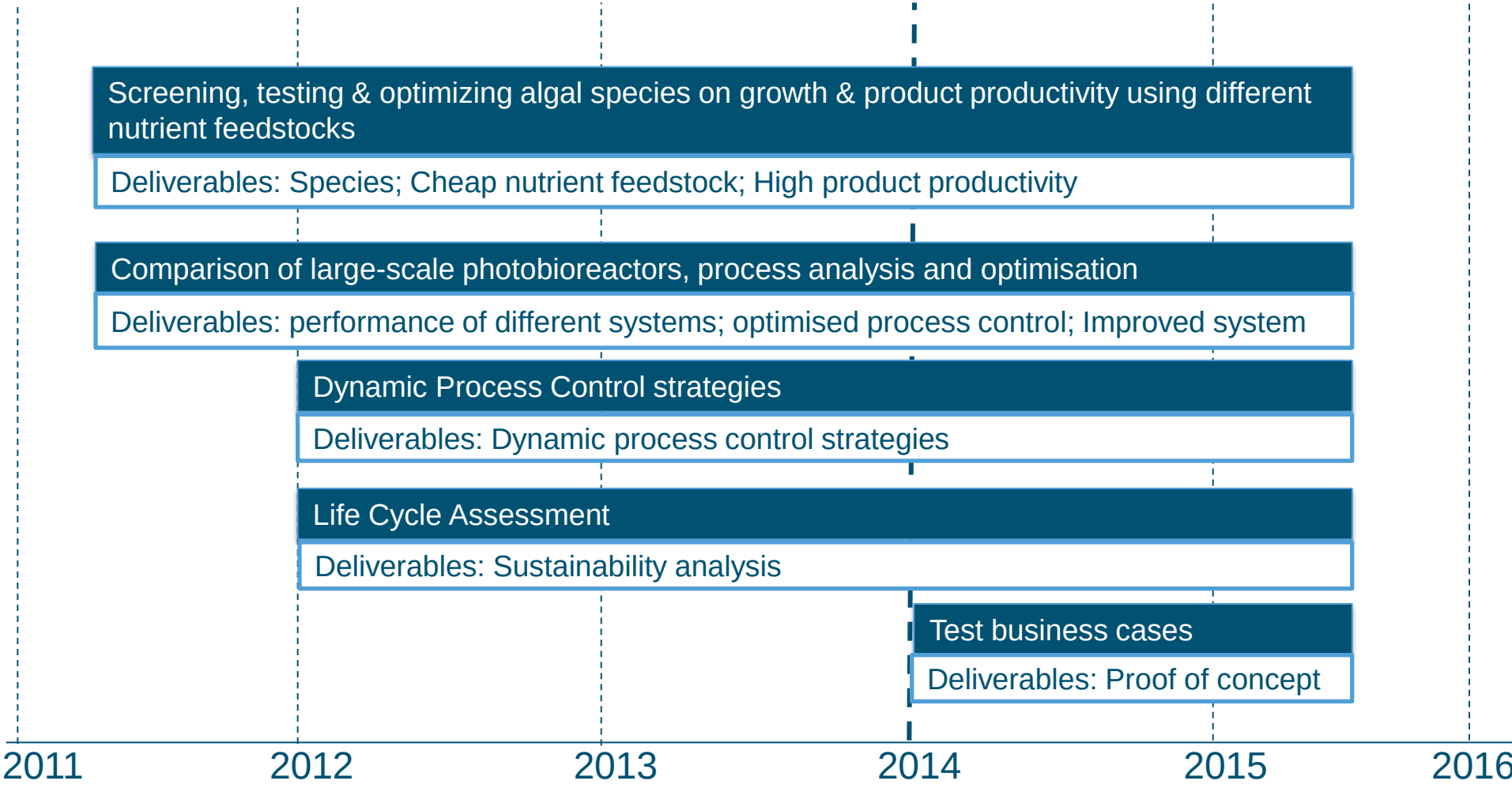
R&D activities AlgaePARC



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Screening, testing & optimizing algal species on growth & lipid productivity under different feedstocks

Screening of species

- Literature research selection of 10 species (growth, nutrient requirements)
- Feedstocks literature research + partners --> availability
- Medium optimisation and feedstock testing
- Further selection of species on productivity

Optimisation in lab scale photobioreactors

- Optimisation of lipid productivity under nutrient limitation for 1 selected species

Cultivation outdoors

- testing in 2.4 m^2 systems
- proof of principle in 24 m^2 systems

PhD student
Giulia Benvenuti

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Comparison of large-scale photobioreactors, process analysis and optimisation

Create base case data

- Areal and volumetric biomass and lipid productivity
- Energy balance
- Nutrient requirements
- Carbon dioxide consumption and oxygen production
- Operational costs
- Cleanability
- Culture stability (assessment of infections and algae population)
- Robustness of the system

Information for improvement of operation

PhD student
Jeroen de Vree

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Dynamic Process Control strategies

Optimize productivity and decrease energy requirements by dynamic process control under changing light conditions

- Modelling and validation outdoors

Energy input

- Supply CO_2
- Remove O_2

Mixing

- Prevent sedimentation
- Distribute nutrients and light

Productivity

Optimal biomass concentration

Challenge

- Enhance transfer rates
- Process control to exploit external conditions

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Project submitted

Life Cycle Assessment

- Use life cycle assessment as tool to set design standards for sustainable, large-scale microalgal production systems.
  - Cumulative energy demand
  - Global warming potential
  - Water consumption

- Evaluate sustainable design parameters based on applicability to geographic location.

Postdoc
Laura Brentner

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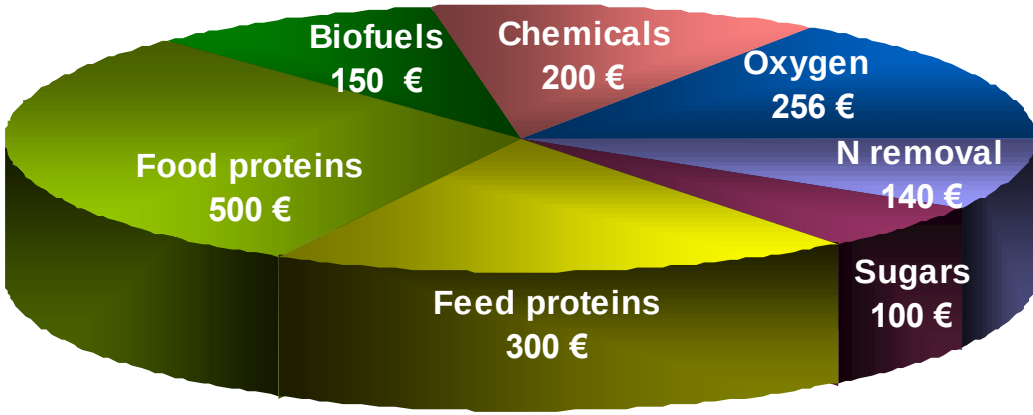
Next steps

- Development of demo projects
- Biorefinery
  - Mild cell disruption techniques
  - Fractionation biomass with maintainance of functionality of proteins



- Norsker et al. (2011) *Biotechnology Advances* **29**: 24-27
- Wijffels et al. (2010). *Biofuels, Bioproducts & Biorefining,* **4**: 287-295.

AlgaePARC

Algae Production And Research Center

www.algaeparc.com

You can also follow us at twitter: @AlgaePARC

AlgaePARC TOURS

- No access to AlgaePARC facility without guidance
- Tours are divided into 8 groups
- Pictures can be made
- Start at the gate of outdoor facility

Tour guides

Rouke Bosma

Jeroen de Vree

Maria Cuaresma

Giulia Benvenuti

First tour starts at 18:00

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