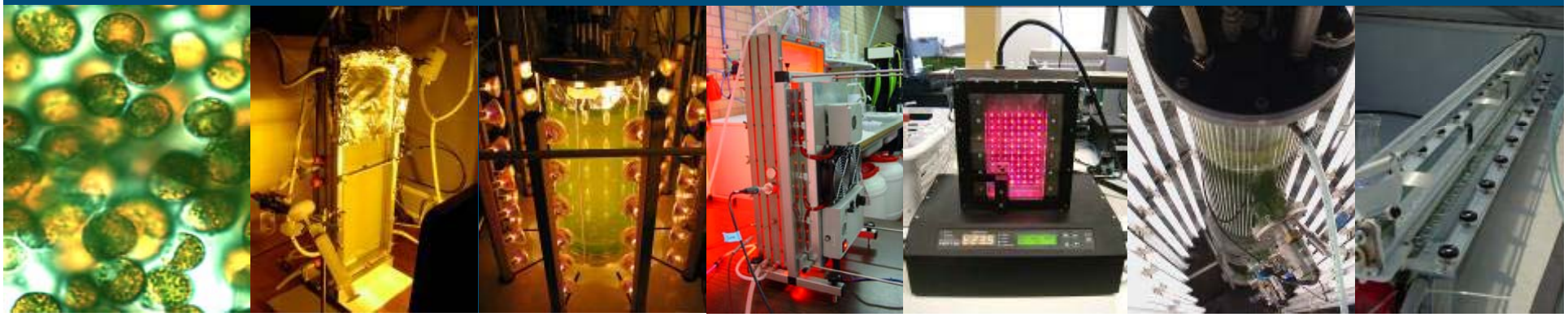
AlgaePARC

Algae Production and Research Centre

Maria Barbosa, Rouke Bosma

Brenda Israel, René Wijffels

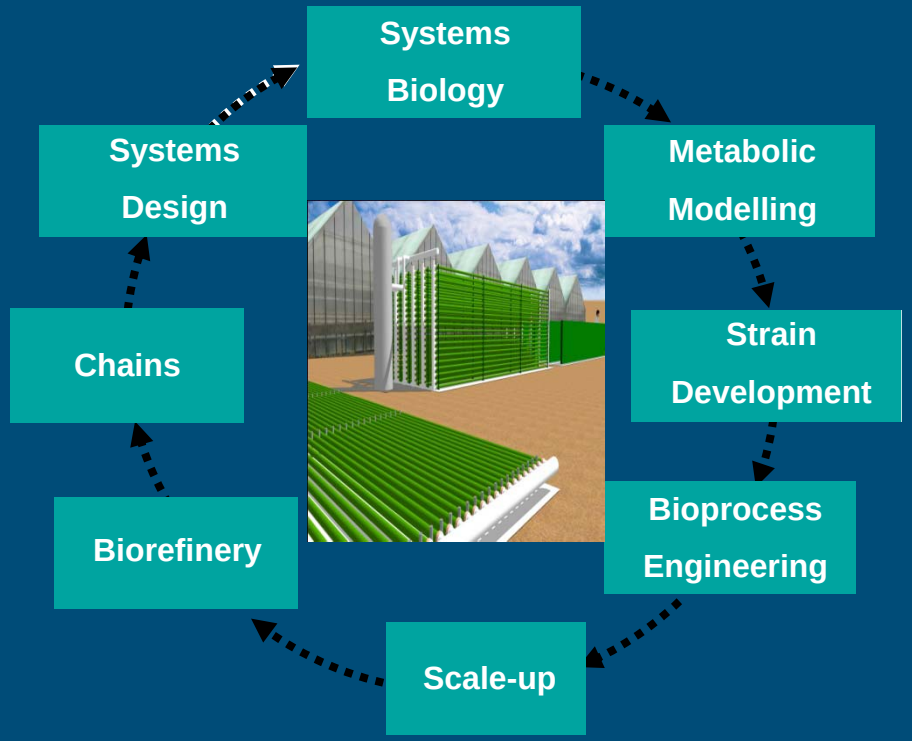
Wageningen University and Research Center



AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

Objectives

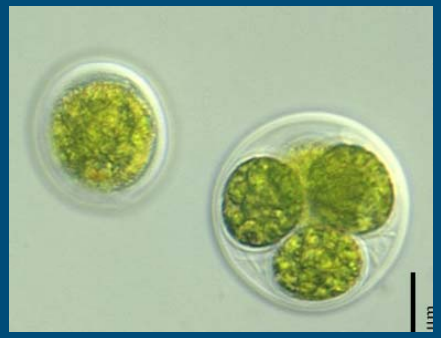
- Development of a new technology for cost-effective production of fuels, foods and chemicals from algae
- Requires a multidisciplinary approach



AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

Why microalgae?

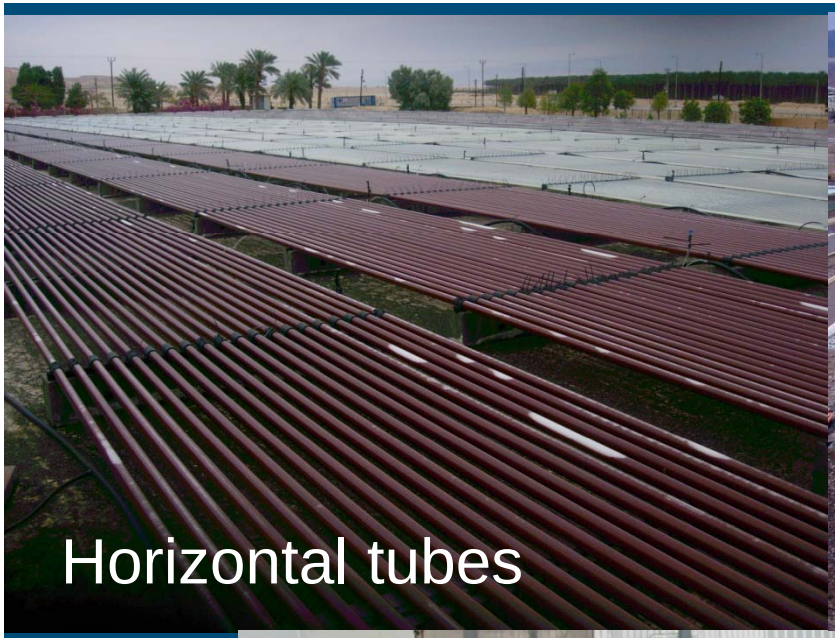
- No competition for arable land
- High areal productivities
- Great variety in species -> variety in products!
- Production of a wide range of biobased products + energy
- Offer possibility to steer metabolism to production of specific compounds
- Ability to accumulate large amount of oils
- CO_2 mitigation
- Recycling nutrients



Why (not) microalgae? Present challenges!

- High biomass production costs
- Negative net energy ratio (due to water pumping, CO_2 distribution, mixing and harvesting)
- No experience on large scale cultivation (hundreds –thousands of hectares) and processing – Knowledge is still at its infancy
- Large variability in performances among culture systems and difficulty to standardize techniques
- Instability of the culture (difficulty in maintaining the selected species (and we do need the selected species)
- Lack of trained personnel
- Lack of (serious) companies specialized in photobioreactors
- Product development to commercial applications
  - Regulatory approval for use of algae in different applications
  - The full range of potential products, best combinations and their market values is unclear

2007: Delta Feasibility Study



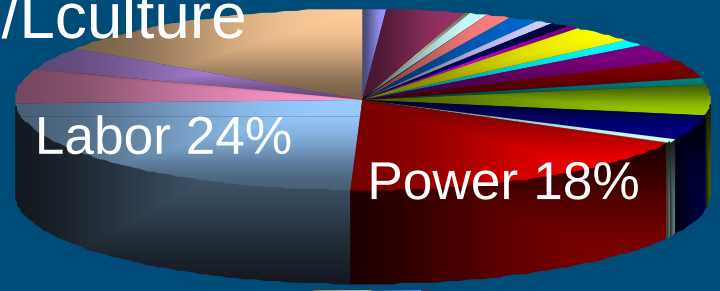
AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

2007: Delta Feasibility Study

Netherlands

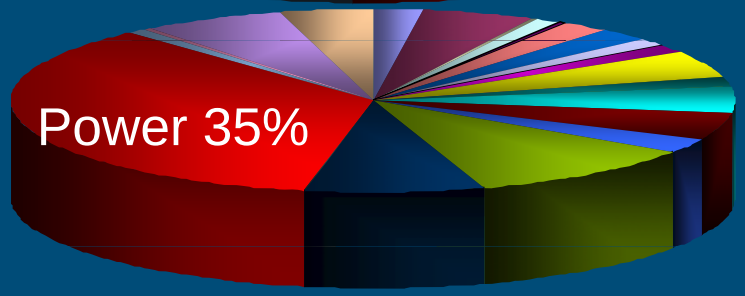
Flat panel 1L/min/Lculture

1 ha

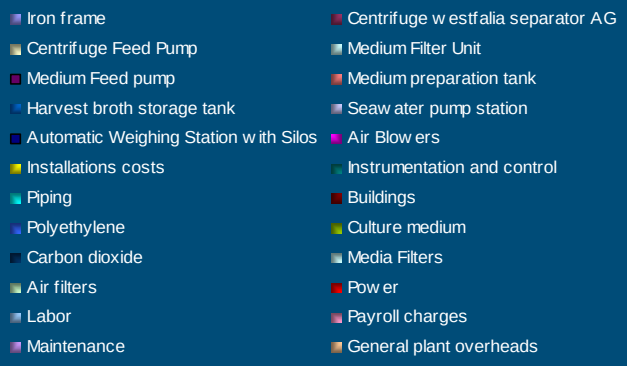


7.9 € / kg biomass

100 ha



4.0 € / kg biomass



potential

0.4 € / kg biomass
15 €/GJ

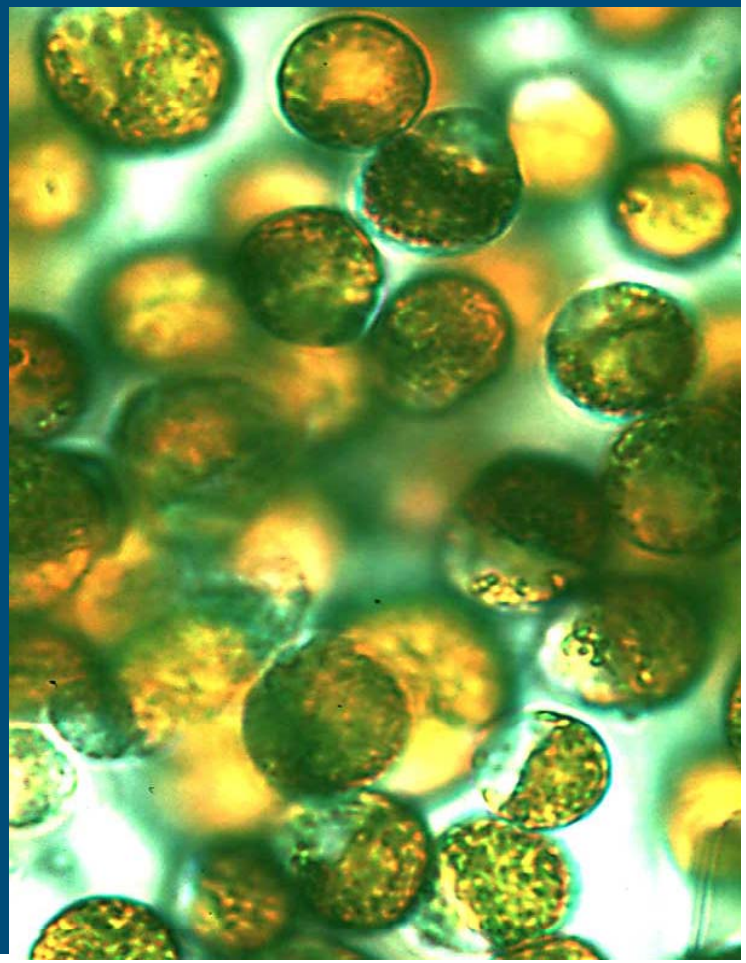
AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

How ?

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

Wageningen Research Agenda

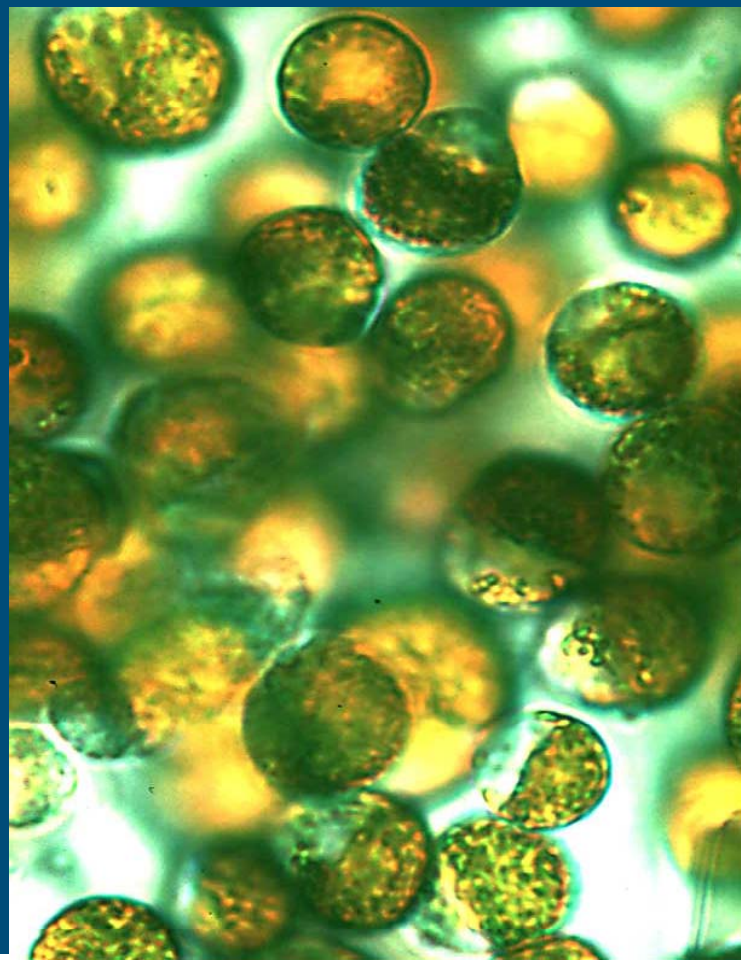
- Maximization biomass productivity/ yield
  - Reactor design
  - Control of primary metabolism
  - Cultivation conditions
  - Screening for new strains
- Reduction of energy input
  - O_2 removal and CO_2 supply
  - harvesting
- Maximization metabolites productivity
- New nutrient sources: upcycling nutrients
  - Biofilms for post-treatment wastewater)
- Biorefinery
- Design scenarios



AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

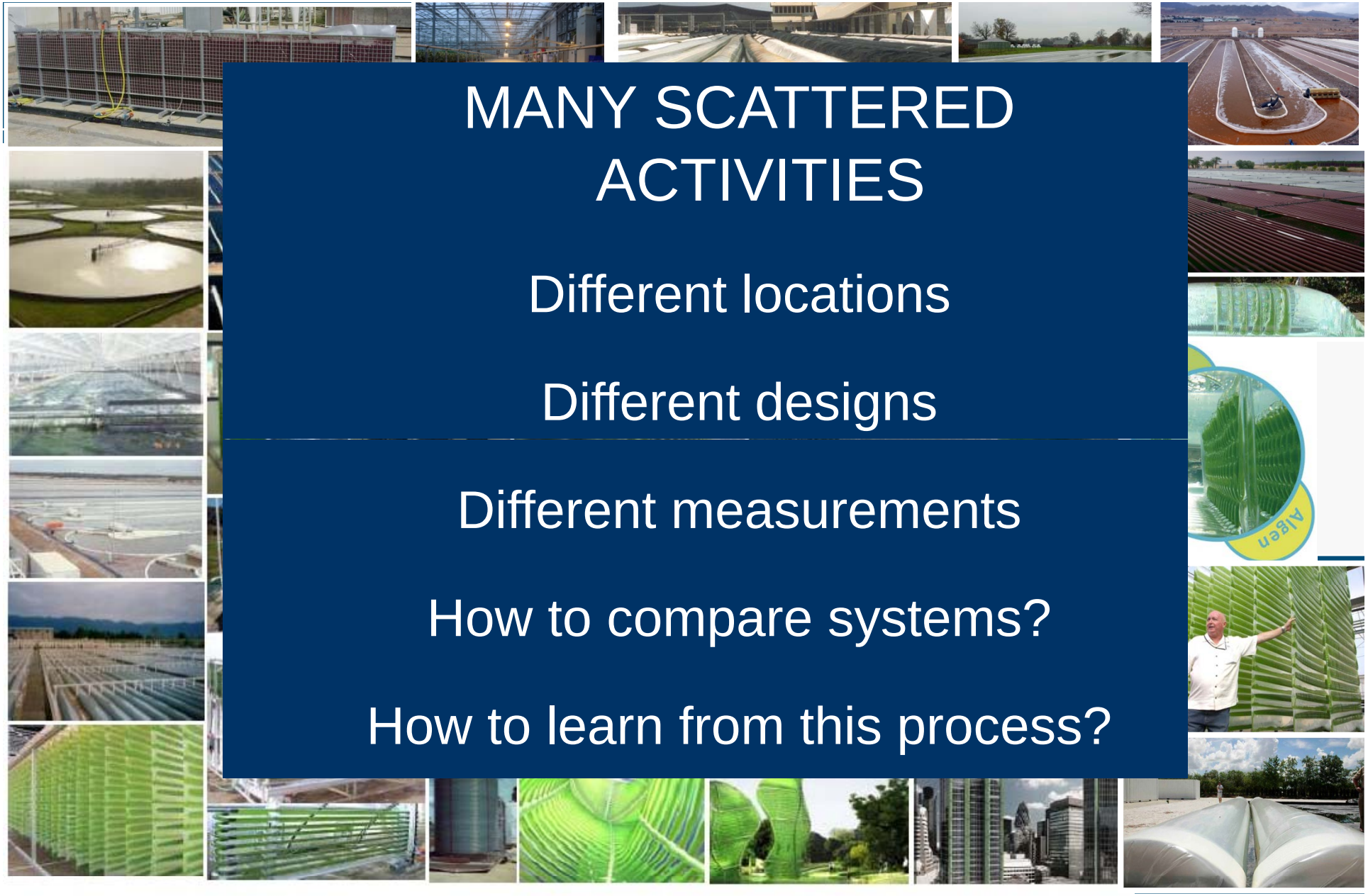
Focus of AlgaePARC

- Maximization biomass productivity/ yield
  - Reactor design
  - Control of primary metabolism
  - Cultivation conditions
  - Screening for new strains
- Reduction of energy input
  - O_2 removal and CO_2 supply
  - harvesting
- Maximization metabolites productivity
- New nutrient sources: upcycling nutrients
  - Biofilms for post-treatment wastewater)
- Biorefinery
- Design scenarios



AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

If we take a look around…



MANY SCATTERED ACTIVITIES

Different locations

Different designs

Different measurements

How to compare systems?

How to learn from this process?

AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

Fill the gap: Translate research into applications

1. Cultivation

AlgaePARC - Algae Pilot and Research Center

2. Downstream – biorefinery

3. Develop process chains: from production until biorefinery

AlgaePARC

Algae **P**roduction **A**nd **R**esearch **C**entre

AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

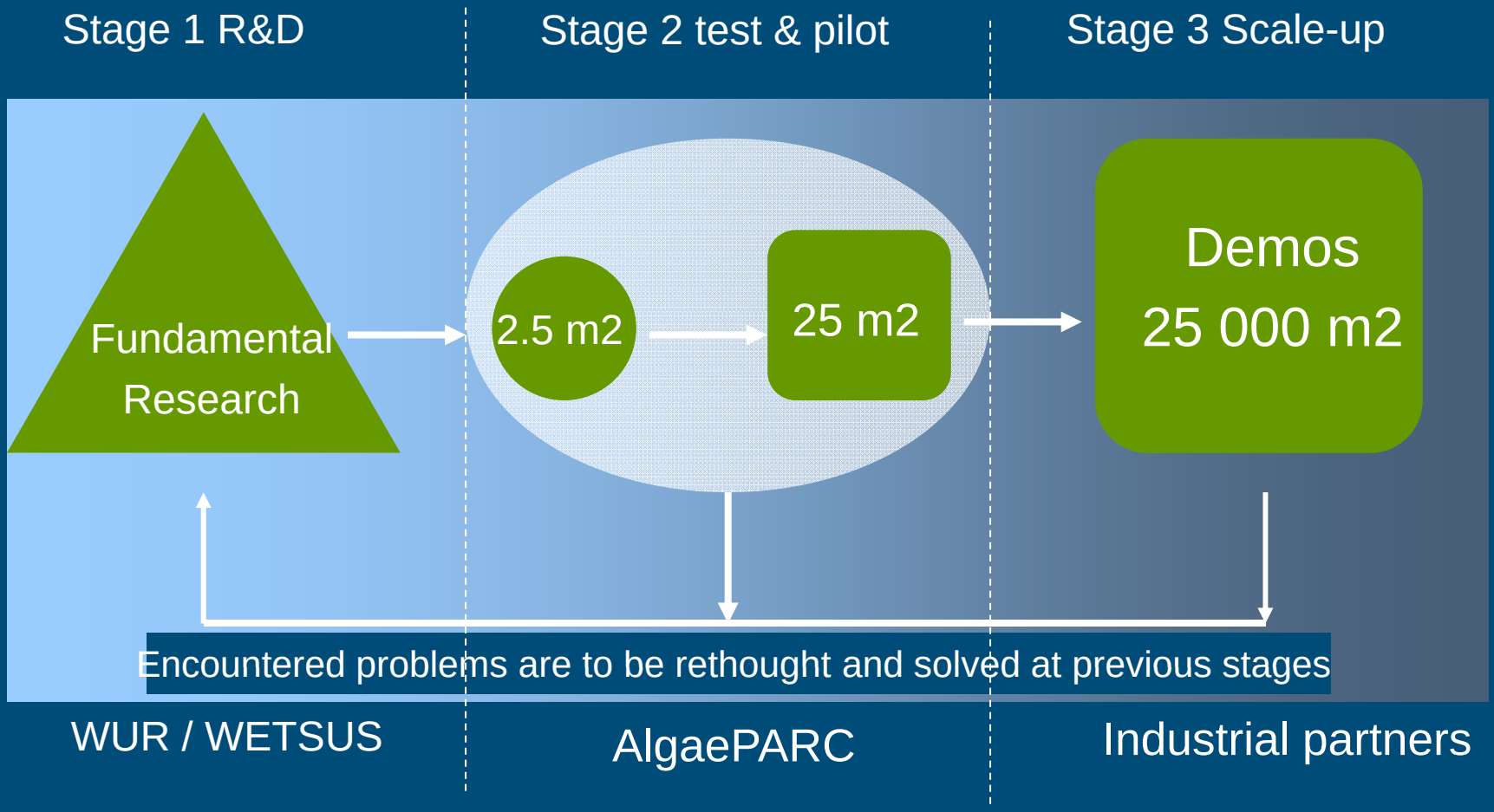
Algae PARC: Objectives

- Build up an international , open and independent centre for applied research
- Translate research towards applications
- Acquire Information for design of full scale plants
- Develop competitive technology (economic viability and positive energy balance)
- Cradle to Cradle: Closing material loops - CO_2, N, P
- To be applied in and outside the Netherlands
- Defined Research Programme (5 years) & Contract research
- Production of algal biomass for bulk chemicals, food and feed ingredients and biofuels
- Pilot as intermediate between lab and demo

Algae PARC: Objectives

- Build up an international , open and independent centre for applied research
- Define Research Programme (5 years) & Contract research
- Translate research towards applications
- Develop competitive technology (economic viability and positive energy balance)
- Acquire Information for design of full scale plants
- Cradle to Cradle: Closing material loops - CO_2, N, P
- Production of algal biomass for food, feed, bulk chemicals and biofuels
- To be applied in and outside the Netherlands
- Pilot as intermediate between lab and demo

Translate research towards applications



AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

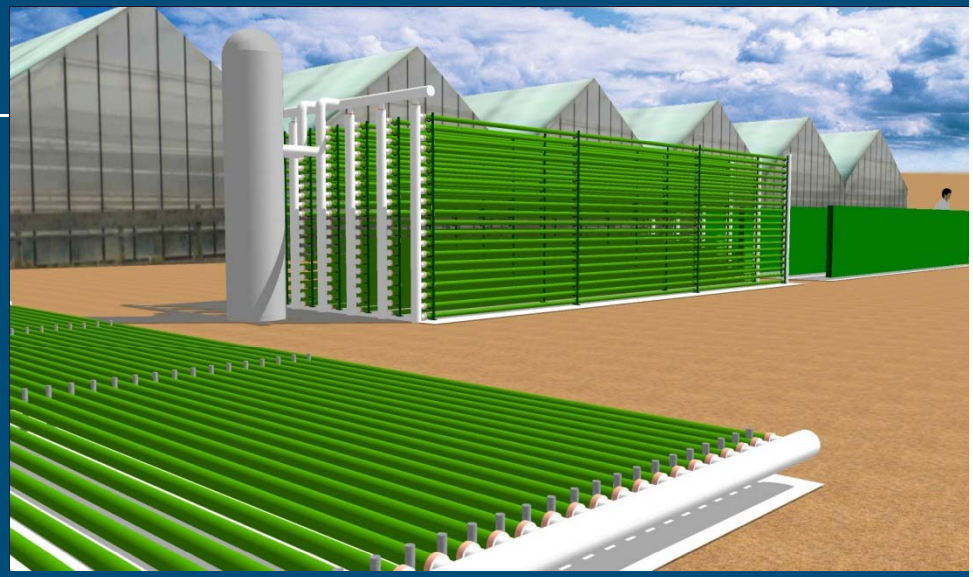
Economic viability

- Increasing productivity
  - reactor design
  - cultivation conditions
  - strain improvement / screening
- Decrease energy requirements
  - gassing
  - mixing
- Integrating processes
- Develop low cost and energy downstream processes

AlgaePARC

AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

Research Program



- Strain Selection
- Testing of different nutrient feed stocks
- Comparison of photobioreactors performance
- Development of new photobioreactor concepts
- Development of a process chain and testing business cases

AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

Facilities

- 4 outdoor systems of 25 m^2
  - Long term experiments
- 3 outdoor systems of 2.5 m^2
  - Short term experiments and testing

Facilities : 25 m^2 systems

Open pond: reference Ingrepro

Horizontal tubular: high light intensity, oxygen accumulation Paques

Vertical tubular system: light dilution, oxygen accumulation Paques

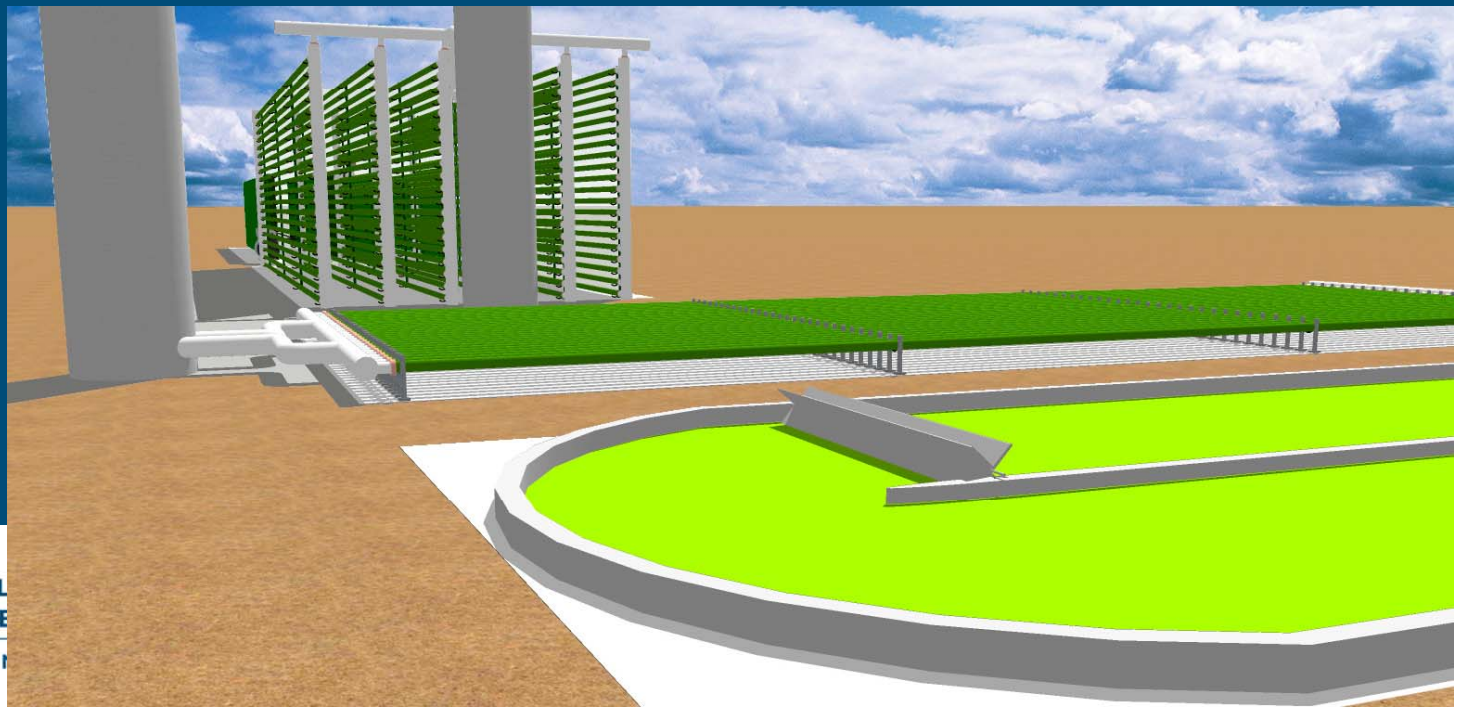
Vertical plastic films: light dilution, no oxygen accumulation ProviAPT system

Light distribution and mass transfer

AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

25 m^2 systems

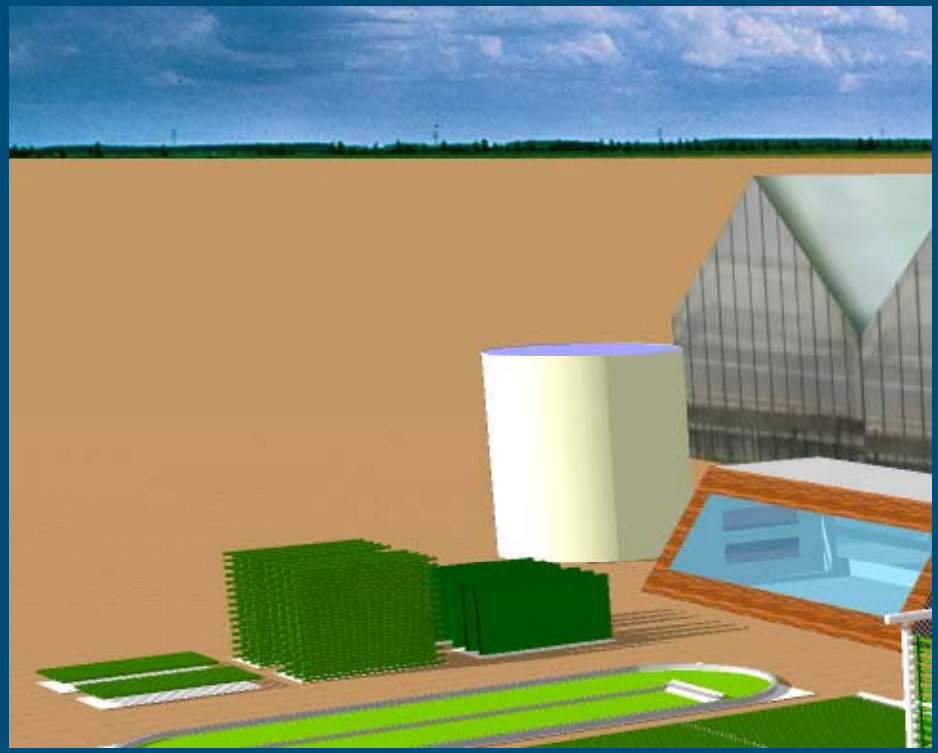
- Long time performance (1 year)
- 4 systems running in parallel
- Problems: solve in lab
- Representative productivities for full scale
- Information for design of full scale plants (Layout, Distance between tubes or plates, Light path, Orientation)



AGROTECHNOL
FOOD SCIENCE
WAGE

2.5 m^2 systems

- Phase between lab and pilot
- Test things where you are not sure of
- Different strains
- Different feed stocks
- Adaptations in design
- New systems
- If successful
  - To 25 m^2 scale
- If not successful
  - More experiments
  - Reject



Algae PARC

Main Features

Uniqueness - 4 different systems that can run in parallel (minimum)

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

Flexibility: The reactors should be easily changeable to allow fast testing of different systems

Budget & Time plan

Facilities 2010 (2.8 M€)

- Q2-Q3 2010
  - engineering and building
- Q4 2010
  - Test runs

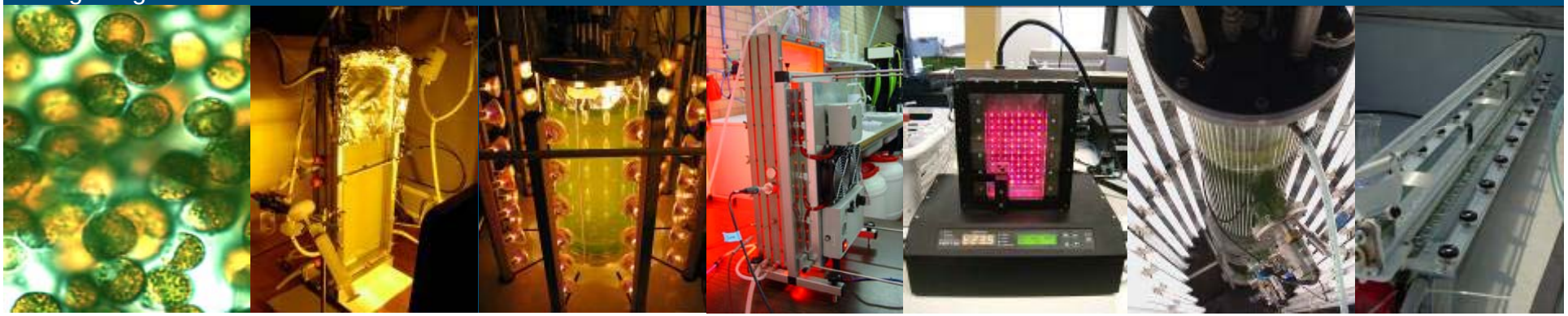
Research Programme 2010 -2014 (4 M€, 14 Industrial partners)

- Q2 2010 consortium agreement

What we aim at…

AlgaePARC : ***the*** European test centre for microalgae technology

www.algae.wur.nl



AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR