

Advanced scenario studies for large scale biofuel production using algae

YoungAlgaeneers 2012

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Need: large scale production

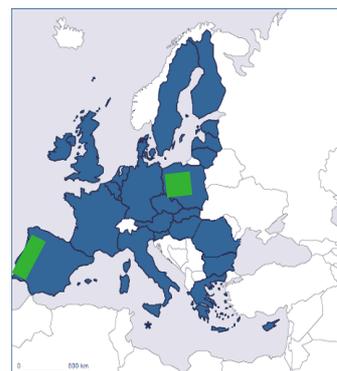
Currently



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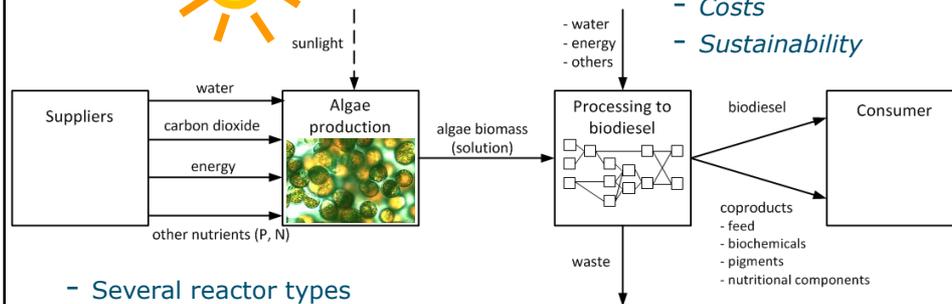


Desired



Complex production process

- Sunlight changes (day, seasons)



Consider:

- *Product formation*
- *Energy consumption*
- *Costs*
- *Sustainability*

- Several reactor types
Best depends on algae species, locations

- Several products, which ones?



Systems analysis

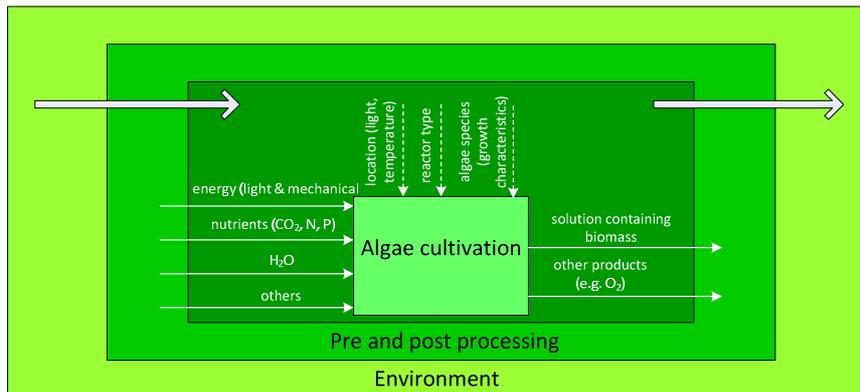
- Regards the whole production system at once
- Subdivision to study details
 - Using scenario studies
 - Include interaction with other subsystems: environment affects decisions to make

Advantage:

- Make efficient use of the opportunities of the environment of the algae plant

=> better design than with sequential optimisation

System division algae plants



1. Develop models to assess algae production in photobioreactors

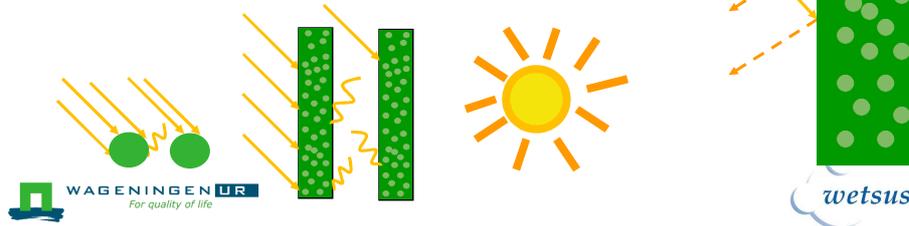


Production depends on:

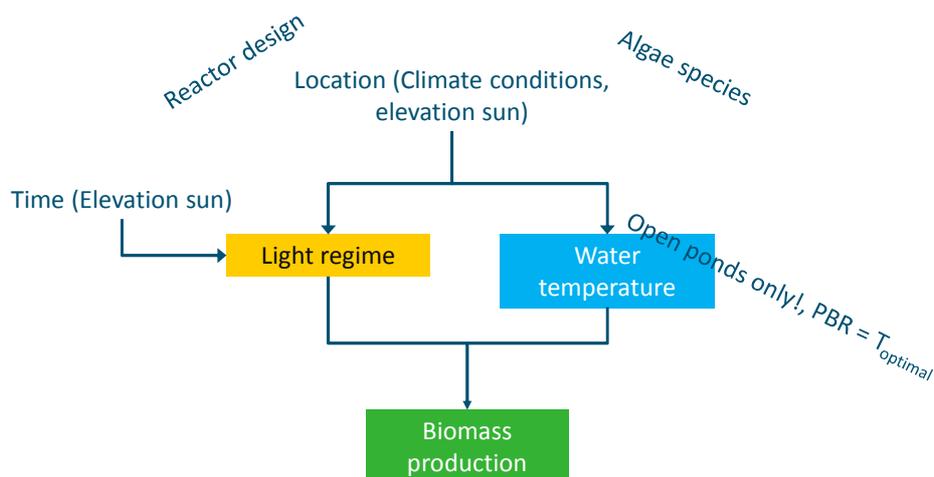
- Location (light and climate conditions)
- Algae species
- Reactor design
 - Photobioreactor type
 - Light path
 - Height
 - Distance between parallel reactors (and rows)
 - Biomass concentration

PBR models – 3 main elements

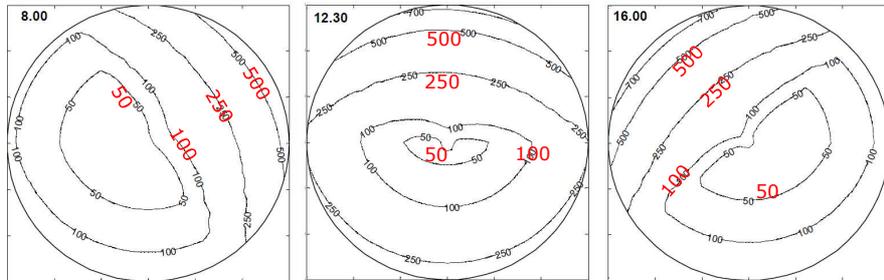
1. Quantifying the light falling on reactor wall
 - Include shape, shading etc.
 - Remove light loss due to reflection, transparency
2. Local light gradient in reactor volume
3. Growth of algae according to light gradient + associated substrate consumption and O₂ production



Schematic overview PBR model



Study internal light profiles: derive optimal design for location, algae etc.



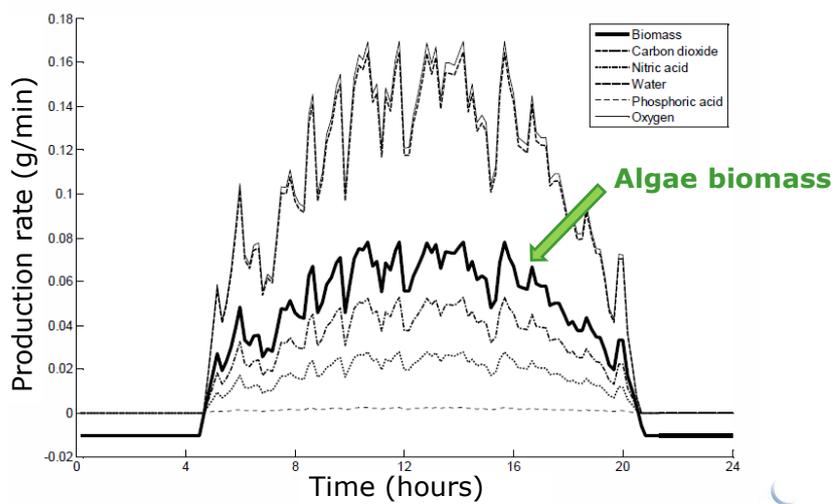
30 June 2009



Single tubes, Netherlands
P. tricornutum, $C_x = 1 \text{ g/L}$

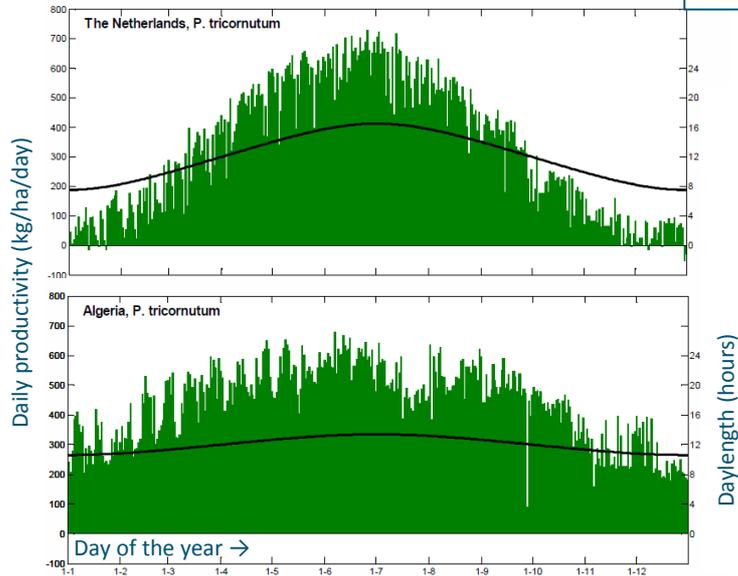


Insight in production and consumption pattern during a day

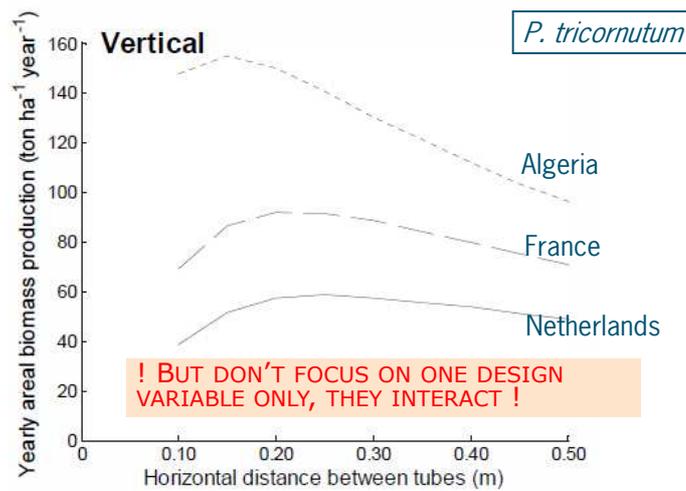


And in yearly production in e.g.flat panels: Algeria vs Netherlands

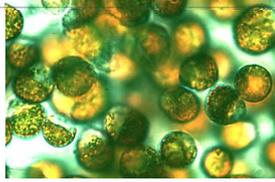
P. tricornutum
d = 0.03 m



Optimal design: simulate effect design on productivity (in tubular PBRs)



Only biomass production?



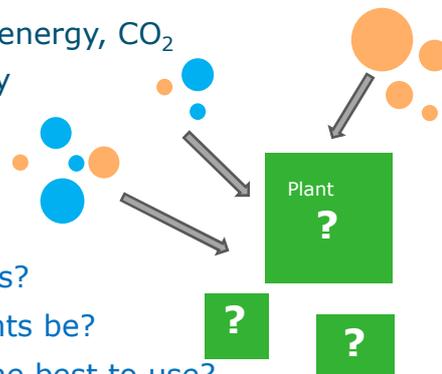
- Energy consumption in reactors
- Sustainability
- Costs



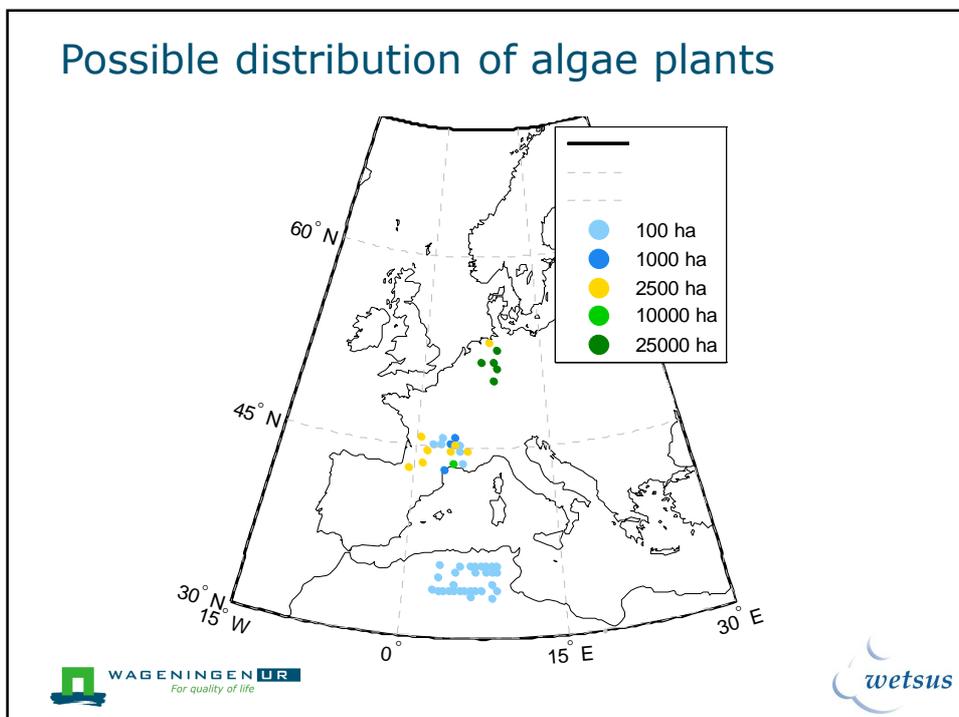
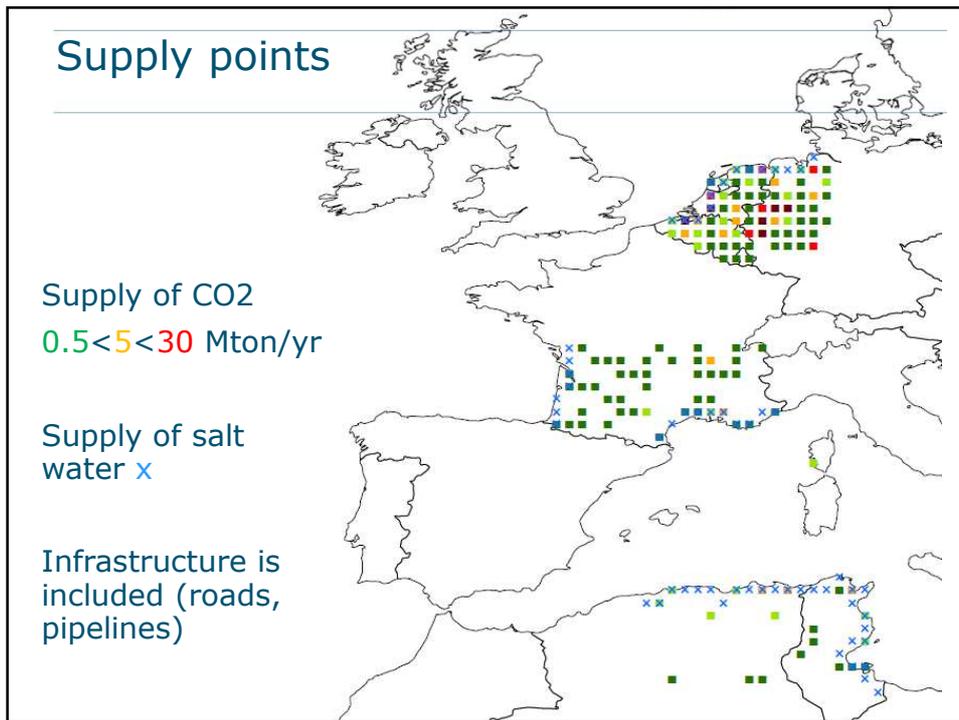
2. Connection with supply chain

Algae cultivation is connected to the supply chain for resources

- Availability of water, energy, CO₂
- Infrastructure density



- What are suitable locations?
- How large should/can plants be?
- Which reactor types are the best to use?



Outlook

Scenario studies for algae

- Integrate parallel research lines
- Predict based on best current knowledge
- Identify critical issues in knowledge
- Explore bottlenecks in production system



Algae: Future of agriculture and energy...

Thanks for your attention.

Questions?

