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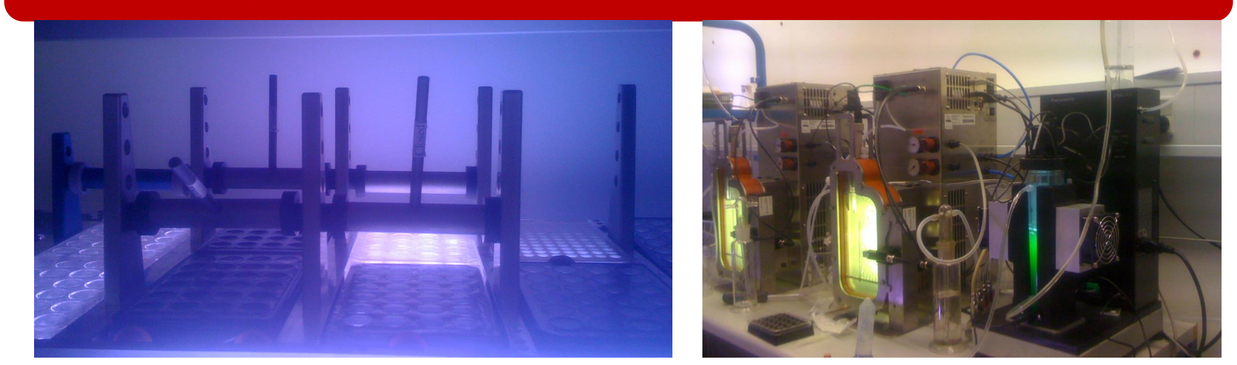
Utilization of industrial wastewaters

Kalundborg, Denmark has been recognized for developing the world's first working industrial symbiosis. In this system wastes or residuals from one business become the raw material for another business. In the last year, a collaboration between DTU and Cluster Biofuels Denmark has begun to investigate ways to use waste-water, heat and nutrients to support microalgae cultivation and high-value product extraction. There are three major components of this project: development of screening methods to identify promising species of microalgae for growth on waste- nutrients from various industries; creation of a waste-water infrastructure that makes an effluent more suited to growth of green algae; establishment of a pilot photobioreactor at the municipal wastewater treatment facility.

Screening and lab-scale cultivation

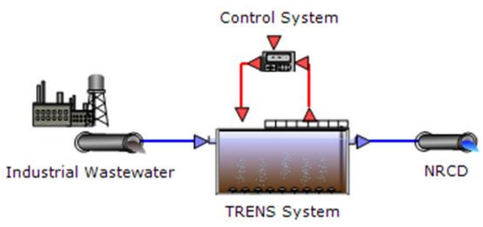


*Microplates illuminated from below can be used to measure exponential growth rates in thin cultures (**left**), while photobioreactors (**right**) are used to measure actual reactor performance.*

When cultivating microalgae, it can often be difficult to translate results obtained at the lab scale to the industrial scale. For this reason, we have examined a microwell plate system which was designed to screen different strains of algae on different industrial wastes. Preliminary results have shown it is possible to increase the observed period of exponential growth by measuring the fluorescence of low-density cultures in microwell plates, thereby allowing better quantification of the exponential growth rate. Work is currently underway to use a previously developed model (1) to validate that the exponential growth rates observed in the low-density microplate cultures can predict performance of high-density industrial cultures.

TRENS System: *Enhanced resource recovery*

Design and implementation of a cost-effective, bacteria based wastewater treatment process that can provide optimum conditions for the downstream cultivation of mixed green microalgae.



*A unique process configuration and operation strategy allows TRENS (**left**) to transform wastewaters into media suitable for optimal algae cultivation. The algae suspension produced would be directly used as fertilizer or digested for biogas depending on seasonal requirements.*

Process configurations and operation strategies for "Nutrient Rich, Carbon Depleted" (NRCD) water with:

-Balanced N : P ratio

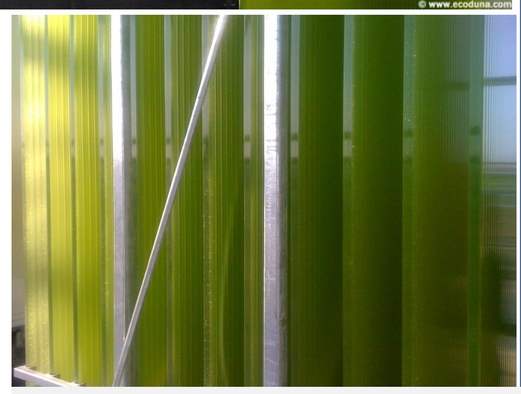
-Optimum pH -For more information contact Prof. Plósz at: beep@env.dtu.dk

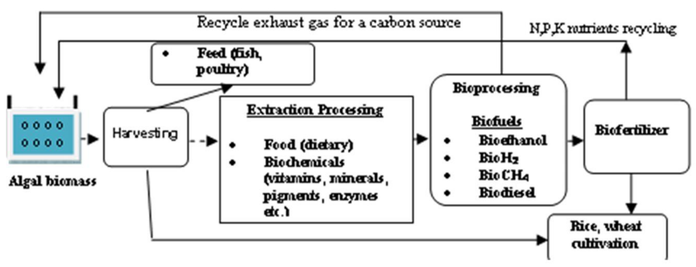
RTD Facility

Cluster Biofuels Denmark

KALUNDBORG SYMBIOSIS

*A greenhouse has been constructed (**above,** approximate height 9 m) at the municipal wastewater treatment facility, near a settling tank visible in the foreground. Through a water-to-water heat exchange installation, residual thermal energy in the effluent water from the settling tank is utilized as a ressource to allow for a stabile process temperature throughout the year. Photobioreactors supplied by Ecoduna (**right**) will be used for the growth of microalgae. The reactors consist of an array of flat panels, which are 6 m high and 3 cm thick. The reactors are mounted on bases which rotate to track the sun. This unique configuration allows for a high photo-active surface to volume ratio, with limited exposure to the high light intensities that can result in photoinibition.*





Schematic (**above**) demonstrating potential of algae biomass to produce multiple products in a bio-refinery. Focus will be on demonstration that high value products can be reliably produced and residuals utilized.

Local residue streams available

Fresh water (at site)

- From nearby lake (Tissø)
- Distributed through the Industrial Symbiosis water system

Heat from wastewater effluent (at site)

- 16-22°C (all year)
- Up to 3000 m^3/hour

Electricity from effluent run off (at site option)

- 1-2 m drop through a hydro-power generator
- Up to 3000 m^3/hour

CO_2 from biogas and fermentation off-gas (at site option)

- From upgrading or combustion of biogas
- Off-gas from fermentation

Acknowledgement and References

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Funded by the European Commission

SEVENTH FRAMEWORK PROGRAMME

1 - M Huesemann, J Van Wagenen, T Miller, S. Hobbs, A Chavis, and B Crowe. "A Screening Model to Predict Microalgae Biomass Growth in Photobioreactors and Raceway Ponds." Biotechnology & Bioengineering. 2013