Biomass and bioenergy from algae, CO2 and wastewater

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In collaboration with Umeå Energi AB, Umeva AB, RagnSells AB and Uminova Innovation AB

The main financer is The Swedish Energy Agency

Processum Biorefinery Initiative AB

Kempestiftelserna

- Nitrogen is the most limiting nutrient in agriculture and forestry
- Phosphorus is a limiting nutrient and we are approaching the P peak

Process

Algae

Biomass (biodiesel, biogas, bioethanol, fish feed, manure)

Why to grow algae

- Grow faster than land plants
- Can grow on wastewater
- Can use flue gases (CO_2, NOx)
- Can grow on marginal land (non-arable lands)
- Produce high level of lipids (60% and more)
- Produce protein for animal consumption
- Production of astaxanthin and other pigments of high economical value
- Can be use to treat wastewater recycling nutrients
- Can be use for CO_2 sequestration
- Can be used for production of biofuels (biodiesel, bioethanol and biogas)

Summary

- Reduction of gaseous emissions (CO_2)
- Reduction of N and P in wastewater
- Growing algae using as substrate wastewater, CO_2 emitted from industries (ex. power plant, wastewater plant)
- Large production of economically interesting products such as biodiesel, biogas, bioethanol, fish feed, manure etc.

Umeå project

The Umeå project has three strong points:

- tight collaboration among SLU, Umeå Energi AB and Umeå Vatten och Avfall AB (Umeva), RagnSells and help from Uminova Innovation for network establishment.
- Approach to the problem going directly to the problem core
- Experimental work carried out both in lab as well as at the power plant using real raw materials.

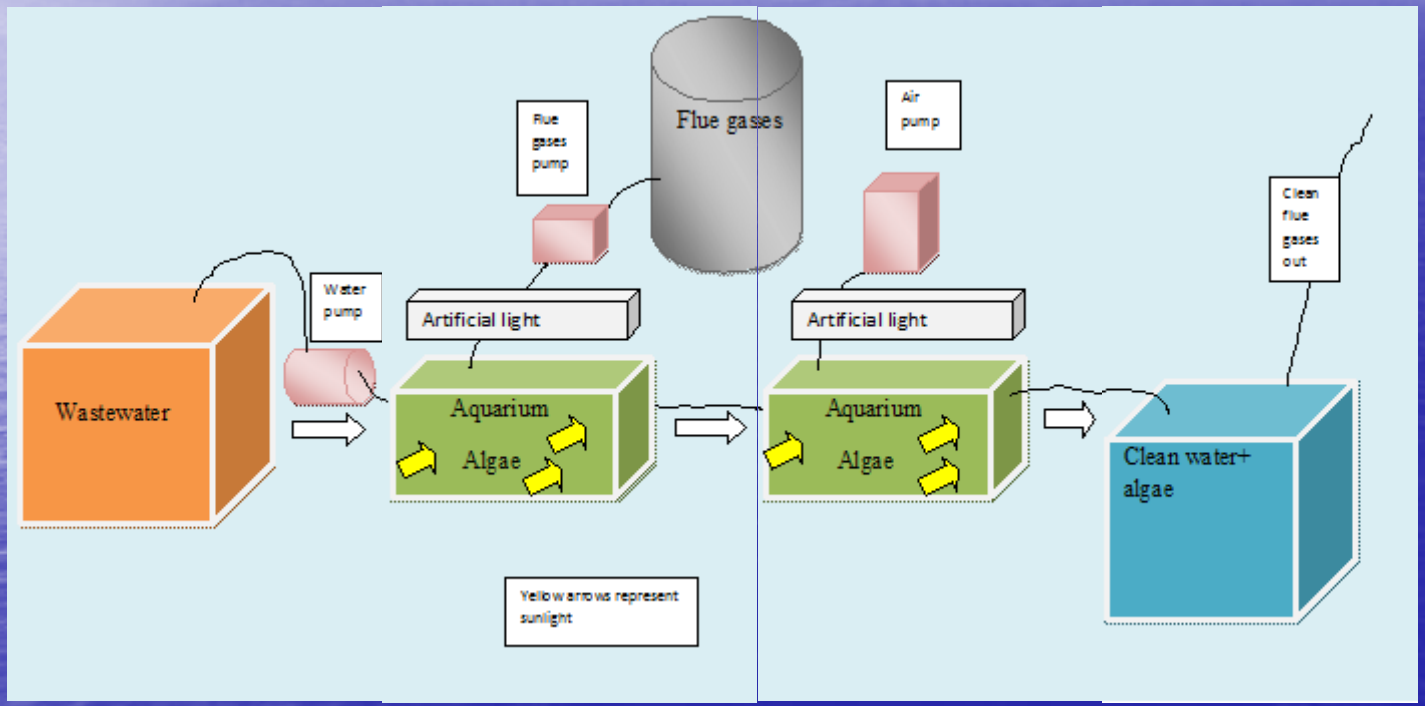
Project plan

Phase 1 Phase 2 Phase 3

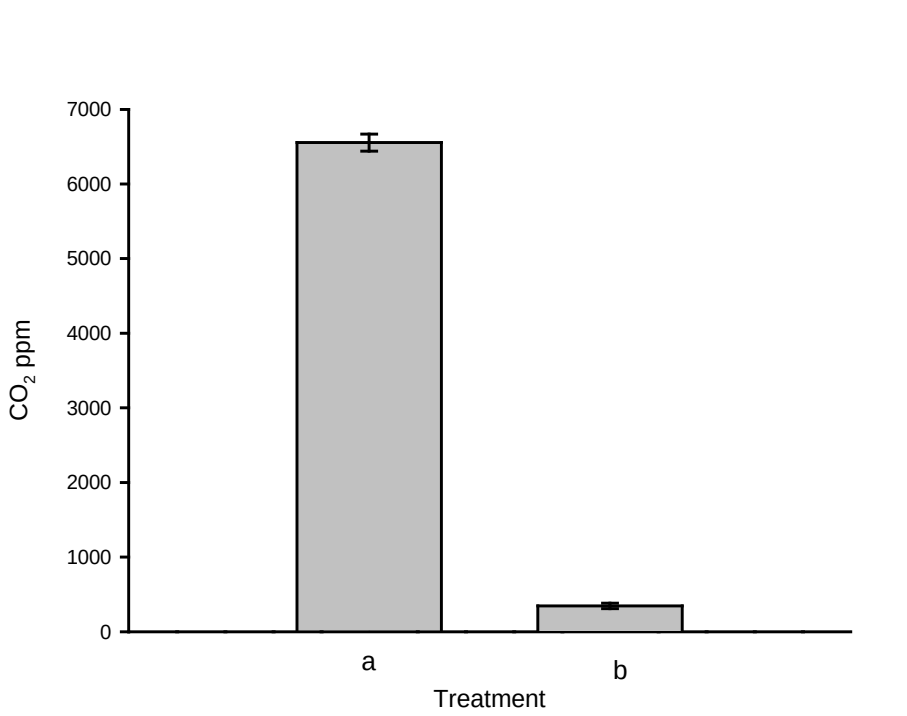
Laboratory (small scale) → Power plant (small-mid scale) → Prototype at power plant → Power plant (pilot plant)

Growing system...

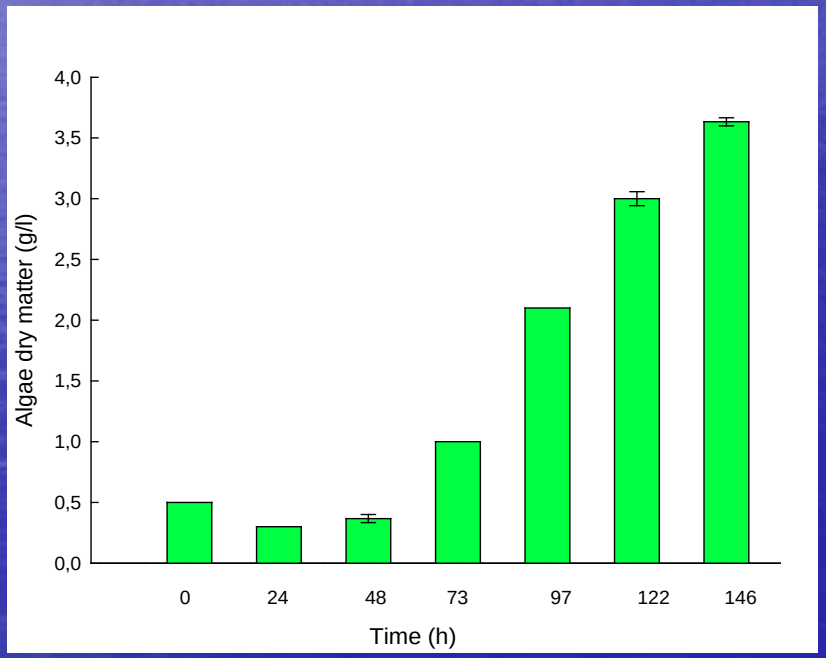
Larger scale at Umeå energi power plant



Some result



CO_2 from organic waste fixed in the two treatments: a) control without algae and b) with algae. The values are mean±SE for four-six replicate.



Biomass yield of 3,7 g/l algae DM in 6 days. A daily production of 1.1 g/l/d DM in the lab.

At power plant station....

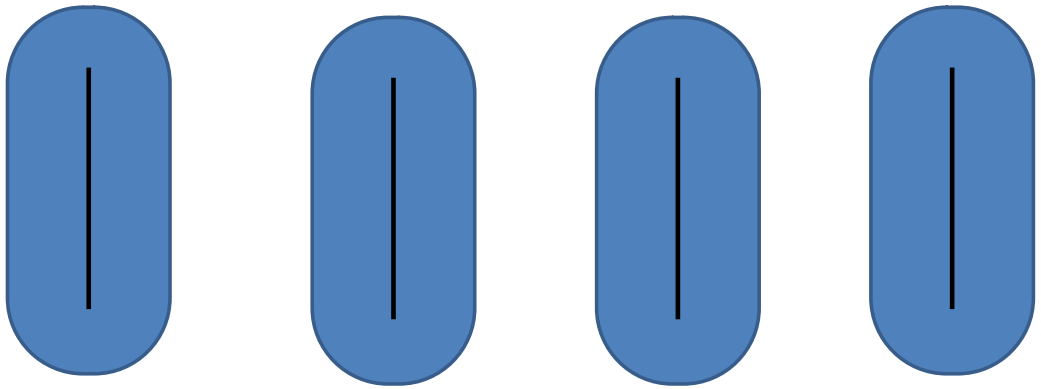
- Algae biomass production from 0.1 to 0.5 g/l dependent on retention time.

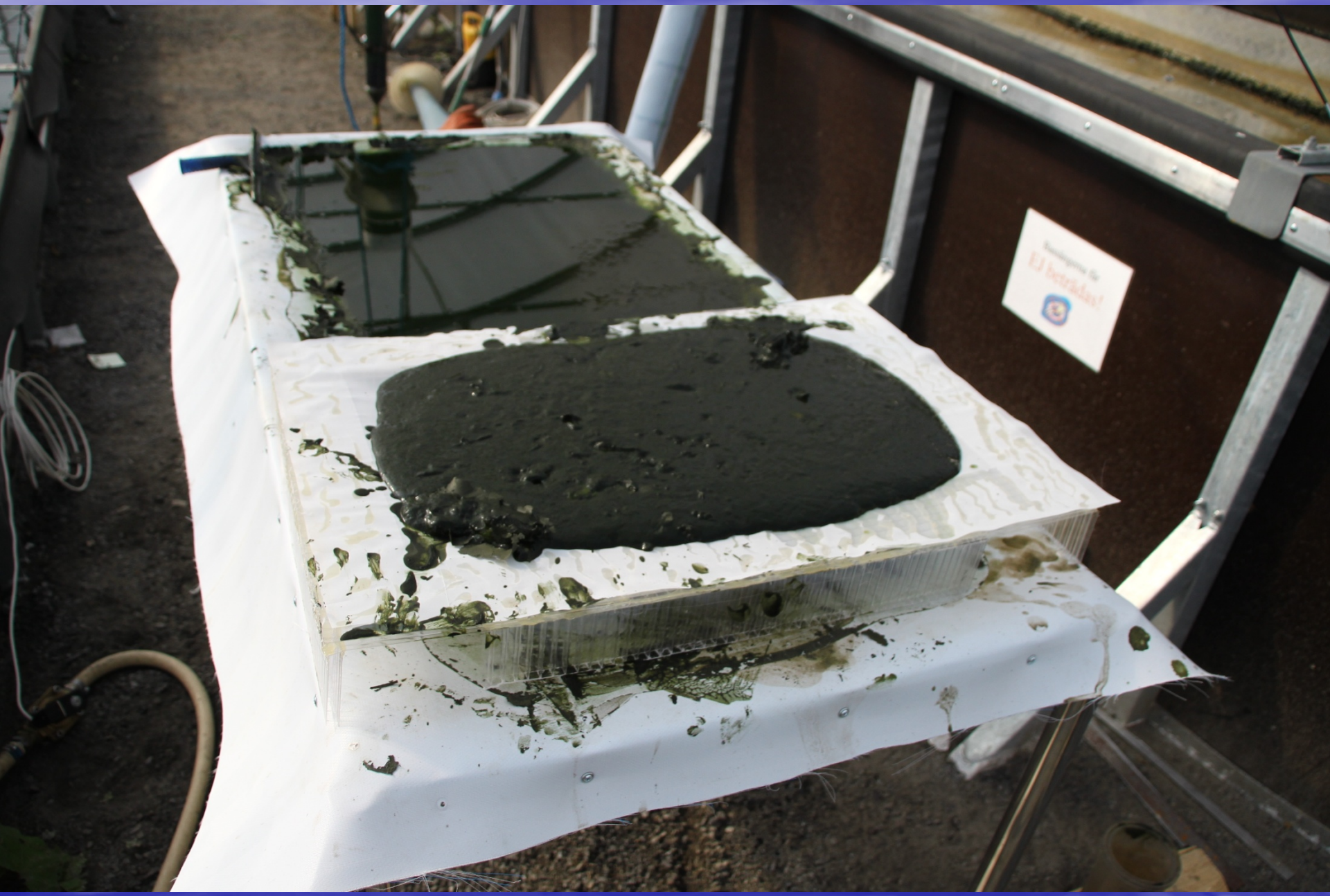
Using influent (raw wastewater)

- Total inorganic nitrogen (NH_4+NO_3) reduction from 44 to 82% after a retention time of 3.5 days.
- Phosphates were reduced on average by 46% and total phosphorus followed a similar trend.

The pilot plant

Lab unit.





Some result from the pilot

- Algae biomass concentration from 0.03 to 0.49 g/l.
- During July-August 2013 we have had a productivity of 19.1 g/m2/day in totally open pond and 13.3 g/m2/day in a pond under the greenhouse.
- Retention time was 3 days.

Using influent (locally produced)

- Total NH_4 reduction of 73% after a retention time of 3 days; while total phosphorus was reduced by 75%.

Projects linked to the pilot

- SLU (Umeå), UmU, Åbo (Finland) and Australia, thermochemical analyses of algal biomass
- SLU-UmU-LTU system integration of algae-cyanobacteria Bio4Energy project
- SLU-UmU pharmaceuticals reduction
- SLU-SP Umeå-bäckhammar collaboration
- SLU-Mälardalen University biogas production from algae biomass
- SLU-Holmen the use of algae slurry as a fertilizer

Under discussion

Pilot project