

Biomass and bioenergy from algae, CO₂ and wastewater

Francesco Gentili

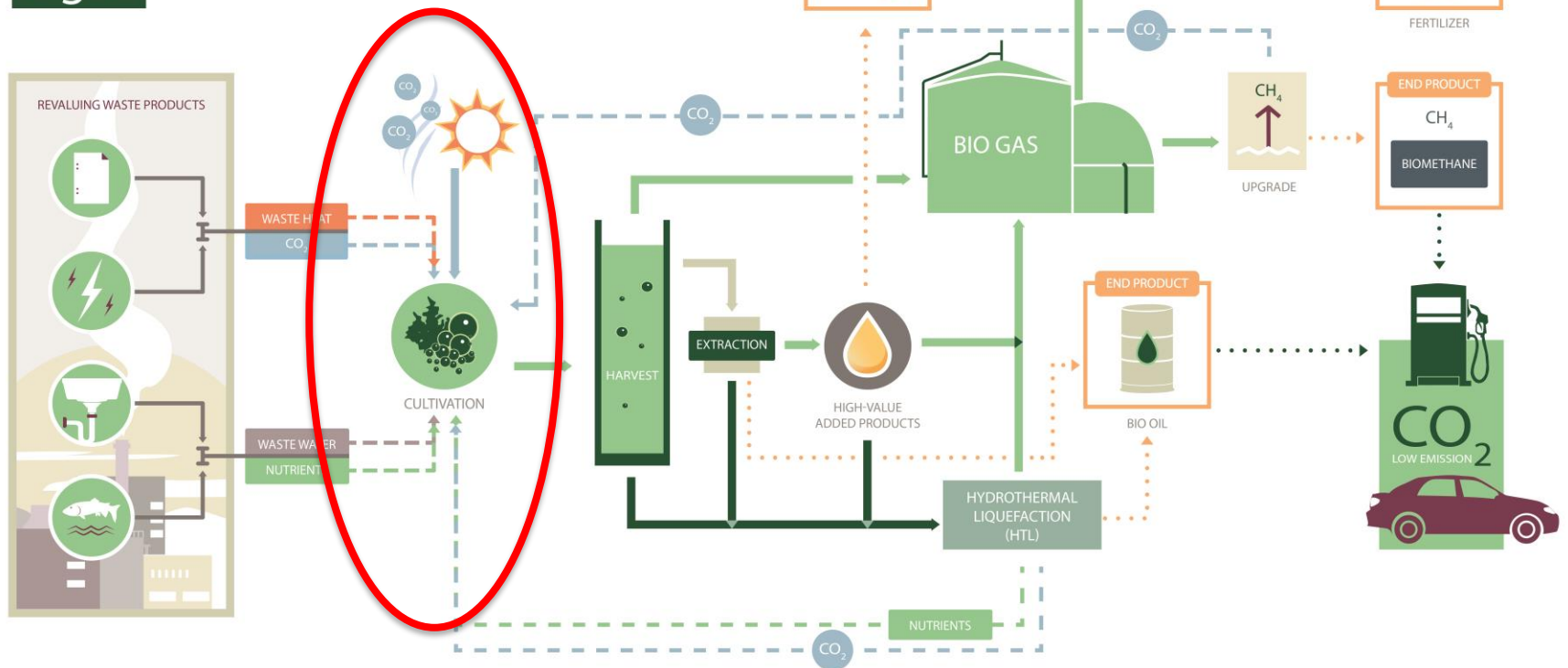
Department of Forest Biomaterials and Technology SLU, 90183 Umeå



Interreg
Botnia-Atlantica
European Regional Development Fund



Production potential



PROJECT COURSE

REVALUATION OF WASTE PRODUCTS

CULTIVATION

HARVEST

TRANSFORMATION

SYSTEM ANALYSIS



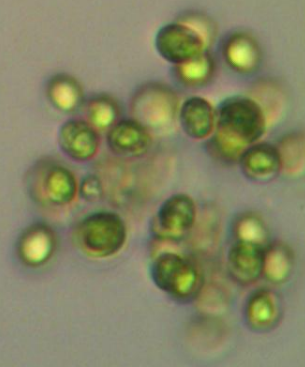
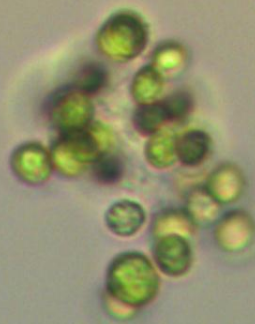
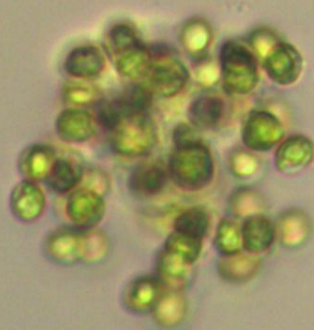
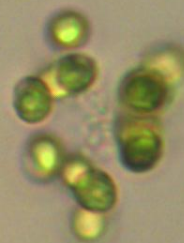
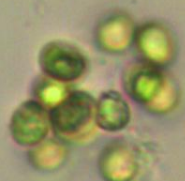
Nitrogen is the most limiting nutrient in agriculture and forestry

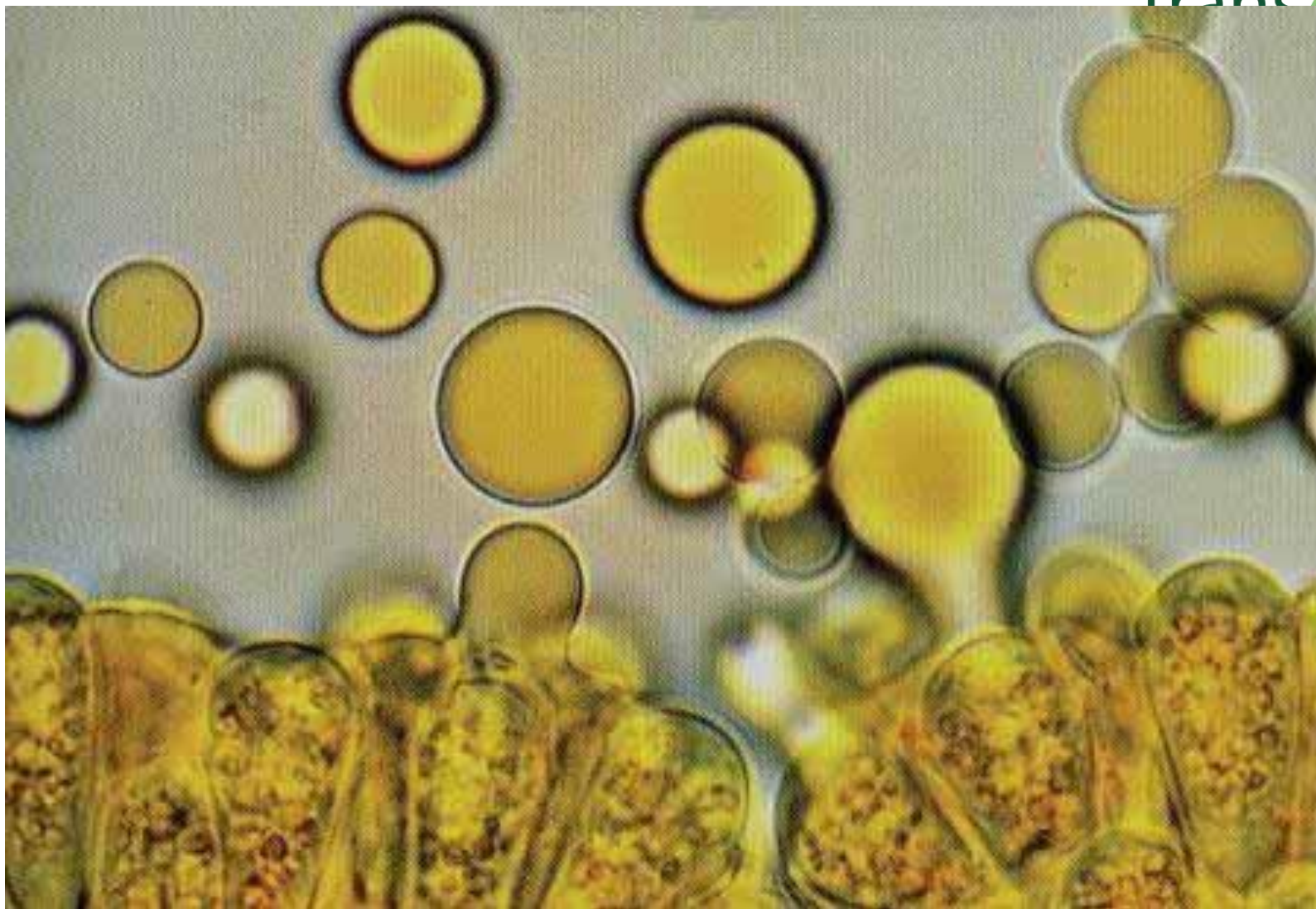


Phosphorus is a limiting nutrient and we are approaching the P peak

With over 40 000 species already identified and with many more yet to be identified, algae are classified in multiple major groupings as follows: cyanobacteria (Cyanophyceae), green algae (Chlorophyceae), diatoms (Bacillariophyceae), yellow-green algae (Xanthophyceae), golden algae (Chrysophyceae), red algae (Rhodophyceae), brown algae (Phaeophyceae), dinoflagellates (Dinophyceae) and 'pico-plankton' (Prasinophyceae and Eustigmatophyceae)







Why to grow algae



- Grow faster than land plants
- Can grow on wastewater
- Can use flue gases (CO_2 , NO_x)
- 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)

Algae can be autotroph, mixotroph and heterotroph



We can divide the algal growing system in two groups:

- **Open system identified as open ponds (raceway ponds, circular ponds etc.)**
- **Close system called phobioreactors (PBR)**

Some factors affecting algae growth in outdoor cultures

mixing rate

contamination

From Mario Tredici (ponds
by Ami Ben Amotz)

temperature

O₂ accumulation

pH

CO₂ supply

nutrient availability



...some examples



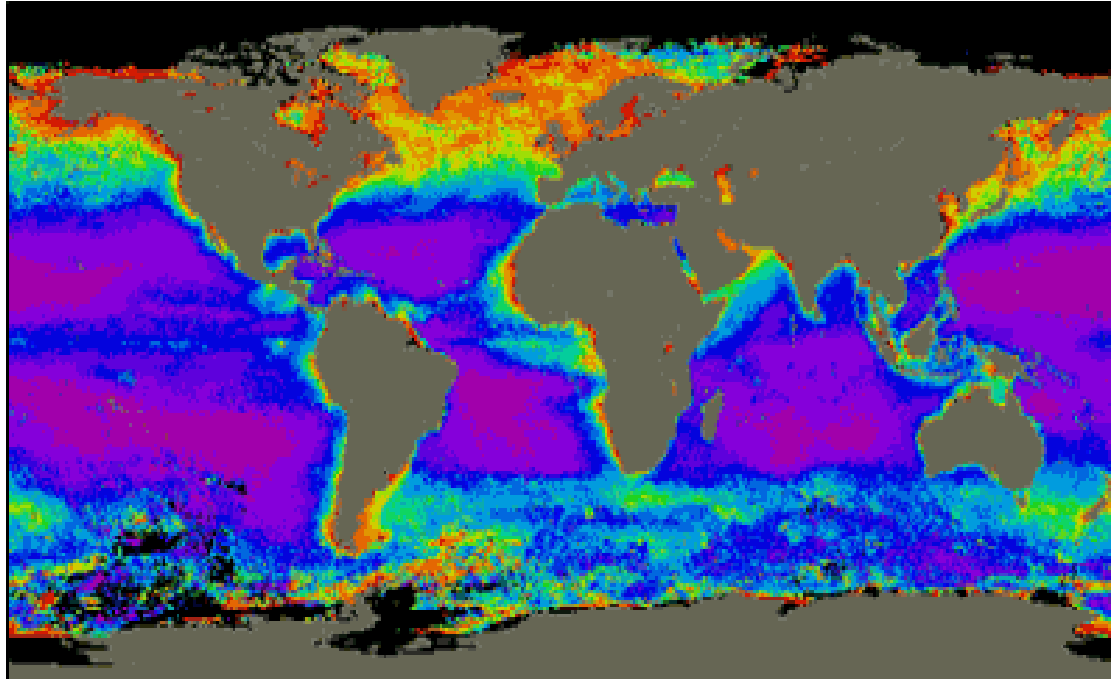
Process Algae



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

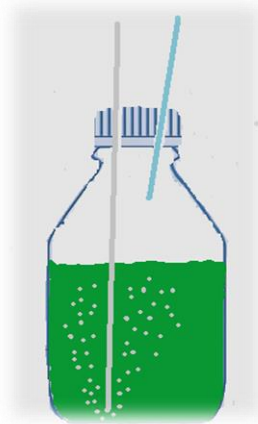
Oil yields liters/ha-yr

Soybeans	400
Sunflower	800
Canola	1600
Jathropha	2000
Palm Oil	6000
Microalgae	60000



The above image indicates relative concentrations of marine algae throughout the world's oceans, with the highest concentrations in red and orange, and the smallest concentrations in dark blue and purple. (Image: NASA - SeaWiFS)

Growing system...



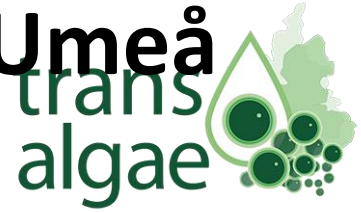
At Vakin in Umeå

trans 

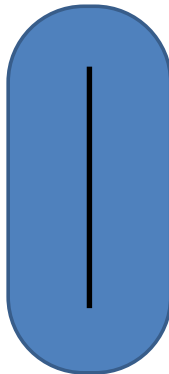
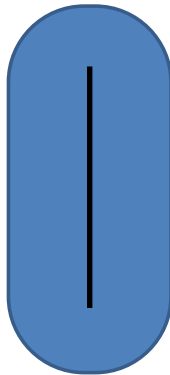




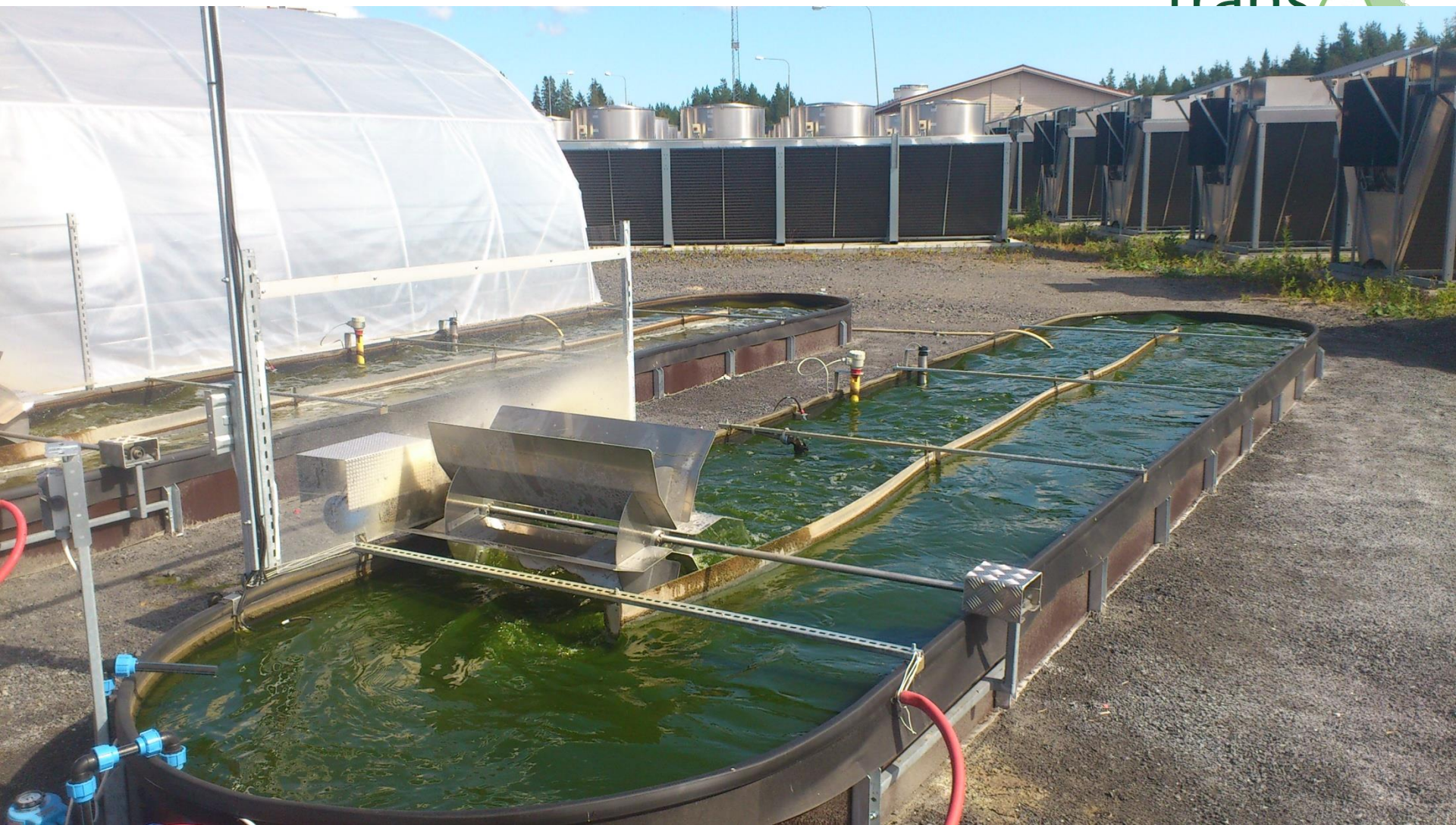
The pilot plant at Umeå Energi in Umeå



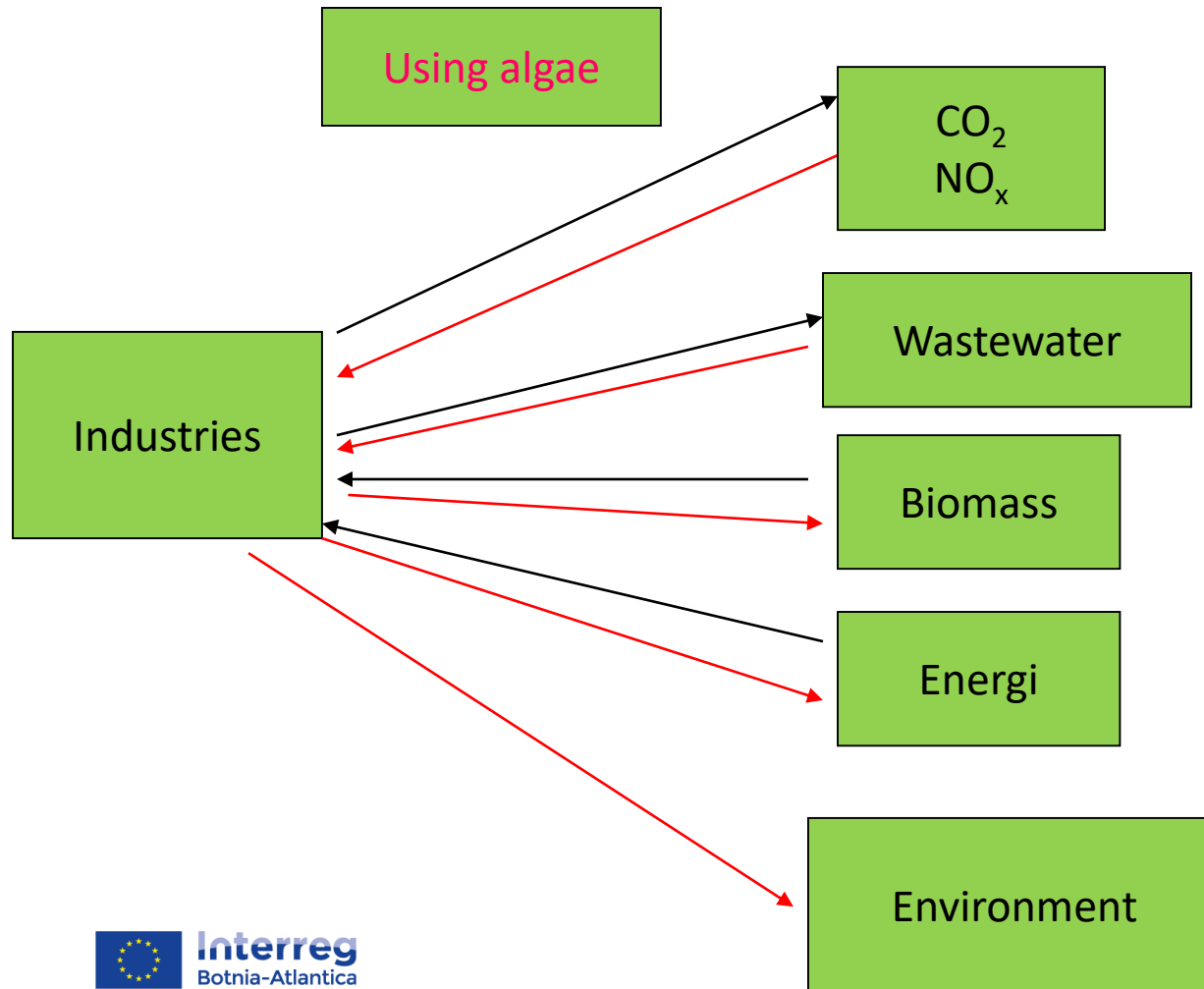
Lab unit.







Algae system





Thank you!!!

www.biofuelregion.se/transalgae

