The Macro Algae Biorefinery (MAB3) – with focus on cultivation, bioethanol production, fish feed and sustainability assessment

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Objectives
A new Danish macroalgae project (Acronym MAB3) financed by the Danish Strategic Research Council presents an integrated macroalgae biorefinery concept. It has started last year and will last for 4 years (2012-2016). Objectives of the MAB3 project are to develop new technologies in laboratory and pilot scale, leading to a sustainable production and further conversion of two brown macroalgae i.e. Saccharina latissima and Laminaria digitata into three energy carriers and fish feed: Bioethanol, Biobutanol, Biogas and a protein rich fish feed supplemented with essential amino acids. S. latissima and L. digitata will be produced from only CO2 and natural resources, in that way making energy and food supply in a sustainable way. The bio-remediation potential will be addressed by cultivating the algae through capturing CO2 from the atmosphere and anthropogenic nutrients from eutrophied coastal seawater. The whole production chain will be evaluated and followed up by a sustainability tool (e.g. LCA), a thorough feasibility study and a business plan for a full scale demonstration project.

Approach, results, and innovation
During the summer 2012, 10 km lines were set-up in an 18 km² area in Limfjorden in Denmark. The result from these cultivation trials will be compared with other smaller scale units at 6 locations in Kattegat in relation to production potentials, bio-chemical compositions for both species of Saccharina latissima and Laminaria digitata.

Initial studies on first harvested materials will be presented on bioethanol set-up and trials. The macroalgae substrates were screw-pressed to dewater and the algae biomass were fractionated before storage by ensiling (with lactic acid bacteria) or simple drying. Pretreatment was carried out using wet-milling and enzymatic hydrolysis in accordance with 1G bioethanol technology from corn. Different commercial enzyme mixtures for fully or partly hydrolysis of algae sugar polymers into monomers were tested and conversion of the released monomers into ethanol by fermentations with different microorganisms i.e. Saccharomyces cerevisiae, Pichia angophorae, Pichia stipitis were compared. The residues from ethanol fermentation trials contain mainly proteins and nutrient salts, which were characterized for potential fish feed.

The scenario for sustainability assessment will be presented for this innovative process of biorefining of value-added algae proteins derived directly through fermentation processes of algae sugars to bioenergy carriers.