Development of macroalgae as a substrate for biogas production

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Aim and Deliverables

To develop technical and logistical guidelines for biogas production from marine macroalgae addressing topics of harvesting, storage and processing.
The potential methane content of different algae species from the North Sea will be determined and linked to their specific growth stage. In addition, the feasibility of a full scale system for cultivation and anaerobic digestion (AD) of macroalgae will be investigated to guarantee the sustainability and the economics of the system.

What is the methane potential of macroalgae?

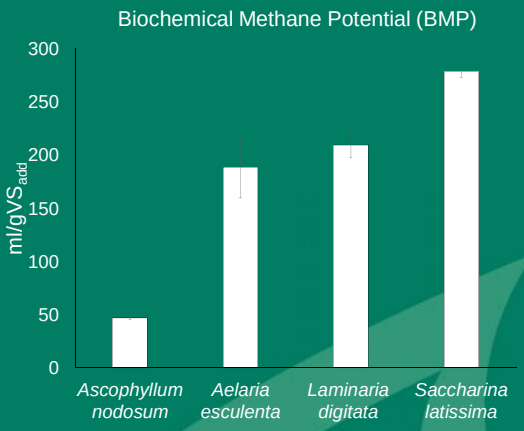

Fig.1 - The BMP is performed in 320ml bottles maintained at 37° C for 60 days. *F. vesciculosus* not available.

The methane content of macroalgae varies between algae species and it depends on the chemical composition, the growth environment condition and the algae age. The project is currently investigating the impact of seasonal variation of five different algae species to identify the optimal biomass depending on the harvesting period.

Tab.1 – Algae elemental composition. All data reported in term of mg/kg TS. Algae are collected from the wild environment by SINTEF, Norway.

	Aelaria esculenta	*Ascophyllum nodosum*	*Fucus vesciculosus*	*Laminaria digitata*	*Saccharina latissima*
Al	50	< 50	**140**	< 50	63
Sb	< 1.00	< 1.00	< 0.99	< 1.00	< 0.99
As	70	23	36	**86**	68
Ba	7.8	6.8	13	**18**	14
Pb	**1.1**	< 0.5	< 0.5	< 0.5	< 0.5
B	110	120	**180**	110	120
P	**3100**	520	890	2600	2400
Fe	< 150	< 150	**260**	190	230
Cd	**2.7**	0.14	0.86	1.0	0.91
Ca	**22000**	12000	14000	18000	16000
K	20000	14000	21000	**76000**	64000
Cu	< 2.5	3.1	**5.5**	< 2.5	3.0
Cr	< 2.5	< 2.5	**4.3**	< 2.5	< 2.5
Mg	5600	**8900**	7300	8000	8200
Mn	3.1	10	**80**	3.8	4.4
Na	22000	32000	28000	44000	**48000**
Ni	< 2.5	< 2.5	**6.9**	< 2.5	< 2.5
S	6200	**32000**	28000	14000	11000
Ti	< 5.0	< 5.0	**8.1**	< 5.0	< 5.0
Zn	36	49	41	**63**	38

Mesophilic or Thermophilic digestion condition?

1. BIOMASS
Cultivated *S. latissima* harvested in June 2014

2. PRE-PROCESSING
Algae are blended to homogeneous mixture

3. DIGESTION
5L reactors at 37° C and 52° C

4. PERFORMANCE
SLR 2.1 gVS/L with a HRT 19d
The substrate composition changes every 3HRT from 100% wwt sludge to 80:20 (sludge:algae), 50:50 and 20:80.

Daily Biogas production
Biogas composition
Solids content
Conductivity
Viscosity
VFA
pH

How to guarantee a positive energy and economic balance?

An integrated biorefinary solutions is the only feasible alternative to maintain positive energetic and economic balance while cultivated algae for biofuels production. The project will perform a full scale energy/costs analysis to identify the optimal flowsheet configuration. This will help companies to develop and design efficient integrated AD plants.

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