From marine biomass to substrate

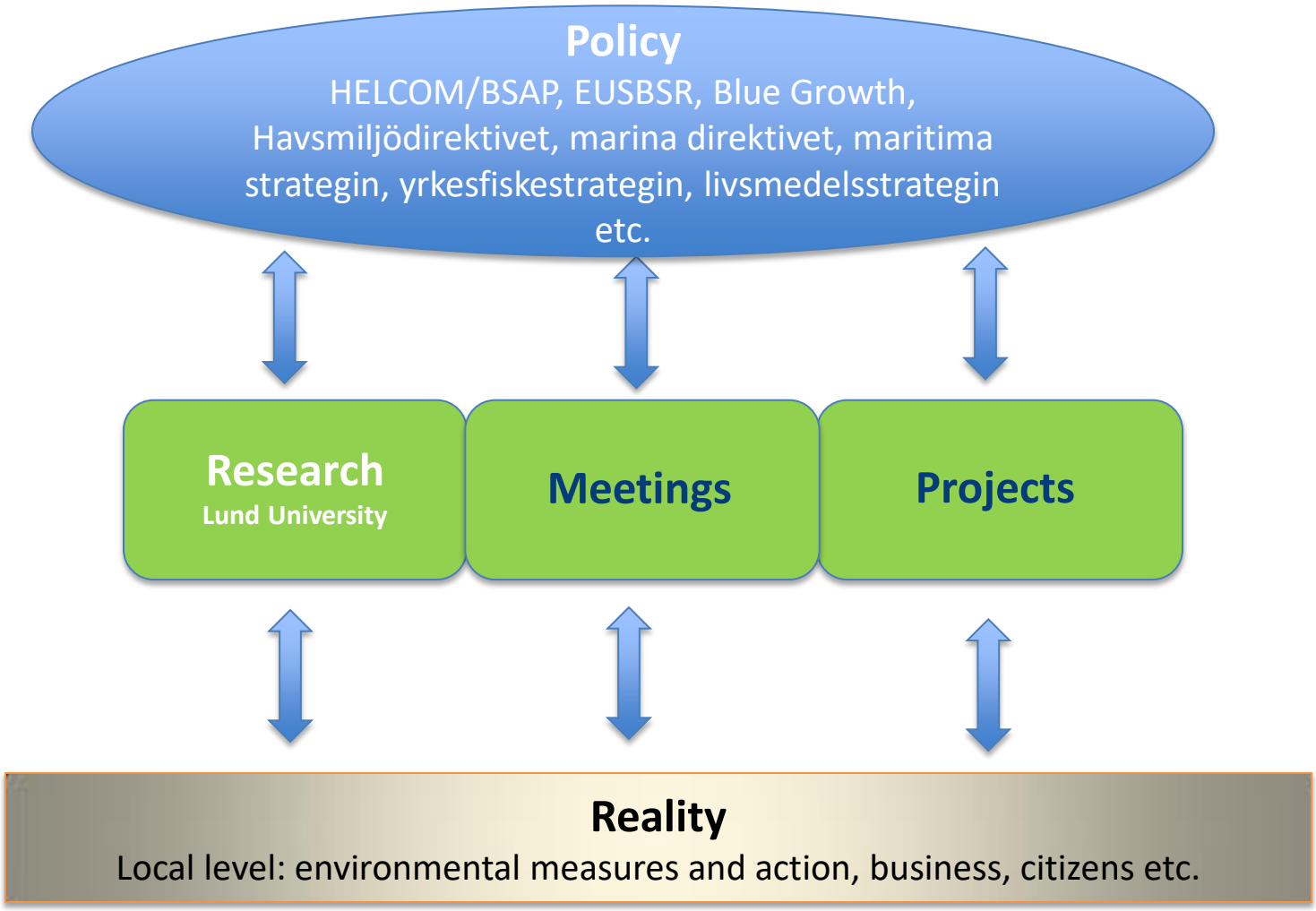
Ann-Marie Camper
marine biologist,
coordinator

Marint centrum is a place where entrepreneurship, research and protection of the marine environment interact and create synergies to benefit the Baltic Sea region








Policy
HELCOM/BSAP, EUSBSR, Blue Growth, Havsmiljödirektivet, marina direktivet, maritima strategin, yrkesfiskestrategin, livsmedelsstrategin etc.
Research
Lund University
Meetings
Projects
Reality
Local level: environmental measures and action, business, citizens etc.

From marine biomass to substrate

- What kind of biomass?
- Harvest
- Dewater/Stabilize
- Preservation/Storage
- Transport

What kind of marine biomass?

- **Macro algae and eel-grass**
- **Fish offal**
- **Mussels**
- **Micro algae**

Cultivated or from natural resources

Focus

Macroalgae

Marine biomass from macroalgae

Chemical Composition of Some Marine Macroalgae

Marine Macroalgae		Dry Weight (%)			
		Ash	Protein	Carbohydrates	Lipids
Brown algae	*Dictyota ciliolata*	47.2	4.1	15.2	7.8
	Hydroclathrus clathratus	49.4	4.2	18.3	2.9
	Fucus virsoides	17.7	12.3	15.8	3.2–4.7
	Cystoseira barbata	20.4	13.5	17.4	1.3–2.4
	Padina boryana	33.5	10.6	18.4	5.2
	Rosenvingea nhatrangensis	56.6	6.6	8.4	3.1
	Turbinaria conoides	34.4	5.9	19.7	2.3
Red algae	*Gracilaria compressa*	23.5	17.7	20.2	—
	Gracilaria salicornia	49.3	6.0	24.4	1.3
	Laurencia majuscula	42.2	12.5	18.8	5.1
	Portieria hornemannii	37.4	9.8	21.8	5.3
	Hypnea sp.	34.7	6.9	31.7	3.4
Green algae	*Enteromorpha intestinalis*	49.5	3.2	18.7	1.8
	Halimeda macroloba	64.4	4.6	2.7	2.5
	Halimeda opuntia	89.7	3.2	2.5	2.9
	Caulerpa racemosa	47.7	6.9	14.7	4.4
	Ulva lactuca	16.6	13.9	29.5	1.8

Sources : Peterfi, S. and Ionescu, A., *Algal Handboo* k (in Romanian), Romanian Academy Publisher, Bucharest, Romania, Vol. 2, pp. 25–42, 1976; Renaud, S.M. and Luong-Van, J.T., *J. Appl. Phyco* l., 18, 381, 2006.

Harvesting macroalgae biomass

A number of mechanised harvesting methods have been developed and explored, such as mowing with rotating blades, suction, or dredging with cutters, each of which invariably requires the use of boats or ships.

Harvesting macroalgae biomass

Post harvest macroalgae biomass

- Cleaning
- Size reduction
- Dewatering or drying
- Preservation and storage (ensilation?)

Challenge: optimized, energy efficient process in each of these areas

Cleaning

- Seaweed is first treated to remove foreign objects and debris by mechanical means or washing.
- If salts do need to be removed it will have a considerable effect on water usage, effluent production and overall process energy input requirements. (the biofuel process states the need)

Size reduction

Commonly chopping or milling of the treated biomass is then required to increase the surface area to volume ratio that will improve the efficiency of combustion, AD and the hydrolysis of complex carbohydrates to sugar for fermentation.

Dewatering

- "..removal of water by mechanical methods from the algal biomass, such as pressing and centrifugation or drying of seaweed biomass to 20%–30% will increase "shelf-life" and reduce transportation costs"

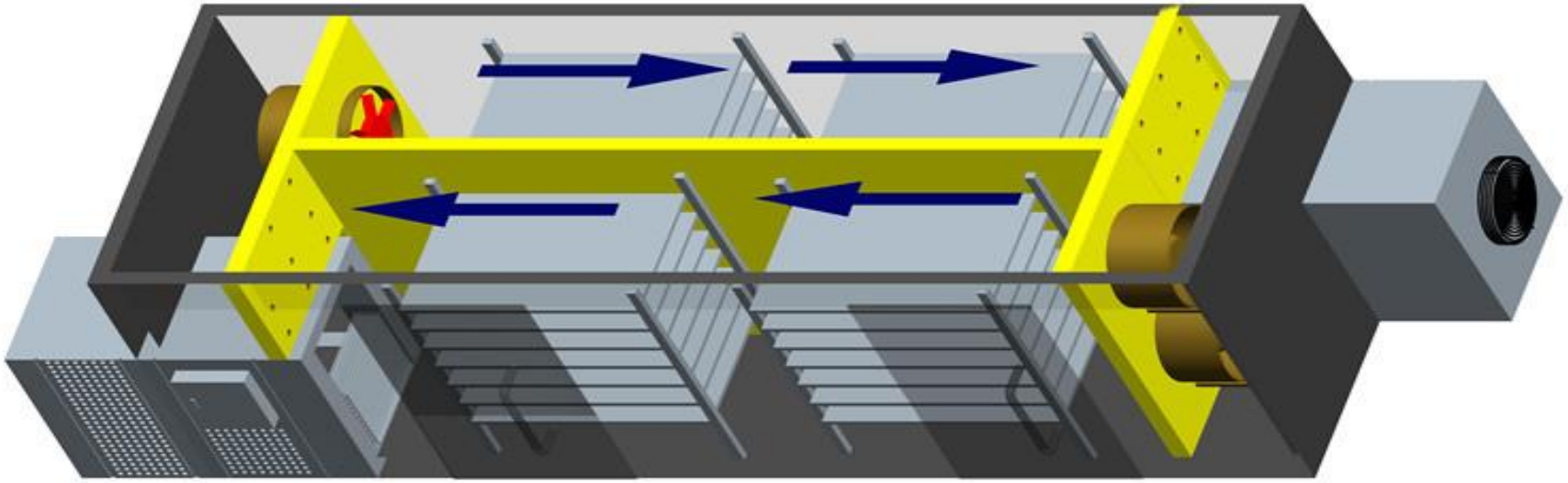
Source: Macroalgae-Derived Biofuel: A Review of Methods of Energy Extraction from Seaweed Biomass

Drying

"Finding a controllable and cost-effective method of large-scale seaweed drying is clearly key to establishing a viable seaweed-to-fuels processing industry"

Source: Macroalgae-Derived Biofuel: A Review of Methods of Energy Extraction from Seaweed Biomass

Drying



heat pump dryer + drying room parts + trolleys = whole dryer machine

Transportation

By boat or barge to the shore, and once it arrives on shore it will need to be transported to the ensilage, storage and gasification plants. The low energy density of biomass and its often dispersed geographically locations can cause transport costs to rise rapidly with size of biomass conversion facility

Challenges macroalgae biomass

From natural sources

- Seasonal and geographical variation
- Effect on ecosystem
- Harvesting method depending on seashore structure and accessibility
- Shore is nearby infrastructure. Transportation
- Harvesting on sandy beaches gives…sand!
- High content of Cd

Challenges macroalgae biomass

From cultivated sources

- Seasonal variation (preservation needed)
- Reduction of eutrophication effects with time
- High content of Cd

MARINTCENTRUM
Där havet är en tillgång

Thank you

Table 1. Methods of energy extraction from macroalgal biomass.

Method	Utilises entire organic biomass	Requires biomass drying after harvesting	Primary energy product
Direct combustion	Yes	Yes	Heat
Pyrolysis	Yes	Yes	Primarily liquid by fast pyrolysis
Gasification	Yes	Yes [b] (conventional)	Primarily Gas
Biodiesel production	No	Yes [c]	Liquid
Hydrothermal treatments	Yes	No	Primarily Liquid
Bioethanol production	No [a]	No	Liquid
Biobutanol production	No [a]	No	Liquid
Anaerobic digestion	Yes	No	Gas

[a] Polysaccharides require hydrolysis to fermentable sugars. Some of the sugars produced from the breakdown of seaweed polysaccharides are not readily fermented; [b] Supercritical water gasification (SCWG) an alternative gasification technology can convert high moisture biomass; [c] No current commercial process for the wet trans-esterification of wet macroalgal biomass

Source: Macroalgae-Derived Biofuel: A Review of Methods of Energy Extraction from Seaweed Biomass

KTH Land and Water
Resources Engineering

POTENTIAL BIOGAS PRODUCTION FROM FISH WASTE AND SLUDGE

Chen Shi

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Review

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Potential process 'hurdles' in the use of macroalgae as feedstock for biofuel production in the British Isles

John J Milledge* and Patricia J Harvey

Abstract

This review examines the potential technical and energy balance hurdles in the production of seaweed biofuel, and in particular for the MacroBioCrude processing pipeline for the sustainable manufacture of liquid hydrocarbon fuels from seaweed in the UK.

The production of biofuel from seaweed is economically, energetically and technically challenging at scale. Any successful process appears to require both a method of preserving the seaweed for continuous feedstock availability and a method exploiting the entire biomass. Ensiling and gasification offer a potential solution to these two requirements. However there is need for more data particularly at a commercial scale.

Keywords: seaweed; algae; macroalgae; biorefining; biofuel; bioenergy; gasification