A new Norwegian bioeconomy based on cultivation and processing of seaweeds: Opportunities and R&D needs

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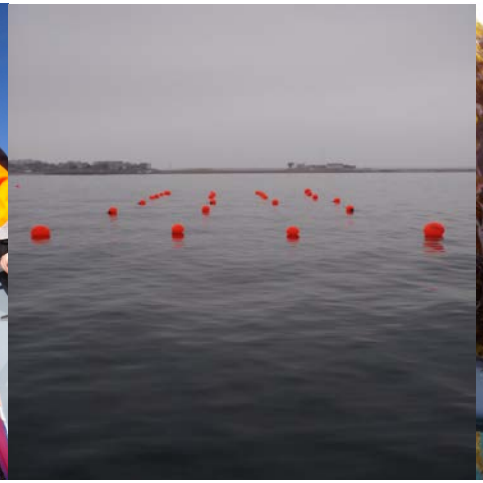


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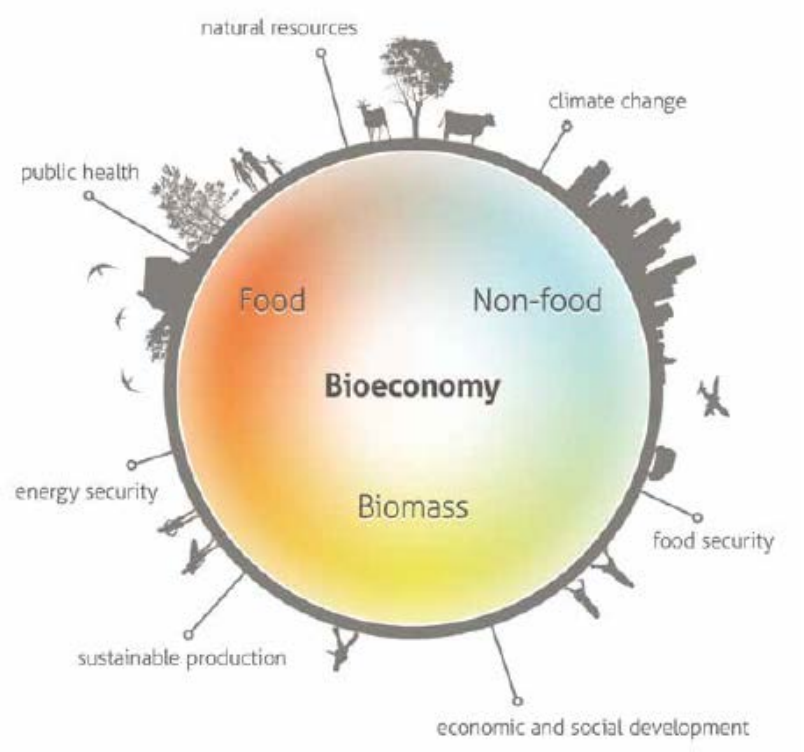
The trends in the bio-economy

"The bioeconomy encompasses the sustainable production of renewable biological resources and their conversion into food, feed, bio-based products and energy"

(European Commission, "Innovating for sustainable growth: A bioeconomy for Europe", 2012).



Markedsverdi på bio-produkter i 2020:

300 milliarder $

TARE

Unik mulighet for Norge: En ny marin, bioøkonomisk verdikjede

Mat og farma

Fôringredienser

Biokjemikalier

Gjødsel

Bioenergi

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Utredningens mål

Å kartlegge FoU-behov knyttet til dyrking og utnyttelse av tang og tare, samt utfordringer knyttet til forvaltning.

- Faglig vurdering av basale forskningsbehov langs hele verdikjeden
- Synliggjøring av nye teknologiske muligheter for næringslivet


Photo: SINTEF Fisheries and Aquaculture


Photo: Seaweed Energy Solutions

Kort om utredningen:

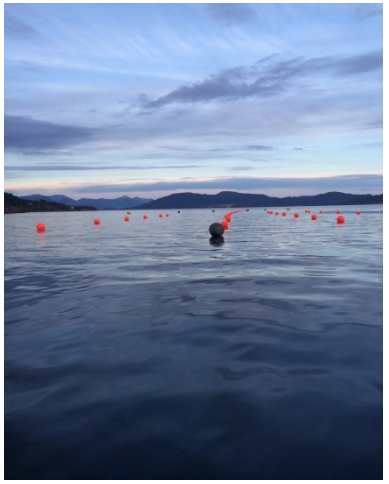
- Støttet av: Innovasjon Norge
- Hovedforfattere: Jorunn Skjermo, Inga Marie Aasen, Johanne Arff, Ole Jacob Broch, Ana Carvajal, Hartvig Christie, Silje Forbord, Yngvar Olsen, Kjell Inge Reitan, Turid Rustad, Judit Sandquist, Roar Solbakken, Kristine B. Steinhovden, Bernd Wittgens, Robert Wolff and Aleksander Handå
- Norske kompetansemiljøer deltok på dialogmøte i Trondheim 21.november 2013
- Internasjonale eksperter konferert på møte i København (MACROSEA/MacroArena) i januar 2014.

The three "stakeholders"

The Seaweed industry
Goal: High biomass quality and output, high priced products

The Ecosystem
Goal: Maintain ecological resilience

The Regulatory authorities
Goal: Area management



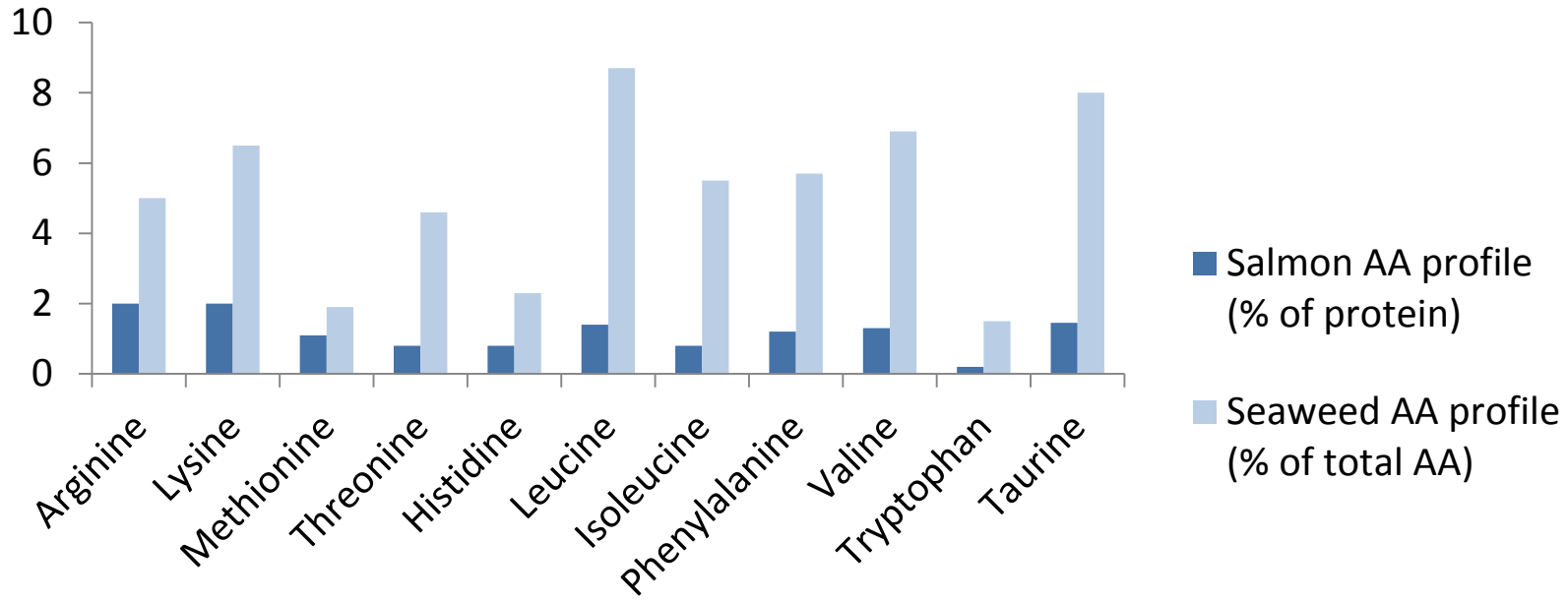
Muligheter for biobaserte produkter

Komponent	Potensielt produkt og/eller marked	Potensielt prisleie*
Hele planter	Mat	Lav-medium
Ekstrakter	Kosmetikk	Medium
Karbohydrater / polysakkarider	Farmasøytiske produkter	Høy
	Fortykningsmidler, viskositetsøkende midler	Medium
	Prebiotika	Medium
	Substrat for fermentering (biodrivstoff, fôrprotein)	Lav
Protein / aminosyrer	Fiske- og dyrefôr	Lav-medium
	Bioaktive peptider (fôr og mat)	Høy
Polyfenoler	Antioxydanter (mat, fôr, kosmetikk)	Høy
	Antimikrobielle produkter (mat preservering, anti-begroing m.fl.)	Medium-høy
Aske	Verdifulle mineraler	Medium-høy
	Gjødsel	Lav-medium

* Lav: < 10 kr/kg; Medium: 10-100 kr/kg; Høy: >100 kr/kg

Muligheter for bioetanol og fôrprotein

- Salmon area today: 800 km^2
- Ethanol potential: 470.000 tons
- Protein potential: 240.000 tons



Muligheter for IMTA og bioremediering

Biomass production over a <u>two year</u> period

- Salmon 5 000 tons ww **1 800 tons dw** (36% dry matter content)
- Seaweed 10 000 tons ww **1 500 tons dw** (15% dry matter content)

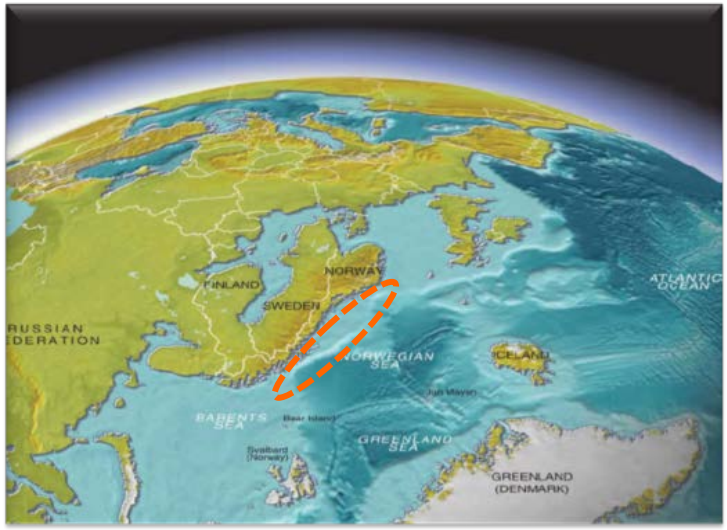
Bioremediation by IMTA (integrated multi-trophic aquaculture)

- Per year a 30 ha seaweed farm will have a net uptake of 10% of the DIN from 30 ha salmon farm.

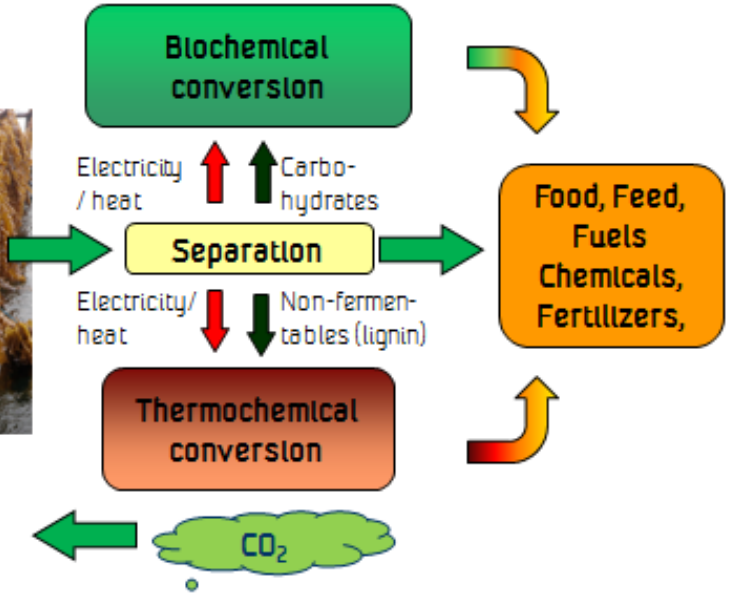
Utfordringer (eksempel 1) - begroing

Utfordring (eksempel 2) - Areal

- Area used for aquaculture today (salmon): 800km^2
- Area needed for seaweed farming in **2050**: 1200 km^2
  - Economic value of seaweed industry will increase from 1,2 in 2012 to 40 BNOK in 2050 (DKNVS/NTVA, 2012)



Utfordring (eksempel 3) - Bioraffineri



FoU-behov innen dyrking

Need
Cost effective production lines for macroalgae farms in the sea
Cost effective production lines for macroalgae cultivation in tanks
Predictable chemical composition of cultivated biomass
Predictable biomass production
Anti-biofouling measures
Reveal the IMTA potential
Impact of large scale seaweed farming on the environment
Up-scaling from experimental to commercial phase

FoU-behov innen bioraffineri

Need	
Contents and properties of potential valuable compounds	
Technologies for storage and pre-processing	
Impact of proteins from macroalgae	
Processes for isolation of protein and higher-value compounds	
Processes for fermentation of the carbohydrates to fuels or chemicals	
Market analysis for a range of products from macroalgae	

Suggested strategy for a seaweed bioeconomy (i)

Phase 1 – focus biomass production

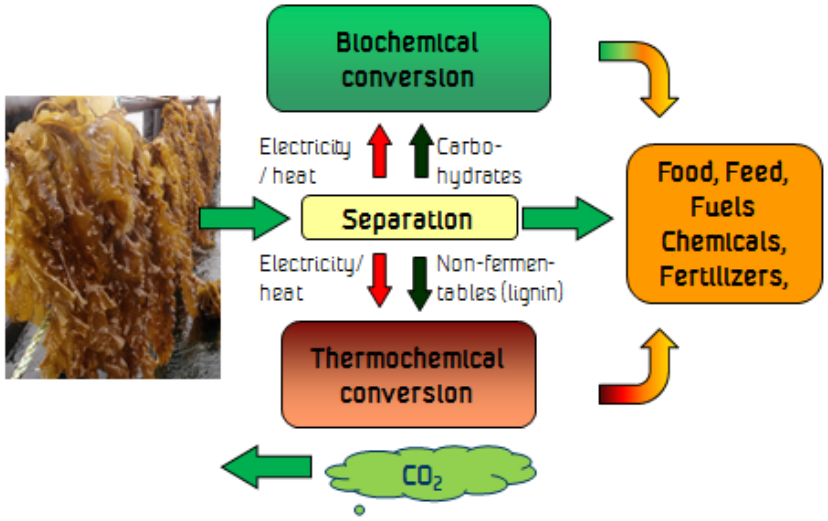
- Cultivate **kelp** – known technology can be scaled up, large biomass production
- **Preservation** techniques - stabilize the biomass, allow for year-through processing of biomass
- Produce "low-technological", demanded products like **energy** (biogas) or **proteins** with well identified markets




Suggested strategy for a seaweed bioeconomy (ii)

Phase 2 – focus biorefinery

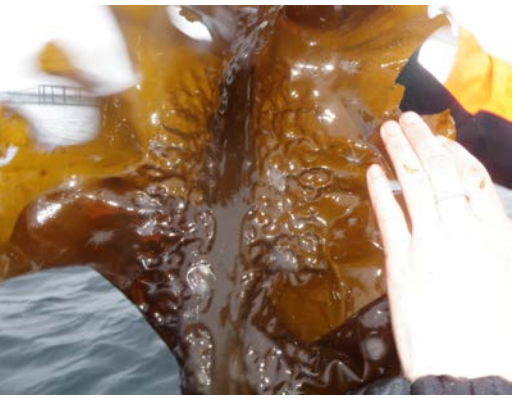
- Advanced processing techniques for biorefinery
- Utilization of the whole biomass
- High-value products should then be focused



Suggested strategy for a seaweed bioeconomy (iii)

Phase 3 – focus species diversification and product quality optimization

- Develop into a **broad range of products and markets**, based on a (limited) number of cultivated seaweed species.
- Cultivation technology for **a number of species** should make industrial scale production possible.
- The processing of different components and products should be **refined** to ensure the optimum quality of the products. Flagship plants demonstrate **cost effective biorefinery**.




Seaweed Bioeconomy Special Interest Group (SB-SIG)

- Ønskelig med en egen norsk interessegruppe, ref AB-SIG i UK?
  - Nettverksarbeid
  - Utredninger (technology roadmaps)

- På initiativ fra: Industrial Biotech Network-Norway

Lys i horisonten…?