

Opportunities from the Oceans for the Food Industry

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GHG emissions – meat and dairy products

- Livestock accounts for some 15% of the world's GHG emissions – of which some 65% is attributable to cattle (ref. FAO)
- FAO expects the consumption of meat to increase by 54% towards 2050 and the consumption of milk by 73% - the growth rate is significantly higher than the population growth rate
- Are there better sources of animal proteins than from cattle, pigs and chicken in a GHG context?

Feed conversion ratio

Amount of feed to produce 1 kg of animal:

Cattle 4-10 kg (depends on feed)

Pork 3 kg

Chicken 2.2 kg

Farmed salmon 1.1 kg

Percentage of edible meat varies with animal – highest 61% for salmon

Source:Marine Harvest

GHG emission per kilo throughout food supply chain

measured in kg CO2 equivalent – data for Denmark

source: tabel over fødevarers klimaaftryk, Mogensen et al, DCA, 2016

Meat and dairy products

- Beef: 14
- Pork: 5
- Chicken 3
- Lamb 14
- Milk 1
- Yellow cheese 10
- Butter 10

Vegetables, fruit, whole grain

- Salat 0.5
- Potato 0.2
- Onion 0.4
- Apple 0.1
- Wheat 1.2
- Pasta 1.2

GHG emission per kilo throughout food supply chain measured in kg CO2 equivalent – data for Denmark

Seafood from the ocean

- Cod 1.2
- Herring 0.7
- Shrimp 3.0
- Mussels 0.1

Sea food from aquaculture

- Trout 1.8
- Salmon 2.0-2.5

Can fish farming be sustainable ?

- Norway produces more than 1 million tons of salmon per year in fish farms in the ocean in sheltered water. There are limits to further growth.
- We see two mega trends to multiply production in a sustainable manner:
 - Move production to RAS facilities on land (RAS stands for recirculating aquaculture system)
 - Move production sites further offshore

Traditional near shore fish farm lay-out



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Krüger RAS 2020 System – land based fish farm



Salmar Ocean Farm 1 – offshore fish farm



Nordlaks “Havfarm”- offshore fish farm

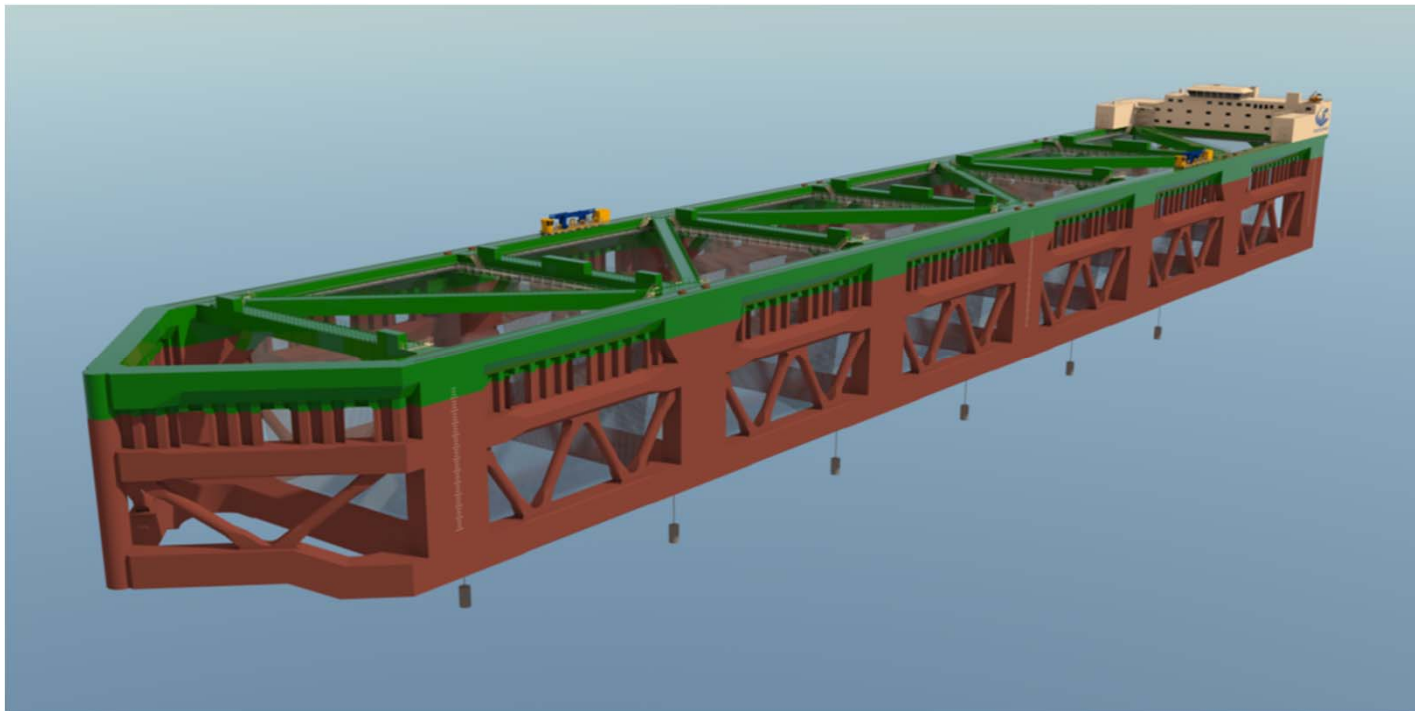


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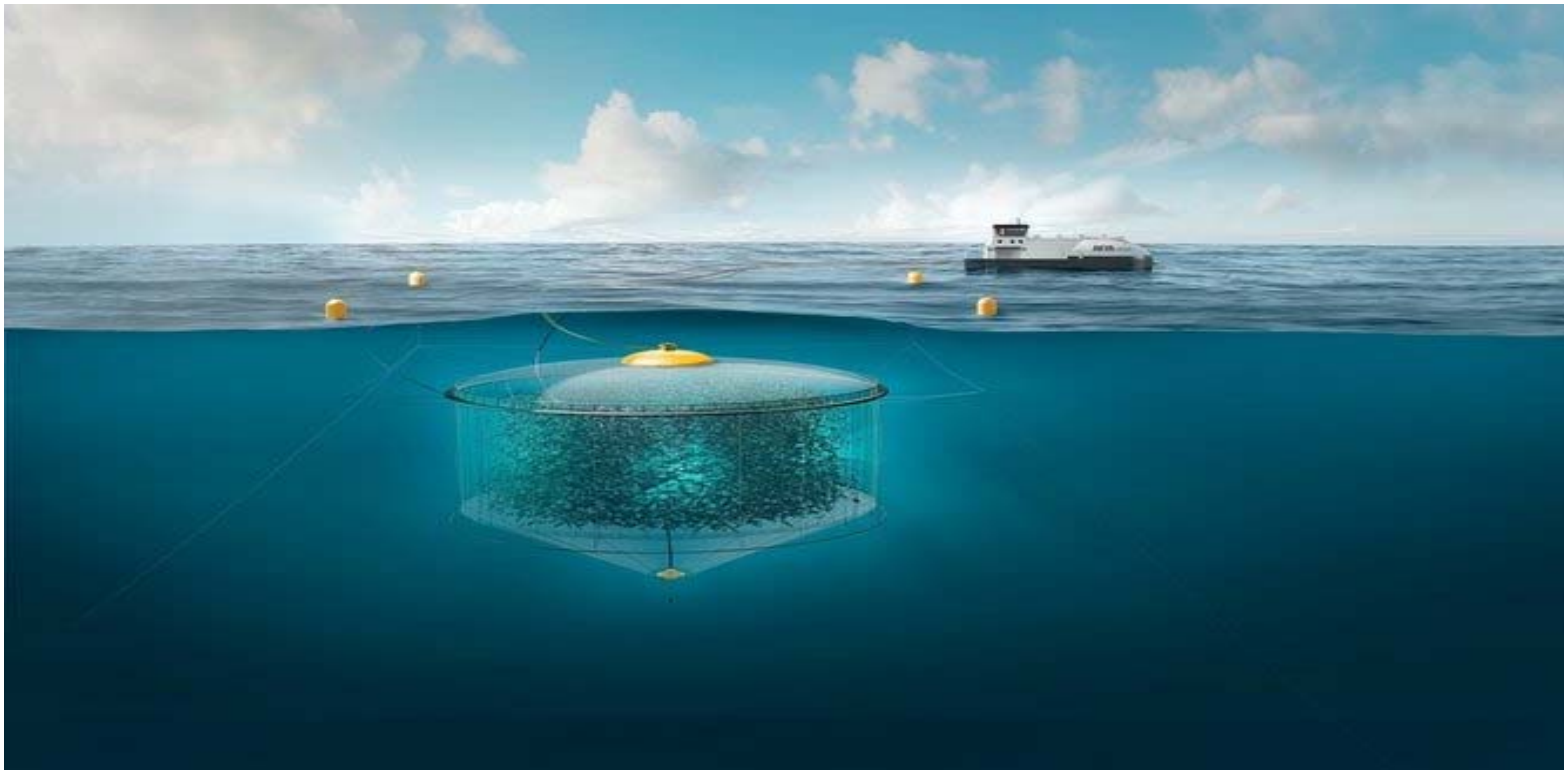
Nordlaks “Havfarm”- offshore fish farm



Marine Harvest and Hage Aqua “The Egg” – offshore fish farm



Atlantis Subsea Farming “Atlantis” – offshore fish farm



“Aquatraz” – Offshore fish farm



Converted Cape Size Bulk Carrier fish farm



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Feed – “you are what you eat”

- 75% of the world’s agriculture area is used for animal production including animal feed production
- Denmark with a population of 6 million people imports soya from an area in South America corresponding to the area of the largest island Zealand – this is mainly to feed 30 million pigs
- Farmed salmon has a diet with 50-75% soya imported from South America
- The percentage of fishmeal and fish oil in the feed is decreasing
- Introduction of more krill in the feed can be sustainable
- Today you need to eat twice as much farmed salmon to get the same amount of Omega 3 as 10 years ago

Sugar tongs and other seaweeds can be a solution for sustainable fish food production

- Can be produced industrially in the ocean – more “natural” to fish
- Scale is needed to reduce cost – e.g. for drying
- Absorbs phosphor and nitrogen from the ocean
- Absorbs CO₂ at the same level as a rain forest
- Can be harvested once or twice a year
- Can also be used for production of biofuels
- Combined fish farming, mussel production and seaweed production has additional value creation potential

Seaweed production



Marine Algae can be another fish feed solution

- We have only studied a very small portion of marine algae
- Some marine algae allows light to penetrate thereby making fast growth in large tanks possible
- Pilot projects on land utilize CO₂ emissions from smelters to increase growth rate of marine algae in very large tanks
- Marine algae has many uses also beyond fish feed

Conclusion

- The Ocean Space will become increasingly important to create solutions to our sustainability challenges
- Industrial production of healthy and sustainable feed and food from the oceans must become a priority
- We must increase the amount of farmed fish in our diets – both fresh and frozen
- How can we motivate for this to happen – and fast?