



Carbon Management and Policies towards 2050
BNCT workshop 7th October 2021

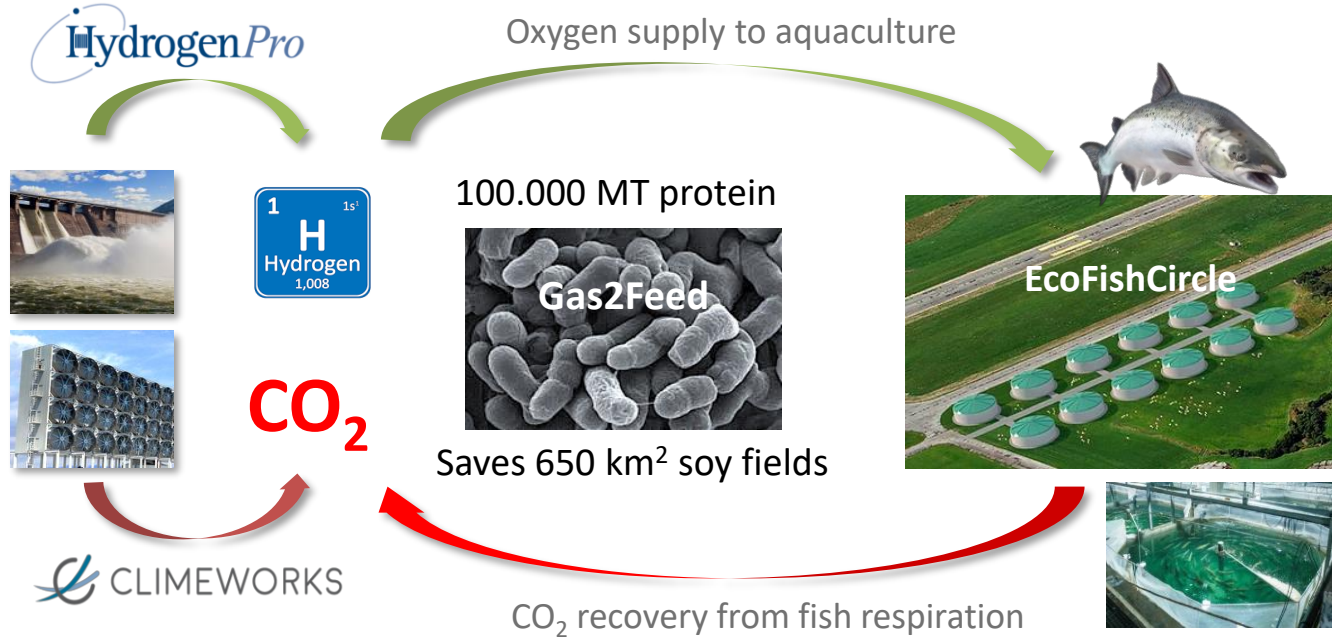
PRODUCTION OF FISH FEED BY GAS FERMENTATION

Norway, case study 1

Ole Jørgen Marvik, Innovation Norway



Creating an industrial pathway to DAC



Chemical catalysis

Gas fermentation

RAS aquaculture



Sustainability impact and dilemmas

Sustainability aspects

- Substitution of plant-based protein, e.g. soy or wheat.
 - Climate: 6 kg CO₂ equivalents saved per kg product replacing soy.
 - Environmental: Reduced need of land, thus eliminating deforestation.

Impact

- Capacity only limited by availability (and cost) of renewable power.
 - Envisioned production capacity by 2030: 100-200.000 MT.
 - Business case will depend on cost of DAC vs. cost of fossil CCU (carbon tax).

Policy trade-offs

- Biodiversity versus renewable power consumption.



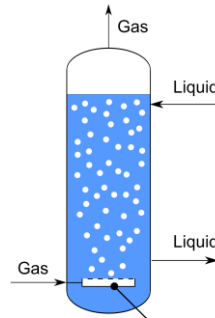
Public policy issues

Innovation policies

- Public grants and publicly funded scale-up facility

Market stimulation

- None so far.



Joint undertaking of Norwegian government agencies to create an integrated test site for technologies related to utilization of carbon waste streams by gas fermentation.



LISTA LAKS RAS PLANT

The attached material was presented as Norway's contribution at an OECD seminar where 8 nations, including USA and Norway, were talking about new green initiatives and how governments can stimulate the development.

Norway's case no 1 is based on plans to recycle carbon from a land-based fish farm to produce 30% of the required fish feed, mainly protein, through a fermentation reactor. The process also requires hydrogen and oxygen that will be produced onsite from splitting water. This integrated production system will make the plant self-supplied with protein directly and by exchange, as well as oversupplied with oxygen to both fish and bacteria. The protein will replace all the controversial soy-based protein, be of the highest quality and free for toxic ingredients, all at a very competitive cost. A profitable production will add to the sustainability of the concept and in itself be a driver of further expansion on a commercial basis.

The sister companies Gas 2 Feed and EcoFishCircle will deliver the prototype plant to Lista Laks, a subsidiary of EFC. TM Holding is the leading financial partner in the group and HydrogenPro, an affiliated company, is a sub-supplier of the electrolyzers. Electric power is the single highest cost factor and the high-power efficiency of HyPro's new technology is an important contribution.

The Lista Laks plant will set a new standard in traceability and provide the consumer with detailed info about fish quality and fish welfare based on new proprietary technology from Queen's University in Belfast.



EcoFishCircle

Lista Laks will turn land-based fish farming into a great contributor to global food sustainability by:

- ** Reducing CO2 emission from production and transportation of feed by 2,2 kg/ kg fish
- ** Eliminating use of soy-based protein from rain forest areas amounting to 0,3 kg/ kg fish
- ** Adding new biomass production capacity by recycling carbon amounting to 0,4 kg/ kg fish without use of farmland
- ** Using solar panels to feed DC power directly to the electrolyzers with low-cost grid power during nights
- ** Using EFC's independent tanks design to increase overall control and reduce financial risk
- ** Providing high quality salmon at a competitive price which will drive investments

The LISTA LAKS plant has the potential to spearhead a change in the future of land based Recirculating Aquaculture Systems (RAS) and turn salmon farming into a contributor in the battle for healthy food and reduced global warming.

Moreover, G2F will through the project gain important knowhow that can be applied to a next potential step =>

- ** Use CO2 captured from the air instead of from the fish water.
- ** The microorganisms will then make new protein from air, sun and water and thus solve the basic protein equation.

Due to G2F's:

- ** Innovative proprietary fermentation plant
- ** New energy efficient electrolyzer technology from HyPro
- ** Promising new absorption technology (DAC) from Climeworks
- ** Projected new cost-effective solar technology

the group may take a leading role in adding new biomass plants anywhere in the world without taxing the existing food production capacity.