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CIRCULAR ECONOMY Blue-Green Bio Lab

Bio-industrial symbiosis

Policy Brief

Design of bio-industrial symbiosis with blue biomasses - Sweden

This brief is a part of the Blue Green Bio Lab Tool Kit, that represents the findings in the Blue Green Bio Lab project. The project targets the urgent challenges of reducing nutrients to waters of the Baltic Sea Region, limiting greenhouse gas emissions, and enhancing European self-supply with food, feed, and energy. Together, aquaculture, agriculture and industry can provide solutions to these challenges through industrial symbiosis based on the sustainable exploitation of local blue and green biomasses initially grown and/or harvested with the objective to produce positive ecosystem services. The Blue Green Bio Lab project is co-financed by Inter-Reg Baltic Sea Region with partners in Denmark, Latvia, and Sweden.

Anna Gunnäs, maritime business developer Lysekil Municipality.

This brief contains the findings from the Swedish workshop on designing of bio-industrial symbioses on blue biomasses as part of the Blue Green Bio Lab Project. The purpose of the workshop was to identify challenges and barriers and how to move forward. The workshop was held by Lysekil Municipality together with Innovatum Science Park and Sotenäs Municipality in February 2023.

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Resumé

The Swedish workshop was held on February 3rd, 2023, with 23 participants representing various companies, infrastructure providers as well as business support organisations. The workshop was conducted in collaboration with both Innovatum Science Park and the neighboring municipality Sotenäs who has experience in working with circular symbiosis.

The invitation to the workshop was sent out via social media and newsletters as well as via direct mail and telephone calls to companies and organisations identified in collaboration with the Swedish associated partners, Innovatum Science Park and Chalmers Industriteknik. The aim was to identify and address primarily local companies that could possibly be part of the symbiosis starting with the identified warmwater biomasses, the red algae Asparagopsis, Vannamei (giant shrimp) and the fish Clarias.

Before the workshop, the participants were invited to watch three films about industrial symbiosis. The workshop started, as suggested in the general form, with an inspirational introduction to industrial symbiosis in general to ensure common knowledge, but it was also an attempt to frame the day.

Some of the participants knew each other beforehand, but most of the participants had not met each other earlier. Overall, the meeting went very well, the participants were interested in the topic and contributed with their knowledge and expertise. There was, however, one key company who was reluctant to share facts about their resource flows. The company was in a critical stage with regard to raising capital and did not want to be fully open about their resources and potential. The organizers of the workshop learned this when contacting the participants before the workshop

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and thus took it into account when planning the workshop in detail. This did to some extent affect the workshop, as volumes and quantities from this company could not be fully and openly discussed at the workshop.

Mapping of the bio-industrial symbioses

Choice of biomass

The setting in Lysekil, Sweden differs from the settings in Skive, Denmark and Zemgale Region in Latvia in various ways. In Denmark the local project is based upon available and well-known biomasses with existing value-chains. Skive Municipality also has a history of working with industrial symbiosis and thus has both experience in the subject and trust from society. In the Zemgale Region there is limited experience with bio-industrial symbiosis, however the biomasses at focus in Latvia are well known.

In Lysekil, the topic is new to both the municipality and the local companies even though Lysekil has followed closely developments in the neighboring municipality, Sotenäs. As the project also introduces "new" non-native species, farmed by relatively new companies in a land-based fully controlled setting, the work will naturally be conducted in a slightly different way than in Skive and Zemgale.

As part of the project in Lysekil there is also afeasibility assessment being performed for a climate neutral industrial park very close to the oil refinery producing residual heat. The chosen biomasses in Lysekil in focus are thus tropical: Vannamei and Asperagopsis, based upon two pilot cases in Lysekil, and African catfish (Clarias), as it also is a warm water species and there are existing companies in Sweden with experience with this species.

Vannamei, pilot farm in Lysekil:

The environmentally friendly land-based methods for farming tropical shrimp in cold climates is built upon the use of residual heat from nearby industries. The cultivation method is based on Bioflock, which provides a probiotic environment and is the basis of the feed. The cultivation system is closed, which minimizes nutrient leakage to the environment. In other words, it is possible to farm tropical giant shrimps completely without antibiotics, mangrove destruction or adverse socioeconomic conditions.

Asperagopsis, pilot farm in Lysekil:

"If cattle were a country, they would rank third in greenhouse emissions". The methane emissions from cattle can be decreased by 70–90% per day when dried red macroalgae (Asperagopsis) is included in their feed (0.6%). A land-based factory enables optimization of temperature, light, and nutrients to maximize the red algae's growth rate while ensuring a high and standardized quality of the feed supplement. To ensure a sustainable production footprint and viable production economics, the algae produced needs renewable electricity, waste heat, and CO2 from nearby industries.

Clarias

African catfish (Claria) is a common food fish around the globe. It is a wild freshwater fish found in Africa and Asia. In a land-based system water quality, energy could be controlled and the eutrophication that a fish farm usually contributes could be effectively handled. Clarias is a semi-fatty cutlet fish, rich in omega 3, with firm meat reminiscent of chicken, monkfish and pork tenderloin.

Industrial circularity

Before the workshop Lysekil Municipality, Innovatum Science Park, Sotenäs Symbiosiscenter discussed the structure of the workshop to encourage participants to start thinking about possible symbioses / industrial circularity within their organisations, as the organizers assessed that it would be most beneficial to work organizationally with the following questions:

1. What flows are available in your businesses

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today?

2. What intangible flows exists? Competence, knowledge, and information? (Social symbiosis).

Furthermore there was focus on additional questions related to company inputs and outputs to help participants get their thinking process started.

- INPUTS: What is expensive to buy today? What large quantities do you buy?
- OUTPUTS: What is expensive to get rid of? What large amounts do you want/need to get rid of?

Here are some of the findings from participants in the workshop:

- Seafood processing company (mainly herring): uses lots of water, district heating, electricity, transport in and out. Organic material as output – large quantities of nutritious sludge. Today transported more than 230 km before ending up as biogas.

Intangible assets: Product developing, seafood expertise, existing supply chain, free capacity in premises.

- Oil refinery: 75 MW of residual heat is not being used today. The hot water has an outbound temperature of 120-120 C and 60 C on return. A lot of untreated water, and carbon dioxide.
  Shipping, the refinery operates classified harbours. 7,6 million sqm of land.

Searching for new and green input biomasses as they are stopping processing crude oil.

- Aquaculture and food processing company: work with sea squirt (tunicate) biomass all the way from cultivation to product with zero waste. Aims at a capacity to harvest 1400 tons per year within 2 years. Have just started to investigate the possibility to produce another product – fish feed. Getting access to residual heat is interesting.

Strengths and opportunities

In Sweden 72% of the consumed seafood is imported, presenting a national food security challenge but also a sustainability challenge due to transportation and eventual climate harsh farming conditions. The development of sustainable aquaculture in controlled environment based upon local opportunities such as residual heat would target both challenges.

The realization of the circular business park could have a considerable impact for the local society. An important indirect effect of an expanding aquaculture industry and seafood sector is that new jobs are created in both primary production and the wider seafood industry and could also affect the tourism sector.

Each biomass has its own substantial market, naturally within the food sector, both for more or less direct consumption, but also as ingredients in, for example materials and fodder. In Sweden the research and innovation process for utilizing and using whole fish and shellfish is just in its infancy and will surely result in climate smart products.

The discussions showed that there are potentials for various kinds of symbiosis: even though the water outside Lysekil is rather salty compared to the rest of Sweden, extra salt is need when farming Asperagopsis – which could be supplied by a company processing herring.

Asperagopsis could clean the water for the Vannamei farm – and the reverse is also beneficiary: the water during the breeding of Vanname is nutritient rich and would act as fertilizer for the Asperagopsis farm.

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And finally, the residual heat from the oil refinery could be used for both farming and drying biomasses.
(See a 3D model diagram of possible resource flows at the end of this brief.)

Barriers and obstacles

There is potential, but this work is easier said than done. Farming non-native species, outdated regulations, and long permit processes are just a few of the barriers before successful bio-industrial symbiosis will be a reality.

The transition to a circular society requires a transition on several levels. Today not only do we work mainly sector wise, the legal framework and the way our government is structured is also organized in silos. But climate and environmental challenges require a totally different set up – focused on systems rather than silos. In Sweden different authorities need to handle and are responsible for similarly challenging questions. In the worst cases some authorities end up counteracting each other. This in turn gives companies unpredictable development conditions. Furthermore, experience shows that regional authorities sometimes assess cases differently and when it comes to new non-native species this is particularly noticeable. The company farming Vannamei contacted four different regions in Sweden asking for legal advice and got four totally different answers.

One example discussed during the workshop: A land-based RAS (recirculating aquaculture system) salmon farm, who is planning to build a symbiosis system where the plant primarily will produce salmon, but the purification process also includes algae cultivation, from which silicon is extracted. In addition, the salmon and algae farming are linked to a biogas plant. The result from the symbiosis is almost no leftover waste. Despite this, the permit process is now entering its sixth year! The algae farm and the biogas plant are up and running. However, the legal system handling aquaculture in Sweden is just considering how much fodder should being used in the fish farm, and not how much nitrogen and phosphorus which is actually leaving the plant. In short, the road to the permit is long and bumpy.

Additionally, there are questions with regard to a future circular symbiosis with regard to water sharing for the farming of red algae and Vannamei shrimp. The definition of where one business process starts and where the next business process takes over could directly affect the permit process.

One of the companies also introduced waste regulations as a question to be further investigated. When a resource, in a process, has been defined as a waste product – there is a lot of work to have that waste defined as a resource again. This kind of set up is not beneficiary for a circular society.

Next steps

There are several opportunities to be taken care of. Even though there are some considerable obstacles the upside is substantial, both for the environment, climate, and the local society.

The barriers identified are well known and are hardly solvable within the Blue Green biolab project. The next step will therefore be to investigate and analyze what initiatives are already ongoing and to see how we could join forces with them.

In the municipality we will also continue to work

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with the feasibility study for the business park and will continue to work with the organisations participating in the participatory workshop as their input is valuable in the planning process.

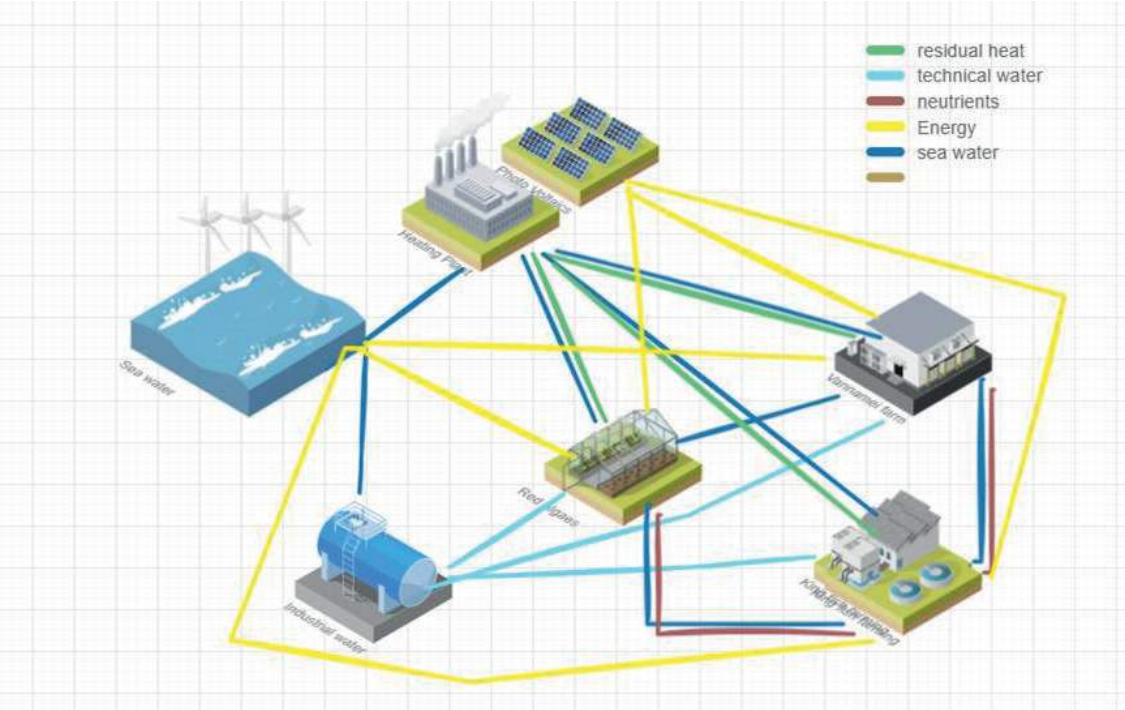
On the basis of the positive feedback from workshop participants, it is also evident that the workshop was valuable for the organisations' internal processes. The organizers and participants left the workshop meeting room with smiles on their faces and looking forward to further collaborations. It was a good day.

Reflections / learning

The workshop, and the process before the workshop, proved to be valuable for the organizers, who have now taken some, even though fairly small, steps towards industrial symbiosis in Lysekil. The businesses have their business models and as the permits are based upon their own products and biomasses it requires guts, trust and courage to take the first steps towards industrial symbiosis as the legal setting is not built on circular models. From a "good society point of view" it is easy to see all the benefits; saving resources, limiting residuals etc., and thus we would all like circular revolution to happen overnight. There is a need for long-term strategies and commitments.
The set up in Lysekil is both introducing a new way of operating and non-native species at the same time. The non-native species will be bred and farmed on land, in closed systems, but how this will be handled in the legal context is very unclear and will be further investigated in the next part of the project.

It will be of utmost importance to be very clear about what the goals are and to communicate them effectively. The focus on the potential for farming non-native species needs to be based on a knowledgeable discussion, not driven by emotions. It is important for everyone to understand that these aquaculture systems are closed and are fully controlled.

The workshop made it clear that the set up in Lysekil will be an interesting journey, and there is a lot to be learned along the way.



Mapping of resource flows based on knowledge developed in the Blue Green Bio Lab workshop in Lysekil, Sweden.

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Project facts

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