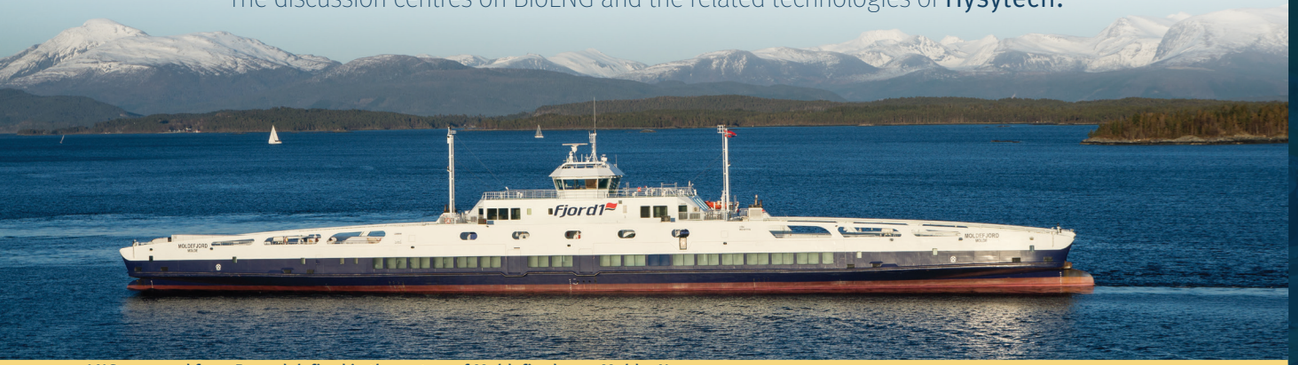
Hysytech's take on BioLNG

Industrial gas consultant **Stephen B. Harrison**, a regular **gas**world contributor, interviews **Andrés Saldivia**, who is responsible for business development at Italian engineering company **Hysytech** and managing partner at sister company **Stirling Cryogenics**. The discussion centres on BioLNG and the related technologies of **Hysytech.**



LNG-powered ferry Romsdalsfjord in the waters of Moldefjord near Molde, Norway

Stephen B. Harrison
Andrés, before we go into the details of BioLNG, what's the essence of your business as Hysytech?

Andrés Saldivia
We are an equipment and engineering company that specialises in industrial gas business technology. Most of all, we deliver systems to recover purify and make the most out of gaseous streams that can be used in industry. For some time now we have been active in biogas to biomethane upgrading, and in bioenergy. And, of course, BioLNG, the cryogenic liquid form of biomethane, by applying the reverse Stirling cycle.

SBH
So you can liquefy the biomethane to BioLNG. And do you also have a solution to liquefy the carbon dioxide which is captured during the biogas to biomethane upgrade?

AS
Yes, we can do that. We have invested in the last years to extend our technology offering from CO_2 (carbon dioxide) recovery to include CO_2 liquefaction. Our technology generates biogenic CO_2 that meets the specifications for technical and food grade applications. In fact, the most interesting use-case is the food and beverage market.

SBH
Let's dive into those processes. For biogas to biomethane and biogenic CO_2 upgrading, what kind of technology do you offer to do the purification and separation of the biogas?

AS
It depends on the source of the biogas. Some sources are easier to process than others. Today, the market is heavily focused on agricultural biomass, which tends to be the purest form of biogas. To a lesser extent, biogas is generated from urban wastewater treatment. This source can be more challenging to process since it may contain higher amounts of impurities like sulphur, VOCs, ammonia, and siloxanes. And then there is landfill gas, which tends to be very difficult to treat. In total, Europe has about 19,000 biogas plants and the number goes up all the time.

SBH
Do all of these biogas plants generate biogenic CO_2?

AS
No. Most of them are still doing combined heat and power generation from the biogas. But there is a significant number that already perform biogas upgrading to capture CO_2. But the majority of those 19,000 biogas plants are fed with agricultural waste and are generally suitable for biogas to biomethane upgrading with biogenic CO_2 capture. So there is still a huge market potential to address.

SBH
Could you describe the biogas treatment technology in more detail?

AS
Depending on the biomass, you may need several different pre-treatment stages to remove sulphur compounds, organic compounds, ammonia, and moisture. There are several alternatives for doing that. So at Hysytech we implement pre-treatment according to the impurities in the source. Following that, we implement one of two core biogas upgrading technologies to separate biomethane from biogenic CO_2.

SBH
Which two core technologies would they be?

AS
One of the two technologies that we offer is based on membranes. We have a standard three-stage membrane technology which can generate biomethane at the purity required for injection to the natural gas pipeline grid.

It offers a very high biomethane recovery with very low methane losses. This minimises the potential for methane emissions to atmosphere and improves the economics. Environmental concerns are one of the most critical factors for the user's carbon-equivalent footprint and business case. Maximising the methane recovery also improves the revenue potential.

SBH
And you mentioned there were two core technologies. What would the second one be?

AS
For biogases with high levels of impurities, we offer what we call a hybrid process. It still involves three stages, but the first stage is a pressurised water scrubber which is followed by two stages of a membranes. You achieve the same grade of biomethane, but you have a more reliable, more robust plant which can tolerate fluctuations in impurities. This set-up would be more suitable for biomass which generates a high level of ammonia or H_2S (hydrogen sulfide) that would be very costly to pre-treat with alternative technologies.

SBH
But for BioLNG, biogas injection to the grid would not be the chosen business model. What equipment would be used for biomethane liquefaction to BioLNG?

AS
That's right. If there is a good business case to produce BioLNG, or there is a lack of local gas pipeline infrastructure to inject into, the solution is to liquefy. This cryogenic technology has existed for many years. In fact, Hysytech has been involved in cryogenic process equipment for more than 70 years with Stirling Cryogenics. The first projects we did with liquid methane were 12 years ago. Prior to that we worked with fossil LNG.

The technology is based on the reverse Stirling cycle. A closed loop of helium gas acts as the refrigerant within the system and the cooling is achieved through a sequence of gas compression and expansion. This is a highly efficient liquefaction process for capacities in the order of one tonne per day per module. Larger scale applications are served with multiple liquefaction modules, currently up to 25 tonnes per day.

SBH
Is that a standard process for methane liquefaction?

AS
Yes, these machines are manufactured in our in our Stirling Cryogenics sister factory in the Netherlands. In fact, the Dutch engineering company Philips adapted the Stirling cycle for cryogenic cooling around 1946 and developed the Stirling Cryogenerator. ▸

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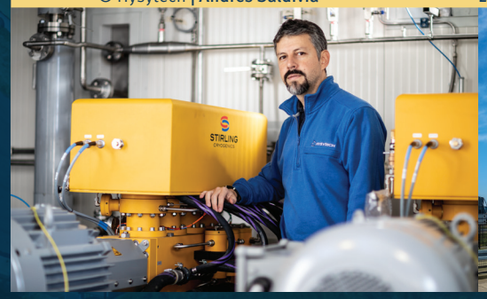
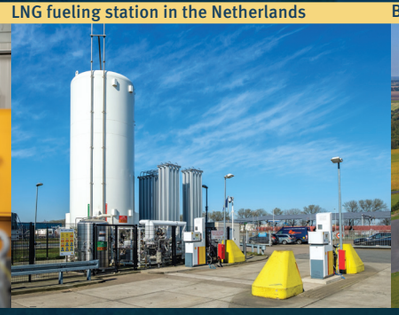


LNG fueling station in the Netherlands



Biogas production

This is the origin of the technology that we use.

The equipment was first implemented for maintaining low pressure in the LNG storage tanks. In these cases, some of the LNG boils off. This is the vapour phase that evaporates due to a small amount of heat leaking into the storage tank due to the large temperature difference between ambient conditions and the cryogenic LNG.

To prevent the vaporised LNG being vented and to preserve the pressure of the tank, our equipment is used to re-liquefy the vapour into the tank. For this use-case, you need a technology which operates well at relatively small-scale. This scale is actually ideal for biogas liquefaction to BioLNG.

Liquefaction of biomethane using our equipment can be achieved at as low as 0.60 kWh/kg LNG and the equipment is extremely reliable, with more than 8,500 hours of operation per year.

SBH
Coming back to biogenic CO_2. Is the same liquefaction process used for CO_2?

AS
No, that's a different technology. The reason we use different equipment is that for BioLNG we need to get to –160°C, whereas with the CO_2 we get into the neighbourhood of –30°C to -35°C. So we use different refrigeration techniques for BioLNG and biogenic liquid CO_2.

SBH
Can you tell us more about the liquefaction process used for CO_2?

AS
In contrast to the reverse Stirling cycle, we use a different thermodynamic cycle and a different refrigerant gas to liquefy the CO_2. In this equipment, selection of the refrigerant gas is critical. Traditionally, F-gases have been used to achieve the temperatures required for CO_2 liquefaction. However, there are worldwide directives to transition to refrigerant gases with lower global warming potential (GWP).

The transition to lower GWP refrigerants has led to some changes in the process and equipment that we use. Currently, what we are offering is technology based on HFO refrigerant gases, which have a very low GWP and are non-toxic. This simplifies the safety regime around the liquefier.

SBH
Does the selection of the CO_2 liquefier refrigerant influence the overall CO_2 equivalent intensity of the biogas or BioLNG?

AS
Yes. The combined production of biogenic CO_2 and biomethane replaces fossil origin CO_2 and fossil origin methane from natural gas. Depending how the end-user can certify their process, they may be able to certify a biomethane that is in the neighbourhood of 20 to around 30 grammes of CO_2 per MJ of biomethane energy.

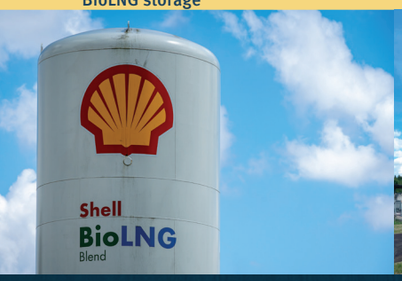
SBH
So, with a negative CO_2 footprint in your process, you're allowing somebody else, somewhere else, to continue burning diesel on their truck – and we end up with Net Zero CO_2 emissions...

AS
Correct. And for farms in remote locations BioLNG is produced on-site and can be used to fill trucks which bring seed, feeds and fertilisers to the farm and transport livestock, milk or crops from the farm. Additionally, farm vehicles can run on BioLNG to reduce the CO_2 intensity of the harvest and food production.

SBH
In that round, that means you are shortening supply chains and increasing local energy security, in addition to monetising biogas and protecting the environment.

AS
Yes, that's right. That's exactly the multi-faceted vision we have for these technologies. gw

BioLNG storage



© Hysytech | BioLNG plant

LNG-powered truck