Interreg Atlantic Area
European Regional Development Fund
SEAFUEL

HYDROGEN ENERGY

CASE STUDY

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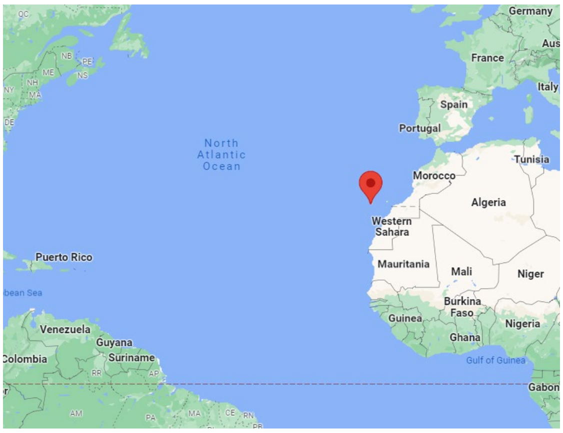
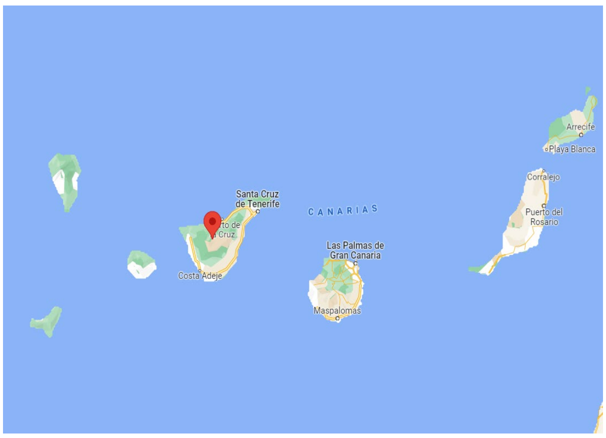
Tenerife – The SEAFUEL Experience

Background

Tenerife is a Spanish island of 2034km2, with a population of just under 900,000 people, located in the east Atlantic Ocean, approximately 200 miles off the west coast of Africa and 1300 km from mainland Spain. As a remote island it is, therefore, highly reliant on the ability to import many products, including energy via submerged interconnectors. This means that the island is extremely vulnerable should any issues with the interconnectors.





However, as an island and due to its latitudinal location, Tenerife is also rife for the use of renewable energy, particularly in terms of solar and wind energy. The Atlantic Area is made up of many islands that are reliant on the import of fuel primarily in the form of oil or gas. This means they are highly vulnerable to events outside their control as we are exaggeratedly seeing at the minute. The region is located in a closed environment with a goal of becoming self-sufficient in the generation of energy, which currently depend on oil imports with high costs, i.e. Canary Islands pay 42k million euro/year.

As reported by CMS (https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/spain), “Hydrogen has been recognised in the country’s National Energy and Climate Plan (“NECP”) as having a key role in the Spanish energy transition. Due to the country’s significant renewable energy resources, most notably solar and wind, and its ambitious plans to decarbonise the power, transport and industry sectors over the next 10-20 years, the contribution of hydrogen to these sectors is likely to increase.” At present, Spain consumes approximately 500,000 tons of hydrogen a year, almost exclusively for industrial uses (70% in refineries and 25% in chemical industries) – all of which is from fossil fuels. This provides a massive opportunity for conversion to green hydrogen to help with decarbonization targets.

The Unique Selling Point

The primary challenge of the project relates to the use of seawater for the electrolysis. The water treatment system within the SEAFUEL refueling station takes the processed seawater and makes it suitable for use in the electrolyser. Pure water is essential for the electrolyser to function properly. The purity of the water affects the lifespan of the electrolyser and the purity of the hydrogen that the electrolyser produces. The purer the hydrogen, the better the quality of drive and energy provided to the vehicles in which it is used. The pureness also helps to ensure the vehicle engines last longer.

The Challenges

The SEAFUEL project has faced a series of challenges across the project lifetime, many of which were outside the immediate control of the project partners.

The first major challenge that brought issues was Brexit. With the UK leaving the EU and the implementation of the Withdrawal Agreement, things that had previously been simple became much more difficult and bureaucratic. One area this was seen was in the process of transporting parts and equipment from the UK (Scotland) to Spain (Tenerife). An issue noted was that when a van that was required for installation travelled across the new EU border an inventory of every single piece of equipment down to individual screws was required, adding a massive amount of time and effort to the movement of vehicles. Solutions to cover this that were investigated included establishing whether it would be cheaper and simpler to procure a van for use in Spain and only require the movement of people.

Another aspect of the movement of goods was encountered when it came to moving vehicles and the refueling station itself across borders with enormous levels of planning and paperwork required.

This particular aspect was further impacted by the arrival of the Coronavirus Pandemic of 2019-2021. The pandemic saw multiple and long-lasting lockdowns for citizens and shut-downs of businesses and industry. This meant that during the assembly stage of the refueling station many further unexpected delays were encountered. For example, one particular component of the station was being manufactured in France, but the manufacturer closed down indefinitely leading to a delay in Logan energy being able to obtain the part.

This, allied with the changes to the withdrawal agreement, led to much longer delays than could have been predicted. The knock-on effect of this was that the refueling station took longer to complete, and therefore longer into the project to export to Tenerife, and it was much later in the project than planned before it was in place. Fortunately, due to these issues project extensions were available and these were agreed with the program funding body.

Another area that has caused some concern has been around the malfunctioning of parts within the refueling station and the liability for replacement of those parts. This provides a good lesson in ensuring that any agreements and understandings in this area are properly agreed before work commences and is an area that should be identified when developing a project.

The Vision

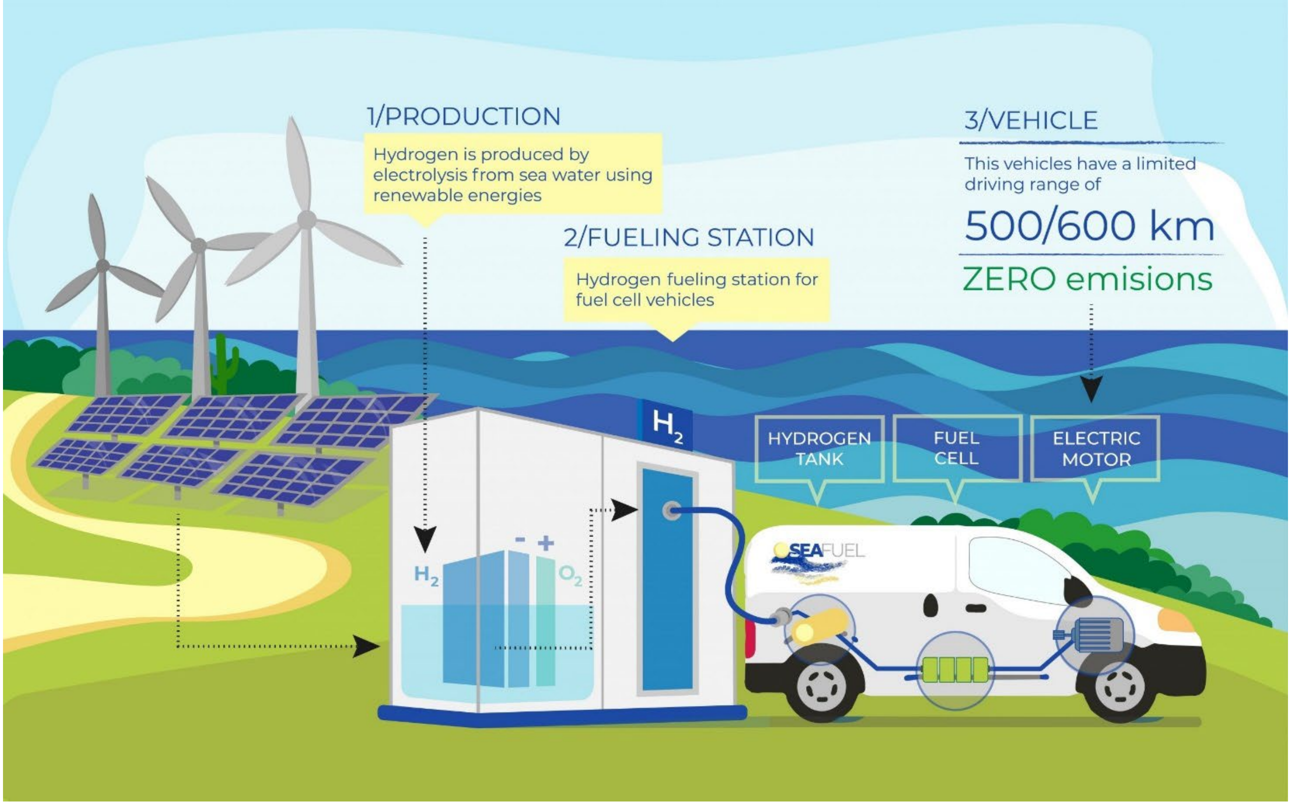
The SEAFUEL Project is a 3 year Project (now extended due to the pandemic and other factors) INTERREG Atlantic Area Project in the Resource Efficiency category and is worth €3.4m over its lifetime. The Project kicked off in January 2018 and is now due to conclude at the end of August 2022. The consortium is made up of 9 full partners and a range of associated partners.

The lead partner is NUI Galway. University of Liverpool have been leading on the scientific side of the project particularly in terms of the electrolysis of salt water. ITER - Instituto Tecnológico y de Energías Renovables – And AIET - Agencia Insular de Energía de Tenerife based in Tenerfie and founded to focus on the development and promotion of R&D&i technologies within the fields of Renewables, Environment and ICT.

The Aran Islands Energy Co-op – based on the Aran Islands with great experience in electric vehicles and retrofitting of houses with renewables. AREAM – Agencia Regional de Energia – a not for profit organization on Madeira responsible for promoting sustainable development and innovation in energy and environment. Hyenergy – a private company led by Ian Williamson providing technical and commercial support services to the hydrogen and energy sectors.

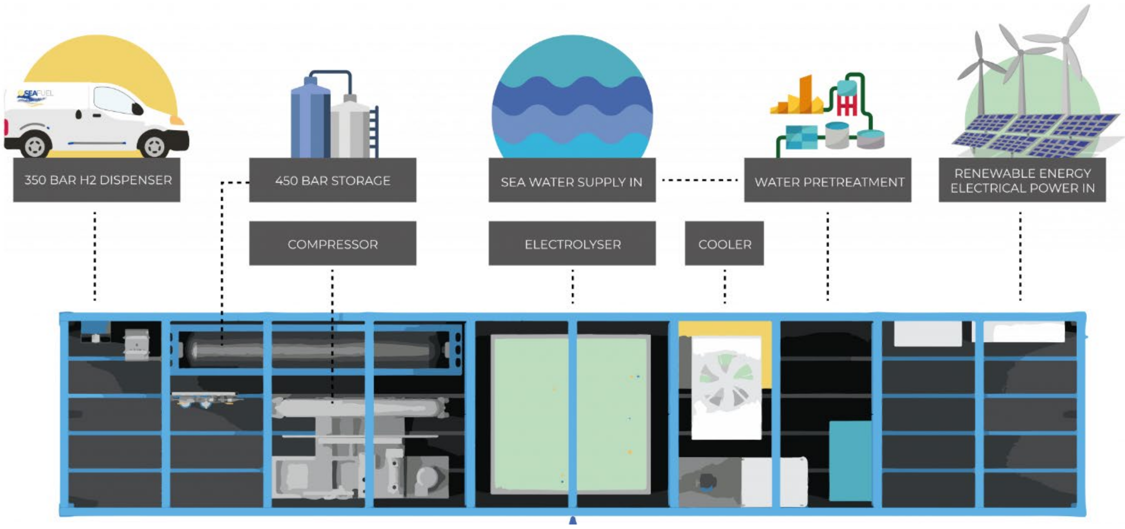
Finally, Logan Energy – A Scottish company with expertise in the design, integration, procurement, installation, operation and maintenance of hydrogen technology base systems incorporating fuel cells, electrolysers, compressors, storage and H2 refueling stations who have been the key developer and producer of the refuelling station and convertor of vehicles to utilize the hydrogen.

The reason for the partners joining this project was that similar challenges to Tenerife are seen in the likes of smaller islands such as Madeira but also larger islands like Ireland and Great Britain. All these islands are also home to abundant levels of renewable energy potential and water, including seawater.



The Installation

The electrolyser and fuelling station are now installed on the island of Tenerife, on the premises of Instituto Tecnológico y de Energías Renovables (ITER) and are able to provide fuel for a range of vehicles that are also on the island. These vehicles are made up of a mix of retro-fitted electric vans and some new hydrogen fuel cell powered cars provided by Toyota. These vehicles are replacing a range of standard petrol or diesel vehicles and information is currently being collated to establish how much CO2 these replacement vehicles will save over the next 10 years. A diagram of the installation can be seen below:



This diagram needs to be read from right to left, but we can follow through each section. One of the key aspects of the SEAFUEL project is that it has been looking at the ability to use sea water for electrolysis. The installation here includes a sea water treatment plant that treats and desalinates the water. As previously mentioned, the water treatment system takes the process seawater and makes it suitable for use in the electrolyser.

The excess renewable energy from a combination of on-site wind turbines and solar PV is fed into the electrolyser. The electrolyser basically takes water and electricity and produces hydrogen and oxygen. The electrolyser in the Seafuel hydrogen production and refuelling station is a PEM electrolyser. Polymer electrolyte membrane (PEM) electrolysis is the separation of water into hydrogen and oxygen in a cell composed of a solid polymer electrolyte. The polymer electrolyte is responsible for the conduction of protons and the separation of the two component gases.

The hydrogen is collected in a buffer tank ready for compression and storage, and the oxygen is vented to atmosphere. Waste heat is also produced, which reduces the overall efficiency of the system. This passes through a cooler and the treated water which is then separated into hydrogen with the oxygen vented off. (This could later be captured for use if required).

Once the water is split into the two components, the hydrogen then passes through a compressor and is compressed to 450bar for storage within the filling station. The hydrogen storage tanks in the Seafuel hydrogen production and refueling station are capable of storing up to around 30kg of hydrogen. They store the hydrogen that has been produced by the electrolyser and then compressed by the hydrogen booster. These hydrogen storage tanks are Type IV, which are pressure vessels made of polymeric liner fully wrapped with a fibre-resin composite.

There is then a 350bar hydrogen dispenser that is used to fill the vehicles. This unit incorporates a nozzle, filling hose, and display and control buttons. The hydrogen fuel dispenser is similar to a diesel or petrol pump. It locks into place on the car and takes about three to five minutes to fill the tank with hydrogen.

The vehicles in use at the minute are currently located on the site of the refueling station and are primarily used within the bounds of the ITER complex but will be able to travel further afield. This will allow for a massive saving in CO2 emissions over the next number of years.

Conclusions

Tenerife as an island region provides a fantastic opportunity to see how a closed system can benefit from the implementation of a H2 system. The opportunity to investigate the ability to purify seawater and use it in a refueler is also massively important and interesting due to the potential provided from this method. The project has seen many challenges as well from those caused by several outside influences – Brexit, a global pandemic, problems with parts of the refueler and these are the key areas of learning that can be taken for anyone looking to develop a project. No matter how well planned the project is, it is important to be agile and ready to adapt to unexpected challenges.