



First application of hydrogen technologies
in port handling equipment in Europe

Newsletter

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FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING



H2Ports role on the deployment of hydrogen at ports

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H2Ports is currently on its second year of a total of four years of project duration. While the first year focused on design and development of concepts and the actual testing will occur during the third and

fourth year, the second year is crucial as it acts as the bridge between ideas and reality. As a result, in this period the consortium is identifying and discussing about every practical aspect that may become important for a successful test of hydrogen technologies in port environments.

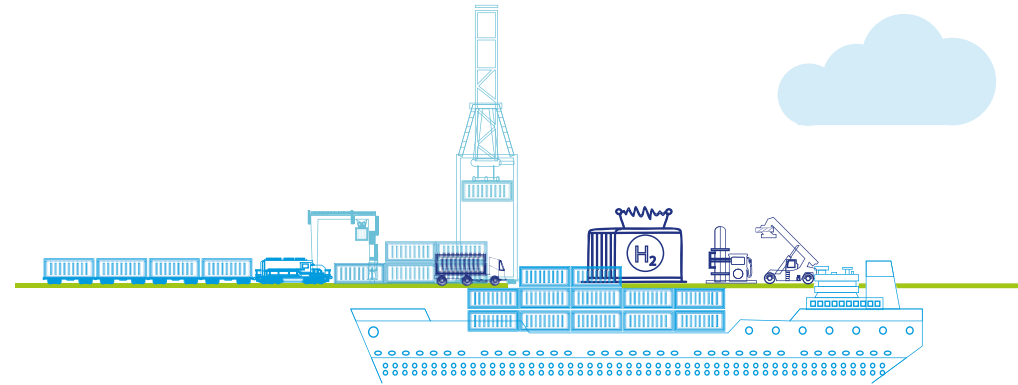
H2Ports will be the first project on the use of FC and hydrogen in a European Port, and the experience abroad (e.g. Port of Los Angeles) is currently under development, so that means that there is no existing map yet. Actually, one of the most important outputs to be obtained from the project is to act as a guide for the future use of hydrogen technologies in the port maritime sector, identifying both potential benefits and challenges to be overcome.

From the beginning of the project, all of us (i.e. H2Ports consortium) have showed a very strong

commitment on the resolution of all the issues that have been (and are and will be) showing up, and this aspect will be a key factor for the success of the project. During this time, we all have already identified the potential of the technology as an essential player on the future zero emission ports, which is really promising. We have also identified some difficulties that will have to be overcome for this to happen, some of them technical (the development of the hydrogen powered versions of port machinery requires a lot of engineering providing innovative solutions) but also commercial (there is not a hydrogen supply chain developed comparable to that of hydrocarbons) and human (FC and hydrogen technologies are highly unknown to most of the people involved in some way in the success of the project, such as port workers, health and safety departments, authorities, etc.).

The project has also received a lot of interest from many sectors and the best way to thank all the received interest is through the dissemination and diffusion of results of the project through different channels. H2Ports has a strong presence in media, both specialised and general, it is also frequent the participation of project partners in

conferences or workshops and the project has a very active presence in social networks. As a part of this communication strategy, several newsletters such as this one will complement other additional tools already developed such as the webpage (<https://h2ports.eu/>), the LinkedIn group or the Twitter account (the later easily accessible from the webpage). Additionally to those 'formal' channels, all the involved partners will be pleased to share or comment any aspect related to H2Ports. These conversations and feedback will for sure contribute to identify the best solutions of the any challenges to be faced, so we take this opportunity to invite everyone to get more involved in the success of the project. We will keep in touch!



Hydrogen as a driver for the decarbonisation of shipping

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We are living in times where the expressions decarbonization and energetic transition are more and more present in our vocabulary. This is the result of the growing global awareness of the need to reduce CO₂ emissions into the atmosphere from human activities, including maritime transport.

Hydrogen is an alternative towards the path of decarbonization that could have greater acceptance at a global level. Hydrogen can be used as an energy source through a fuel cell. A fuel cell is an electrochemical device where through chemical reactions, hydrogen as a fuel, generates electricity. The waste that is generated is water, so if the hydrogen is generated in a clean way from renewable energy sources such as solar energy, wind or biomass, the process of generating that energy does not produce waste. In other words, a very attractive alternative for generating electricity for a zero-emission future.

Hydrogen fuel cells have proven their performance in a variety of applications, including buses, trucks, cars, forklifts and even passenger trains. Therefore, its application to yard machinery would be out of question. However, the use of hydrogen-powered fuel cells for ship propulsion, by contrast, is still at an early design or trial phase

– with applications in smaller passenger ships, ferries or recreational craft.

The use of hydrogen fuel cells, in particular, shows great promise in decreasing ship-generated carbon emissions. Fuel cells convert chemical fuel into direct-current electrical energy, usually by combining hydrogen and oxygen and emitting water vapor and heat.

For marine vessels, fuel cells are the only viable true zero-emission option. Just like batteries, fuel cells produce electricity with high efficiency through an electro-chemical process. The difference is, with a fuel cell, energy is stored separately in the form of hydrogen fuel. As long as fuel is available, the fuel cell power systems will produce electricity as a generator, emitting only water vapour and heat.

Making the transition to a new energy source is a major undertaking. In the case of fuel cells for marine vessels, the hurdles are in the refuelling infrastructure, and hydrogen availability in ports. Before operators can power their vessels using fuel cells, hydrogen supply and fuelling infrastructure needs to be further developed.

In the nearer timeframe, hybrid battery/fuel cell applications are viable for certain type of vessels, such as Ferries, Cruise and river vessels.



The applications would be powering small vessels, such as ferries and river vessels, powering auxiliary loads on larger vessels, such as cruise ships, where the auxiliary power demands are high or providing shore power to docked vessels.

A battery is not practical for many maritime applications as a result of its relatively high weight and limited range. A powerful source of energy is needed based on an efficient fuel. Many experts see hydrogen as such a fuel. But storage tanks full of highly flammable hydrogen puts people off. There are technical solutions that make safe storage possible – similar to the ones found for the use of natural gas on water – but the certification process is long and burdensome. That's why scientists are looking for alternatives in which not hydrogen itself but a harmless raw material is stored and chemically converted into hydrogen when the fuel cell requires it. This kind of storage could bring about a hydrogen revolution.

In an effort to reduce air pollution and carbon emissions, governments, port authorities and organizations across the world are tightening emissions standards for marine vessels. However further research, funding from the authorities and appropriate regulation is requested to meet the zero-emission target.



Hyster develops a fuel cell reach stacker for the port of Valencia

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Container handling is a vital part of logistics operations at ports around the world. Hyster has supported ports and terminals with materials handling equipment built to lift containers that are up to 45-ft wide. In the past this equipment has been powered by large diesel engines, but as port and terminal operations are charged with becoming more environmentally friendly, Hyster has been working on the development of container handling trucks that use electricity instead of diesel power and therefore produce zero emissions.

Creating electric versions of Hyster® container handling trucks is not without its challenges. With electric cars, the car battery is big enough to provide around 300-500km of driving range, which is acceptable for most drivers. However, when it comes to providing enough power to keep a large container handler such as Hyster's ReachStacker working throughout a shift, this is more difficult – a battery pack for the ReachStacker would need to be almost as big as the truck to work for an entire shift!

In addition to the size of the batteries needed, there are considerations around the charging of batteries. Dedicated charging takes time and takes the ReachStacker out of operation. Although opportunity charging throughout the working day is a possible solution, it requires detailed planning and can reduce productivity. Also, the amount of charging power needed can be more than the power grid can provide. Charging a number of Hyster® ReachStackers takes the equivalent of the power necessary to run a small village.

For these reasons, Hyster Europe has been working on the development of several alternative power solutions that will make zero emissions container handlers a reality. In 2019, the company began the development of a zero-emissions electric Hyster® ReachStacker featuring a hydrogen fuel cell.

The hydrogen fuel cell converts hydrogen (H₂) to electricity and acts as a range extender for the ReachStacker. It has been designed so that enough hydrogen is stored on board to provide an acceptable range or number of operating hours for port operations. In addition refilling of the H₂

tanks can be done in as little as 10-15 minutes

Hydrogen is a clean energy carrier with the benefits of easy storage and when used produces no emissions other than heat and water.

The first Hyster® Reachstacker with a hydrogen fuel cell was developed for the Port of Valencia as part of the European Horizon 2020 programme and H2Ports project, funded by FCH-JU (Fuel Cells and Hydrogen Joint Undertaking) and supported by the Valenciaport Foundation. This makes it the first port in Europe to incorporate hydrogen energy in its operations.

The port project has provided the means to develop and test the container handler in real-life operations at the MSC Terminal Valencia (MSCTV), providing valuable information about how the technology can be used to help evolve the ports and terminals industry into a low carbon and zero-emission sector.



Meeting hydrogen as a fuel

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Hydrogen is an energy carrier not an energy source, which means that its potential role has similarities with that of electricity. Both hydrogen and electricity can be produced from various energy sources and technologies. Both are versatile and can be used in many different applications. However, when the hydrogen is produced using renewables energies, no greenhouse gases, particulates, sulphur oxides or ground level ozone are produced from their use. If the hydrogen is used in a fuel cell, it emits only water.

Hydrogen contains more energy per unit of mass than natural gas or gasoline, making it attractive as a transport fuel. However, hydrogen is the lightest element and, as a consequence, has a low energy density per unit of volume. This means that larger volumes of hydrogen must be moved to meet identical energy demands as compared with other fuels. This can be achieved, for example, through the use of larger or faster-flowing pipelines and larger storage tanks or using high pressure storages. Hydrogen can be compressed, liquefied, or transformed into hydrogen-based fuels that have a higher energy like ammonia, methanol, etc., but the conversion and the subsequent re-conversion uses some energy.

Hydrogen is a non-toxic gas, shows a high flame velocity, has broad ignition range and low ignition energy all of which makes it highly flammable. This is partly mitigated by its high buoyancy and diffusivity, which causes it to dissipate quickly. Hydrogen has a flame invisible to the naked eye and it is colourless and odourless, making it harder for people to detect fires and leaks. There are already many decades of experience of using hydrogen industrially, including in large dedicated distribution pipelines. Protocols for safe handling at these sites are already in place, and they also exist for hydrogen refuelling infrastructure in site-specific forms.

Hydrogen is no more dangerous than other flammable fuels, including gasoline and natural gas. In fact, some of hydrogen's properties actually provide safety benefits compared to gasoline or other fuels. However, all flammable fuels must be handled responsibly. Like gasoline and natural gas, hydrogen is flammable and can behave dangerously under specific conditions. Hydrogen can be handled safely when simple guidelines are observed and the user has an understanding of its behavior.

One interesting example about the hydrogen use safety is that hydrogen fuel cell powered Hyundai Nexu has just undergone its first crash test, and subsequently, one of the U.S. Insurance Institute

for Highway Safety's (IIHS) first crash tests of a hydrogen fuel-cell vehicle. Not only did the vehicle pass, but it also earned a Top Safety Pick+ award, plus a load of "Good" and "Acceptable" ratings for its other safety systems.

Usually, people's main concern is the high pressure of the storage vessels. Typical tests for high pressure components such as tanks are burst test, bonfire test, chemical exposure test, ambient temperature, and extreme temperature pressure cycle tests, accelerated stress rupture test, impact damage test, leakage test, hydrogen gas cycling test. All the previous tests are necessary be done in order to have the product certification and sell the hydrogen compressed vessel.

In summary, the hydrogen is ready to be used as an alternative fuel and it is not more dangerous than another fuels. It is needed know properly their characteristics and design adequately.



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