H2 PORTS

First application of hydrogen technologies in port handling equipment in Europe

3 Newsletter

May 2022

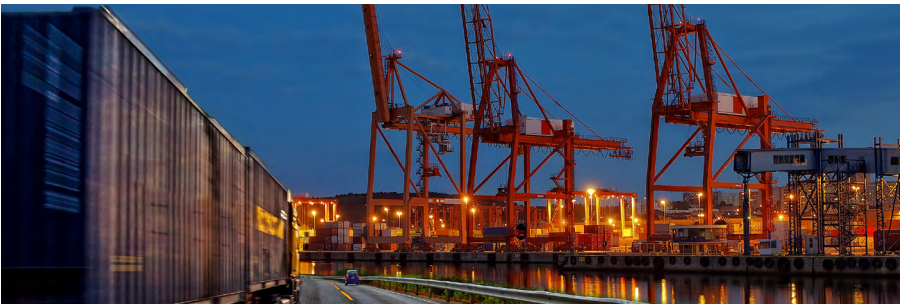
Clean Hydrogen Partnership

Co-funded by the European Union

The necessity of speeding up the Energy Transition in Europe is being motivated by factors such as the current geopolitical situation or the increasingly evident impacts caused by global warming. Hydrogen will play a major role in this energy transition due to its versatility. The massive deployment of green hydrogen production will be used in many applications such as the decarbonisation of heavy industry, as a substitute of natural gas, to facilitate the integration of renewable electricity production, as feedstock for the chemical industry, as a fuel for zero emission vehicle, and many others. Ports are an ideal scenario from which to start this hydrogen economy, as they are logistic and industrial nodes that agglutinate many of the potential uses of hydrogen. So it seems that the future of ports and hydrogen are interlinked.

This Newsletter explores the connection of both worlds from the point of view of three partners of H2Ports consortium: Ballard, ATENA and the recently incorporated Carburos Metálicos. In addition, H2SHIPS project will also be presented as an initiative for testing the use of hydrogen in water transport.

INDEX



Zero-emission fuel cell solutions for port applications

Kristina Fløche Juelsgaard Director of Market Development
& **Maria Luisa Angrisani** Project Manager _ **Ballard Power Systems Europe A/S**

Shipping ports are a critical part of our global logistics system and world economy. They provide an intermodal transportation system, create jobs, and, importantly, sustain a global supply chain by enabling us to transport goods across the globe. But ports are also a significant source of greenhouse gas (GHG) emissions, air pollution and noise, compounded by the variety of port vehicles and machinery – many of them powered by diesel engines.

With the increasing pressure to decarbonize and stringent environmental regulations coming to the marine industry, ports and operators need to make the change to zero-emission technologies while still maintaining efficient and reliable operations.

Hydrogen power for zero-emission port operations

Hydrogen and fuel cell technology are the most promising, reliable, and scalable power solution that can meet zero-emission requirements, decarbonize the industry, and satisfy the key needs of port operators.

Hydrogen fuel cell powered vehicles can meet the tight schedules, demanding payload and 24-7 operational time, which is often required at ports by offering efficient operation, short refueling time, long range, and low maintenance costs. Fuel cells also eliminate local emissions such as CO_2, NO_x, and noise entirely, offering significant improvement to the air quality for local residents.

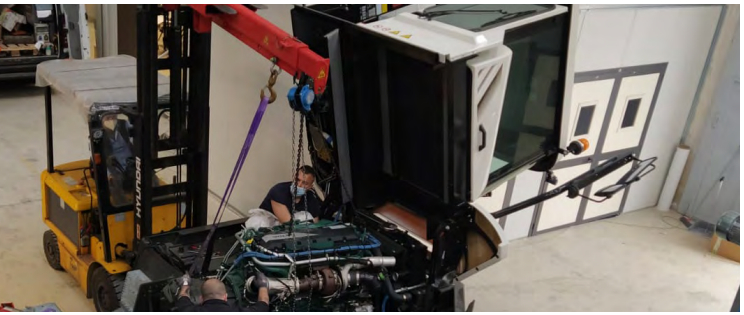
Like batteries, fuel cells produce electricity. With fuel cells, hydrogen fuel is the energy carrier. The fuel cell power system will produce electricity for the port's equipment/vehicle, as long as hydrogen is available. Furthermore, if a port vehicle is refueled with green hydrogen produced from renewable energy sources, it is a 100% zero-emission solution.

Designed specifically for the requirements of the maritime industry, Ballard's FCwave™ is the first fuel cell module to receive DNV Type Approval for maritime applications, certifying that it meets all the requirements for global commercialization for ports and ships. This is a long-awaited breakthrough, which also demonstrates the industry's confidence in zero-emission fuel cell solutions.

Today, hydrogen fuel cells are successfully powering thousands of commercial vehicles around the world, and now the first fuel cells are also beginning to prove their value at sea and at ports. Within the framework of the H2 Ports project, Ballard has retrofitted a yard tractor with a fuel cell, demonstrating the benefits of hydrogen powered equipment in real life operational port environment.

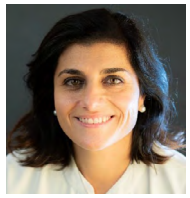
Future proofing with fuel cells

Fuel cells are a future proof option for many motor-powered requirements that require long operational run time. However, port operations are also a very complex ecosystem that require multiple types of port equipment. At this point, a standardized "off-the-shelf" fuel cell solution for every type of port application is not readily available. Internationally, various pilot projects are taking place to investigate options to standardize the technology for more widespread adoption. The H2port project is providing such a platform to test a fuel cell yard tractor – one of the most frequently used applications - and will provide valuable data and information about how fuel cell technology can help decarbonize the port and marine sector.



The first European Hydrogen Yard Tractor for the port of Valencia developed by ATENA

Elio Jannelli Full Professor University of Naples Parthenope and CEO **ATENA Scarl**
& **Viviana Cigolotti** Project Manager in Department of Energy Technologies and Renewable Sources, ENEA and European Project Manager, **ATENA Scarl**



The first hydrogen-powered cargo-handling vehicle will soon operate in a European port. Developed by the H2PORTS partners, leaded by ATENA Scarl with the support of ENEA, Cantieri del Mediterraneo spa and University of Naples "Parthenope". The 4x4 heavy-duty hydrogen truck will be tested for the first time in port of Valencia, Spain by Grimaldi Group in the ro-ro terminal managed by Valencia Terminal Europa. This new clean vehicle will not produce any polluting emissions, thanks to its hydrogen propulsion system, that only releases water and heat, during operation.

"The yard tractor we are developing has a fuel cell/battery hybrid powertrain which allows the vehicle to perform all the intensive tasks that it is demanded to during typical roll-on/roll-off operations. This hybrid powertrain owns high operational efficiency, allows for low maintenance costs and, of course, is a zero-emission powertrain. The storage system of the vehicle, having an overall capacity of around 12 kg of hydrogen, guarantees a continuous operation of at least six hours before refuelling and fast refuelling times."

The beneficial effects on the environment brought by this innovation, in terms of avoided emissions, is significant: a fleet of six vehicles, serving a single average terminal port, produces around 500 tons per year of CO_2 and 5 tons per year of NO_x.

"These estimations are related only to the direct use of the yard tractor, but they do not consider the indirect effect due to the operation of the ship auxiliary systems, such as the ventilation system, that typically is required to operate intensively to remove the pollutants produced by the vehicle engines inside the ship. These indirect emissions also significantly contribute to the overall in-port emissions, and they could be avoided thanks to the adoption of our hydrogen yard tractor, since there would be no pollutants produced by the vehicles inside the ship to remove."

Today, 1 billion tons per year of CO_2 emissions (that is the 2.5% of global GHG emissions and the 13% of the overall GHG emissions from the transport sector in EU) are related to shipping in the maritime transport sector, 20 million tons of which are accounted for ships port stays and in-port operations. Even in the most optimistic scenario, these emissions are much likely to undertake a dramatic increase: at least by 50% by 2050, if no ground-breaking actions are taken.

"A green-oriented redesign of such vehicles represents a necessary step towards the decarbonization and the mitigation of energy use in port areas. Among all the possible clean technologies available, the hydrogen fuel cell is probably the most promising, thanks to its scalability, flexibility and high efficiency, which confer a high potential, especially when coupled to storage energy devices like Li-ion batteries".

In the next years, ATENA scarl will continue in developing and validating hydrogen heavy duty vehicles for port operations, which produce zero local emissions and without affecting the performance and safety of these applications. ATENA Scarl, high technology district in the field of energy and environment, joints companies, universities and research institutions in the field of sustainable development. ATENA supports the scientific and technological excellence to attract investment in high tech manufacturing sectors, contributing to the strengthening of technical and scientific skills of the consortium partners as well as to the enhancement of the regional, national and international research system.

Through several projects, ATENA Scarl will continue to operate in research, development and technology transfer of hydrogen technologies and systems applied to logistic applications in port ecosystems.

Carburos Metálicos' Hydrogen Present in the Port Sector

Miquel Lope General Director of **Carburos Metálicos**

Renewable hydrogen is an energy vector capable of providing carbon-free power to a wide variety of industrial processes and transport systems in multiple sectors, including maritime. One of the main challenges facing this activity, like most others, is to make its growth compatible with sustainability.

Carburos Metálicos, a leading company in the industrial gases sector in Spain, is driving the transition to a carbon-free economy through hydrogen. The company is part of the Air Products Group, the world's largest producer of hydrogen, a molecule that was used to take man to the moon; in fact, NASA rockets have been using hydrogen supplied by Air Products since the beginning of the space age.

This experience is useful to also address the decarbonisation of mobility in port ecosystems, often located next to large cities where reducing environmental pollution is an increasingly pressing need. This challenge will be even greater in the future as maritime trade will almost triple by 2050 compared to 2015, according to the World Bank forecasts.

Port ecosystems

The maritime and port sectors have begun their own energy transition process and hydrogen is one of the alternative fuels that the European Union has committed to using. Thus, the H2Ports project (Implementation of fuel cells and hydrogen technologies in ports) was conceived with the objective to demonstrate and validate hydrogen technologies on port machinery achieving a comparable performance and operational safety to that of traditional fuels, but in this case without emitting carbon dioxide (CO_2) or other greenhouse gases into the atmosphere. This effort is aligned with the European Union's long-term energy transition objectives by 2050.

Carburos Metálicos contributes its unmatched, long-established expertise, technology and reliability in the production and supply of renewable hydrogen to this pioneering project within the European Union. In particular, it will be responsible for the refuelling and associated logistics service of two vehicles that will be used in the handling of the Port of Valencia: a reach stacker for the transport of containers within the MSC Terminal and a 4x4 ro-ro terminal tractor designed for the same purpose that will work in the holds of the ships at the Europa Terminal.

However, the possibilities of this technology allow its use in many other vehicles within the port ecosystems, from trucks transporting goods to forklifts.

This versatility extends to the supply of hydrogen, which the company provides both by pipeline and by means of hydrogen refuelling stations. It is, therefore, a suitable element for fixed and mobile machinery and all types of vehicles, including tugboats, ro-ro ships and other vessels that carry out port operations. It can also supply hydrogen to any type of shipping transport that requires it for its propulsion.

Experts in all the Hydrogen value chain

The promotion of hydrogen for mobility is one of the strategic lines of Carburos Metálicos, which is using its experience in the entire hydrogen value chain: from production through distribution to dispensing to offer end-to-end solutions. In this regard, since 2021 the company has been promoting the Hydrogen Route throughout Spain, a series of refuelling and supply demonstrations with urban hydrogen fuel-cell buses that have shown that 'zero emissions' mobility is already a reality.

This initiative contributes to other milestones in this field. One example is the participation in the first permanent bus line in Spain powered by renewable hydrogen. The service, which began this year in January in Torrejón de Ardoz (Madrid), also uses technology developed by Carburos Metálicos. In 2023, the company will also inaugurate the first hydrogen refuelling station open to the public in Tarragona, in the heart of the Mediterranean corridor and close to the city's important port area.

Creating system-based solutions for H2-fuelled water transport in North-West Europe Interreg NWE project H2SHIPS

Christian-Frédéric Berthon Project Coordinator **EIFER** (European Institute for Energy Research)

Shipping in North-West Europe, with its many small, medium-sized, and big ports and dense population, is responsible for a considerable part of CO_2 and other greenhouse gas emissions. Still, shipping is more energy efficient and friendly to the environment than some other modes of transport. This is why cleaning up the shipping sector in this region – but also worldwide – is one of the most important tasks to meet international climate goals.

Hydrogen solutions for short sea and inland sea shipping have already been successfully demonstrated at small scale. Now, systems, infrastructure, and ecosystems for H2 water transport have to be researched and developed. This is the overarching goal of the Interreg NWE project H2SHIPS. With 12 partners from 5 countries and 3 ports among them, H2SHIPS demonstrates the technical and economic feasibility of hydrogen bunkering and propulsion for shipping. The project identifies the conditions for successful market entry for the technology and is building a platform for knowledge transfer, past and current research, and demonstration projects surrounding hydrogen shipping.

In 2022, the project activities mainly revolve around the implementation of the 2 pilot projects, the action plan for a pilot in Paris and the H2SHIPS platform.

A new representative hydrogen vessel for the Port of Amsterdam

The hydrogen vessel HS Neo Orbis, which will set sail in early summer 2023, and navigate the port of Amsterdam, the City of Amsterdam, and the North Sea Canal, will be the first application in shipping of an innovative solid form of hydrogen storage: Sodium borohydride (NaBH4). The storage system was developed and tested by H2SHIPS partner TU Delft in cooperation with the University of Amsterdam and allows for fast bunkering and very safe and easy storage of hydrogen. Once on board, the powder is combined with water to release gaseous hydrogen. A fuel cell and electric motor then propel the vessel and supply energy for on board appliances.

HS Neo Orbis © Port of Amsterdam

A demonstration project for H2 infrastructure maintenance vessels

The pilot in the Port of Ostend concentrates on the overall improvement of the hydrogen port infrastructure. In close cooperation with the Interreg 2 Seas project ISHY, a refuelling station will be built to allow the bunkering of vessels required for the maintenance of offshore wind farms. Once the design studies are finalised in June 2022, the refuelling station will be built in February 2023.

Action plan for the future implementation of a fluvial H2 demonstrator

The partners in Paris are researching the potential for a hydrogen demonstration project. The main goals are to identify the right locations for the hydrogen infrastructure (e.g. electrolyser, HRS), clarify regulatory frameworks, and get a good picture of supply and demand for the region.

Project Overview

The H2SHIPS project is coordinated by EIFER (DE) with partners in 5 countries: Hynamics (FR), University of Birmingham (UK), Port of Amsterdam (NL) Delft University of Technology (NL), SYCTOM (FR), HAROPA Ports |Paris (FR), Port of Ostend (BE), Steinbeis Europa Zentrum (DE) Hydrogen Europe (BE), Transport & Environment (BE), and Tata Steel Ijmuiden (NL). The project began in 2019 and will end in mid-2023.

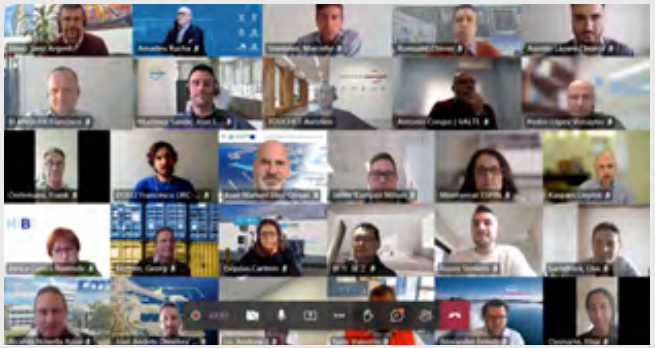
H2PORTS project News

Valenciaport's commitment to hydrogen, reference for the European Commission

The H2PORTS project has been selected by the European Commission as a strategic initiative for the decarbonisation of maritime transport. Moreover, the Port Authority of Valencia has presented it at the European Hydrogen Week 2021 (EHW 2021), as an example of the maritime sector's commitment to decarbonisation and the fight against climate change.

The hydrogen Terminal Tractor within the framework of the H2PORTS project is in full development

This Terminal Tractor has a fuel cell/battery hybrid powertrain which allow the vehicle to perform all the intensive tasks that are required during roll-on/roll-off operations. Its hydrogen storage system, made of four Type 3 cylinders (350 bar), has an overall capacity of around 12 kg, which guarantees a continuous operation of at least 6 hours before refuelling, corresponding to the average duration of a working shift. The electric motor is a light and efficient device, particularly suitable for power demanding applications. It is fed by a high-performance LiFePO4 battery, with 25 kWh energy capacity, and a 70 kW Ballard fuel cell module. In particular, the electric motor can receive power for traction from the fuel cell and battery simultaneously or charge the battery during braking or decelerations. At the same time, the fuel cell can provide power both to the electric motor and the battery, if needed. The hybrid powertrain shows high operational efficiency, since it takes advantage of a significant share of kinetic energy recovery, up to 15%.



H2PORTS project 3rd stakeholder group analyses the hydrogen logistics

On 9 March the 3rd meeting of the H2PORTS hydrogen project stakeholders group was held in virtual format with a great success, reaching more than 80 attendees. On this occasion, the H2 logistics was chosen as the central topic of the meeting, and four relevant speakers were selected: Francesco Dolci, scientific officer from Joint Research Centre; Romuald Chiron, from Calvera; José Luis Martínez Sande, from Enagás Renovable; and Natalie Gupta, from Yara Clean Ammonia.

Carburos Metálicos Joins the consortium H2PORTS project

Carburos Metálicos, a leading company in the industrial and medical gases sector in Spain that is part of the Air Products Group, has recently joined the consortium of H2PORTS project.

Carburos Metálicos will lead the installation of the HRS at the Port of Valencia and will manage it during the two-year pilot period thus guaranteeing good practices of the team involved, and the correct handling of hydrogen loading operations. Additionally, Carburos Metálicos will provide the renewable hydrogen for the project, developing all logistics needed for proper supply to the port machinery. Finally, it will provide support for safety training and the exchange of best practices with partners and stakeholders to ensure safe operations.

Shipping / Hydrogen International Events

2022

ESPO CONFERENCE REGATTA 2022

2-3 June 2022

Valencia (Spain)

https://www.espo.be/events

32nd EIGA Annual General Meeting

3 June 2022

Valencia, Spain

https://www.eigass.eu/agm-agenda.html

TOC Europe

14-16 June 2022

Rotterdam

https://www.tocevents-europe.com/en/Home.html

London International Shipping Week - LISW

11-15 September 2023

London, United Kingdom

https://londoninternationalshippingweek.com/

GreenPort Cruise & Congress

18-20 October 2022

Bruges, Belgium

https://www.portstrategy.com/greenport-cruise-and-congress/the-conference/conference-programme

European Hydrogen Week

Nov-Dec 2022(to be confirmed)

Brussels, Belgium

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