EUROPEAN HYDROGEN PORTS AND MARITIME POLICY CONFERENCE

Hydrogen and Fuel Cells – A Zero Emission Alternative for the Ports and Maritime Sector

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Conclusions

Hydrogen is increasingly being used as an energy vector and transport option in the ports and maritime sector. The International Maritime Organisation (IMO) set demanding emissions reduction targets in April 2018 and the Conference looked at the use of hydrogen and fuel cells as a key option in meeting these targets. Over 60 participants registered for the Conference from a wide range of backgrounds including policymakers from different tiers of government and representative bodies. Some participants came from the United Kingdom and the United States but the majority of participants were from the EU, particularly the North Sea and North West Europe Regions.

The Challenges of GHG Reductions in the Ports and Maritime Sectors

The IMO has adopted stringent emission reduction targets which aim for at least a 50% reduction in emissions by 2050 compared to 2008 levels. There is also a commitment to full decarbonisation. This will be made more difficult by the growth of the Shipping and the Maritime Sector which is anticipated to grow rapidly by 2050. The IMO Strategy will be revised in 2023 and the targets may be intensified.

- The current strategy involves the short-term use of existing technologies and further operational measures such as slow steaming while medium and long term measures include the greater use of zero emission fuels.
- Concentrations of logistic activity, energy generation and industry make some ports 'hotspots' for GHG emissions, NOx, Particulate Matter and SOx emissions. Both ESPO and the World Ports Sustainability Program are active in facilitating measures amongst their Members to reduce air pollution and emissions. ESPO has introduced the concept of the Eco-Port and many of its members have joined the Initiative. The World Ports Sustainability Program has developed carbon reduction projects in ports and has also produced a Ports Emission Toolkit.
- Supportive actions to promote GHG emission reductions include research; technical co-operation; incentives for first movers to take up new technologies such as hydrogen and fuel cells; measures to encourage port development including the provision of infrastructure for low and zero emission fuels.
- The use of LNG alone will not reach the IMO targets and could lead to stranded investment and infrastructure.

- Hydrogen can play a crucial role for the decarbonisation of the shipping sector either as final fuel or as an input source for other close to or zero emissions fuels. The widespread adoption of hydrogen as a fuel on board ships will depend on technology development of storage and machinery (e.g. fuel cells). R&D will play a pivotal role in achieving hydrogen's potential.

- There are synergies with other economic and transport sectors in terms of storage and demand management requirements. These are key considerations in large scale green hydrogen infrastructure development

Increasing the Use of Hydrogen, Fuel Cells in the Ports and Maritime Sector – Policy Challenges

Some academic reports have suggested that ocean going vessels powered by hydrogen will be operating from 2030 if the policy and technological challenges are met. The Conference heard:

- Up to €800million will be utilised under CEF Transport but the estimated level of investment in alternative fuels infrastructure by 2025 could be up to €22 billion.

- The Preliminary Findings of DG Energy's ASSET Study were presented. This study looks at the actions needed by all sectors of the economy to enable energy transition to a low carbon economy.

- ASSET foresees multiple roles for hydrogen in sectoral integration and a particular role in the transport sector. ASSET sees competition with hydrogen in the maritime sector with the development of biofuels.

- Comments were made about the Alternative Fuels Directive published in 2014. For maritime activities, only LNG and onside electricity were part of the Directive. This now needs to be widened to include hydrogen. In addition, there were calls for the LNG infrastructure mandate and subsidies to be withdrawn.

- The maritime sector is 'discovering hydrogen transport' and the scope for the use of hydrogen in ports through sector coupling is great. Many ports have the potential to produce large amounts of hydrogen through renewables and it can be used for a variety of maritime and land transports; heating and cooling in buildings and the production of feedstocks.

- Project work is being funded and examples were given. The PURE project develops auxiliary power units for yachts. The Maranda project has integrated a PEM fuel cell into a research vessel and HYSEAS III, which aims to have a hydrogen ferry in the water by 2020. Other FCH-JU funded projects will be announced in January 2019. The Water Go Round project in San Francisco will also have a ferry in the water by 2019.

- Further projects and research are needed to develop liquid hydrogen storage and larger fuel cells. There were discussions about funding mechanisms to be developed in the ports and maritime sector. These included grants or partial grants offered in EU programmes such as Horizon 2020 and INTERREG, lending, structural financing, guarantees, project bonds from banks like the EIB and EBRD. An EU Maritime Climate Fund was also suggested.

- EU regulations and policies do not apply to coastal states that are non-EU member states, such as Norway and possibly the UK after Brexit. Separate national regimes in non-EU Member States in the North Sea may therefore need to be taken into account when engaging in cross-border activities

- There were calls for changes be made in the London Protocol to provide for a better international CCS value chain and ETS regulations for international CO2 transportation per ship can be improved.

- It was suggested that the revised Renewable Energy Directive which includes a Guarantee of Origin scheme for renewable energy should be extended to gaseous fuels such as hydrogen. A carbon intensity threshold for hydrogen should be applied and certificates awarded to producers of low carbon hydrogen.

Increasing the Use of Hydrogen, Fuel Cells in the Ports and Maritime Sector – Technology Challenges

A number of technology pathways have been analysed. A technology mix of liquid hydrogen, battery and NH4 seemed the most likely to developed. Hydrogen both in fuel cells and internal combustion engines was possible especially if R&D, technological developments and new policies were introduced to create a favourable environment for the development of port and maritime applications for hydrogen.

- The technological challenge is to adapt a number of transport, energy and stationary applications and apply them to the more demanding port and maritime environment which use large amounts of heavy duty equipment.

- Fuel cell manufacturers have been active in ports and the maritime sector and a number of applications have been developed. These include propulsion mechanisms for inland waterways and short sea shipping. Current project activity will see the use of fuel cells in ferries by 2021.

- A number of challenges face the hydrogen industry and can be grouped around the commercial justification for the use of hydrogen and fuel cell products. These challenges include the capital investment cost, the market price for hydrogen and Total Life Cycle Costs.

- There are specific challenges for the adoption of fuel cells in large ships. It was stated that the Shipbuilding Industry is relatively unfamiliar with fuel cells and does not yet have the experience to write applications. There are relatively few suppliers with experience of liquid hydrogen onboard storage, and ship scale bunkering technology. In addition, there is limited production of Liquid hydrogen in the EU.

- There is no prescriptive code for hydrogen from the IMO and this is another major challenge. The alternative process of approval is lengthy, complicated and expensive.

Case Studies, Strategies and Projects

The Case Studies included strategies and projects predominantly from the port sector. These included the Port of Los Angeles and Long Beach and also from CMB who operate the Hydroville vessel in Antwerp. CMB also outlined their future plans.

- Groningen Seaport presented their 'Follow the Energy' Strategy which sees the development of a Hydrogen Valley with a variety of private sector partners including Vattenfall, Nouryon, Gasunie and Equinor. The project builds on a natural gas pipeline network which will have hydrogen injected into it. Developments include a green hydrogen production plant; hydrogen storage facilities and the use of hydrogen for a variety of transport uses. The Nuon Blue Hydrogen Project will develop a CO2 ship operating between Groningen and Norway. The Strategy builds on Groningen's position geographically which allows it to be linked to a number of pipelines and renewable energy sources.

- Large scale stationary PEM Fuel Cell power plants have been successfully developed, deployed and operated within the ports' domain. Nedstack's oldest port based power plant has been in operation since 2007 and Nedstack deployed the world's first 1MWe (2011) and 2MWe (2016) power plants at ports in Europe, the Caribbean and East Asia.

- Nedstack leads the Dutch FELMAR consortium with the aim of industrialising PEM Fuel Cell engines and power plants for the inland navigation and short sea domain and to have them ready for market deployment by the end of 2019.

- The Port of Los Angeles has particular problems with high levels of PM2.5 and NOx in the South Coast Air Basin Corridor between the railhead and the port. Drayage trucks represent only one per cent of vehicle miles travelled in California but 12% of total NOx emissions in the Basin.

- The goals of Los Angeles Port are that all trucks should be zero emission by 2025 and terminal equipment should be zero emission by 2030; GHG emissions should be reduced by 80% by 2050 compared to 1990 levels. There are a number of financial incentives to make this possible.

- California is involved in a number of projects including the **Hydrogenics and Stratos Wind to Hydrogen Project.** This is the largest zero emission hydrogen production facility in North America and is located in Palm Springs, California. It uses wind energy to power PEM electrolysers. Construction began in January 2017 and is still continuing. It produced 2.5 MW l in July 2018. 65 kwh is needed to produce 1 kg of hydrogen at 700 bar.

- Another California project is the **Fuel Cell Energy and Toyota Biogas-to-Hydrogen Project.** Announced in December 2017 as the world's first megawatt-scale 100% renewable power and hydrogen generation station. It is a Trigeneration plant in Long Beach, it will produce 2.35MW of electricity and 1,270kg/day and will fuel Mirai sedans through the port and Toyota's Heavy Duty Hydrogen Fuel Cell class 8 truck. Current Californian projects also include the funding of eight fuel cell trucks and a refuelling station for cargo transport.

- There are a number of new projects in California. These include the funding of ten hydrogen fuel cell trucks operated by four companies with two new refuelling stations. Yard tractors and top loaders will also be funded.

- The Port of Amsterdam looked at the creation of a Hydrogen Valley in the Port Region. It has a key geographical position and extensive fuel infrastructure where hydrogen could replace fossil fuels in an energy transition. A Kick Start Program will create local demand and obtain scale by developing several mobility projects simultaneously. A Development Program will enable large scale hydrogen production from offshore wind. Synergies will also be created between sectors such as chemicals and mobility. This will stimulate significant infrastructure for the hydrogen cluster by 2050.

- Hydroville is a hydrogen powered catamaran (hi-speed with a non-planing hull) which is 14 metres in length and has a beam of 4.2 metres. It carries 16 passengers and is powered by two dual fuel internal combustion engines. The two engines were retrofitted. It operates a commuter route in Antwerp.

- CMB Technologies believe that Hydrogen-Diesel co-combustion is very suitable when applied to ships. There are no fundamental changes to the main engine and hydrogen quality can be lower than fuel cell grade hydrogen. The project took a year and a half to complete and was launched in November 2017. The hull and machinery have been approved by Lloyds Register and a new Hydroville engine is in development.

- Hull has great potential to develop hydrogen both in the Humber Ports and the wider Region in terms of renewable energy generation, major industries including chemical and food manufacturing, R&D capabilities and a highly skilled workforce. The chemical industry in the Humber already produces hydrogen as a by-product. Green ammonia and hydrogen production as planned is up to five hydrogen refuelling stations with captive fleets. Team Humber Marine Alliance has joined a consortium of Southern North Sea regions with the aim to create a Southern North Sea 'Innovative Energy Garden'. This will be a 'field lab' for energy integration including hydrogen.

Next Steps and Conclusions

- Ports around the world are making a concerted effort to reduce emissions and improve the air quality for their cities. Fuel cells, powered by hydrogen, are emerging as one of the best possible options to replace diesel in heavy duty and maritime applications due to its longer range, short refueling time, and ability to handle high duty demand cycles.

- OEMs, industry and government will need to continue to invest in hydrogen fuel cell technology if it is to reach commercialization and bring down costs of components and fuel.

- There should be greater levels of co-operation between the ports, maritime and hydrogen sectors so that they work together to solve common problems and move towards zero emissions. This co-operation could be at local, regional, national and EU levels.

- There needs to be action taken on targets and standards and regulations. In addition, there needs to be discussions about the funding opportunities available at both at EU and national levels so that hydrogen and fuel cell zero emission solutions can be progressed from demonstration projects to eventual commercialisation.

- There were calls for hydrogen and fuel cells to play a greater role in the maritime sections of the Alternative Fuels Infrastructure Directive. These calls included targets for the availability of hydrogen in ports as there are for shoreside electricity and LNG.

- The EU Budget post 2021 is under discussion and details such as funding programmes for Horizon Europe, EU Structural Funds and INTERREG Programmes are currently being negotiated. There were calls that these programmes should include greater resources being made available to hydrogen and fuel cells in the ports and maritime sector.