DEVELOPING HYDROGEN PORTS AND MARITIME POLICY IN THE NORTH SEA REGION

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. This Conference looked at the current situation in the North Sea Region (NSR) and further explored ways in which hydrogen applications in the sector could increase. The International Maritime Organisation (IMO) set demanding emission reduction targets in April 2018 and the Conference looked at the use of hydrogen and fuel cells as a key option if the NSR is to meet these targets. Around 60 participants registered for the Conference. They came from a wide range of backgrounds and included policymakers, port operators and participants from the hydrogen and maritime industries. Most participants were from the United Kingdom and the Netherlands but participants were drawn from all North Sea countries apart from Belgium

The Challenges of GHG Reductions in the Ports and Maritime Sector

Presentations emphasised the need to reduce port and maritime emissions:

- Shipping currently accounts for 2.3% of global CO_2 emissions, roughly equivalent to an economy the size of Germany.
- GHG emissions from the sector are expected to grow between 50 – 250% by 2050 under a business as usual scenario.
- In the EU, transport risks becoming the largest emitter of CO2 by 2030.
- In 2016, domestic shipping accounted for 10% of the UK's total domestic NOx emissions, as well as emitting 10 times more sulphur oxides than road transport. Emissions from international shipping and shipping in transit have an even larger impact on UK air quality.

At present, it is not possible to predict the exact mix of fuels and energy vectors that will allow the emission targets to be met and this will be dependent on the energy systems adopted. U-MAS has looked at three pathways (renewables dominate; biofuels dominate; and an energy mix) and hydrogen is most important where renewables dominate.

The Conference then looked at a number of key issues to promote hydrogen use in the port & maritime sector.

Policy Challenges

There are only a handful of hydrogen vessels operating in the NSR. The Conference looked at the ways in which these vessels could be increased through changes in the policy framework and technological advances. The aim is that ocean going vessels could be introduced at the end of the next decade. It is important that change was accelerated in the short term through the **development of vessels to operate in inland waterways and short sea shipping.** Inland waterways can play a key role in the early development of hydrogen vessels due to:-

- Close to shore so ease of support.
- Limited power and infrastructure needed.
- There are over 13,000 inland ships operating in Rhine countries, particularly the hubs of Amsterdam, Rotterdam, Antwerp and Duisberg. This area has a significant air pollution ratio in relation to dense urban areas and it has great potential for improving air quality in the short term.
- The Netherlands built over 150 small sea going vessels in 2017 so there is market potential in this sector.

Ports can play a pivotal role as they produce plans and strategies to deliver Government policies and they often have policies for air quality and climate change. Many ports have the capacity to develop large quantities of renewable energy and hydrogen. A wide range of activities are carried out in port areas and regions. These not only include the servicing and refuelling of vessels but also the operation of vehicles in the ports such as cars, vans, heavy duty trucks and buses. Heavy machinery such as yard tractors and lifting machinery can also be converted to hydrogen.

The **potential of ports** to develop both energy and hydrogen resources was emphasised. For instance, the Port of Hull and the North Sea ports in Scotland have much potential from offshore wind which can be used to increase hydrogen production. The importance of hydrogen in gas pipelines was stressed and ports are also industrial centres that can develop hydrogen solutions. This is particularly the case in heavy industries such as steelmaking and, for example, in heavy duty trucks operating between ports and regional distribution centres. In fact, ports can become integrated hydrogen economies also known as Hydrogen Valleys. There is great potential for the larger ports in the NSR to become Hydrogen Valleys.

A favourable policy environment for the development of hydrogen in the ports and maritime sector will be essential. The lack of **rules and regulations** was a key topic. Due to the limited experience with hydrogen vessels, hydrogen specific rules have not been developed and a risk based design process needs to be performed. The alternative design procedure in the IGF Code of Safety for Ships using Gases and low flash-point fuels needs to be followed. Lloyd's Register has been involved in several such safety studies both for LNG in the past and recently with hydrogen vessels.

The Development of Government Policies

In January 2019, **the UK Government** published its Maritime Strategy 2050 and it also made a commitment to publish a Clean Maritime Plan in spring 2019. The Clean Maritime Plan will allow the UK to move towards Zero Emission Shipping.

The Maritime Strategy 2050 aims to create a framework to lead on clean maritime growth. It aims to strengthen the UK's reputation for maritime innovation. The Strategy also wants to maximise the benefits to the UK from new maritime technology and the UK should be recognised as the global leader in maritime safety, security standards and expertise.

Currently there are very few regulations or policies in the UK to specifically incentivise zero emission shipping. There is a similar situation in the **European Union** which needs to create targets for hydrogen in

the ports and maritime sector. When the Alternative Fuels Infrastructure Directive was adopted in 2014. It only included voluntary targets for hydrogen and, at the time, there was little use of hydrogen in the maritime sector. However, interest has mushroomed in the past few years. 15 Member States have opted to include hydrogen in their National Planning Frameworks. The European Union has also funded Research and Innovation in the maritime sector through the Horizon 2020 Programme and there are a number of projects for developing propulsion systems in hydrogen vessels including ferries. There was a great deal of discussion about the need for Research and Innovation projects in the sector (see Technological Challenges.)

The Scottish Government has looked at the role of hydrogen in the gas network and developed two scenarios to guide their decisions. It has been very active in the promotion and use of hydrogen and much of this activity was centred in coastal areas. It will continue to work with our stakeholders on a range of hydrogen energy and transport initiatives, and publish an interactive mapping tool charting hydrogen activity on a region by region basis across Scotland. The Scottish Government has also looked at 2050 energy scenarios: one with hydrogen producing 4 Twh out of 11 Twh produced and the other producing 87 Twh of hydrogen produced from 140 Twh.

The Scottish Government also intends to explore further opportunities for the generation of low carbon hydrogen, and the use of the gas networks for its distribution and storage. Scotland is already producing large amounts of renewable energy and there is more potential from offshore wind.

The Technological Challenges

There are many potential uses for hydrogen in ports and this use is not confined just to the refuelling of vessels but the varied activities including the powering of land transport and heavy machinery. Many small hydrogen forklifts are already being used in ports and this needs to be extended to heavy port side machinery (port tractors and cranes etc.)

Speakers in the Conference examined a number of technological challenges. The challenges included the use of fuel cells in maritime equipment, the production of large quantities of green hydrogen, and the use of hydrogen in different forms and bunkering.

Fuel cell technology has been developed for land transport but it is now being tested in the marine environment. Initial demonstration projects have been successful and fuel cells found to be both reliable and robust. Multi-MW fuel cells for the fuel sector are in development and these will be used in larger ships.

Scaling up the production of **green hydrogen** was a key issue as a ferry will need around 500 kg hydrogen per day. The largest PEM electrolyser in the World is currently around 10 MW but there are feasibility studies being undertaken for 100 MW electrolysers. Research done in Germany has led to some key conclusions in terms of renewable energy:

- Wind and PV installations have reached terawatt level globally which is resulting in a large drop in price and has the capacity to reshape the energy sector.
- In some Regions, Full Load Hours (FLh) can be substantial leading corporations and governments to look at green hydrogen production. It was stated that interest in hydrogen was largely policy driven but it is possible to move towards parity with fossil fuels.
- A major issue will be the GWs of electrolysis needed to meet energy system targets. There are still relatively small amounts of hydrogen produced by electrolysis and there needs to be much greater amounts of green hydrogen produced.

There is lots of potential for fuel cells in the sector but more research and demonstration projects are needed for vessels. Issues to be examined would include legislation and regulation; commercial justification and viability; customer perception; fuel supply and storage.

Hydrogen can be stored in a number of ways including compressed H2, LH2, metal hydrides, and as ammonia or methanol. There were advantages and disadvantages to each storage system and the potential use of these fuels needs further investigation and should be addressed through demonstration projects in the **Research and Innovation Programmes of the European Union and national governments.**

Case Studies, Projects and Strategies

bremenports' **Smart Harbour Application Renewable Integration Concept (SHARC) project** aims to develop the intelligent integration of renewable energies through sector coupling. The project will take place in the overseas port area of Bremerhaven. The aim of SHARC is to develop the intelligent integration of renewable energy resources. It will examine energy consumption in the ports and develop concepts, one of which will be chosen to develop. The project will develop a CO2 neutral port. The first phase is to carry out an actual-state-analysis of the port's energy consumption and different scenarios developed. One scenario will be selected and taken further so that a business model and investment plan is created. This could include the promotion of a regional hydrogen strategy and the provision of hydrogen infrastructure.

There are a number of **ferry projects** funded by Horizon 2020 Programme (HySeas III and Flagships) and by national governments**.** One fast ferry will operate on the Norwegian coast and includes both battery and hydrogen fuel cell operation in a vessel which will travel between 25-45 knots. The aim is for the ferry to be market ready in 2020. There does not seem to be a problem with the operation of the fuel cell but there are a number of challenges which include the production of large quantities of hydrogen on-board and in ports.

The problem of sufficient quantities of hydrogen has also been raised in the HySeas III project which will develop a ferry to operate in the **Orkney Islands**. The HyDime project in the Orkneys uses an injection system to put hydrogen into the fuel mix of an auxiliary engine on a vessel. Regulatory support from the MCA/IMO is necessary for hydrogen to be used as a marine fuel in the project

Developments on Orkney were mentioned by a number of speakers and the Big Hit and Surf 'n' Turf projects outlined. As a port, Orkney has a number of issues to face with energy transition. The issues include fuel cost and availability; space needed for storage infrastructure; bunkering and refuelling; role for renewable energy in a whole energy system approach; training; and maintenance.

The North Sea INTERREG's **Dual Ports Project** which includes the feasibility of bunkering options on Orkney including fuel type, fuel usage and the bunkering system including the design of the system. In addition, it will involve a ferry routes study and a study of proposed hydrogen production sites.

Developing Closer Working and Networking in the NSR

There was a Panel Discussion about closer links across the NSR to stimulate the use of hydrogen in ports and the maritime sector. This was preceded by a presentation about the activities of the **North Sea INTERREG Programme** which is an EU funded Programme. The Programme covers Norway, the west of Sweden, Denmark, and the coastal areas of Germany, the Netherlands, Belgium and the UK. The Programme has Eco-Innovation and Green Transport and Mobility priorities where hydrogen projects can be developed.

The Programme has CO2 reduction in transport as a key aim. It believes that hydrogen fuel cells represent a good long term sustainable alternative to fossil fuels, but comes with a pricetag. Cooperation between key stakeholders on demonstration projects can increase the number of users and bring prices down. A new Programme will be developed for the EU Budget period beginning in 2021.

There was agreement in the Panel that there should be greater co-operation across the NSR. While co-operation in projects and project development was important, joint working could look at issues such the development of Business cases, scaleability, and financial mechanisms to support hydrogen applications.

Next Steps and Conclusions

- The NSR has some very successful hydrogen 'hotspots' such as Orkney and Norway. Policy learning from these hotspots is needed so that hydrogen technologies can be developed through the NSR and the Conference demonstrated the potential of hydrogen usage in ports, inland waterways and short sea shipping. In view of its inland waterways and short sea shipping routes, the NSR has many advantages to develop hydrogen as a port and maritime fuel. This can be combined with expertise in shipbuilding. The NSR also has great potential in terms of the use of hydrogen in an energy system based on renewables.
- The availability and price of green hydrogen is an issue if hydrogen port and maritime applications are going to increase across the NSR. For instance, 120,000 kg of hydrogen is needed to fuel a small vessel.
- The importance of Business Cases was stressed. These should include scaleability, financial mechanisms and measures to reduce CAPEX and OPEX costs and safety issues.
- There is still a lot of work to do in terms of research and innovation. This includes research into the different types of hydrogen used in the ports and maritime sector, bunkering and safety issues. This research will also have a bearing on legislation and the creation of targets for the use of hydrogen in the maritime sector.
- A number of large NSR ports have seen the potential of hydrogen and there needs to be operation in each port and amongst large ports so that hydrogen can be successfully developed. There was much enthusiasm amongst participants for greater co-operation and exchange of views.
- Many participants saw the advantage in ports becoming the centre of Hydrogen Valleys.