HyLAW

National Policy Paper - Norway

Main Author(s): [Sigrid Damman, SINTEF, Jan Carsten Gjerløw, Norwegian Hydrogen Forum]

Contributor(s): [Heidi Bull-Berg, SINTEF, Steffen Møller-Holst, SINTEF, Kristian Vik, Norwegian Hydrogen Forum]

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1. Introduction and summary

1.1 HyLAW Summary and Methodology

HyLaw stands for Hydrogen Law and removal of legal barriers to the deployment of fuel cells and hydrogen applications. It is a flagship project aimed at boosting the market uptake of hydrogen and fuel cell technologies providing market developers with a clear view of the applicable regulations whilst calling the attention of policy makers on legal barriers to be removed.

The project brings together 23 partners from Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden, Portugal, the Netherlands and United Kingdom and is coordinated by Hydrogen Europe.

Through extensive research, interviews and legal analysis, the HyLaw partners have identified the legislation and regulations relevant to fuel cell and hydrogen applications and legal barriers to their commercialization.

This National Policy Paper provides public authorities with country specific benchmarks and recommendations on how to remove these barriers.

1.2 Policy Summary at National level

Norway claims to be a pioneer in hydrogen technology. Largescale production was established as early as in 1929, and hydrogen has been an element in our industry since then. In recent years, SINTEF, IFE, and NTNU have taken lead roles in research on hydrogen as energy carrier. In 2005 the Government defined a hydrogen strategy with a focus on coordinating research and development activities, and HyNor as a pilot "hydrogen highway" was set up in 2009.

Since then there have been ups and downs, but currently there is a strong momentum for increased hydrogen deployment. The target of reducing greenhouse gas emissions 80-95% by 2050 calls for new technology and system change. The national hydrogen strategy established as part of the white paper on Energy of 2016 states explicitly that the Government wants to promote production and storage, as well as use of hydrogen.

Since transport is the sector with the largest potential for reducing national greenhouse gas emissions, vehicles are in focus. Hydrogen cars benefit from the same incentives as electric vehicles, and a national support scheme for refueling stations was established in 2017. The system of subsidies and taxes for fossil fuel transport is the focus of revision and political debate. At the same time, increased support for research and development is offered through new and existing funding schemes, such as Pilot-E, EnergiX, and Enova's support programs.

One result of this is that ASKO is getting Europe's first fleet of hydrogen trucks in regular operation, starting now in 2018. The number of private cars is increasing, and the long-term demonstration of hydrogen buses in Oslo is scaling up. There are several pioneering projects on hydrogen for ships, and increasing interest in production and industry applications. Actors such as NEL, Statkraft and Equinor are involved in planning and exploration of different options for largescale production. The potential market for hydrogen is enormous: According to the Hydrogen Council, hydrogen will represent 18% of the global energy consumption by 2050, associated with an industry worth 2.5 trillion dollars annually.[1]

Countries such as Germany and France are in front, with integrated and elaborate strategies for sustainable hydrogen deployment. While Norway is richly endowed with competence and energy resources, our strategy is less explicit when it comes to industry collaboration and development. To enable sustainability transition and benefit from our competitive advantages, there is the need for a holistic perspective, with more focus on market development for the whole value chain.

[1] Hydrogen Council (2017): Hydrogen scaling up. A sustainable pathway for the global energy transition. Hydrogen Council, November 2017.

2. Hydrogen in the maritime

Greenhouse gas emissions from the maritime sector in Norway were 7.4 million tons CO2e (about 14% of total national emissions) in 2015. The amount will increase to 11.5 million tons by 2040, unless action is taken soon.[2] Alternative fuels are key to realizing the ambition of a 40% cut in the emissions from domestic shipping by 2040.

With a total value creation close to 175 billion and more than 100,000 employees, the maritime industry is one of the largest and most important sectors in the Norwegian economy. The industry also accounts for a large share of Norwegian export. Almost 90 per cent of ship's equipment from Norwegian companies are exported. In 2014, Norwegian ship's equipment alone was 9 per cent of total Norwegian exports of goods and services.[3] We have also positioned ourselves as a frontrunner in sustainable maritime technology: Of the first 50 LNG propelled vessels ever built, 95 % were Norwegian. The world's first electrical car and passenger ferry powered by batteries – Ampere - entered into service in early 2015 in Sognefjorden.

Currently, there is a booming interest in hydrogen solutions. There are at least 10 pilot projects on hydrogen in ships, that is: Fuel cells installed into a boat or ship, for use as a means of propulsion through chemical reaction between hydrogen and oxygen, and with no emission except clean water. These projects include a hybrid fishing vessel and an urban water shuttle, as well as a high-speed passenger ship with the capacity for 100 persons and a speed of 28 knots (52 km/hour). The world's first larger hydrogen ferry, for longer crossing/operating timescales, is projected in Western Norway, and the aim to launch the ferry by 2020. Last but not least, one of our major shipping companies is planning an emission-free cruise-ship powered by liquid hydrogen.

The importance and potential value these initiatives have for society is underscored by figures from the International Energy Agency (IEA) and OECD: International maritime shipping currently accounts for about 800 million tons CO2e emissions per year, and this figure could almost double by 2060. Low-carbon fuels are considered as a key solution to enter on to a more sustainable course.

2.1. Overview and assessment of current legal framework

Since the white paper *New emission commitment for Norway for 2030 – towards joint fulfilment with the EU*, greener shipping has been a national priority area. A number of emission reduction measures, such as reduced electricity fees for ships in business activity, a lending scheme for condemnation and renewal of the local shipping fleet, a grant scheme for climate and environmentally oriented public procurement processes and increased funds for research into climate-friendly shipping have been introduced. Norway has also been working through the International Maritime Organization (IMO), to introduce energy efficiency reporting requirements and define an initial, international strategy on the reduction of greenhouse gas emissions from ships. Launched in April 2018, this initial strategy envisages a reduction of total annual GHG emissions by at least 50% by 2050.[4]

Most of these efforts are associated with a principle of technology neutrality. Hydrogen and fuel cells have been considered as a relatively immature alternative. However, now there is increasing confidence in the technology. A resolution by the Parliament in June 2016 encourages the use of development contracts for hydrogen ferries. The Norwegian Public Roads Administration has established a development project for a hydrogen-powered ferry, where the contract was awarded in 2018 and the construction is to be completed by 2021. The Government's recent ban of any kind of carbon emissions in the waters of the UNESCO World Heritage sites Nærøyfjorden and Geirangerfjorden from 2026 is another important step. Given the length and limited grid capacity in these fjords, and the economic importance of cruise-ships and tourism in Western Norway, this is strengthening the drive for hydrogen solutions.

The industry and relevant authorities are working hand in hand to address remaining challenges. However, shipping is for a large part governed through international conventions, which take very long to change. The assessment carried out in HyLaw underscores the need for international collaboration to address regulatory gaps, and for Norwegian authorities to spearhead this development, to fulfill our ambitions as a sustainable maritime nation.

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[2] DNV-GL 2016. Reduksjon av klimagassutslipp fra norsk innenriks skipsfart. [Reduction of climate gas emissions from shipping in Norway]. Report for the Ministry of Climate and Environment. Report No 2016-0150.

[3] Menon 2017: Maritim verdiskaping. Analyse av næringen i en krevende tid. [Maritime value creation. Analysis of the maritime industry in a challenging time.] Maritimt Forum.

[4] Compared to 2008.

Design/Type approval – a regulatory gap and main barrier

HyLaw has assessed five legal-administrative procedures for hydrogen in ships. Design or type approval is the most substantial requirement, whereby it is certified that a type of vessel, system, component or separate technical unit satisfies the relevant administrative provisions and technical requirements. The *International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code)* is the overarching legal framework. The national *Regulation of ships using fuel with flashpoint below 60°C* makes the IGF Code mandatory for new constructions or reconstructions in Norway. It contains detail requirements for natural gas as fuel only, and internal combustion engines, boilers and gas turbines.

Continued work has been agreed under the IGF Code working group, but the use of fuel cells is presently not regulated. Due to this regulatory gap, approval must be sought through the Alternative Design approach, as defined in *MSC.1/Circ.1455 – guidelines for the approval of alternatives and equivalents.* This is a costly and time-consuming process, including comprehensive technical, risk and environmental assessment, as well as broad stakeholder involvement. As per the IGF Code, the design team itself should include experts having the knowledge and experience in fire safety, design, and/or operation as necessary for the specific evaluation at hand.

It is estimated that the procedure takes at least one extra year, as compared to gaining final approval for conventional ships. On top of this, there is the need for technology qualification and development of standards. The EMSA Study on the use of Fuel Cells in Shipping notes, in particular, the need to address uncertainty regarding possible failure modes; to test materials ductility for the low temperatures of liquid hydrogen; to decide on the possible allowed locations of pressure tanks; and to qualify pressure tanks for maritime use.[5] The Norwegian Maritime Authority (NMA) is working on a list of minimum documentation requirements, as well as additional documentation requirements for different designs. In the meantime, entrepreneurs are left uncertain, as to what the time and cost implications will be.

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Ship registration – additional documentation requirements anticipated

IMO numbers are mandatory for cargo vessels of at least 300 gross tons and passenger vessels of at least 100 gross tons. Individual registration in international or national ship registers is required also for smaller ships/boats. Beside IMO requirements, a declaration of safety from an approved classification society and a set of qualification requirements are commonly required. Presently, there are no specific requirements for hydrogen-powered ships. Additional documentation requirements may come in, following the anticipated minimum requirements for alternative design, but once the design has been approved, it is not foreseen that there will be any barrier associated with ship registration.

Operations and maintenance – special safety requirements could be a hindrance

When it comes to operations and maintenance, the national *Regulation on ships using low-flashpoint fuels (flashpoint below 60°C)* includes special requirements. These are based on the *Regulation on safety management systems for Norwegian ships and maritime installations (ISM regulation)*. As per now, there are no special requirements for hydrogen-powered ships. The additional documentation requirements for alternative designs may be followed by specific operation and maintenance requirements, but due to lack of experience it is difficult to assess to what extent this will be a barrier and what the time and cost implications could be.

Approval of landing/bunkering facilities – need for guidelines

Onshore landing and bunkering installations for hydrogen fall under the same legislation as onshore landing and bunkering facilities for of other inflammable gases, that is the Norwegian *Regulation for safe handling of inflammable, explosive and pressurized substances, including relevant installations and equipment*. Small installations may be established freely, but all bunkering installations harboring more than 5 tons of hydrogen require special consent from the Directorate for Civil Protection.

Following an ongoing revision of the regulation (entering into force in the second half of 2018), all bunkering of hydrogen for passenger ships will require special consent. This is already applied in practice, through individual decisions. Applying for special consent from the Directorate for Civil Protection is a time-consuming process. The

[5] DNV GL (2017): European Maritime Safety Agency (EMSA) study on the use of fuel cells in shipping.

normal processing time is 3 months, including a 4-week hearing period, but the procedure may also take considerably longer, if revisions are needed. A comprehensive, quantitative risk assessment is required for approval, and this is often outsourced to a consultant. The costs depend on case and are difficult to specify. This adds further uncertainty to technological innovation projects, which are financially risky at the outset.

As the legislation in this area is function-based rather than providing detail regulation, new procedures specifically for hydrogen installations may not be needed. However, there is the need for close assessment and consideration of specific guidelines. Current procedures for bunkering of LNG and the experience from hydrogen filling stations for cars provide a first knowledge basis, but further risk studies and technology qualification is needed, both for liquid and compressed gaseous hydrogen. All pressurized components, such as tanks, piping and equipment, must be in compliance with EUs *Pressure Equipment Directive* (97/23).

In other words, there is a knowledge gap and need for more specific guidelines for onshore landing and bunkering installations. The lack of detail regulation is supplemented by comprehensive assessment requirements, which can be quite challenging for economic operators, at this early stage in the development.

Onboard hydrogen transport – updating will be required

Onboard transport of hydrogen is of high relevance for Norway, considering the foreseen export opportunities for green as well as "blue" hydrogen, produced from natural gas.

Generally, transportation of compressed or refrigerated hydrogen in bulk or as packed cargo, is regulated under the *International Maritime Dangerous Goods Code (IMDG Code)*. Here, the requirements for compressed and refrigerated liquid hydrogen are comparable to those for natural gas, and they have the same limitations as packed cargo. However, the *International Gas Carrier Code (IGC Code)* lacks specific requirements for hydrogen.

To address this regulatory gap, IMO adopted a set of interim recommendations for carriage of liquefied hydrogen in bulk (resolution MSC.420(97) under in November 2016. Their application is so far limited to a pilot project where Kawasaki Heavy Industries Ltd got Approval in Principle (AiP) from ClassNK. There is little available documentation of the experience from this project, and it is therefore difficult to assess the impact of the interim recommendations.

Under the IGF Code it is anticipated that initial restrictions regarding storage quantities and locations will be put in place for hydrogen (e.g. storage on top deck).

Thus, this is another area where adjustment of legal frameworks is needed, in order to provide clear and predictable conditions for technology and market development.

2.2. Conclusions

Deployment of hydrogen in ships is an important step towards a more sustainable transport and energy system. In Norway specifically, the application of hydrogen as a means of propulsion for ships is needed, to meet the ambitious emission reduction target for the maritime sector. It represents a major business opportunity for our maritime industry. Furthermore, increased use of hydrogen and fuel cells in ships will help build a market, both locally and internationally, for green and blue hydrogen produced in Norway.

While Norwegian authorities have taken important steps to facilitate development and application of hydrogen solutions in the maritime, significant barriers remain. Most critical of these is the lack of regulation for design/type approval for hydrogen and fuel cells in ships, which has severe time and cost implications.

NMA is working on a list of minimum requirements for the approval of alternative design. Once the requirements for design approval become clear, individual ship registration is not likely to be associated with any barrier. The list of minimum requirements and additional requirements for different alternative designs will also be an important step towards defining any specific operations and maintenance requirements needed for ships running with hydrogen and fuel cell solutions.

Another important barrier is the lack of knowledge and specific guidelines for landing and bunkering installations for hydrogen. As the regulation in this area is function-based rather than providing detailed requirements, adjustment of the legislative framework may not be required, but there is the need for further risk studies, technology qualification and guidelines very soon. For maritime hydrogen solutions to take off, landing and bunkering infrastructure must be put in place.

For the onboard transport needed to develop a global hydrogen market, interim requirements for liquefied hydrogen have been developed. However, there are remaining regulatory gaps, both under the IGC and the IGF Code.

The use of development contracts to facilitate introduction of hydrogen and fuel solutions in the maritime sector is a promising strategy, which may strengthen public-private dialogue and increase common efforts to remove legal barriers.

2.3. Policy Recommendations

- It is important that Norwegian authorities work to strengthen international collaboration, and if possible force the pace in IMO's work to regulate hydrogen solutions and provide a procedure for type approval under the IGF Code.
- NMA's work on a list of minimum requirements for the approval of alternative design should be prioritized.
- Support for further risk studies and technology qualification is needed, both for hydrogen and fuel cell propulsion systems and for landing/bunkering installations.
- Specific guidelines for landing/bunkering installations for hydrogen solutions are urgently needed.
- Further use of development contracts to facilitate introduction of hydrogen and fuel cell solutions in the maritime sector should be actively encouraged.
- The regulation of onboard hydrogen transport should be kept on the agenda.