Interreg
North-West Europe
H2SHIPS

System-Based Solutions for H2-Fuelled Water Transport in North-West Europe

Deliverable

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HFC	Hydrogen Fuel Cells
EU	European Union
IMO	International Maritime Organisation
CESNI	Comité Européen pour l'Élaboration de Standards dans le Domaine de Navigation Intérieure
JS	Joint Secretariat
LP	Lead Partner
NWE	North West Europe
PA	Partnership Agreement
PP	(Full) Project Partners)
WP	Work Package

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1 Executive Summary

Port of Amsterdam analysed relevant regulations parallel to the development of the pilot project "Havenbeheer" concerning the use of H2 as a bunkering fuel for shipping as input for the deliverable T2.2.1 National Regulatory report. Several rules and regulations on a national and on EU / international level are relevant for the development of sea- and inland ships on H2 and the development of the bunkering process of this green alternative fuel for shipping. Because of the fact that there are only a few ships in EU sailing on H2 there is a lack in relevant regulations for bunker process and for the so called classification of inland and sea ships. Further development of these regulations "to enable the use of H2 as a bunkering fuel" is needed, on a national level (mostly concerning environmental regulations for the use of H2 as a bunkering fuel) and on a EU / IMO level for the classification of ships sailing on H2 or H2 related (synthetic fuels like synthetic methanol). Beside the further development of regulations in this field also the training and knowledge level of for instance regional and local fire departments and environmental departments is a challenge concerning the use of H2 as a fuel for ships. The same is relevant for so called classification bureaus who do the classification of individual ships based on EU and IMO regulations.

2 Introduction

The „*National regulatory reports on the current and foreseen situation in H2SHIPS pilot current and future implementation countries (FR, NL, BE)*" provide an in-depth undestanding of the regulatory frameworks in NWE countries and regions addressing questions linked to hydrogen deployment for waterbourne transport (ship certification, fuelling, bunkering infrastructures and other measures).

This report includes:

1. A short introduction on the EU and International rules
2. A more detailed explanation on the national and regional requirements affecting:
    - Rules and restrictions which incentivise the introduction of alternative fuels (like hydrogen) in waterborne transport
    - Ship type approval and certification for vessels with H2 propulsion
    - Hydrogen storage in ports
    - Refuelling of ships with hydrogen

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3 Applicable rules on international and European Level

3.1 Policies and Regulations

The Commitment by the IMO to reduce CO2 (50% reduction by 2050) and the rules restricting other emissions such as Sulphur (0.1%-0.5% limits) requires the maritime sector to look at hydrogen or hydrogen-based fuels, along with other low emission alternative fuels to power the world shipping industry of the future.

This section covers specifically the problems associated with Hydrogen used directly as a fuel or Hydrogen used as a fuel in hydrogen fuel cells

3.2 Ship Type Approval[1]

3.2.1 International regulations

At the International level, (i.e. under the scope of the International Maritime Organisation), the International code for safety of ships using gases or other low-flash point fuels (IGF Code)[2] contains mandatory provisions for arrangement; installation; control and monitoring; equipment and systems using low flashpoint fuels.

As Hydrogen has a flashpoint below 60° C, the IGF code generally applies. Nevertheless, the use of hydrogen as a fuel and hydrogen fuel cells is not explicitly covered by IMO rules. The regulatory gap applies to both propulsion (main or auxiliary) as well as the use of HFC for heating, cooling and other power generation purposes.

In the absence of specific normative provisions, according to the IGF code, the use of other low flashpoint fuels including hydrogen can be approved based on alternative design[3].

The Alternative Design Assessment is regulated by the convention of life at Sea (SOLAS II-1/55). The alternative design is the process by which the safety, reliability and dependability of the systems must be demonstrated to be equivalent to that

[1] This section draws heavily on the analysis conducted and published by the HyLaw project (www.hylaw.eu)

[2] Resolution MSC.391(95) (adopted on 11 June 2015)

[3] IGF code chapter 2; 2.3.2 "*Fuels, appliances and arrangements of low-flashpoint fuel systems may either: .1 deviate from those set out in this Code, or .2 be designed for use of a fuel not specifically addressed in this Code. Such fuels, appliances and arrangements can be used provided that these meet the intent of the goal and functional requirements concerned and provide an equivalent level of safety of the relevant chapters*"

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achieved with new and comparable conventional oil-fuelled main and auxiliary machinery.

The equivalence of the alternative design shall be demonstrated by a risk-based approach as specified in SOLAS regulation II-1/55 and approved by National Maritime Authorities

The IMO Circulars developed at the level of the Maritime and Safety Committee, MSC.1 / Circ. 1212 and MSC.1/Circ.1455 provide guidance to perform the Alternative Design Process. The criteria to be applied include:

- Equivalent level of safety to relevant IGF Code chapters (acc. IGF Ch.2)
- Fulfilment of the goals and functional requirement
- Risk assessment as required by IGF code Chapter 4

The process has five stages:

1. Development of a preliminary design,
2. Approval of a preliminary design,
3. Development of final design,
4. Final design testing and analyses, and
5. Final approval.

The guidelines describe the process in detail and includes comprehensive technical, risk and environmental assessment, with broad stakeholder involvement. The procedure for approval of alternative design is briefly described in the figure below.

Additional documents to be used as guidance during the assessment include:

- Specific rules published by classification societies (where available)[4].
- Any other rule or widely accepted (land-based) standard deemed necessary by the design team

Approval of Fuel Cell installation (e.g. according to rules operationalised by classification societies)[5] include

- Environmental tests[6] :
- Vibration tests
- Inclination test
- Salt mist test
- Temperature condition test
- Risk Assessment

[4] For example, DNV GL Rules for Fuel Cell Installations (Part 6, Ch.2, Sec.3) and Low Flashpoint Liquid Fueled Engines (Part 6, Ch. 2, Sec.6)

[5] For example,as those stipulated by DNV GL Pt.6 Ch.2 Sec.3 FUEL CELL INSTALLATION – FC installations

[6] For example, DNV GL CG 0339 Sec.3

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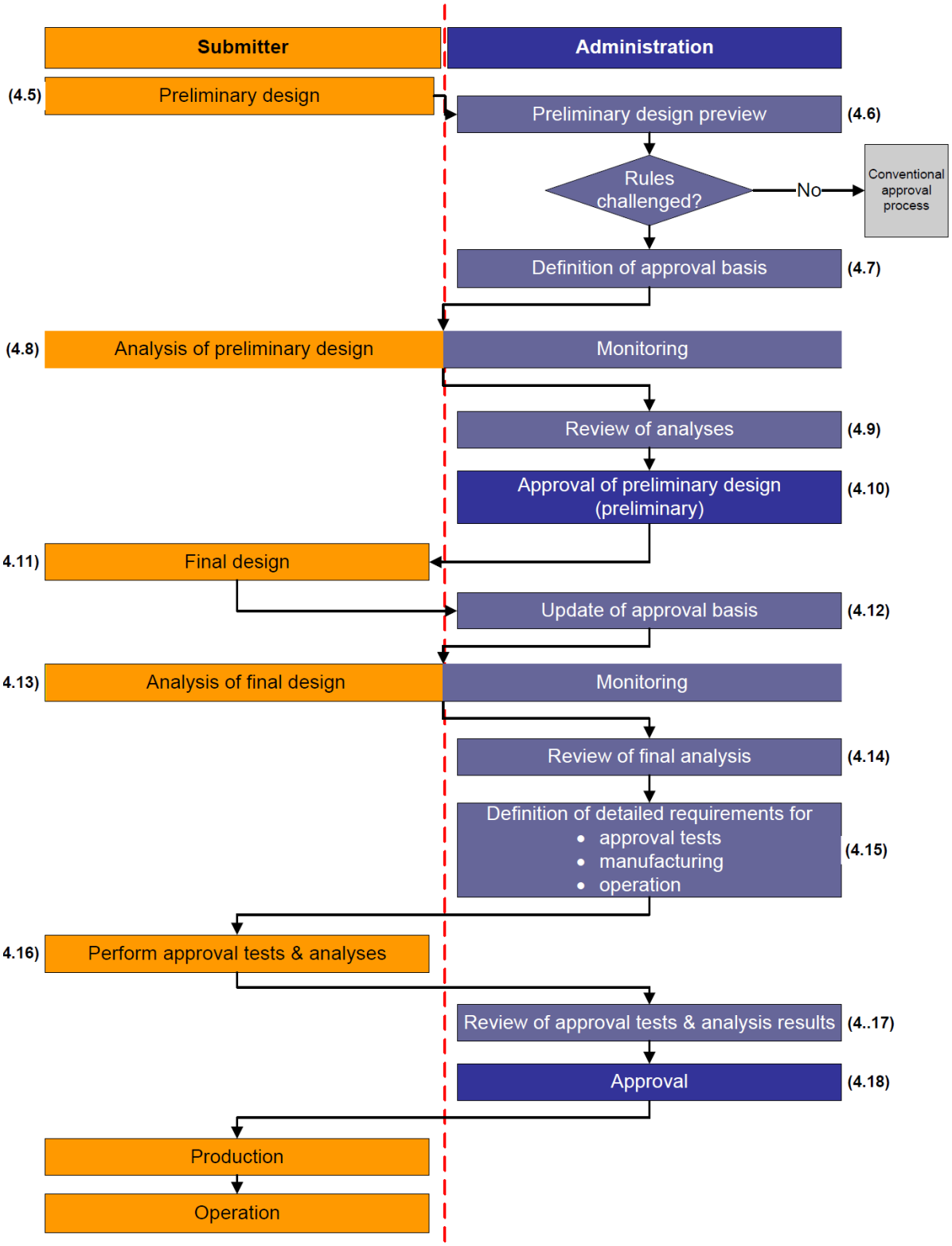
Figure 1: Design and Approval Process[7]



[7] MSC.1/Circ.1455, available at: https://www.mardep.gov.hk/en/msnote/pdf/msin1339anx1.pdf

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3.2.2 Inland navigation (Europe)

The *Comité Européen pour l'Élaboration de Standards dans le Domaine de Navigation Intérieure* (CESNI) is the European committee for drawings up standards in the field of inland navigation. It was established in June 2015 as the European Committee of the Central Commission for the Navigation of the Rhine (CCNR). Special inland vessels are to be approved and periodically surveyed by a class society e.g. inland vessels carrying dangerous goods, passenger vessels, ferries, high speed crafts. Currently, for Fuel Cells and Hydrogen:

- European Standard for Transport on inland navigation vessels elaborated by CESNI, ES-TRIN provides general provision for low-flashpoint fuels (Ch. 30; Appendix 8)
- EU Directive 2016/1629/EU provides the possibility for recommendations by the CESNI WG in order to issue special permits for new technologies
- The equivalence of safety shall be demonstrated by a risk assessment

Although very little practical experience exists, the legal situation of type approval of inland vessels containing hydrogen as a fuel and hydrogen fuel cells used for propulsion or auxiliary power appears to be similar to that described in the previous section on maritime vessels in the sense that it is characterised by the absence of specific normative rules which allow the type approval of such vessels.

3.2.3 Conclusions

The alternative design process is currently the only means for approval of HFC vessels for maritime use. This process implies high cost, regulatory uncertainty and delays (estimation of more than one extra year for approval[8], as compared with other, more established technologies).

According to the conclusions of the HyLaw project, in the absence of normative rules, the deep decarbonization of the maritime sector, as agreed by the EU (70% reduction of GHG emissions by 2050) and the IMO (50% reduction of GHG emission by 2050)[9] is in serious danger of becoming unattainable, as LNG and LPG technologies cannot achieve such a deep reduction in GHG on their own.

Considering an average lifetime of 30 years of vessels, the deployment of HFC vessels needs to take off, at an accelerated pace, from 2020 in order to meet the demand for new, greener, vessels and have a chance to realistically meet the commitments made.

[8] Estimation based on the experience of the Maranda project (Finland)

[9] 72nd session of the Marine Environment Protection Committee (MEPC 72) at the International Maritime Organization (IMO) , Memo, 13 April 2018

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The development of specific rules allowing for the type approval of hydrogen and HFC vessels at International level as well as for inland transport in EU waterways is needed in order for this sector to develop.

3.3 Landing / Bunkering[10]

In most countries, requirements for bunkering (loading) of hydrogen as a fuel on-board the vessel are not yet developed.

According to analysis conducted by the HyLaw project (www.hylaw.eu) general rules stemming from storage of hydrogen and rules covering Hydrogen Refuelling stations would apply.

Hydrogen storage units can only be installed in locations where such activities are allowedby applicable land use plans.

Subject to significant operational variance (in terms of scope of application and operationalisation of requirements), the storage of hydrogen is, generally, subject to the following requirements:

- Risk Assessments (as operationalised from the general obligations laid down in the SEVESO Directive[11]). Such requirements will always apply to storage facilities which store more than 5 tons of Hydrogen. Additional requirements ("upper tier") will apply to those facilities storing more than 50 tonnes
- Health and Safety requirementsand conformity assessment procedures, as envisioned by the ATEX Directive[12]. As this directive applies to zones where potentially explosive atmospheresmay occur, these obligations result from the nature of hydrogen as a flammable gas
- Environmental Impact Assessment procedures, as envisioned by the SEA[13] and EIA[14] Directives. Under which storage of Hydrogen may fall within the projects listed in Annex I[15] or under Annex II[16], for which Member States shall determine whether the project shall be made subject to an assessment or not. As Member States may choose to impose EIA/SEA obligations to hydrogen storage unitsts or not, in certain countries, the

[10] This section draws heavily on the analysis conducted and published by the HyLaw project (www.hylaw.eu)

[11] Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances,

[12] Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres

[13] Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (SEA Directive)

[14] Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (EIA Directive)

[15] 6 -Integrated chemical installations, i.e. those installations for the manufacture on an industrialscale of substances using chemical conversion processes, in which several units are juxtaposed and are functionally linked to one another

[16] 6a and 6c -production of chemicals; and storage facilities for chemical products

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storage of hydrogen below certain thresholds is not subject to such requirements[17]

When considering liquid Hydrogen, according to the EMSA Study on the use of fuel cells in shipping, current procedures for bunkering of LNG are based on cryogenic insulation, and double piping when going inside the vessel. Together with the experience from hydrogen filling stations for cars, this will be the first knowledge basis for all cases. All pressurized components, such as tanks, piping and equipment, must be in compliance with EU Directive 97/23/EC[18] -

4 National and regional requirements

4.1 Ship type approval and certification for vessels with H2 propulsion

4.1.1 Process

The International Maritime Organisation set up guidelines for the construction of ships and their energy systems. An example is the Code of safety for ships using gases or other low-flashpoint fuels (IGF-code). The basic philosophy of the IGF-code is to provide mandatory criteria for the arrangement and installation of machinery, equipment and systems for vessels operating with gas or low-flashpoint gases.
The Netherlands is a member of the IMO and based on the codes of the IMO, the Ministry of Infrastructure and Water management of the Netherlands translates this to Dutch regulations.
To make sure sea ships are sailing according to the codes of the IMO, the Human Environment and Transport Inspectorate (ILT) conducts inspections at the sea ships. So the ministry of Infrastructure and Water management translates the codes of the IMO to Dutch regulations and based on this the ILT supervises.
The certification of those ships will be done via certification agencies like Veritas or Lloyd's register.

Besides the ship type approval and certification, de development of regulatory issues in general can be indicated on four different levels:

Level	Organisation

[17] For example, in Germany, for hydrogen storage on–site >3t <30t –an environmental impact assessment could be required due to specific local circumstances; ≥ 30t < 200t –an environmental impact assessment is required, if the project as such can have considerable negative impact on the environment at the discretion of the approval authority by an overall preliminary assessmentand for hydrogen storage on–site≥ 200t –an environmental impact assessment is always required;

[18] The Pressure Equipment Directive (PED) (2014/68/EU) applies to the design, manufacture and conformity assessment of stationary pressure equipment with a maximum allowable pressure greater than 0,5 bar

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International (worldwide)	International Maritime Organisation (IMO)
European	Central Commission for the Navigation of the Rhine (CCNR) and the European Maritime Safety Agency (EMSA)
National	Ministry of Infrastructure and Watermanagement, Ministry of Social Affairs and Employment and Ministry of Finance.
Regional	Environmental Agency, Municipalities and the Port authority

Taking into account the regulatory roles of the organisations on the four different levels, the port authority does have a facilitating role in the development of regulatory issues.

4.1.2 Applicable Legislation

Bunkering can be done in various ways. Most of the time bunkering is done from truck to ship or ship to ship. Regulatory issues differ when bunkering an inland ship from truck to ship and a sea ship from ship to ship. When bunkering from truck to ship the environmental law is applicable. The environmental agency grants permits to companies that are willing to bunker in this way. When bunkering from ship to ship the port by law is applicable.
Port by law: https://www.portofamsterdam.com/sites/poa/files/media/pdf-en/port_bylaws_2019.pdf
Environmental law→ environmental damaging activity → Transport, logistics and supportive to that: https://aandeslagmetdeomgevingswet.nl/regelgeving/regels-voor-activiteiten/milieubelastende-activiteiten-hoofdstuk-3-bal/

4.1.3 Analysis of Barriers and challenges

For ship type approval and certification: No deytailed guidelines in the IGF code of the IMO yet for hydrogen or hydrogen related fuels.

4.2 Hydrogen storage in ports

4.2.1 Process

For storing hydrogen applicable rules in the field of safety are not set up yet. But important to take into account is the following:

The Port area of Amsterdam is divided over three zones.

Zone I: For this zone applies that there is only space for primarily existing risk companies, called bevi-companies. This zone is not suitable for expanding of

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existing not self-reliant functions or for new vulnerable objects (Royal Haskoning, 2009).

Zone II: This zone contains risk companies and labour-intensive industry. The zone serves to remain available risk companies, but must also accommodate labour-intensive industries, with permission of the environmental service. Zone II have fewer expansions and location options in comparison with zone I. This zone is not suitable for expanding of existing not self-reliant functions (Royal Haskoning, 2009).

Zone III: This zone is considered less suitable for the arrival of new ones and the expanding of existing risk drivers. Some risk companies are located in zone III. Given the relatively short distance to the city, large offices and recreational areas are mainly used for this less risky activity (Royal Haskoning, 2009).

Besides the different zones there are other guidelines to take into account to point out a correct location for bunkering hydrogen.

A Safety contour is a drawn area where the risk contour should not exceed the safety contour. The following basic principles have been taken into account in determining the exact location of the safety contour: The Westpoort External safety area vision, the presence of high risk establishments, the presence of vulnerable objects and their functional bonding and the developments that can reasonably be expected. In addition, possible cumulation of the location related risk and the options for limiting group risk as much as possible have been taken into account.

The group risk. The group risk is the cumulative probability that a present group of 10, 100 or 1000 people die as a direct result accident involving dangerous substances (Royal Haskoning, 2009).
The location related risk refers to the probability per year that an imaginary person dies as a direct result of an accident involving dangerous substances if this person is continuously and unprotected in the vicinity of a risky establishment or transport axis. In zone I are new transport axis, pipelines, LPG-stations and berths with dangerous goods possible as long as the probability of the location related risk is less than 10^{-6}, no vulnerable objects in the near surrounding. The maximum permitted location-related risk must be observed, environmentally licensed and fit into spatial planning (Royal Haskoning, 2009).

Vulnerable objects are for example windmills. Vulnerable objects must be taken into account when placing storage tanks with hydrogen for example. Extra attention in the field of regional safety will be given.

4.2.2 Content

To make reservations in the spatial planning for bunkering hydrogen in preperation the first demand for hydrogen by inland ships and sea ships in 2030 or earlier. The

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reason to do this is to minimalize the risk that there is no suitable bunkerplace for hydrogen.

4.2.3 Analysis of Barriers and challenges

At this moment the barrier is that there are no rules and regulations yet for adoption of hydrogen in the shipping sector. For storing hydrogen: Not clear how safety contours will look like for storing hydrogen. Risk analysis are not made yet for hydrogen.

4.3 Refueling ships with hydrogen

4.3.1 Process

Environmental agency
When bunkering gas hydrogen or $NaBH_4$ hydrogen from truck to ship the environmental agency is the organisation to grant bunker permits. Important to note is that the environmental agency is not a department of the city of Amsterdam. The environmental agency has different departments and works for different provinces and municipalities. In the North Sea canal there are two environmental agency, one for area Amsterdam and Zaanstad and one for area Ijmond. In 2021 the new environmental law will be published. The role of the environmental agency is to grant permits which are land orientated for bunkering. The most well-known land orientated bunker type is truck to ship but can also be a fixed installation at the quay to ship.

Municipalities
The most well-known water orientated bunker type is ship to ship. When bunkering from ship to ship the port by law is applicable. The port by law is applicable in the municipalities of Velsen/Ijmuiden, Beverwijk, Zaanstad and Amsterdam. Those municipalities, the Harbour Master's Division of the Port of Amsterdam and the juridical department play an important role in the designation of bunkering hydrogen in the port by law.
Besides the designation of bunkering hydrogen in the port by law, port authorities make it mandatory in the port by law to bunker according the International Association of Ports and Harbors (IAPH) checklists. Those checklists give an overview on a step-by-step basis how to bunker in a safe and correct way. To make the bunkering of gas hydrogen and $NaBH_4$ hydrogen possible in the following 10 years it is desirable to set up the IAPH checklist also for bunkering gas hydrogen and $NaBH_4$ hydrogen.
The checklists have been published on the World Ports Sustainability Program (WPSP, 2018). The checklists can be found by the following link:
https://sustainableworldports.org/clean-marine-fuels/lng-bunkering/bunker-checklists/

Port authorities
Taking into account the different organisations and their role on each level, the role of the port of Amsterdam is to facilitate the cooperation between the organisations to develop a regulatory understanding by the companies that have interests in bunkering hydrogen.

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With this, companies can react faster and more correctly on the regulatory part of the development of hydrogen and as a consequence, are more willing to invest in the development of hydrogen supply chain.

4.3.2 Applicable Legislation

Bunkering can be done in various ways. Most of the time bunkering is done from truck to ship or ship to ship. Regulatory issues differ when bunkering an inland ship from truck to ship and a sea ship from ship to ship. When bunkering from truck to ship the environmental law is applicable. The environmental agency grants permits to companies that are willing to bunker in this way. When bunkering from ship to ship the port by law is applicable.

At this moment gas hydrogen and $NaBH_4$ hydrogen is not designated yet in the environmental law and the port by law.

4.3.3 Analysis of Barriers and challenges

At this moment the barrier is that there are no rules and regulations yet for using hydrogen in the shipping sector.

- For bunkering hydrogen:
  - Not clear when and how hydrogen will be designated in the port by law
  - Not clear when and how hydrogen will be designated in the environmental law.

5 Conclusions and Recommendations

Recommendations:

- Designate bunkering hydrogen in the port by law.
  - Set up IAPH bunker checklist for gas hydrogen and $NaBH_4$ hydrogen. Peter Alkema and team Clean Marine Fuels (CMF) are started to realize this. The Port by law of different ports refer most of the time to the IAPH bunker checklist to make sure bunker companies know what they have to take into account before bunkering hydrogen.
- Designate bunkering hydrogen in the environmental law.
- Make reservations in the spatial planning for bunkering hydrogen.
- Further investigation is required to get to know how the regional safety principles will look like for producing, storing and bunkering hydrogen.
- Further investigation is required to get to know the capex and opex to the upstream,- and downstream supply chain from raw materials to end customer.

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