Interreg
North-West Europe
H2SHIPS

EUROPEAN UNION

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

Deliverable T1-1.4

Document Control Sheet

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AF	Application Form
NWE	North West Europe
PA	Partnership Agreement
PP	(Full) Project Partners
WP	Work Package

1 Executive Summary

This report is deliverable T1-1.4 of Work Package 1 of the H2SHIPS project: Note on Social Acceptance. The H2SHIPS project is an Interreg North West Europe project. It will demonstrate the added-value of hydrogen for water transport and develop a blueprint for its adoption across North West Europe. The project involves three demonstrators: in Paris, Oostende and Amsterdam. In Amsterdam an electrical driven Port Authority ship with a hydrogen Fuel Cell and dry storage of hydrogen in a chemical hydride will be built. In Oostende, a supply barge for the bunkering of sea ships with gaseous Hydrogen will be established, and in Paris the building of a Local Electrolysis hydrogen production plant will be prepared, aimed to deliver the hydrogen for future use of vessels on the river Seine.

The objective of this report is to analyse potential opposition to hydrogen technology for each pilot, in order to identify any necessary actions to be included in the communication strategy of the Hydrogen initiatives in each pilot.

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In the report, a theoretical framework is described, with reference to recent literature (PhD thesis, journal papers, reports) on the subject of Public Acceptance of Hydrogen projects and Maritime Demonstrators. In this framework, a balance between positive emotional drivers (joy and pride) and negative emotional drivers (fear and anger) is introduced. This balance operates on the issues of perceived environmental benefits of the Hydrogen project, the perceived risks of the project and the perceived usefulness of the project.

Important for the H2SHIPS project communication is, to facilitate an open cross-sectoral communication, e.g. in terms of technology exchange in other, sometimes more mature sectors, and to establish a well structured international dissemination of project results to prevent radical and disruptive results of demonstrators from being neglected in a broader perspective.

In all cases, a solid and timely communication of both the potential of the project as well as the risks of the project is paramount for a mature Social Acceptance of the projects. A solid position of industry and government facilitates this process.

The already gained experiences in the 3 Demonstrator areas acknowledge these insights. In most cases the balance between joy and pride related to the potentially positive environmental impact of hydrogen propulsion on ships was welcomed. In parallel, all ports organise stakeholder meetings to clarify potential risks of hydrogen application on board of floating platforms to control expectations and concerns in terms of for instance explosion and flammability risks of the storage of hydrogen in bunkering systems and on board of ships.

It is recommended to verify the theoretical framework of this report with the experiences within the framework. An important element in this verification could be the comparison of gaseous hydrogen storage with the probable lesser risks of the solid storage of hydrogen in hydrides. And finally it is recommended that the Communication Strategy of the H2SHIPS project is verified with the conclusions of this report.

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2 Introduction

2.1 The H2SHIPS project

In July 2019, Interreg Nort-West Europe (NWE) gave the final authorisation to the project H2SHIPS: *System-Based Solutions for H2-Fuelled Water Transport in North-West Europe.* [Application Form H2SHIPS, Berthon, pp.1] Given the conclusions of the (H2020) PROMINENT project "that the inland waterway and maritime transport sectors have a large potential to become more environmentally friendly" [AF H2SHPS, Berthon, p. 2], the H2SHIPS project was started to create the required breakthrough alternatives. Hydrogen (H2) propulsion approaches full market maturity and is the only option that allows total decarbonisation of waterborne transport: high efficiency, energy density and no local GHG emissions. Its uptake requires dedicated infrastructure, close to end users. With predictable routes and proximity with other industries, water transport proves particularly adapted to H2. The H2SHIPS project will demonstrate the added-value of H2 for water transport and develop a blueprint for its adoption across NWE.

Key element of the H2SHIPS project is the development of Demonstrator Projects for waterborne hydrogen application. Three demonstrator projects are defined (ref. figure 1).

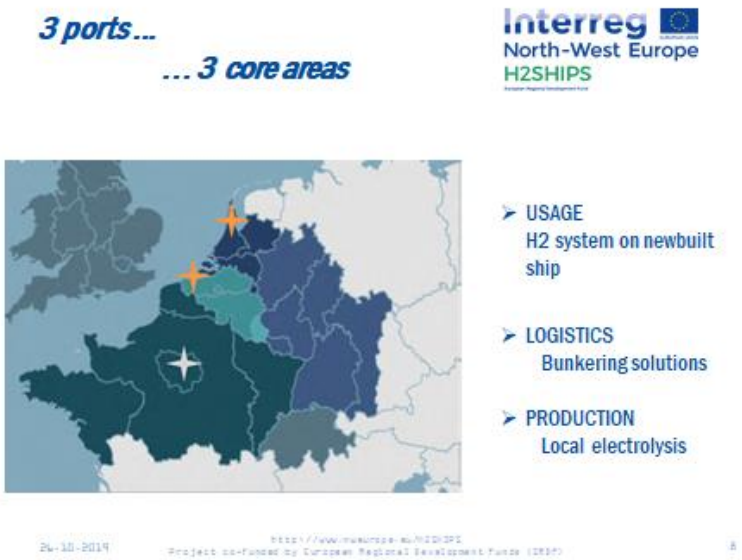

Figure 1. Overview of Demonstrator Projects in H2SHIPS

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Three major aspects of maritime H2 application are being researched in the 3 demonstrators:

a. Amsterdam: the design and building of an electrical driven Port Authority ship with a hydrogen Fuel Cell and dry storage of hydrogen in a chemical hydride [USAGE], including the logistics and supply chain required to deliver and bunker Hydrogen on board of the ship.

b. Oostende: the design and building of a supply barge with the bunkering of sea ships with gaseous Hydrogen, stored under pressure. [LOGISTICS]

c. Paris: the preparation of the building of a Local Electrolysis hydrogen production plant, aimed to deliver the hydrogen for future use of vessels on the river Seine.

The Work Packages in H2SHIPS structure the objective of the project (figure 2).

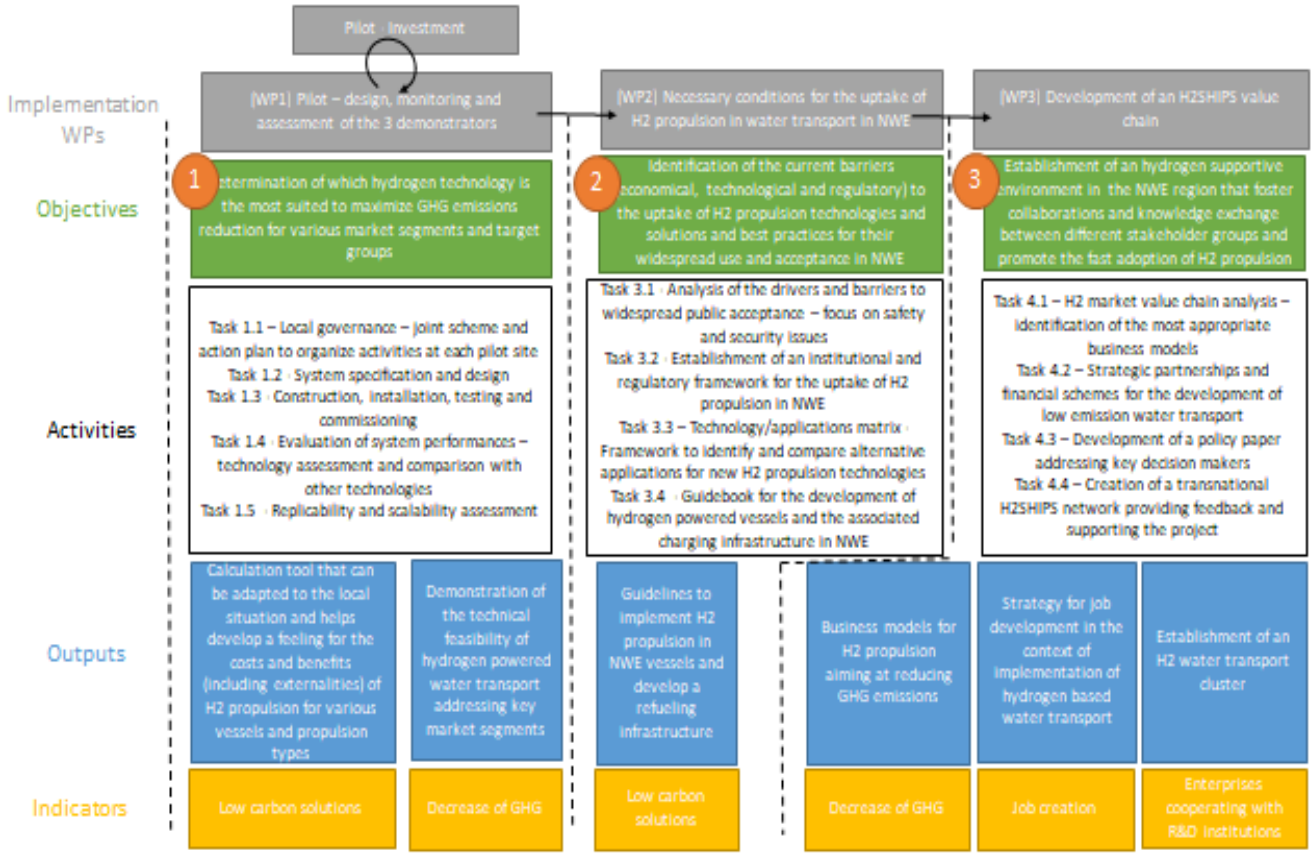

Figure 2: Structure of the Implementation Work Packages

Work Package 1 is the first Implementation Work Packages of the Project. The objective of this Work Package is *the Joint steering of project demonstrators and*

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creation of sustainable local ecosystems around each pilot project. Work Package 1 is structured in 4 activities, see *table 1*.

#	Activity
1	Joint scheme and action plan to define common ground to organise activities and stakeholders' contribution on each pilot site
2	Development of local ecosystems around H2 propulsion and storage demonstrators implemented in H2SHIPS
3	Replicability and scalability assessment (of the demonstrators)
4	Joint specifications and evaluation of system performances – Technology assessment and local governance system

Table 1. Description of Activities in Work Package 1.

As mentioned in Table 1, Activity 1 aims to describe a *Joint scheme and action plan to define common ground to organise activities and stakeholders' contribution on each pilot site.*

The Application Form clarifies this Activity as follows: *The process of associating at local level all relevant stakeholders, local & port authorities, civil society, shipbuilders and industry players is jointly defined by partners and adapted to each specific pilots. Cooperation of key actors will allow H2SHIPS to gather actual priorities, valuable to assess the results of the pilots on common basis while adapting approaches to specific environments. Activity is lead by Ports authorities, namely Port of Ostend and Port of Amsterdam.* [Berthon, AF, pp. 25].

Earlier deliverables focused on the stakeholder structure of social ecosystem in the Demonstrator Area's and the technical requirements for a successful design, development, building and testing of the Demonstrators.

However, elementary for this H2SHIPS project is the implementation of Hydrogen as an alternatively fuel. Both from a historical and social perspective, the acceptability of this fuel is not evident. On the one side, as stated in this introduction, hydrogen is one of the very few alternatives that allows total decarbonisation of waterborne transport and could accept a willing of positive attitude of the general public. On the other hand, several storage options for hydrogen could be experienced by the public as riskful, and implementation of hydrogen as a shipping fuel would require very

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significant public investments, which could displace public investments in other environmental or policy issues. For that reason this deliverable T1-1.4 analyses potential opposition to hydrogen technology for each pilot, in order to identify if any necessary actions are to be included in the communication strategy of the Demonstrator initiatives.

This deliverable was due in April 2020. However, the actual developments in the three pilot areas showed their own diversity in maturity of the local project, culture of the social, business and governance structure in each region and timeframe of the hydrogen implementation project. For that reason, from the perspective of this Deliverable T1-1.4, it was decided to benefit from the observations in the first project year and to describe the first insights in possible social acceptance issues close to one year after the kick-off meeting in Oostende (in August 2019). Further guidance for the description of the local action plans in each demonstrator area were discussed during the Project Meeting in Birmingham (21-22 January 2020), a videoconference of WP1-stakeholders on 15 May 2020 and the online Project Meeting of 10 June 2020. Needless to mention that the online nature of the last meetings were inevitable giving the restrictions imposed by the COVID-19 control measures in Europe.

The Report will first start with a Literature Survey. This framework will be verified with a short analysis of topical experiences. The Report will conclude with conclusions and recommendations for the communication strategy of the three Demonstrator projects.

2.2 Objective of the Report

This report is the Deliverable 1.4 of Activity 1: Note on Social Acceptance. The objective of this report is to analyse potential opposition to hydrogen technology for each pilot, in order to identify any necessary actions to be included in the communication strategy of the Hydrogen initiatives in each pilot.

The scope of this report is constrained towards public social acceptance. In earlier deliverables the role of professional stakeholders. Nevertheless, in early July 2020 a report of EICB was submitted by order of the Dutch Government which focuses on very relevant conditions for the implementation of Hydrogen: *Waterstof in binnenvaart en Shortsea, een inventarisatie van innovatietrajecten.* This report identifies four stakeholders:

• Hydrogen Logistic and infrastructure supply parties;

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• Logistic supply parties for the cargo;
• Parties which cover the financial investments;
• Governmental parties responsible for rules and regulations of the technological hydrogen solutions.

3 Theoretical Framework

In this chapter, recent literature (PhD thesis, journal papers, reports) will be introduced and discussed. Some of the literature (Di Ruggero, the NEMO project) was already introduced in Deliverable T1-1.1 [Visser, 2019] from the perspective of stakeholders, but they will now be considered from the perspective of Social Acceptance, the objective of this deliverable T1-1.4.

The literature research will end with sub-conclusions, relevant for the focus of the H2SHIPS project.

3.1 Public Acceptance of Hydrogen: Di Ruggero.

This paragraph is a quote from an earlier deliverable. T1-1.1 [Visser, 2019, paragraph 3.1.1, pp. 9-10], where already a reference was made to public Acceptance in Chapter 3. Visser makes a reference to the doctoral thesis

Anticipating Public Acceptance: the Hydrogen Case [Di Ruggero, 2014]. Di Ruggero identified three problems: "first, hydrogen is such in an early stage of development that citizens don't know much about it. Second, being an energy carrier, the implementation of hydrogen will require many other technologies such as the primary energy sources used to produce hydrogen, the way in which hydrogen is transported or applied. Third, and related to the previous point, the public is heterogeneous in preferences." [di Ruggero, pp. 134]. In his abstract, he states: "The results confirm that the public is heterogeneous and that there is no straightforward answer to the question of whether hydrogen will be accepted, yes or no." Di Ruggero focused his thesis on the general public, and did not address other stakeholders in the social acceptance within local ecosystems, like mentioned in the Application Form of H2SHIPS [Berthon, AF, pp. 25]

- local public authority
- regional public authority

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- national public authority
- infrastructure and (public) service provider
- interest groups including NGOs
- higher education and research
- enterprise, excluding SME
- SME

3.2 The emotional dimensions of energy projects: Anger, fear, joy and pride about the first hydrogen fuel station in the Netherlands: Huijts

In her paper *The emotional dimensions of energy projects: Anger, fear, joy and pride about the first hydrogen fuel station in the Netherlands* [Huijts, 2018] Huijts describes the balance between positive emotions (pride and joy) and negative emotions (anger and fear) in the implementation of hydrogen as a fuel.

	positive		**negative**	
Emotion	joy	pride	fear	anger
Drivers	1. Good awareness/ communication prior to the project 2. Trust in industry 3. Trust in Government		1. Perceived procedural unfairness 2. Perceived unfairness in distribution of costs, risks and benefits	

Table 2: Oversight of Emotional Dimensions of energy projects [Huijts, 2018]

Huijts describes three relevant themes for shaping the public opinion for hydrogen projects:

a. The perceived outcomes for the environment,
b. The perceived risks of the project
c. The perceived usefulness of the project

Finally, Huijts draws very significant conclusions which could be very relevant for the Demonstrator projects of H2SHIPS: „Identifying, adjusting, and communicating about factors that reduce anger and fear, as well as factors that bring joy and pride, may thus strengthen support for and reduce resistance to a project. In any case, in communication, a good balance should always be struck between discussing positive and negative outcomes of a project. Otherwise citizens may be or feel manipulated, which can easily backfire“

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3.3 Danish demonstration projects as drivers of maritime energy efficient technologies: Mosgaard, Kerndrup

In their paper *Danish demonstration projects as drivers of maritime energy efficient technologies* [Mosgaard, 2016], Mosgaard and Kerndrup give a very interesting analysis of 5 demonstrator projects for energy efficient technologies. The data collection was funded by SAIL, EU Interreg IVB, The North Sea Region Programme. The objective of their paper was to analyze the drivers and barriers in demonstration projects in the maritime sector and the potential outcome of the projects. Although the projects did not involve Hydrogen projects, the process analysis in this paper is very relevant for the Demonstrator projects of H2SHIPS. One of their specific findings is, that the maritime sector tends to be conservative. The characteristics of the demonstrators could initiate disruptive change for the sector, therefore effective change management, including social and professional adaption and adaptation of involved crew managers and technical staff, is paramount.

Two very specific sub-conclusions were drawn:

a. the maritime sector is believed to operate in a rather „closed“ way towards other sectors. This could initiate a barrier for new technologies: the innovative character of new technology on board of ships could have an already very mature character in other sectors. For H2SHIPS an open mind to other than maritime sectors and a dynamic dissemination of results could already reduce the barriers for new technology.

b. another subconclusion was that, despite the principally international character of shipping, the selection of demonstrator partners seemed to be limited to a small region, mostly national. That is a barrier for dissemination of innovation knowledge too. Mosgaard and Kerndrup recommend to organise a structured dissemination (funding included) to prevent loss of implementation gain because of too much a regional (non English speaking) scope. For H2SHIPS the already structured international cross-level dissemination is vital for long-term operationalisation of project results.

With reference to Mosgaard and Kendrup: *„It is difficult for “non-maritime” actors to enter this sector, and the demonstration projects described have created an opportunity for this by including new actors in their cyclic collaborations. It seems that the collaboration is easier in the projects that only include maritime actors, but also these projects mainly result in incremental changes. It is important that the demonstration projects also have funds for dissemination that can facilitate the distribution of the*

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knowledge gained in the projects about changes in practices as well as the application of technologies and technical specifications; this is not the case today".

3.4 Experiences with earlier hydrogen ships

This paragraph refers to earlier experiences with hydrogen ships. Extensive experience has been developed within the Amsterdam NEMO H2 project. The project was referenced in Deliverable T1-1.1 of H2SHIPS [Visser, 2019, pp. 10, para 3.1.2]. It involved the design, building and operation of a 20 meter canal boat for 100 passengers sightseeing the canals of Amsterdam. The propulsion system included a fuel cell and pressurized hydrogen gas as fuel. The boat was delivered in 2011. In July 2011 the public Final Report was published [Ministry Economic Affairs NL, July 2011].

[Huijts] describes the balance in the public experience with hydrogen as a fuel for cars: from the one side joy and pride because of the zero emission characteristic of hydrogen, and on the other hand the perceived risk of the hydrogen gas and its storage may attribute to more negative feelings like anger and fear.

NEMO delivered interesting evaluations for the application of the theory of [Huijts] for maritime hydrogen systems. One of those evaluations was, that in the early stages of the project, pride and joy were dominant in the general public consideration, but later in the project, the design and the awareness of the (explosion) risks seemed to overtake this general feeling, regardless the approval of the National Maritime Safety authority. "Despite frantic efforts of the ship owner and third parties, the City Council of Amsterdam has never permitted a license to operate in the City canals. As a result the Nemo H2 was stuck at the jetty alongside the Amsterdam Central Station as an example of a unwilling City Council". [https://nl.wikipedia.org/wiki/Nemo_H2_(schip,_2009)]

The careful approach towards certification of the system took extra time, but was an important enabler for the final technical acceptance of the system. As the Wiki citation shows, the lack of public acceptance of the City Council was the bottleneck in 2011, although the root cause might not be the technology of the ship but the risks of the supply chain . From the ship perspective, the developed regulations may still be a blueprint for new systems on board of ships of this size. It will be interesting to observe the process of City Licenses for the new Port Authority vessel, the H2SHIPS demonstrator.

It is important to assess the grade of social acceptance of other hydrogen vessels. There are good examples in Hamburg (Alsterwasser), Nantes (Jules Verne 2), Bristol

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(the Hydrogenesis) and Birmingham (the Ross Barlow). The general observation is, that these vessels showed a good public acceptance, especially considering that these ships were all passenger/tourist vessels. It will be interesting to see whether cargo vessels meet other public assessments.

Nevertheless, with a reference to the document of deliverable T1-1.1 , although the acceptance of previously cited boats was good, what brought the two most emblematic projects to an end (Nemo and Alsterwasser) was the lack of a viable value chain, including the required adapted supply chain for the H2. Two conclusions may be drawn from this: the scope of social acceptance should include this total value chain (hydrogen production, transportation, bunkering and consumption, and if applicable the transport of spent fuels), including the social acceptance of the performance and risks in the components in these chains. The big challenge is to reach the same level of acceptance when we install electrolysers, storage and bunkering stations, i.e. industrial-looking facilities, with 'visible' fear agents like pressure tanks. A permissive social acceptance of this integrated chain might realise the paradigm shift towards a total acceptance of hydrogen transport solutions.

Given the development of hydrogen technology in general (including hydrogen cars) and the application of sodiumborohydride specifically in Amsterdam, it may be considered that the stakes are different in 2020 than those after the first decade of this century in Amsterdam and Hamburg.

3.5 Subconclusion theoretical framework

Given the considerations in the analysed literature, Social Acceptance of hydrogen will always involve positive emotions (joy and pride, enhanced by early notification of the project and trust in industry and government) and negative emotions (anger and fear, driven by perceived unfairness in legal procedures and the distribution of costs, risks and benefits) [Huijts].

These positive and negative emotions should have a balanced approach, and should both be addressed. The most important themes in these emotions are the perceived benefits for environment, the perceived risks of the technological solutions and the perceived usefulness of the project.

Important for the H2SHIPS project communication is, to facilitate an open cross-sectoral communication, e.g. in terms of technology exchange in other, sometimes more mature sectors, and to establish a well structured international dissemination of project results to prevent radical and disruptive results of demonstrators from being neglected in a broader perspective [Mosgaard, Kendrup].

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In all cases, a solid and timely communication of both the potential of the project as well as the risks of the project is paramount for a mature Social Acceptance of the projects. A solid position of industry and government facilitates this process.

4 Discussion

The paper of [Huijts] has been distributed to the WP1-partners after the WP1 online meeting of 15 May 2020. The preliminary reactions of the projectpartners were, that the observations and analysis of Huijts were recognised in the Port experiences. In most cases the balance between joy and pride related to the potentially positive environmental impact of hydrogen propulsion on ships was welcomed. In parallel, all ports organise stakeholder meetings to clarify potential risks of hydrogen application on board of floating platforms to control expectations and concerns in terms of for instance explosion and flammability risks of the storage of hydrogen in bunkering systems and on board of ships.

Two practical observations were made in the meeting. The first one was, that the required technology and infrastructure to mitigate the potential risk of gaseous hydrogen bunker stations could result in very high investments costs. Examples in London were referred to. This could be a trigger for negative public acceptance (fear, anger, as introduced by Huijberts) for local implementation initiatives.

The second observation was, that most of public concerns were related to the flammability and explosion risks of hydrogen. This required an extensive classification process in the NEMO project. The interesting characteristic of H2SHIPS is, that the project does not constrain itself to gaseous, hyperbaric storage of hydrogen, but that solid storage of hydrogen (in a complex hydride) is being taken into account too in the Amsterdam demonstrator project. The hypothesis is, that the flammability and explosion risks are much lower in case of the hydride storage. It will be very interesting to observe whether this can be verified in the project, and if this has a positive impact on Social Acceptance of maritime hydrogen application in the region.

The three demonstrator ecosystems in H2SHIPS offer a very relevant platform to assess the parameters which drive the social acceptance of hydrogen solutions. It was already concluded, that the local cultures and ecosystems in Paris, Ostend and Amsterdam have their own characteristics and their mutual differences. Paris is developing a new hydrogen transport system without previous experiences with hydrogen ships, Ostend will focus on the floating storage and distribution of hydrogen and Amsterdam will launch a ship with a new hydrogen carrier. It is paramount to understand the impact of these respective differences in local

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ecosystem culture on (possible differentiation in) social acceptance of maritime hydrogen solutions in these three ports. Within WP T1 this phenomenon will be closely observed in order to deepen our understanding of parameters of social acceptance.

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5 Conclusions and Recommendations

A literature review was carried out, in order to establish a theoretical framework for Hydrogen Public Acceptance. From this literature review, it was concluded that Social Acceptance of hydrogen will always involve positive emotions (joy and pride, enhanced by early notification of the project and trust in industry and government) and negative emotions (anger and fear, driven by perceived unfairness in legal procedures and the distribution of costs, risks and benefits) [Huijts].

For the communication strategy of the H2SHIPS project, it is important that these positive and negative emotions have a balanced approach, and should both be addressed. Within this approach, the most important themes are [Huijts]:

- the perceived benefits for environment,
- the perceived risks of the technological solutions and
- the perceived usefulness of the project.

A relatively “closed” approach is not uncommon for the maritime sector. It is very relevant for the H2SHIPS project to maintain an open approach to other than maritime sectors, in order to facilitate disruptive and radical inputs of other sectors in transition to low carbon technology. The dissemination structure of results should guarantee an international impact, ensuring cross-region and cross-sectoral awareness of game changing Hydrogen implementation initiatives.

In all cases, a solid and timely communication of both the potential of the project as well as the risks of the project is paramount for a mature Social Acceptance of the projects. A solid position of industry and government facilitates this process.

Within the Demonstrator ecosystems of Amsterdam, Ostend and Paris, these conclusions are acknowledged. The joy and pride of potential zero carbon ship propulsion technologies meet potential anger and fear on the perceived unfairness in distribution of costs, risks and benefits. Given earlier experiences, the scope of societal acceptance should include the total hydrogen value chain, including storage and supply.

The H2SHIPS project is not constrained to gaseous hydrogen storage. The solid storage of hydrogen in the Amsterdam pilot might give an alternative for these risks. It will be interesting to observe any impact of the level of Societal Acceptance for this Hydrogen implementation alternative.

It is recommended to verify the described parameters for Societal Acceptance of Hydrogen during the H2SHIPS project developments in Amsterdam, Ostend and

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Paris, in order to evaluate the described theoretical framework parameters of this report.

Finally, it is recommended that the Communication Strategy of the H2SHIPS project is verified with the conclusions of this report. .

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