HyDelta 2

WP10 – Social acceptance for hydrogen transport and storage

D10.2 – Results from stakeholder interviews on the societal embeddedness of hydrogen technology development and deployment in the Netherlands.

Status: final

This project was co-financed by TKI New Gas | Top Sector Energy from the PPP allowance under reference number TKI2022-HyDelta.

Document summary

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Document history

Version	Date	Author	Affiliation	Summary of main changes
1		Marit Sprenkeling, Kevin Vedder	TNO	First version
2	03-04-2023	Marit Sprenkeling, Kevin Vedder	TNO	Final version

Dissemination level

PU	Public	
RE	Restricted to • Project partners including Expert Assessment Group • External entity with whom a Non-Disclosure Agreement exists	X

Document review

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Summary

Hydrogen has the potential to play an important role in the future (sustainable) energy system of the Netherlands and reducing greenhouse gas emissions. For the development and application of energy technologies, it is important to consider social aspects in addition to technical aspects.

Based on 14 semi-structured interviews, hydrogen developments in the Netherlands were mapped according to the four Societal Embeddedness Level (SEL) dimensions (impact on the environment, stakeholders and public, policy, laws & regulations and market & (financial) resources). Because environmental and market impacts are also highlighted in other work packages of HyDelta 2.0, these interviews focused on stakeholder and public involvement and policy laws and regulations.

The research question for this task is:

"What are the stakeholder perspectives on the societal embeddedness of the development and deployment of hydrogen technologies in the Netherlands and associated societal risks?"

First, the impact of hydrogen as an energy carrier in the Netherlands on the environment was examined. This shows that the greatest potential impact is experienced when it comes to (the feeling of) safety, use of space for energy transition and living environment and nuisance from light, noise and use of space during the (re)construction of projects.

Second, we looked at stakeholder and public involvement. Here it emerges that hydrogen seems to have a positive image among the public, although the level of knowledge is still low. There is a need for communication from either the government or knowledge institutions to the public, but also to organizations that (want to) get involved with hydrogen. Public information needs are in the areas of practical issues, safety and finance. Organizations (wanting to) get involved with hydrogen need more communication about the vision and goals regarding hydrogen in the Netherlands. In obtaining and maintaining public support, information and communication play an important role, but trust and a sense of justice are also important.

Third, policy, laws and regulations were examined. This shows that the policy framework regarding hydrogen is still evolving. New standards need to be set and roles of established and new parties are changing. Licensing procedures still have a long lead time, which is perceived as a challenge by parties involved. There is much development in this area, for example in the form of the Temporary Guidelines for Safety.

Finally, we looked at market and financial resources. Here it emerges that the market for hydrogen has yet to be established or brought into being. There is still uncertainty in the development of supply and demand. The uncertainty of supply and demand combined with uncertainty in the policy framework and long-term vision from the government means that investing in hydrogen is often still seen as risky.

The analysis of the perspectives of hydrogen in the four SEL dimensions shows that social support for hydrogen in the Netherlands is currently good. A number of (societal) challenges also emerge:

1. There is no consensus yet on how hydrogen should be applied in the Netherlands.
2. Public support may diminish when project developments start. This can be influenced by:
    a. Lack of trust in activities or parties involved;
    b. Lack of sense of fairness.
3. Lack of policies and standards can delay project development and deter companies from investment decisions.
4. Long lead time of permitting procedures can delay progress of project development.

5. The energy system is changing, and so are roles, for example those of government, grid operators, regulators and energy providers.
6. The energy transition is a major task but available space in the Netherlands is limited. A risk is that insufficient space is available.
7. There is scarcity of knowledge and labor. The tightness in the labor market can cause project development and permitting to have a longer lead time.

The results from this report indirectly contribute to the results of HyDelta work package 3 (risks and collaboration in H2) and HyDelta work package 6 (safe operations LP grid).

Following this task, the results of the literature review, local case studies and stakeholder interviews will be brought together in a synthesis. Through co-creation workshops with HyDelta research partners and (local) stakeholders the results will be compared, validated and worked towards what 'risk governance strategies' for societal risks and uncertainties can look like.

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1. Introduction

Hydrogen has the potential to play an important role in the future (sustainable) energy system and reducing greenhouse gas emissions. For the development and application of energy technologies, it is important to consider societal aspects in addition to technical ones. Societal aspects, such as social capacity, supportive policies and willingness to invest can both accelerate and delay the development and application of hydrogen technologies.

HyDelta 2.0 is a research program that evolves around identifying how the challenges for the safe and large-scale implementation of hydrogen in the Netherlands can be overcome within the existing gas grid. Work package 10 focuses on the societal embedding of hydrogen and revolves around the question:

"What are the main societal challenges for developing and implementing transport/distribution, storage and applications in the built environment in the Netherlands, and how can these challenges be overcome?"

Figure 1 shows the activities of work package 10 in HyDelta 2.0. In the first task, 'state of the art' (Elbert, 2022: www.hydelta.nl), a literature review was conducted on social acceptance of hydrogen. This showed that the willingness of the Dutch public to accept hydrogen is average to high, but that this acceptance might decrease when developments get closer to the public, for instance in concrete project development. The study also found that the publics' knowledge level is still low. Opportunities to increase the knowledge level and acceptance are good communication and participation in project development, according to the literature review.

The aim of task 10.2, part of HyDelta 2.0 work package 10, is to gain a deeper understanding of the societal preconditions of hydrogen developments in the Netherlands using interviews with a diverse stakeholder group. These interviews use the Societal Embeddedness Level (SEL) methodology to focus on stakeholder and public engagement and policy, legislation and regulation. The research question answered by this task is:

"What are the stakeholder perspectives on the societal embeddedness of the development and application of hydrogen technologies in the Netherlands and associated societal risks?"

Following the stakeholder perspectives discussed in this report, four local case studies were examined. The findings of the local case studies are presented in report 10.3. Following this task, co-creation sessions are held with stakeholders from the HyDelta consortium and stakeholders in the Dutch hydrogen field. In these sessions, the perspectives as reflected in this report are discussed and work towards 'risk governance' strategies. Finally, the synthesis brings all tasks together and draws final conclusions using internal validation sessions.

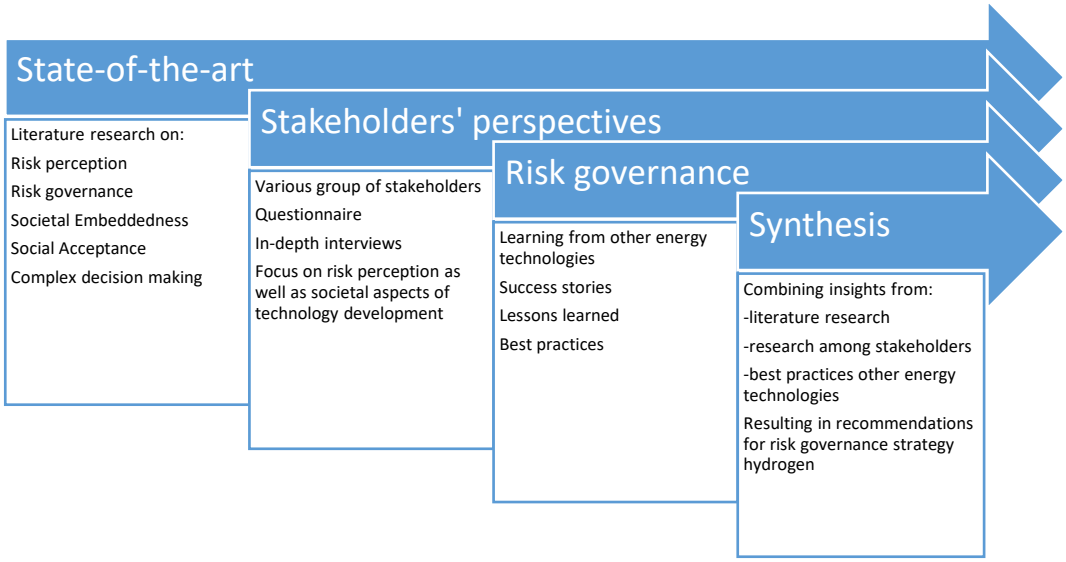

Figure 1: HyDelta 2.0 work package 10 tasks

This report discusses stakeholder perspectives on the societal embeddedness and societal risks and uncertainties of hydrogen developments and applications in the Netherlands. The perspectives were retrieved using semi-structured interviews with 14 stakeholders. The dimensions of the SEL methodology (Sprenkeling et al., 2022) were used to retrieve the perspectives.

2. Research method

2.1. Methodology social embedding level (SES)

The SEL methodology (Sprenkeling et al., 2022) is a methodology that can be used to identify societal challenges of a technology or project and measure the societal embedding of a technology or project. Outcomes lead to recommendations on how to overcome the societal challenges towards adoption of the technology or project. The SEL framework considers four levels (exploration, development, demonstration and deployment) and four societal dimensions (see Table 1) (impact on the environment, stakeholders and public, policy and regulations and market and [financial] resources). For this task of HyDelta 2.0, the four SEL dimensions as shown in Table 1 are used.

Table 1: SEL dimensions

Impact on the environment	Considers the impact of the technology or project on the natural, built and social environment. This includes the perception of the impact on the environment.
Stakeholders and public	Deals with gaining societal support with the participation of relevant stakeholders and the public at different stages of technology development and deployment. This includes stakeholder needs and concerns, (procedural, distributive, intergenerational) justice and trust.
Policies and regulations	Deals with the presence or development of a policy framework around the technology, the identification of incentives and barriers in this area, licensing processes, standardizations and certifications, grant funding and cooperation with and between the various authorities involved.
Market & (financial) resources	Deals with the market, financing options for different development phases, market dynamics, developing a business case, investment risks.

The research question and results were structured using the dimensions from the SEL methodology. These dimensions were used to obtain an integral overview of the social preconditions of hydrogen applications in the Netherlands. The topics of risk perception and communication were added. As we consider a wide range of hydrogen applications, it was not possible to conduct a full SEL assessment within the timeframe of HyDelta 2.0 (1 year). The inventory resulting from this task provides tools to conduct an SEL assessment for the independent parts of the hydrogen supply chain.

2.2. Semi-structured interviews

Fourteen semi-structured interviews were conducted with a select group of stakeholders representing the different parts of the hydrogen chain (production, transport, storage and applications). From this group of respondents, the translation to the hydrogen chain in the Netherlands is made. Themes and questions were prepared in advance of the interviews. During the interviews, the themes were followed, but time was also given to respondents to talk freely and provide additional information. The established questions laid a foundation for the conversation, which was used to go deeper into themes and topics that respondents had experience with. The aim of the interviews was to get in-depth information on respondents' perceptions, experiences and opinions on hydrogen developments in the Netherlands. Respondents were selected in cooperation with the partners of work package 10,

resulting in a list of stakeholders involved in various hydrogen developments in the Netherlands across the chain. To approach respondents, the network of the HyDelta consortium and the LinkedIn platform were used. This resulted in a longlist of potential candidates, of which 14 accepted the invitation for an interview. This resulted in 14 interviews with 15 respondents (see table 2). All respondents had knowledge of at least one of the dimensions from the SEL methodology. The responses have been anonymized. The respondents' level of knowledge regarding the different SEL dimensions varied. Some respondents had specific knowledge or experience with one of the dimensions, while others had more general experience with multiple dimensions.

Table 2: Respondents

Application/type of stakeholder	**Number of respondents**
Storage	2
Transport	3
Applications	2
Government, regulator	3
eNGO	1
Other/multiple facets	3

Procedure

The interviews were conducted between October 2022 and December 2022. The interviews lasted between 60 and 90 minutes. 13 interviews were conducted online, one interview took place on location. All respondents received an information letter and signed a consent form about using the interview data. The interviews were conducted by two researchers. During the interviews, notes and sound recordings were made which formed the basis for the interview report. The interview report was approved by the respondents.

The interview protocol (see appendix 1) is based on the SEL dimensions with specific attention to safety and perception of safety of both the respondent and the audience.

3. Results

This chapter presents the results of the interviews. It starts with the stakeholders' general perception of hydrogen developments in the Netherlands. Then, using the structure of the SEL dimensions, the research question is answered.

3.1. General view stakeholders

In this section, we discuss the respondents' overall perspective on hydrogen developments in the Netherlands.

15 Stakeholders with a role in hydrogen applications, transport, storage or government were interviewed. From the respondents, there is a mixed view on how hydrogen will ideally be applied in the Netherlands. While the majority agree that it should primarily be applied in industrial processes, opinions are divided on using hydrogen in the built environment for heating homes. Some of the stakeholders do not see any role for hydrogen in residential heating, while others argue that it can play a good role, for example when full electrification is not possible, such as in the monumental buildings of pilot area Lochem. Respondents advocate for having the conversation on such issues with well-founded arguments.

Hydrogen as an end or as a means

A common comment among respondents is that hydrogen should not be seen as an end, but rather as a means to energy transition. Ultimately, hydrogen is only one of many components to provide for the future energy system. Better solutions can often be found in certain cases or applications, but hydrogen can be an appropriate solution in some cases. That there is an importance for hydrogen in the energy transition is not in doubt, but to what extent this importance should be emphasized is where opinions differ. On the one hand, it is argued that there is a great societal interest in developing hydrogen because the Netherlands wants to become a hydrogen economy. Opposite to this, however, is the view that the Netherlands should not immediately want to become the largest in Europe in the field of hydrogen, but should deploy hydrogen for the benefit of the future energy system, with the goal of energy transition.

Speed of developments

There is a difference of opinion on the current and desired speed of hydrogen developments. For instance, on the one hand, there is the opinion that developments should accelerate. This perspective is often given in the light of achieving climate targets. On the other hand, there is the opinion that we are moving too fast. After all, with the current speed of developments, we would go through certain developments with regard to safety too quickly, which means that in some cases we already want to continue developing, while the outcomes of previous research are still uncertain and/or unknown. It is also indicated that we are moving relatively fast in the Netherlands compared to other countries. Whereas other countries go through the process step by step and simultaneously collect a lot of test data, it is felt that this is much less the case in the Netherlands, as the speed of development is higher here.

The Netherlands as a frontrunner in hydrogen development?

As mentioned above, it is perceived by some respondents that the speed of developments in the Netherlands is faster than abroad, because elsewhere one would go through a more step-by-step process in which more test data is gathered. The fact that the Netherlands is moving faster than other countries is an aspect on which there seems to be consensus. However, whether going faster is a

positive or a negative aspect is subject to different opinions. For instance, some see the step-by-step process as advantageous because more test data and operational data can be gathered here. All the steps of the developments are completed accurately. From the other perspective, on the contrary, respondents state that it is good that the speed of developments is so high because the Netherlands should want to be a leader in hydrogen. For instance, it is stated that the development of hydrogen policy is viewed with positive surprise from other countries; the Netherlands would have a good market for hydrogen development. We can share the knowledge in this field with other countries. Conversely, the Netherlands can learn from the test data and operational data of countries going through a more step-by-step process. In short, opinions differ on the speed of Dutch developments compared to developments abroad, although it does seem to have the advantage of knowledge sharing; knowledge sharing will take place on different aspects in different directions, where both parties/countries can benefit.

3.2. Impact on the environment

This section discusses the impact of hydrogen developments in the Netherlands on the natural, built and social environment. Here, the perception of the impact on the environment also plays a role. The impact that people experience, or think they will experience, influences social acceptability. Further technical aspects on safety of hydrogen applications and their impact on the environment are addressed in HyDelta 2.0 work packages 5, 6, 7 and 9.

Impact on the natural environment

Impact on the natural environment is investigated during the environmental impact assessments made when applying for an environmental permit. This takes into account a multitude of aspects, such as emissions during the various project phases, impact on air, soil and water quality, and impact on flora and fauna. Hydrogen projects have a green image and contribute to the energy transition and the sustainability of industry. From this comes the perspective that it has a positive impact on the natural environment. Project construction involves emissions, such as NOx. This may be an impediment to carrying out projects in the future.

A number of respondents mentioned a possible negative impact on the natural environment when hydrogen is imported. When it is produced in the Netherlands, there is visibility of the impact and how 'green' the hydrogen is. When produced in other parts of the world, there is not always such guarantee. In turn, this can also have a negative impact on public support.

Impact on the built environment

Impact on the built environment is expected especially in terms of scarcity of available space. Different groups have interests in the use of space in the area where projects are developed. This should take into account:

- Natural areas: Conservation of natural areas and the impact of project developments on natural areas.
- Environmental pressure on residential areas: When project development takes place in or around residential areas, possible nuisance from light, noise, accessibility and emissions must be taken into account.
- Spatial integration of other (energy) projects: Energy transition takes up a lot of space. Different projects may demand the same space, creating conflicts. This takes place both on land and at sea. An example is the discussion on the space requirements of electricity vs gas.

- Safety in the built environment: The condition of gas pipes in homes is not always known. When hydrogen is used in homes, this is currently still important to consider on a case-by-case basis to ensure safety. This is also important when the low-pressure network is used in the built environment. Its condition is easier to monitor, but because it is in the built environment, where no zoning regulation applies, it is important to ensure safety properly.

Impact on the social environment

Part of the impact on the social environment refers to the user and the impact they experience from the technology. In the case of hydrogen, for example, this could be an occupant of a house that is transitioning from natural gas to hydrogen. The resident experiences impact due to the conversion in the home (e.g. boiler and gas line), change in energy costs and changing safety measures in the home. Some of the respondents argue that hydrogen is safe to use in the built environment. However, they also argue that at the same time it is difficult to control what residents do 'behind the front door'. Although much is possible with technology in terms of safety measures, human behavior is hard to influence. Residents often have access to gas pipes; this can be a risk that needs attention, for instance by making the meter box less accessible.

Impacts can also be experienced when hydrogen technology is not used in the home, but in the neighborhood. For example, through nuisance from light and/or noise during the construction phase, accessibility of access roads. For emergency services, such as the fire brigade, there is also an impact on their activities. For example, when it comes to assessing a situation in case of calamities, and it is no longer taken for granted to know what kind of gas or combination of gases they are dealing with.

Finally, feeling safe also impacts the social environment. Here, it does not always matter whether the risks are real, or a false perception of risks. This makes it important to communicate clearly about safety and safety measures. Not only for hydrogen in homes, but also for other applications that take place in the living environment, such as transportation and storage. If the public is under the impression that underground hydrogen storage leads to risk of subsidence and subsidence of homes, it is important to answer questions about this. As hydrogen has the image of a highly explosive gas, people may experience a sense of unsafety when hydrogen is used, transported or stored in or near their homes.

3.3. Stakeholders and public

This section addresses the public engagement and stakeholder engagement component. This includes gaining public support through the participation of relevant stakeholders and the public at different stages of technology development and deployment, and addresses stakeholder needs and concerns, justice and trust.

Public perception

Currently, most respondents state that hydrogen has a positive image among the majority of the public. A large part of the public perceives hydrogen as an energy carrier as a clean and easy solution for the energy transition. There is a growing interest in hydrogen from the public. This may partly be a consequence of a negative perception of other solutions, for example that making the home more sustainable through insulation and electrification costs a lot of money and is a lot of 'hassle'. The positive image that currently prevails is a risk, according to some respondents. It is said that there is insufficient knowledge about the complexity and costliness of developing and applying hydrogen technologies. Even if hydrogen will be applied for heating homes, the reduction of energy demand through insulation, among other things, will remain necessary due to costliness and scarcity. The

positive social support seen now may change over time. The following aspects may trigger a (negative) change in social support:

Direct impact on the living environment

When local project developments start, the public has to deal with this in their immediate living environment. This can reduce public support. Here, the reduced support can be influenced by the context of the developments. (What experiences are there already in that area with similar projects and the parties involved?) For underground hydrogen storage projects, for example, experience with subsidence and earthquakes in Groningen will play a role in the perception and support for the activities. Even if the technology being used is different, and proven safe, the perception of underground activities may be similar to it and raise concerns about safety.

Lack of knowledge and information

Currently, there is little (accessible) information from the government about the goals regarding hydrogen and the long-term vision. The currently positive image of hydrogen combined with little communication from the government is seen as a risk by several respondents. Public perception can ultimately also be negatively influenced by media coverage. (National) news media tend to publish on topics that cause a stir. This can ensure that a relatively small group that is highly critical gets more media coverage than the more neutral majority, thus influencing (national) sentiment. Perception of the purpose of the project also influences: Is it only for big industry? Does it make industry cleaner? While subsidization for industry may have a negative impact on support, the fact that industry is becoming more sustainable may also make residents more willing to become sustainable.

Trust

Specific projects that are currently being developed (including storage and distribution) have seen critical voices from groups of residents with poor experience of the industry already present in the region. The following aspects emerge here:

- *Trust in involved parties:* Trust in both involved parties and the type of projects plays an important role. When this trust is low, the risk of lack of public support is higher. This plays, for instance, with industrial parties with whom there are negative experiences because the public experiences or has experienced negative (environmental) impact from industrial activities. This can also be a risk when this party is not an initiator of the project, but is indirectly involved or linked to it. This also plays the other way around: when trust in an involved party is high, this can positively influence support.
- *Trust in government:* When the government communicates about goals and developments of hydrogen in the Netherlands, the trust people have in the government can influence how this message is received.
- *Confidence in activities:* When public trust in the type of activities is low, this is a risk for public support for project development. This plays out, for example, in underground storage. In Groningen, trust in mining activities is low due to the experience of earthquakes resulting from gas extraction. Although these activities and risks are not directly related to hydrogen storage activities, the risk is that the public will rely on previous experiences. This can also work the other way round: confidence in the natural gas network in the Netherlands is relatively high among the public. This can have a positive effect on confidence in using the natural gas network for hydrogen distribution.

Justice

Justice is an important issue for public support. This is about sharing the burdens and benefits of developments and applications. Equity came up in several interviews, both when it came to concrete projects already under development and in the broad development of hydrogen technologies and applications in the Netherlands. These aspects are detailed below:

- *Distribution of financial resources: The financial distribution issue can play a role in the development of public perception. If people are asked to invest themselves in making their homes more sustainable and have to bear high energy costs, while industry is subsidized to use hydrogen, this may negatively affect public support for hydrogen developments in the Netherlands.*
- *Burden-benefit sharing: Smaller businesses and residents also hope to be connected to the hydrogen grid in the future. If this does not happen, perceptions may become more negative. On the one hand due to disappointment because expectations are not met, but also because people are inconvenienced by works, but do not benefit from this themselves by being able to use it. This problem can also play a role in hydrogen storage. When storage takes place in regions where residents feel that they bear an unreasonable burden compared to other residents in the Netherlands, this can negatively affect support.*
- *When the sense of fairness in the distribution of burdens and benefits is low (for example, residents feel that they suffer more inconvenience from industrial activities than desired, while they themselves experience no or insufficient benefits from it), the risk of lack of public support is higher.*

Informing the public

The majority of respondents indicated that it is important to have more neutral reporting on the vision, goals and applications of hydrogen in the Netherlands, and how activities are related. Currently, we see that the public is mainly informed from project development, when participation procedures are started. Respondents indicated that a more centralized provision of information from the government about hydrogen goals and safety would positively influence perception and project development, and facilitate project participation procedures.

A risk of too little information and communication from the government about hydrogen developments in the Netherlands is that public support decreases. Without sufficient information, people may make wrong assumptions about the safety and feasibility of hydrogen as an energy carrier, leading to distrust. This can lead to opposition to hydrogen developments and a lack of acceptance of the technology by the general public. Therefore, it is important for the government to provide clear and transparent information about the benefits, as well as the risks, of hydrogen, and to actively communicate with the public and stakeholders to answer any concerns and questions and correct misinformation. By communicating openly, the government can gain public trust and increase public support for hydrogen developments.

According to respondents, communication to the public should meet the following points:

- *A good balance between nuance and optimism:* Currently, public support for hydrogen is high. However, too much optimism may lead to disappointment in the future. Respondents find it important that a nuanced picture is brought out. However, too much nuance can turn sentiment around and reduce support.
- *Objectives and long-term perspective:* Respondents argue that communicating objectives and the long-term perspective gives the public a better picture and can maintain or increase

support. With knowledge of objectives and the long-term perspective, policy choices are better understood and a sense of justice can be secured.

- *Urgency:* Respondents argue that when the public is included in the narrative of climate change, the energy transition, the role of hydrogen in the future energy system and its urgency, public support can be better secured.
- *Safety, risks and measures:* The public wants to be honestly informed. When it comes to safety, the comparison between natural gas and hydrogen can help explain safety and risks. The comparison can be helpful in explaining relative risks, as confidence in natural gas is high, but people also know that natural gas is not without risks. It is also argued that communicating based on measures to manage risks can have a positive impact on risk perception and social acceptance. When something does go wrong, it is better to inform the public itself, rather than having it announced later by the media. This can detract from public acceptance. Finally, it is important to also give the public a place (counter, agency) where they can go with questions, concerns or problems, both during project developments and later in the process.

One of the ways mentioned to ensure social acceptance is to not only inform the public, but also show them what hydrogen can offer them. This can be done by showing that hydrogen can also offer them something, as an element for a reliable and affordable energy supply.

Most respondents advocate for an important role for the government in informing the public. Nevertheless, they also argue that this should include paying attention to how this message is received by the public: is trust in the government sufficient to get the message across properly? Universities/knowledge institutions could also contribute by being able to provide a factual narrative.

Safety

Perception of safety

According to all respondents, safety is a non-negotiable issue that must be in order at all times. When asked what this means, most respondents say that it must be at least as safe as natural gas if we are going to use hydrogen to replace natural gas. A number of respondents stressed that working with hydrogen is not in itself new, and safety can be guaranteed. On the other hand, the legal framework regarding the safety of hydrogen applications is still being developed, and so it is not yet completely certain what legal standards it must meet. It was also stated by some respondents that safety standards for natural gas are not always clearly explained either, and it is therefore difficult to work with the comparison between hydrogen and natural gas.

Communication on safety

When communicating about safety, the comparison with natural gas is often made and perceived as helpful, because people have experience and mostly feel familiar with natural gas. At the same time, people know that natural gas is not 100% safe either. This is perceived as a good way of explaining relative safety.

From initiators of hydrogen projects, it is stated that it would help the projects if the government is the first party to communicate about the safety of hydrogen across the chain. As the policy framework is currently still under development, the initiator is the first party to communicate about safety in project development. However, this party cannot adequately answer all questions from the public, partly because the policy framework is still under development and partly because questions from the public are about the whole chain, while the initiator is usually only involved in one part of the chain.

Public engagement

The general perception is that the public is currently still little involved in the development of hydrogen technologies in the Netherlands. By some of the respondents, current hydrogen development is seen as 'something of the industry' that the public has little to do with yet. This is about applications in industry. Another part of the respondents feels that the participation component is still underexposed, and states that more attention is needed here to secure public support in the future.

From industrial projects that do not interface with public interests and where there are no viewpoint procedures, there is no public participation yet. In this, public involvement is limited to what the government and media communicate. In projects where hydrogen development is already starting and does interface with public interests, such as the development of underground storage requiring environmental permits, the construction of a high-pressure network and pilots in residential areas, participation procedures have already started. From this, we receive the following feedback from respondents:

Participation procedure

Projects under the national coordination scheme (RCR) usually go through the same phases. During a number of formal moments in this process, participation is possible from the surrounding area. At various moments, a reaction or viewpoint (an official way of commenting on documents that are available for inspection) can be submitted. This is possible at the following moments: 1.) the proposal and proposal for participation (reaction), 2.) the draft memorandum of scope and level of detail (opinion), 3.) the draft decisions and the environmental impact report (opinion). Finally, it is possible to lodge an appeal at the end of the procedure for the final decisions.

Residents' meetings

In order to inform the surrounding area properly about the documents that are available for inspection, residents' meetings are often organized. During these meetings, the local residents are informed about the proposed plans and can ask questions. Residents are often invited personally, even before permits are applied for.

Information meetings are often organized by the project initiator. Governmental organizations, such as the Ministry of Economic Affairs, are often involved. When relevant, such as in pilots in residential areas, the regulator (State Supervision of Mines [SSM]) also joins in. The general picture is that residents like being involved (early) in the dialogue and are given the opportunity to ask questions. The presence of the supervisor perceived positive.

From the respondents, there is a mixed picture about the residents' evenings. Although seen as an important form of resident participation, some respondents stated that the residents' evenings do not attract a representative group of stakeholders. The risk of this form of participation is that the same group of people comes along every time, and as a result, the perspectives of all stakeholders are not captured.

In some cases, individual interviews with residents are also held once the permit has been granted. This is when not too many people live in the area. These residents are invited to help think about how something will be done and how it will fit into the environment, for example, the location of access roads and traffic movements.

Other examples of participation are:

1) Informing residents with information leaflets;
2) Doing an environment scan to find out which parties need to be involved at what time;
3) Consulting with local authorities to identify key stakeholders;
4) Conduct interviews with representatives of resident groups;
5) Kitchen table discussions with residents.

Information needs of residents

The following information needs emerge from the participatory processes in which respondents were (have been) involved:

1) Concrete information on what the project means for the residents themselves and what consequences it will have. For example, rebuilding/conversion in the vicinity, conversion and adjustments to the home. Light and noise nuisance and accessibility restrictions are part of this.
2) What does it mean for energy costs. Financial questions are important, especially when it comes to hydrogen pilots in the built environment.
3) Reliability and availability of the energy solution. What are the differences with the current situation and compared to other sustainability solutions?
4) Where do I go when things go wrong? Particularly when residents have had negative experiences with similar projects in the past, they find it important to have certainty that they can go somewhere if things go wrong, e.g. a fixed point of contact.
5) Safety: What do developments mean in terms of safety? This plays out in the built environment in the form of questions about the characteristics of hydrogen as an explosive gas, and in mining activities about subsidence and seismicity.
6) In infrastructure projects, there is a question from both residents and small businesses about whether they can also be connected.
7) In projects affecting spatial planning, there is a tension in space use, for example in relation to natural areas.

Dialogue in the participation process is generally reasonable and open. The questions asked and concerns raised by stakeholders can be traced to past experiences (concerns about soil subsidence) or a lack of knowledge prior to the process (in the case of questions about house connections at a high-pressure network). There are some groups of residents with whom it is more difficult to have a dialogue, for instance when they are pertinently opposed to certain activities or players in the area. However, this is only a small group. Media coverage often highlights this group larger than it actually is.

Participation procedures need to consider a multitude of concerns from different stakeholders. Also, working with a deadline, permit procedures (2 to 3 years) and project construction (1.5 to 2 years) often take a long time. This is seen as a challenge by respondents.

Information needs of the general public

Among the general public, there are some more general questions about hydrogen, such as:

1) How will we heat homes, and does hydrogen play a role in this?
2) Will hydrogen play a role in mobility/personal transport?

3) What are the plans for hydrogen, and what does it mean?

Respondents note that alertness and a critical attitude about hydrogen increases when there is more attention from the media. They also argue that an overly positive image of hydrogen can eventually lead to a more negative attitude, for example when expectations are not met.

At the moment, information is mainly needed from a small group of people who are interested in hydrogen developments, for example to make their homes or neighborhoods more sustainable. These people, as well as municipalities, are actively seeking information.

Hydrogen house Kiwa

A 'hydrogen house' has been set up at Kiwa (Apeldoorn) for the purpose of training and information. At this location, mechanics and installers are trained and guided tours are given to stakeholders. The tours given are currently largely focused on the differences between natural gas and hydrogen, in which an objective perspective is offered on the use of hydrogen. This matches the information needs that people currently have. Tours generally make people more positive about hydrogen when they leave than when they come.

In addition to the hydrogen house, several example houses have been set up, such as "Inspiratiehuis Stad Aardgasvrij" (Inspiration House City Natural Gas-Free | City Natural Gas-Free), which was heated with hydrogen in 2022 in a number of months and can still be seen how the boiler and pipework look when the house is heated with hydrogen. Through this home, grid operator Stedin has shown what converting a home from natural gas to hydrogen entails, and that it can be done safely. Another, similar initiative is 'Tiny House Hoogeveen' (waterstoftinyhouse.nl). This hydrogen house was developed in cooperation between the government, regional businesses and educational institutions. It is a mobile tiny house heated on green hydrogen and made entirely with from sustainable and circular materials

3.4. Policies and regulations

This section addresses the presence or development of a policy framework around the technology, the identification of bottlenecks and success factors in this area, licensing processes, standardizations and certifications, subsidy provision and cooperation with and between the various authorities involved.

Current status of policies, laws and regulations

Much is already happening in the field of hydrogen developments. Yet the general trend is that policy is lagging behind on technical developments. The policy framework to support hydrogen applications is not yet fully developed. It is perceived that in the missing policies lie most of the challenges for hydrogen developments. There are several reasons behind the lagging policy development. Current regulations on energy supply have been optimized over the years for the fossil system. Making these regulations suitable for, among others, hydrogen as an energy carrier requires many adjustments. In general, there is a positive view on developments in this field. For instance, people experience that many developments are taking place in the field of safety standards, both at national and European level. Although policy is still evolving, there is a lot of movement.

Temporary guideline

One of the developments that has taken place at the national level is the development of the temporary safety guidelines by the Ministry of Economic Affairs and Climate (EZK) in cooperation with the Authority Consumer & Market (ACM). These guidelines (generic and supplementary for four hydrogen pilots) were developed in the absence of a legal standard, with the aim of still being able to

start hydrogen projects. Kiwa's hydrogen house in Apeldoorn contributed to the development of these temporary guidelines. Several stakeholders were involved in the drafting of the guidelines. At the European level, several European technical commissions and working groups are working on fleshing out legislation that will be framework-driven. In other words, standardization at European level is still evolving.

Barriers with regard to policies, laws and regulations

Awareness of need for developments

Despite parties' perception that many developments are taking place in terms of policy, laws and regulations, there is also a realization that more needs to be done. The current ambiguities in regulations can potentially cause many delays in developments. This barrier is experienced in all parts of the hydrogen chain. The relevance of this is underwritten by the fact that as early as 2026, the first development of storage in salt caverns will take place.

A point to consider when developing a policy framework is that it is important whether it is now desirable to develop a fixed policy framework. After all, we are in the middle of an energy transition, with hydrogen still in the process of development. A temporary directive, such as the aforementioned guidelines, are an example of policies that ensure safety while providing flexibility. However, the general tendency is that no concessions should be made regarding safety. As a result, respondents argue that unless a temporary directive can guarantee safety with great certainty, a fixed policy framework is more obvious.

Lack of clarity in current policy, laws and regulations

The vagueness and lack of policy for hydrogen developments is perceived by some stakeholders as resulting in a slow development of the policy framework, with the risk that parties do not yet want to invest when there is no clear policy framework. This causes project development to get off the ground more slowly.

The permitting process

The permitting process is seen as an impeding aspect of hydrogen developments. The challenge in permitting lies in the long lead time. This challenge is rooted in several factors. First, the lack of policy means that permits are less easily granted. Policy development and project development run parallel in some cases. Second, many activities and procedures are required when applying for an environmental permit. This is an extensive and careful process, with environmental impact assessments and participation procedures. Although the lead time is perceived as a barrier, respondents recognize that this process serves a purpose and due diligence must be ensured. Thirdly, the current tight labor market affects the processing time. This lies in the processing of permit applications, which, due to the novelty of hydrogen, takes more capacity than other types of permits. Finally, a challenge lies with regulators, who have to supervise activities for which standards and policies have not yet been established.

An example of project development where the lead time of the permit procedure is challenging is the development of salt caverns for hydrogen storage. This project falls under the National Coordination Scheme. The permitting process for the development of salt caverns is extensive. After all, during the process, all environmental effects must first be mapped out, before SSM assesses these effects and advises the Ministry of Economic Affairs on them - particularly with regard to safety and any risks - after which the Ministry of Economic Affairs will take a decision to grant the license on the basis of existing laws and regulations. During this process, the viewpoint procedure also takes place, where

residents have a say (on local aspects). The slow pace is exacerbated by the unfamiliarity with hydrogen. The licensing process for hydrogen is new. Inherent in the fact that hydrogen is very new is the lack of available knowledge, and in particular lack of manpower with the necessary knowledge. The latter seems to emerge strongly in the processing of permit applications - where capacity seems to be an impeding factor. Also, the permitting process is delayed by the lack of standardization, which makes inspecting safety and interpreting the rules difficult for permittees. However, it is uncertain who is responsible for setting these standards. Respondents suggested several parties (government, grid operators, the industry) as parties who could facilitate this standardization. In short, there is no consensus on this subject yet, which makes concrete standard-setting unlikely in the short term. However, the question is whether only one party will be responsible for setting standards, or whether, as with the temporary guideline, this can be done through co-creation.

The long process and lack of standard-setting are not the only two uncertainties that act as barriers. Developers of electrolysers also face uncertainty regarding the outcome of permits, as no sites have yet been designated (almost) for electrolyser development. The government can remove these permitting risks - and with them uncertainty - from developers by designating sites for electrolysers and granting permits for them.

Pace upscaling pilot projects

Finally, respondents argued that in a new development - such as hydrogen development - not too many pilot projects should be set up at the same time. These projects will then potentially all run into the same bottlenecks. This is due to the fact that within an application, uncertainties about policy, laws and regulations are relatively universal. A process where incrementally more and larger developments/pilots will take place contributes to a better understanding of the situation and will therefore possibly slow down fewer pilots, because uncertainties in policy, laws and regulations will diminish due to the practical knowledge gained. Sharing the knowledge and experience gained from practice with parties such as safety regions, environmental services and SSM also serves as input for these parties in their dealings with hydrogen safety, and standards concerning safety.

Cooperation and communication as incentive in policy, legal and regulatory development

Collaboration

In the development of policies, laws and regulations, there is consensus among respondents on the role of collaboration and/or co-creation. Indeed, cooperation between governments and industry is necessary, it is assumed, to include local knowledge in the development of a policy framework, among other things. This cooperation can make use of already existing bodies, in order to learn from each other nationally and internationally. After all, with the speed of current hydrogen developments, it is impossible to keep abreast of all these developments on one's own. Through these bodies, more coordination could also take place. However, it is still unclear who is responsible for coordination. The assignment of roles and responsibilities could be clarified by including it concretely in the policy framework. Overview of roles and responsibilities is very important when developing a hydrogen network.

Communication

Within this process of co-creation, however, clarity is needed from the government towards industry and initiators. For instance, about the locations chosen for electrolysers, and what motivation underlies this. Clear communication on safety from the government is also essential. Residents could be informed about what hydrogen is, why it is being chosen, how it will be deployed in the Netherlands,

and what the measures are regarding safety. This would contribute to public support. Finally, respondents argue that communication about goals beyond 2030 towards 2050 is desirable, so that industry can anticipate.

Roles and responsibilities

As the energy system changes, changes in roles and responsibilities inevitably take place. Two possible bottlenecks raised by respondents in this regard are (1.) the competence to construct a hydrogen network. In the Netherlands, looking purely at legislation, all parties except the grid operator are allowed to build a hydrogen network. Network operators are limited in this because of their regulated role and their protected function. It was suggested that at least the discussion should be held as to whether the role of grid operators should also change in this regard, so that the grid operator is given the legal space to get started with the hydrogen network, but this does not give it the obligation to supply hydrogen. (2.) The role of regulators. How is supervision of the energy system changing? How can regulators perform their role in an energy system in transition, where new technologies are already being experimented with, but standards are not yet fixed? And what is the role of regulators in setting standards and designing the energy system?

3.5. Market en (financial) resources

This section discusses the market, financing possibilities for the different development phases, market dynamics, developing a business case, investment risks. In HyDelta 2.0 work package 3, the impact that risks and uncertainties have on investments in hydrogen in the Netherlands is discussed in more detail. The market for hydrogen in the Netherlands is further analyzed and modelled in work package 2.

Market

Need for market development

The overall picture is that a market needs to be created to remove uncertainties and risks that currently exist in hydrogen development. It is notable that the need for creating a market is mainly focused on generation, and to a lesser extent transport. For instance, it is argued that the market should allow companies to operate as efficiently as possible, enabling cost-efficient development of electrolysers. Here the similarity is drawn with offshore wind, where a market had been created for cost-efficient development of offshore wind power. Reserving sites where electrolysers can be built can contribute to a more stable and efficient market for the construction of electrolysers by reducing the permit risk, as was the case with offshore wind. This will help scale up the development needed for the hydrogen transition.

System integration

For the development of the hydrogen market, it is indicated that demand, supply, and the logistics between them must be balanced. After all, there is currently a lot of uncertainty about the development of both hydrogen supply and demand. Many developments are already taking place in both supply and demand, but it is still unclear how a supply and demand connection can be made, and in what way this connection can be established. System integration, both of the hydrogen chain and the entire energy system, is proposed as a solution direction in establishing the connection between supply and demand. To optimize system integration, it is important to draw up a vision on hydrogen development; how do we want to develop hydrogen? Who will be the users? How will these users get hydrogen? This vision will shed more light on the functioning of and needs within the system, by providing answers to such questions. However, system integration also requires some form of direction. Respondents argue for a directing role for (local) governments. A directing role, to which the

government itself can give substance. Whether the governing role is only needed during the transition phase, or also remains necessary in later phases to facilitate a fair market, is still an open question. Setting a goal through government direction will - so is the general tendency among the respondents - help balance the issues of supply, demand, and transport, in order to bring the transition to hydrogen into operation within a few years. This directive role and vision creation can be reinforced by setting requirements for hydrogen generation. Requiring a minimum percentage of hydrogen to be generated sustainably could help accelerate proper market functioning. However, according to some respondents, this will not work through compensation, but rather through coercion. In other words, setting concrete requirements based on a minimum percentage of sustainably generated hydrogen could contribute to this.

Distribution of costs and benefits

Balancing all aspects of the system not only allows certain parties (e.g. smaller companies) to better manifest themselves in hydrogen development, but it also requires commitment from all parties. The caveat here is which parties should be involved. Is it socially justifiable when mainly foreign parties are engaged within Dutch hydrogen development? The question is what these parties contribute to our economy. The underlying question here is who should benefit from Dutch hydrogen development in the first place? The citizens, the local governments, the national government? One respondent argues that it is good to consider that the Dutch economy benefits more from Dutch developments. To facilitate this, should we also achieve local purchases within local hydrogen initiatives? Unlike initiatives that are under subsidies from the European Union, where ideally all parties come from the EU, and where the benefits remain in the EU, there is no strong opinion on this at present among current local hydrogen initiatives.

Financing opportunities

Subsidy opportunities

The prevailing view regarding subsidies for hydrogen developments is that there is a wide variety of opportunities to apply for subsidies. Subsidy opportunities are offered from different levels of government. For instance, at the European level, there is the possibility of the EU granting IPCEI (Important Projects of Common European Interest) status to projects, allowing for wider opportunities for state aid to hydrogen projects. This ensures that more hydrogen projects could follow in the foreseeable future. Recently, a number of Dutch projects have been granted IPCEI status. In addition, the Green Deal H2 Districts in the Netherlands makes it possible to support hydrogen projects through subsidies. Subsidy from the Green Deal is currently applied to four hydrogen projects (Hoogeveen, Stad aan 't Haringvliet, Wagenborgen, and Lochem) that are currently taking place in the Netherlands in the built environment at various levels. Finally, respondents also mentioned the subsidization that took place within the hydrogen in the built environment pilot in Lochem. For this pilot, a subsidy had been realized from the province of Gelderland to compensate for the hydrogen price, so that residents did not have to pay more than they did before.

Application and allocation of subsidies

Despite the wide variety of grant opportunities, some respondents felt it was very difficult to apply for grants or any other form of funding. Some preconditions regarding the application of subsidies were perceived as a hindering factor. For instance, in an early phase of hydrogen development, financing from banks is not yet possible because they are not yet willing and/or able to take the risk. This makes it necessary to look for other ways of financing, which makes applying for funding or subsidies a very

difficult process. There are solution options, but getting this done is in some cases experienced as hanging and choking.

The fact that applying for grants is perceived as difficult is potentially related to the purpose of the grant, several respondents indicated. Grants will not be allocated equally easily to every function. After all, a respondent indicated, subsidies are only needed when it is not necessary for a company to deal with hydrogen and when it is not profitable to switch to hydrogen. If one of these aspects is present, a company will already step in, and subsidies will not be necessary in this case.

The difference between citizens and companies is also put forward in the provision of subsidies. For instance, it is argued that the government will drive industry with subsidies, while it is more likely to compensate resident initiatives. This choice would follow from the reasoning that industries are commercial organizations, and therefore have a profit motive. Finally, it is stressed that a lot of money is made available for knowledge initiatives on the topic of hydrogen.

Investment risks and uncertainties

Business cases

As mentioned earlier, uncertainty about policies, laws and regulations is a barrier for market players. This makes it more difficult to make investment decisions as investment risks are high. Economic risk can also cause profits to disappear. This results in a major challenge in terms of economic perspective from the industry. Other uncertainties related to investment risk are uncertainty about market development, uncertainty in the balance between imports and exports, uncertainty about available storage capacity, uncertainty about the operation of electrolysers, and so on. Investment risks-uncertainties are discussed further in HyDelta 2 work package 3.

Safety

Security and cost are inherently linked. The safer an application needs to be, the more additional measures need to be taken, and the higher the costs will be. Only when sufficient experience is gained regarding safety measures can optimization in this area take place, and costs can decrease. This is also the underlying reasoning behind the high cost of electrolysers. Only in the long term will electrolysers become cheaper. High - justified - safety requirements will therefore still cause high costs in the short term, resulting in a higher investment risk.

Labor market

Hydrogen is a relatively new development. Being a new development means that the available number of experts in the field of hydrogen is still limited. A lack of manpower with specialist knowledge is therefore a risk that is currently still present in the sector and hinders possible upscaling. This topic is further addressed in HyDelta 2.0 work package 11.

Import or local production

Domestic production is expected not to be able to meet the Netherlands' energy and hydrogen demand. In addition, slowing down exploitation of the North Sea is also an uncertain aspect. Therefore, we depend on both domestic production and imports, is the general trend. Importing hydrogen does require a good story to be drawn up; an example given is that the imported hydrogen will be used for industry, because that is where the need lies. It is also important to look at the whole import chain. One should not only look at whether hydrogen is produced sustainably, but also whether it is transported sustainably, and what the local working conditions are like. This is something we need to

be alert to in large-scale external production. We are already seeing maximum exploitation of the system, and running into limits. But what will it take to avoid running into these limits? Finally, it is important to look carefully at where we import hydrogen from. This is important not only because of the geopolitical context, but also in light of energy dependency. Imports should therefore not place from a single country.

4. Conclusion

Based on 14 semi-structured interviews, hydrogen developments in the Netherlands were mapped using the four SEL dimensions (impact on the environment, stakeholders and public, policy, laws & regulations and market & (financial) resources). As environmental and market impacts are also highlighted in other work packages of HyDelta 2.0, the focus of these interviews was on stakeholder and public involvement and policy laws and regulations.

The research question for this task is:

"What are the stakeholder perspectives on the societal embedding of the development and deployment of hydrogen technologies in the Netherlands and associated societal risks?"

From the analysis of the perspectives of hydrogen in the four SEL dimensions, the following societal challenges emerge:

1) There is no consensus yet on how hydrogen should be applied in the Netherlands.
2) Social support may diminish when project developments start, this may be influenced by:
    a. Lack of trust in activities or parties involved;
    b. Lack of sense of fairness.
3) Lack of policies and standards can delay project development and deter companies from investment decisions.
4) Long lead time of permit procedures can delay progress of project development.
5) As the energy system changes, so do roles, e.g. those of government, grid operators, regulators and energy providers.
6) The energy transition is a big task but available space in the Netherlands is limited. A risk is that insufficient space is available.
7) There is scarcity of knowledge and labor. The tightness in the labor market may cause project development and licensing to have longer lead times.

Perspective on hydrogen

The perspective on how hydrogen should be applied in the Netherlands is still divided. There is consensus that the first applications will be in industry, but there is still disagreement on the role for hydrogen in residential areas, for heating homes.

Currently, public support for hydrogen developments in the Netherlands is good. However, the publics' level of knowledge about hydrogen and its' goals is low. Insufficient information can reduce support. More information and communication from either the government or knowledge institutions could increase support for project development. Respondents state that information needs emerge in participation procedures that are not so much related to the project in question, so that questions cannot be answered adequately. More information on goals and vision is also needed from industrial parties so that they can anticipate this with project development and investment decisions.

Clear and accessible information from the government can ensure that the public, companies and other stakeholders gain a better understanding of what the government's vision and goals are, which contributes to the transparency of developments. Based on this, public and stakeholders are able to form an informed opinion. Good information can also help build trust and credibility in government plans. Communication about the narrative of hydrogen in the Netherlands, underpinned by factual information, might also improve trust in the government itself. Finally, good information can make people feel more involved in developments, which in turn can contribute to public support. Information needs in specific projects lie mainly in practical aspects. People like to know what will change for them, for instance in terms of finances or renovations at home or in the neighborhoods. Questions about safety also play an important role in information needs. Hydrogen has the image of an explosive gas. The comparison with natural gas is felt to be helpful in explaining its relative safety. The positive image of using natural gas also contributes to the feeling of safety with hydrogen. For (subsurface) storage projects, this can work the other way around: if the experience or image with similar (mining) projects is negative, the feeling of safety can also be related to this. When providing information to the public and stakeholders , it is important to provide fair and nuanced information.

Trust in the government plays a crucial role in how the public interprets the information provided by the government. People who have high trust in government are generally more willing to believe and follow the information they provide. On the other hand, people who have low trust in government tend to be more skeptical about the information they provide and tend to be more critical of it. It is therefore important for the government to gain and maintain public trust, to ensure that the information they provide is taken seriously and interpreted correctly. Additionally, at the moment mainly distributive justice plays a role in public support. This is about sharing the costs and benefits of hydrogen developments. In the future, we see that procedural justice could potentially play a role. As project development gains momentum, it will be important to adequately inform, involve and give stakeholders and the wider public a voice in decision-making where possible.

An inescapable obstacle in hydrogen development and deployment is that hydrogen policy is still evolving. While it poses a risk to the progress of projects, there are also opportunities in developing new policies. On this, it is argued that it would be beneficial if the dynamics of the transition of the energy system are taken into account in developing policies. A consequence of the lack of policy and a clear long-term vision of the government on hydrogen is that projects do not get off the ground as well. It is difficult for companies to make investment decisions. Additionally, the uncertainty of how the market will develop in the coming years, in terms of supply and demand, makes investment decisions difficult.

Looking at the future appropriation and incorporation of hydrogen, while reflecting on the respondents' perspectives, regulatory solutions do seem to be emerging - despite the few obstacles at present. It is important to keep the nature of the energy transition in mind. New policies must fit well with changed circumstances, which lead to a less predictable situation. The energy transition provokes a change in roles and responsibilities, with an obligation for the government to reformulate its' (directing) role. In addition, the governments' role is to indicate why which developments should or should not be realized and at certain locations. These choices should be linked to the policy goals, in order to create coherence between policy and practice (choices). However, policy goals are often set 'only' until 2030. For the period beyond 2030, few targets have yet been concretized, which is seen as an obstacle by some respondents, both in terms of certainty, but also in relation to the speed of hydrogen development. These two aspects are also inherent to each other in several cases.

All in all, it is perceived positive that most parties are positively interested in hydrogen developments and that the government is active within hydrogen development. specific targets from the government may boost development, although some respondents expect that green hydrogen is needed to give the final push in the right direction.

To reduce uncertainties and risks of hydrogen developments, government involvement in the development of the hydrogen market is important. In such a market, supply and demand will be balanced through system integration. However, for system integration to function optimally, a clear vision on hydrogen development is needed, in connection with a government steering role. System integration also requires a view on the distribution of costs and benefits, with an explicit focus on the destination of the benefits. This will require a social assessment to see which cost-benefit distribution is socially justifiable. Within such a cost-benefit distribution, it is beneficial to look at the distribution of subsidies and compensations. Subsidies for hydrogen projects exist in great variety. However, it is perceived that in many cases it is difficult to claim these subsidies. Without subsidies, the financial situation may become an obstacle for companies to engage in hydrogen developments and/or projects. In addition, there are some other investment risks due to uncertainties in policy, laws and regulations, (labor) market development, and technical aspects. For example, the safer you want the development to be, the higher the cost of providing safety measures. This is essential because the general trend is not to compromise on safety.

Implications for other work packages

The results from this report indirectly contribute to the results of HyDelta work package 3 (risks and collaboration in chapter 2) and HyDelta work package 6 (safe operations LP grid). For work package 3, social uncertainties and risks are exchanged. For work package 6, results relating to public risk perception and safety information needs are exchanged.

References

Elbert, S. and Wiekens, C., “Overview from the literature/studies on societal support for new energy technologies and hydrogen in particular. An exploration of the aspects that (in similar circumstances) hinder or accelerate societal embeddedness.” HyDelta 2.0 deliverable 10.1, 2022

Elbert, S., Groote, M., Wiekens, C., “Case study report with best practices regarding risk governance and societal embeddedness of innovative energy technologies.” HyDelta Deliverable 10.3, 2023

M. Sprenkeling, T. Geerdink, A. Slob, and A. Geurts, "Bridging social and technical sciences: Introduction of the Societal Embeddedness Level" Energies, vol. 15, p. 6252, 2022.

Bijlage 1 - interviewprotocol

Doelstelling

- Het in kaart brengen van ervaringen, meningen en vooruitzichten van experts en stakeholders binnen de waterstofketen (transport, opslag en applicaties) in Nederland

Relevante variabelen/constructen

- Perceptie van technische risico's
- Perceptie van maatschappelijke risico's
- Communicatie over projecten en risico's
- Publieke behoeften

Introductie van het project en interview

- Intro HyDelta Doel, duur, vorm van het gesprek benoemen
- We zijn geïnteresseerd in uw rol en hoe betrokken bent bij of bekend bent bij de ontwikkeling van waterstof opslag/transport/applicaties
- Duur: 45 / 60 min.
- (Indien online: opname, akkoord? (anoniem/opname wordt verwijderd zodra het is uitgewerkt))
- Vooraf nog vragen?
- We willen het graag hebben over uw perspectief op waterstof opslag/transport/applicaties en de maatschappelijke aspecten die daarmee samenhangen.
- We zijn benieuwd naar uw perspectief op uitdagingen met betrekking tot waterstof opslag/transport/applicaties in de maatschappij.

Openingsvraag

1. Kunt u iets vertellen over hoe u betrokken bent of hoe bekent u bent met de ontwikkeling van waterstof opslag/transport/applicaties?

Maatschappelijke uitdagingen omtrent waterstoftoepassingen (algemeen)

2. Wat is uw perspectief op waterstof opslag/transport/applicaties op dit moment?
3. Op welke manier worden stakeholders en het publiek betrokken bij waterstof opslag/transport/applicaties?
4. In hoeverre is er een beeld van de behoeften van het publiek over dit onderwerp?
    a. In hoeverre wordt er gehoor gegeven aan deze behoeften?
5. Wat is uw perspectief op technische risico's van waterstof opslag/transport/applicaties op dit moment?

6. Wat is uw idee over de beleving van de veiligheid en eventuele risico's van de gebruikers in de omgeving?
7. Hoe wordt er op dit moment gecommuniceerd over veiligheid en risico's naar betrokkenen/omwonenden/publiek wat betreft waterstof opslag/transport/applicaties?
    a. Hoe wordt deze communicatie ontvangen?
8. Wat ziet u als de belangrijkste niet technische/ maatschappelijke risico's/risico's voor maatschappelijke inbedding van waterstof opslag/transport/applicaties?
        i. *(Denk aan: publieke perceptie/ beleid, wet en regelgeving/ markt & financiële middelen)*
    b. Op welke manier wordt hier nu mee omgegaan?

Overige vragen

- Heeft u nog toevoegingen op basis van dit gesprek?
- Zijn er andere mensen waarvan u denkt dat het zinvol is mee te praten over dit onderwerp?

Afsluiting

- Bedankt voor deelname
- Korte samenvatting
- Vervolg: Verwerking gegevens: Respondent krijgt geen terugkoppeling van het gesprek.
- Contactgegevens up-to-date?
- Gemaakte afspraken
- Nog vragen?