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Safety and security arguments in resistance to ammonia production plants: A case study from Sauda, Norway

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In the transition towards green energy, ammonia is regarded as a promising energy carrier within sectors such as maritime transport. However, the establishment of ammonia production plants can encounter resistance from local communities and other stakeholders. One key concern driving opposition is the potential risk of accidents, especially given ammonia's toxic and explosive properties. Resistance to ammonia production and use has received limited scholarly attention, and in-depth studies of specific cases have been called for. Answering to this call, this paper presents a case study of a proposed ammonia plant in Sauda, Norway. The planned ammonia production has faced significant objections from residents. Through a document analysis of consultative statements submitted during the municipal council's review of the project plan, we investigate how safety and security concerns were invoked as arguments against the proposed ammonia plant. In the analysis, all arguments used against the plant, including the frequency of their use, are mapped. These include safety and security arguments, health arguments, climate and environment arguments, arguments regarding effects on the local community, and dissatisfaction with or questions about the municipality's administrative procedure. The arguments are discussed in relation to previous studies on perceived costs, benefits, and risks. Then, the safety and security arguments are subject to a more thorough analysis. We find that residents' risk perceptions differ from the risk assessment conclusions in the ammonia project plan.

Keywords: Hydrogen, ammonia, public acceptance, perceived effects, risk perception.

1. Introduction

Green hydrogen is considered decisive for the European transition towards clean energy (European Commission, 2020). However, for the implementation of green hydrogen and hydrogen derivatives like ammonia, whether involving production, storage, distribution, or end-use, to be successful, the public acceptance of such projects is critical (Carr-Cornish et al., 2019).

Public attitudes towards hydrogen technologies have been thematized in multiple research studies (Emodi et al., 2021; Maketo & Ashworth, 2025). In contrast, few studies have examined public attitudes towards ammonia as an energy carrier (Carlisle et al., 2023; Guati-Rojo et al., 2021). Given that ammonia and hydrogen have different properties and pose different safety and health risks (ammonia is toxic, but hydrogen has a higher explosion risk) (Menefee & Schwartz, 2024), there is a need to study the public acceptance of both energy carriers. Moreover, there is limited research on public attitudes toward the *production* of both hydrogen (Maketo & Ashworth, 2025) and ammonia (Guati-Rojo et al., 2021).

In this paper, we contribute towards filling the existing research gap on public attitudes towards ammonia production by analyzing residents' responses to a planned ammonia plant. For renewable energies in general, there is often a

discrepancy between public acceptance at the abstract level (reflected, for instance, in national surveys) and local resistance in the area where an energy project is implemented (Sütterlin & Siegrist, 2017). This highlights the importance of studying local attitudes towards the hydrogen and ammonia plants.

This study explores public responses to a planned ammonia production plant in Sauda municipality, Norway. By analyzing consultative statements from residents regarding the municipality's area development plan for the ammonia plant, the study contributes to a deeper understanding of local resistance towards ammonia production. Given the risks associated with producing ammonia, we are particularly interested in the residents' use of safety and security arguments.

2. Public acceptance and risk perception

The following theoretical outline describes studies on public acceptance in general but, in line with this paper's aim, particularly highlights the connections between public acceptance and risk perception.

The perceived effects (i.e., the perceived benefits, costs, and risks) of hydrogen technologies have been identified as strong predictors of public acceptance (Scovell, 2022), with trust and knowledge being two other important factors (Maketo & Ashworth, 2025). Overall, new technologies are accepted if the benefits are seen to outweigh the risks and costs.

The perceived benefits of hydrogen technologies are a strong indicator of public acceptance (Scovell, 2022). However, quantitative research on hydrogen energy technologies has primarily focused on perceived environmental advantages, rather than other types of benefits (Scovell, 2022). Other potential positive effects include socioeconomic outcomes, such as job creation. In a mixed-methods study on community trust in hydrogen technology, Ashworth et al. (2019) found that job creation was perceived as a key benefit.

The perceived costs of hydrogen technologies include a variety of costs at different levels, including the cost of production, the use of government funding, increased energy prices, and non-monetary costs such as the use of water (Scovell, 2022). Compared to the scholarly attention towards perceived risks and benefits, there has been relatively little research on perceived costs (Scovell, 2022). Ashworth et al. (2019) identified land use as a perceived cost of hydrogen production. In contrast, Buchener et al. (2025) found that the indirect landscape impacts of hydrogen production—stemming from the substantial renewable energy required for green hydrogen—did not influence local acceptance of hydrogen production.

Several studies have shown that perceived risk strongly influences acceptance of hydrogen technologies (e.g., Scovell, 2022), with some identifying it as the strongest predictor (Ono & Tsunemi, 2017). However, as highlighted by Scovell (2022), most quantitative studies have focused on 1-2 risk items rather than conceptualizing risk as a multidimensional construct that encompasses both the likelihood of harm and the severity of consequences. This highlights the need for a more comprehensive analysis of risk perception associated with ammonia production.

Risk perception is understood as "people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their benefits" (Pidgeon, Hood, Jones, Turner, and Gibson 1992, cited in Cho et al. 2015, p. 11). Although risk perception concerns the individual's perception of risk, some argue that the individual cannot be separated from the social and cultural context that it is part of (Cho et al., 2015) and that risk perception can be perceived as a communication process in which risks can be amplified or attenuated through social, individual, or institutional factors (Kasperson & Slovic, 2003).

People's perception of risk may differ from expert opinion, and various theories seek to explain this discrepancy. A common explanation is that the public has a qualitative perspective with concerns such as exposure and level of controllability, whereas experts are predominantly adopting a technical perspective, focusing on probabilities and consequences (Cho et al. 2015).

Moreover, risk perception can be influenced by various factors, including knowledge and

uncertainty, societal trust, the perceived benefits of an activity, and associations with danger or knowledge of previous incidents (Cho et al., 2015; Kasperson & Slovic, 2003).

Trust is one factor affecting perceived risks and benefits (Huan et al., 2025; Montijn-Dorgelo and Midden, 2008). Emodi et al. (2021) found that trust in government and industry influences the acceptance of hydrogen technologies. Huan et al. (2025) found that communication strategies can increase trust and consequently reduce perceived risks. Montijn-Dorgelo and Midden (2008) studied the relationship between perceived benefits and risks in a pilot project on hydrogen buses in the Netherlands. They identified a stronger negative correlation between risks and benefits when the respondents reported low levels of trust and negative associations (i.e., the respondents reported spontaneous associations were negative, such as fear of hydrogen being explosive).

Although new technologies can be positively perceived at an abstract level (as reported, for instance, in public opinion polls), the implementation of concrete projects involving new technologies may encounter local resistance. (Sütterlin & Siegrist, 2017). In a recent study of risk perception of hydrogen fueling stations, researchers found that local residents and the general public perceive risks differently (Huan et al., 2025). Huan et al (2025) conclude that people living in proximity to the hydrogen installation perceive both a higher probability of an accident occurring and more serious consequences. At the same time, several studies have indicated that proximity to the hydrogen facility (e.g., fueling station) increases public acceptance by making hydrogen use more familiar (cf. Emodi et al., 2021). In terms of hydrogen production, Buchner et al. (2025) found that living at a short distance from a green hydrogen plant did not have a significant effect on the acceptance of such plants.

3. Case and context

Sauda, a municipality with 4600 residents, is situated at the end of a fjord on the south-west coast of Norway. Sauda has experienced a population decline since the 1960s, with a stabilization over the past decade. Second to the municipality administration, the most important employer is a smelting plant owned by the French company Eramet.

In 2022, Iverson eFuels launched its intention of establishing an ammonia production plant, aiming to produce 200,000 tons of ammonia yearly using electrolysis. Given that Iverson eFuels reaches an investment decision, the plant is expected to operate from 2030.

Iverson eFuels informed the public about the ammonia production plans in a series of so-called "Green Cafes" from March 2023 onwards. Before the publication of the area development plan concerning the ammonia plant in April 2024, the project received some public opposition. For instance, some attendants at the Green cafes, as observed in a field visit by one of the authors of this paper, were critical of the project. Additionally, opposition was voiced in local and regional newspapers five times before April 2024 (one interview with the former mayor of Sauda and four letters to the editor, two of which were written by the former mayor). The main argument was the ammonia plant's electricity consumption. The majority of the municipality council has been supportive of the project.

Following the consultation round, in September 2024, "The people's movement against the ammonia plant" was founded. This movement required a referendum regarding the ammonia plant. The municipality council rejected this request but initiated a guiding survey. The survey showed that 80 per cent of the population had formed an opinion on the ammonia plant and 60 per cent of these were negative to the plan (Opinion, 2025). Despite the survey results, the municipality council voted in favor of the proposed area development plan and thus the establishment of the ammonia plant.

4. Methodology

In this paper, we have analyzed consultative statements responding to the area development plan for the ammonia plant. The analysis was conducted in several steps. First, we categorized the submitters of consultative statements and the overall sentiments in the statements (see Section 5.1). In the next step, the residents' arguments were identified and coded in an Excel sheet. This

step yielded 161 codes. Some of the codes overlapped and were therefore combined, resulting in 41 aggregate arguments. Then, the arguments were grouped in six overarching thematic categories (such as safety and security arguments and health arguments), as shown and discussed in Section 5.2.

The further analysis focused on the residents' safety and security arguments. For this analysis, we selected quotations within each category that either illustrate a recurring theme across multiple statements or were deemed particularly salient and relevant to the study. These quotations are presented in Section 5.3 and are discussed in relation to the study's objectives and theoretical framework.

5. Results and discussion

In this section, we first give an overview of the consultative statements (Section 5.1). Next, we present and discuss the overall themes of the residents' arguments (Section 5.2), before analyzing and discussing the safety and security arguments more thoroughly (Section 5.3).

5.1. Overview of consultative statements

A total of 37 consultative statements were submitted by the following responders: 9 public authorities (such as the council administration and the Norwegian Directorate for Civil Protection), 3 interest organizations, 6 enterprises, and 19 (groups of) residents. Individuals who signed as both enterprise owners and residents are considered enterprise owners in this study. Among the 19 statements from residents, 16 were submitted by individuals or couples, whereas the remaining 3 were signed by 40, 168, and 211 individuals, respectively. Note that some people have signed multiple statements.

The responders' overall sentiments towards the ammonia plant are summarized in Table 1. It should be noted that the positive statement submitted by one of the interest groups (i.e., the local industry organization) was supported by 6 enterprises (not to be confused with those who submitted individual statements) and the local high school, reflecting that the number of enterprises that were positive to the ammonia plant is higher than indicated in Table 1. Note that only certain public authorities are entitled to submit formal objections to area development plans. In the case of the ammonia project, the issues raised by public authorities were addressed by the project owner, and the objections were subsequently withdrawn.

Table 1. Overall sentiments towards the ammonia plant.

Responder \ Sentiment	Negative	Formal objection	Neutral	Positive
Public authorities	1	4	4	
Interest organizations	2			1
Enterprises	2			4
Residents	17		2	

5.2. Analysis of residents' arguments

The arguments used in the residents' statements can be divided into six main categories: safety and security, health, climate and environment, effects on the local community, dissatisfaction with or questions about the municipality's administrative procedure, and "other", as indicated in Table 2. In Table 2, column 3 displays an assessment of whether each argument is related to perceived risks (R) or costs (C), or neither risk nor costs (O). Column 4 shows the number of residents' statements using arguments from each of the categories and subcategories[a]. Note that most of the statements include multiple arguments.

As shown in Table 2, the residents' statements include numerous and varied arguments against the planned ammonia plant. We also note a divergence among the residents' statements regarding the number of arguments and themes they include, as well as differences in the tone of voice (e.g., emotional and personal vs. formal). Moreover, some of the statements reflect that a substantial effort has been devoted to understanding and responding to the area plan.

[a] One resident submitted a statement in which he expressed his general support of the group statements. We have not included this statement when assessing the frequency of each argument (Table 2, column 4).

Table 2. Categories and subcategories of arguments used in residents' statements. In column 3, the arguments are denoted as either risks (R), costs (C), or neither of these (O). In column 4, # refers to the number of residents' statements the arguments were used in.

	Argument	**R/C**	**#**
A	**Safety and security arguments**		**14**
A1	Unspecified safety argument	R	2
A2	Need for an alternative location due to safety risks	R	1
A3	Fire hazard	R	3
A4	Explosion risk	R	7
A5	Leakage risk	R	10
A6	Fear	R	7
A7	Lack of evacuation routes, evacuation plan, and/or preparedness capabilities	O	4
A8	Work-related risks	R	1
A9	Risks related to bunkering, transport, and/or use	R	4
A10	Terror and other intentional attacks on facilities	R	6
A11	Risk assessment: probability	R	3
A12	Risk assessment: consequence	R	9
B	**Health arguments**		**13**
B1	Negative effect on well-being	R	7
B2	Health risk due to inhaling	R	2
B3	Noise	R	9
B4	Smell	R	9
B5	Fear and stress leading to health issues	R	5
B6	Light pollution	R	3
C	**Climate and environment arguments**		**12**
C1	Energy inefficiency of ammonia	O	7
C2	Inefficient or negative climate measure	O	2
C3	Negative effect on drinking water sources	C	7
C4	Degradation of nature	C	4
C5	Negative effect on wildlife (including aquatic life)	C	6
C6	Negative effects on recreational areas	C	4
C7	Negative effect on agriculture and/or forestry	C	4
D	**Arguments regarding effects on the local community**		**16**
D1	Negative net effect on workplaces	C	7
D2	Negative net effect on migration	C	9
D3	Value loss of local properties	C	8
D4	Negative effect on Sauda as a tourist destination	C	4
D5	Negative effect on the local high school	C	2
D6	Negative economic effect on the municipality and/or pressure on municipal service capabilities	C	4
D7	Future use of the area dedicated to the plant	O	2
D8	Visual changes	C	4
D9	Negative effect on the local business community	C	5
D10	Foreign owner / unknown investors	R	4
D11	Increase in energy prices	C	7
D12	High energy consumption	O	8
D13	Questioning overall benefits for the municipality, county, and country	O	1
E	**Dissatisfaction with or questions about the administrative procedure**		**11**
E1	Need to involve and have a plan for the affected enterprises	O	8
E2	Lack of specific documentation, information, plan, or investigation	O	6
E3	Democratic issues	O	4
F	**Other arguments**		**9**

Starting with the safety and security arguments (Section A) and health arguments (Section B), most of these arguments concern risks. Whereas perceived safety risks have investigated in multiple studies (cf. Emodi et al., 2021; Maketo & Ashworth, 2025; Scovell, 2022), perceived health risks appear understudied so far. Furthermore, security risks (argument A10: 'Terror and other intentional attacks on facilities') have, to our knowledge, not been investigated in previous studies. As such, the list of arguments can guide future research on hydrogen and

ammonia acceptance by broadening which themes to explore.

Sections C and D primarily include cost-related arguments. For instance, the climate and environment arguments (Section C) mainly concern negative effects on the local natural environment, such as negative effects on wildlife (argument C5). The arguments regarding effects on the local community (Section D) include perceived costs that affect residents directly, such as the value loss of property and increased energy prices (arguments D3 and D11), but also costs for the community, such as a negative net effect on migration (argument D2).

Regarding the dissatisfaction with or questions about the administrative procedure (Section E), several of the requests for more information and documentation (argument E2) concern safety issues. For instance, one resident states: "We cannot find any information regarding accidents, emergency warnings, or evacuation." 4 statements include democratic concerns, including the project owner's power in the process, comprehensive and poorly organized case papers, and a lack of involvement of the young generation. The arguments in the category 'Other' (Section F) range from practical issues (e.g., access to a private road) to general questions (e.g., questions about the qualities of ammonia).

Taken together, with few exceptions (e.g., argument C1: 'Energy inefficiency of ammonia'), the arguments predominantly emphasize local, tangible negative impacts rather than more abstract concerns. This confirms previous research on local resistance towards renewable energy technologies (Sütterlin and Siegrist, 2017) and contrasts Buchner et al. (2025), who found that living close to hydrogen plants did not have a significant effect on public acceptance. By highlighting the breadth of locally grounded arguments raised against ammonia plants, the study shows that such objections can be diverse and substantial.

Moreover, we note that to the residents submitting consultative statements, the potential benefits of the ammonia plant are outweighed by the perceived costs and risks. In fact, the benefits of the ammonia plant highlighted by others (e.g., the project owner), such as job creation and net migration to Sauda (arguments D1 and D2), are questioned in 7 and 9 statements, respectively. According to those arguing that the net effect on workplaces is negative, the jobs created by the ammonia plant will be outweighed by the workplaces lost due to the displacement of (and subsequent negative economic impact on) other enterprises by the ammonia plant. Since perceived benefits are identified as a strong predictor of energy technology acceptance (Scovell, 2022), and job creation can be one such perceived benefit (Ashworth, 2019), it is worth noting that estimates regarding future benefits, such as job creation, can be questioned by the public.

Last, although safety arguments are the focal point of this article, it is important to acknowledge that the residents have numerous concerns regarding the ammonia plant. All the statements addressing safety also raise other concerns, though to varying extents. This suggests that while safety is a key concern, residents are also worried about other issues, particularly the potential costs for the local community.

5.3. Analysis of safety arguments

The residents have numerous safety and security concerns. In the following, we have selected some particularly relevant themes given the theoretical perspectives of public acceptance and risk perception: safe local community vs. dangerous ammonia plant, risk assessments and the use of safety consideration zones, fear, and terror. We use quotes from the consultative statements to illustrate the residents' views and concerns before proceeding to an overarching discussion.

By some residents, the plant is perceived as a threat to what is otherwise considered a safe local community. For instance, one statement says that "Sauda is a safe place, but if the ammonia plant is built, it is not safe anymore" and another describes that "We chose to live in Sauda because it is a safe and peaceful place. With the plans of a ticking ammonia bomb, we now feel an uncertainty that makes us consider moving."

The residents are concerned with risk assessments and the placement of safety consideration zones. A substantial number of statements express concerns related to the consequences of an accident. For example, one

person writes: "This project has too many loose ends, not to mention the potential consequences of an accident are too big." A few are concerned with probabilities and consequences. For the most part, probabilities are expressed as the possibility of an accident occurring, such as: "what if a leak occurs, or worst case, an explosion? We think there is a real possibility that this can happen." It is interesting to note that some are concerned about safety consideration zones and are critical of the assessments made by risk consultants: "In the plan, safety consideration zones are just a hundred meters around the installations. No households are affected. This is not consistent with people's impression." In other words, the residents perceive the risks of the ammonia plant differently from the risk assessments conducted by consultants. These diverging perceptions are in line with Cho et al. (2015) and Kasperson and Slovic (2003).

Several residents express fear related to an ammonia plant in their local community. There are variations in how this is expressed. Whereas some are direct, such as: "if the production plant is built, I will most likely move to a place where I don't have to worry about being killed by a gas leak while sleeping," others are concerned about the long-term health consequences of consistent worry or fear about an incident at the plant.

In addition to safety concerns relating to accidents, some residents fear that the ammonia plant may become a target for actors with ill intent, often relating this to energy security and the uncertainties in Europe relating to the war between Russia and Ukraine. For example, one statement reads, "with the unrest and uncertain times in Europe, it must be allowed to say that Sauda is becoming a growing target for terrorism." Another statement contains critical remarks about the risk and vulnerability assessment, as the European security political situation is not considered.

Based on the analysis conducted for this paper, we argue that it is decisive to regard perceived risks as a dynamic component of how ammonia production plants are viewed by residents. First, risk perception is influenced by other factors, such as knowledge and uncertainty, and perceived benefits (Cho et al., 2015; Kasperson and Slovic (2003). We hold that the relation between perceived risks and benefits can also be reversed, i.e., that perceived risks affect how potential benefits are assessed. Though this study's empirical material is not suited for drawing firm conclusions on the direction of influence between perceived risks and benefits, we see it as plausible that the residents' risk perception has affected their assessment of the ammonia plant's benefits: If the plant is experienced as a threat to personal safety, this triumphs over alleged benefits for the local community.

Secondly, trust can have a detrimental effect on risk perception (Cho et al. 2015; Huan, 2025). There is an element of distrust in the consultative statements. It is not necessarily explicit but is present in the majority of the statements through more specific aspects, such as the residents' criticism of the process and their hesitation towards foreign ownership, and more generally through the number of arguments used and the nature of how the opposition is expressed. Moreover, the risk assessments are accessible to them, but their perception of these documents (which is significantly different from the risk assessment conclusions) indicates distrust towards the information provided.

Last, Kasperson and Slovic (2003) claims that risks can be amplified or attenuated through social processes. This is relevant to consider in the case of Sauda. It is interesting to note that there was limited opposition in the beginning, while the project owner shaped the information flow and dialogue through the Green Cafes. After a while, the population mobilized, and the tone shifted – with the foundation of an opposition group and subsequent engagement that they initiated.

6. Conclusion

This study demonstrates that green ammonia projects can encounter substantial local opposition, even in municipalities where the population trend might otherwise suggest a favorable attitude toward industrial development. The arguments used by Sauda residents rejecting the ammonia plant are locally grounded, highlighting costs and risks imposed on the community. The residents' opposition towards the ammonia plant, as reflected in the consultative statements and in the guiding survey initiated by

the municipality, raises the question of where the project owners "failed". Though this study does not consider the degree to which residents were sufficiently informed and involved in the process, it does suggest a lack of trust from a significantly large group of residents towards the project owner and the municipality's administrative procedure. We recommend that residents' concerns be thoroughly mapped as early as possible in the project planning process—preferably before key decisions and administrative procedures are initiated. This allows the concerns to be appropriately addressed, and, if necessary, enables adjustments to the project plan.

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