Socio-economic assessment

RecHycle

Month 35

Funded by the European Union

RecHycle is funded under the call HORIZON-CL4-2021-TWIN-TRANSITION-01-22 within Horizon Europe, the European Union's framework programme for research and innovation (grant agreement no.: 101058692)

Document Information

Project Title	Recycling (renewable) hydrogen for climate neutrality		
Acronym	RecHycle		
Grant agreement no.	101058692		
Topic ID	HORIZON-CL4-2021-TWIN-TRANSITION-01		
EU Contribution	€ 6,226,743.00		
Coordinating entity	ArcelorMittal Belgium		
Start date	01 Jun 2022	**End date**	20 Sep 2026
Deliverable	Socio-Economic assessment	**WP**	5
Deliverable type	Report	**Dissemination level**	PU
Lead beneficiary	ArcelorMittal Belgium		
Authors	Sergei Kabatskii		
Contributions from	Açelya Seçer, Ludwin Daal		
Approved			

Change Records

Version	Date	Changes
Version 1	23.12.2024	• First version for review • Reviewed by A.Secer & L.Daal
Version 2	30.12.2024	• Updates based on comments. • Ready for 2nd review
Version 3	04.02.2025	• Second round of updates after the 2nd review

Project Summary

RecHycle's goal is to implement a gas hub capable of mixing metallurgic gases produced on-site with or without external (green) hydrogen sources. This will ultimately be fed into the Blast Furnace and a future DRI furnace to produce green steel sustainably. The project will demonstrate a cost-efficient solution to decrease carbon emissions by initiating a new industrial symbiosis between and within the steel and chemical industries and renewable energy sources (e.g., wind or solar to obtain green electricity or hydrogen). The project will contribute to the shift towards a circular economy where waste products are valorised to the maximum of their potential. Furthermore, the project will serve as a stepping stone towards further developing synergies between companies within the North Sea Port industrial area, thus creating new opportunities for innovation and economic activities. Challenges to be addressed are the dynamic optimization of gas mixtures and flows, minimizing risks of hydrogen on material embrittlement, ceramic feed-inlet (Tuyeres) within the furnaces, the quality of the produced steel, and the (future) material scrap streams of the DRI. RecHycle will be executed through a consortium of 6 partners from 4 different countries, including one industrial partner that is world-leading in the steel manufacturing industry and five research partners specialized in hydrogen-based studies.

Acknowledgment: RecHycle - Recycling renewable hydrogen for climate neutrality (grant agreement number: 101058692) is funded under the call HORIZON-CL4-2021-TWIN-TRANSITION-01-22 within Horizon Europe, the European Union's framework program for research and innovation.

RecHycle Consortium

The following table contains information about the consortium members.

Name	Country	Contact
ArcelorMittal Belgium	Belgium	**Project Coordinator:** Joke Bauwens Joke.bauwens@arcelormittal.com
Joanneum Research Forschungsgesellschaft	Austria	**Participant:** Reinhard Kaindl reinhard.kaindl@joanneum.at
Università Politecnica delle Marche	Italy	**Participant:** Filippo E. Ciarapica f.e.ciarapica@univpm.it
ArcelorMittal Maizières Research	France	**Participant:** Rodolfo Santos Ferreira rodolfopaulo.santosferreira@arcelormittal.com
Centre National de la Recherche Scientifique (CNRS)	France	**Participant:** Gerard Vignoles vinhola@lcts.u-bordeaux.fr
IRT Saint Exupéry	France	**Participant:** Laurent Ferres laurent.ferres@irt-saintexupery.com

Table of Contents

1 Executive Summary

This report analyses stakeholder perspectives on the transition to CO_2-neutral steelmaking, with perceptions drawn from 20 interviews involving representatives from industry, research & academia, trade unions, NGOs, environmental organizations, and community groups. The findings provide valuable insights into the technological, economic, environmental, social, and policy challenges and opportunities associated with projects like RecHycle, which aim to decarbonize the steel industry.

Overall, stakeholders expressed optimism about the technological innovations brought by the RecHycle project. However, slight agitations were voiced concerning scalability, safety risks, and persisting high costs of hydrogen. The necessity of balancing advancements and innovations with current socio-economic realities was emphasized, alongside the need for robust infrastructure and policy support to ensure these technologies can be implemented effectively.

From the economic standpoint, the transition offers possibilities for employment and development, at the same time it raises issues of high investment and maintenance costs. All the stakeholders were aware of the environmental gains of carbon-neutral steelmaking, but they had some concerns with hydrogen production regarding the consumption of resources and impacts on the lifecycle.

The report underlines the importance of community engagement in advancing public trust and project success. Although current engagement efforts are rated rather positively, stakeholders called for more transparent and localized communication strategies to address community concerns about employment, environmental risks, and project benefits. Strong policy and regulatory frameworks, including subsidies and efficient approvals, were identified as critical enablers of this transition. Collaboration across sectors and geographies will be essential to overcoming barriers, maintaining competitiveness, and positioning Europe as a leader in sustainable steelmaking.

List of abbreviations

BF	Blast Furnace
BOF	Basic Oxygen Furnace
DRI	Direct reduced iron
CBAM	Carbon Border Adjustment Mechanism
OPEX	Operating expense
CAPEX	Capital expenditure
EAF	Electric arc furnace

2 Background

As the climate crisis concerns have been rapidly increasing in recent years, the European Union has agreed on a new framework of regulations, which was introduced in 2019 under the “Green Deal” and legally bounded European countries from 2021 to achieve carbon neutrality by 2050. ArcelorMittal Belgium started their involvement in several strategic projects and initiatives to reach this target. As a result of Green Deal and other commitments [1], ArcelorMittal Belgium developed a roadmap with the aim to reduce its CO_2 emissions by 35% by 2030 compared to 2018 and to become carbon neutral by 2050 consisting of three axes:

1. Further improving material and energy efficiency.
2. Electrification and embracing hydrogen as a reducing agent.
3. Developing smart carbon concepts at the heart of the circular economy.

The RecHycle project allows ArcelorMittal Belgium to take important steps in all three axes by decarbonizing the blast furnace route by using hydrogen-rich metallurgical gases in the blast furnace. This leads to a reduction of coke and powder coal consumption, resulting in a lower CO_2 emission. This is a very important step for a greener future as the steel industry is a major CO_2 emitter, accounting for 7% of the world’s emissions. About 60% of steel production in the world is produced via the Blast Furnace- Basic Oxygen Furnace (BF-BOF) route where fossil fuel coal is used as the main carbon-rich material to make steel. It's especially important for the Flanders region as 9.6 Mt per year are produced at ArcelorMittal Ghent Mill, which represents 10% of the CO_2 emissions of this region.

“RecHycle” aims to balance economic feasibility and environmental targets. Even though “green” hydrogen was a promising form of renewable energy at the time of the start of the project, the RecHycle project was focusing on a more secure forms of decarbonisation such as recycled metallurgical gases that contain hydrogen. The recent market and economic situation only proves that prioritization of its alternative types (for example, blue hydrogen) was a more strategic approach. [2] Besides the hydrogen availability concerns, steelmaking in Europe is experiencing structural challenges due to rising

competition from outside Europe and lowering demand from European customers. Some key actors even openly say that the industry “is on the brink”. [3] As of the end of 2024, there are ongoing active efforts for new supportive measures (such as the “Clean Industrial Deal”) and calls for “A European Steel Action Plan”. [4;5].

Despite the projected increase in global steel demand, which is expected to rise from 1.5 billion tonnes to 2.3 billion tonnes by 2025, the European steel industry grapples with significant challenges, such as overcapacity from emerging economies like China and the burden of high energy prices and raw material costs; These factors create a complex environment for the European steel producers, who must navigate stricter environmental regulations while contending with market pressures that threaten their competitiveness. The need for substantial investments in innovative technologies and infrastructure further complicates the landscape, as companies aim to meet sustainability objectives without jeopardizing economic viability. [6;7].

As for sustainable innovations, the market situation has not improved significantly in favour of sustainable innovations since the start of the project in 2024: for instance, the hydrogen prices haven’t lowered considerably, and in the case of Belgium, the price for renewable hydrogen has even increased, mainly due to grid fees and taxes. [8] All this highlights the challenging environment for innovative projects such as RecHycle. Precisely because of the above factors, the social dimension of the transition cannot be overlooked. As the restructuring of the industry raises concerns about job security and workforce development, a balanced approach that considers both economic and social factors is necessary. Therefore, in the current circumstances, it’s crucial to investigate different stakeholders’ views on various challenges associated with the green transition of the steel industry and its alignment with current economic realities, together with a perspective on RecHycle in particular. Finally, understanding the perspective of stakeholders (especially local stakeholders) is a crucial step in a dialogue that might otherwise lead to non-acceptance, as can be seen in the example of the conflict involving another large steel company in the Netherlands. [9]

3 Methodology

The goal of this study is **to explore stakeholders' perceptions and insights regarding the transition to CO_2-neutral steelmaking, focusing on:**

- technological innovations
- economic impacts
- environmental considerations
- community engagement
- policy implications.

3.1 Research questions

Based on this goal, the following research questions were formulated:

1. **Perceptions of Technological Innovation**:
    - What are the key stakeholder perspectives on the proposed technological innovations in the steelmaking process, and how do these perspectives vary among different stakeholder groups?
2. **Perceptions of economic impacts:**

- How do stakeholders perceive the potential economic impacts, including job creation and economic growth, resulting from the implementing carbon-neutral steelmaking technologies?

3. **Environmental Considerations Perceptions**:

   - What environmental benefits and risks do stakeholders associate with the transition to CO_2-neutral steelmaking, and how do these perceptions align with climate change mitigation goals?

4. **Perspectives on community engagement**:

   - How do stakeholders assess the effectiveness of community engagement strategies in discussions about the transition to CO_2-neutral steelmaking, and what community needs and preferences should be prioritized?

5. **Policy and Regulation Perspectives**:

   - What are stakeholders' views on the role of government policies and regulations in supporting the transition to CO_2-neutral steelmaking, and what regulatory barriers do they identify?

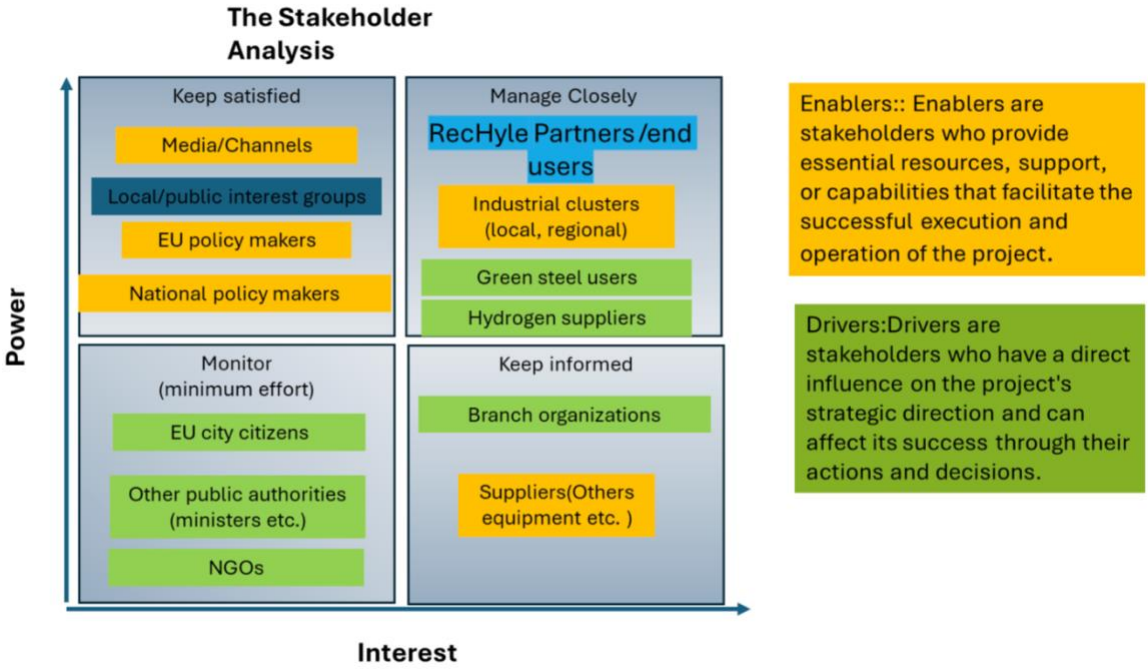
6. **Barriers and Enablers Analysis**:

   - What key barriers and enablers do stakeholders identify in the transition to CO_2-neutral technologies, and how can collaboration among stakeholders facilitate overcoming these challenges?

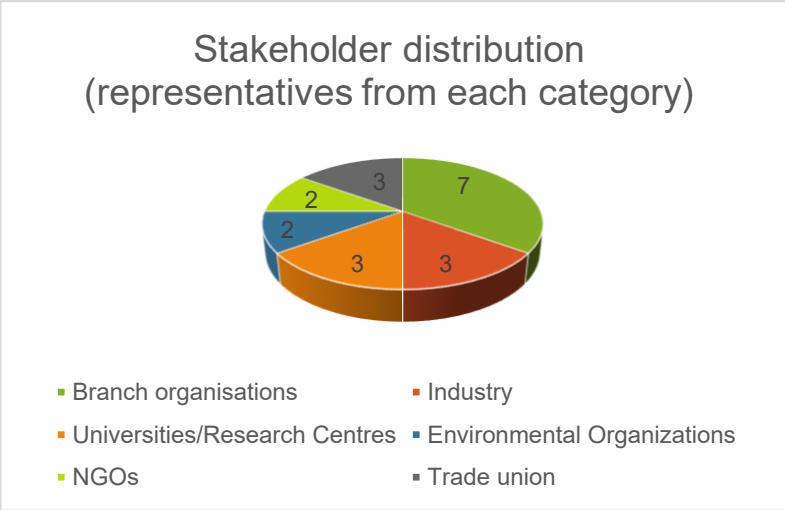
7. **Differences between stakeholder groups**

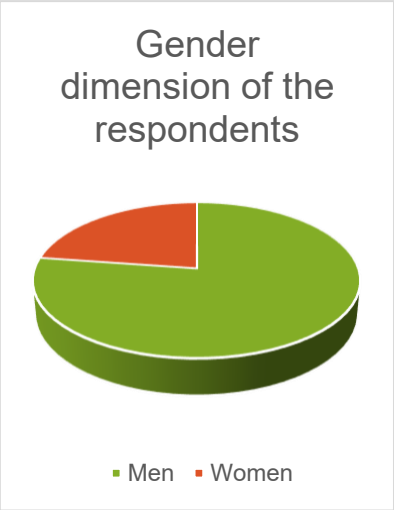
   - What are the differences in main trends, most frequent topics, and perception of all issues among the six groups of stakeholders interviewed?

Prior to contacting all the future respondents to arrange the interviews, the stakeholder analysis was done to identify the most appropriate ones (see the figure below)



By the end of 2024 (the first round of assessment), 20 interviews have been conducted (in which 22 people were interviewed). Most of the interviews were administered online via Teams and recorded (if agreed with the respondents). Each interview usually lasted for around an hour or longer. At the beginning of each interview, a short presentation with the key information on the RecHycle project was shared, and participants were encouraged to ask clarifying questions. Besides, in most cases, respondents have already received this presentation together with the “one-pager” (factsheet) of the project and the link to the official website. These measures allowed the respondents to be put in equal “informed” conditions to measure their perceptions based on that. There were stakeholders from different sectors representing five key European countries. Respondents were anonymized in the cleaned transcripts. Stakeholders were later grouped by their type into six different categories for further comparison: Branch organizations, Environmental organizations, Industry sectors, NGOs, Trade Unions, Research & Academia. Only 5 out of 22 respondents were women (23%) which may be perceived as a limitation but also showcases that the technical sectors around the steel industry are not fully gender balanced.





In total, **307 quotations** were considered (see Annex 7.3). In ATLAS.ti a quote is any part of the data that has been chosen and highlighted by the researcher as significant or valuable during the process of qualitative data analysis. It is a portion of text from an interview transcript/note that is believed to be significant to the research questions or the themes and codes. Quotes are the building blocks of the analysis; they connect data to codes and assist researchers in arranging and understanding the data in a more structured manner.

The questions were divided into two parts and the analysis follows the same principle: one part is devoted to “closed” questions (with provided options for answers), while the other part is devoted to the analysis of the direct speech of the respondents. It is essential to note that even in the closed part, respondents were encouraged to explain their answers. Therefore, the open-part analysis considers some of the answers from the closed part where there were at least some relevant comments or remarks on the respondents’ choices. In contrast, the analysis of the closed part aims to highlight only the most prominent trends, which are less open to interpretation.

NB: to balance out all the responses, no parts of the direct speech is presented in the analysis as the considered quotes were generalised (but the direct speech can be found in the table in Annex 7.3).

3.2 Interviews

The open interview format was chosen over the survey as a more complex and beneficial approach. This method allowed for dynamic conversations, the ability to ask follow-up questions, and the opportunity to explore topics in greater depth, ultimately providing richer insights for the analysis.

3.2.1 Single-choice questions.[1]

There is no definitive methodology for the closed section as it was not the main focus of the analysis. On the basis of the table prepared with all the choices made by the respondents (see Annex 7.2), a comparison was made for each category, which is visually presented in the analysis section in the form of pie charts. The main trends for the six categories identified were then analysed.

3.2.2 Direct speech from the respondents.[2]

Firstly, all transcripts of the recordings were analysed for relevant quotes in respondents' answers to avoid overloading further analysis and to find answers to the research questions. This meant that each interview transcript underwent the time-consuming process of 'data cleaning'.

All responses to each question were then combined into a single quotation. There were a few exceptions, such as where two respondents were present during the interview and their responses were separated ('Person 1 & Person 2'). Where some irrelevant information was omitted, this is indicated by '[...]'. In cases where certain words were missing from the transcript or recording, but implied by the context, they have also been added in "[ ]" to ensure that they don't change the meaning of what was said. Questions with no definitive answer or only the answer to the closed question (chosen from the options provided) were excluded. Most interviews were conducted in English, but a few were conducted in Dutch and subsequently translated.

Based on the questionnaire, the research goals, the type of stakeholders involved, and the initial notes from the interview, a system of codes was developed for ATLAS.ti software (see below). The codes were then assigned to each quotation. **One quote usually contains multiple codes, as the primary purpose is to identify thematic areas for further analysis.**

1. **Technological Innovation (TI) Perceptions**
    - TI1: Stakeholder Perspectives on Proposed Technological Innovations
    - TI2: Perceived Benefits and Risks of Technological Innovations
    - TI3: Feasibility and Scalability of Technologies
    - TI4: Alignment with Sustainable Development Goals (SDGs)
    - TI5: Stakeholder Concerns Regarding Technological Innovations
2. **Economic Impacts (EI) Perceptions**
    - EI1: Stakeholder Views on Economic Impacts
    - EI2: Job Creation Opportunities
    - EI3: Economic Growth Potential
    - EI4: Economic Feasibility Concerns
    - EI5: Investment Challenges and Drawbacks

[1] This naming refers to the closed questions from the interview.
[2] This naming refers to the open questions from the interview and those from the closed part, where explanations for the choses made were provided (or any other valuable additions).

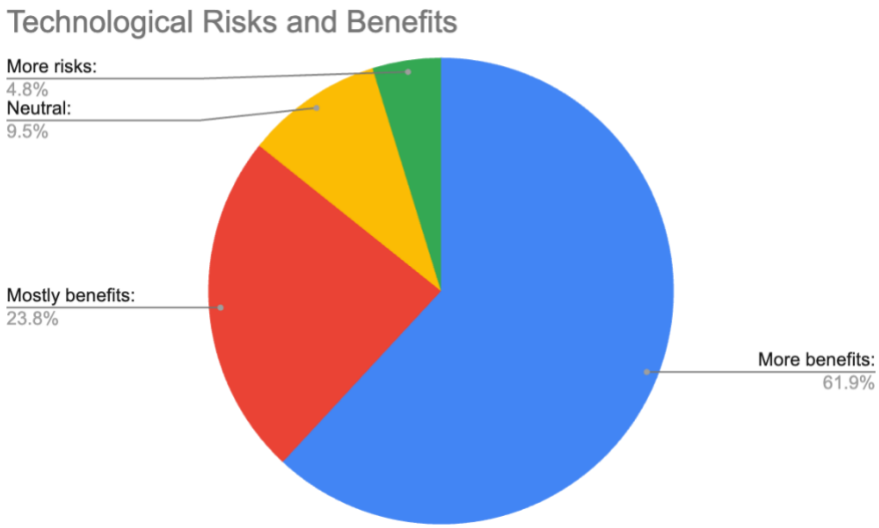
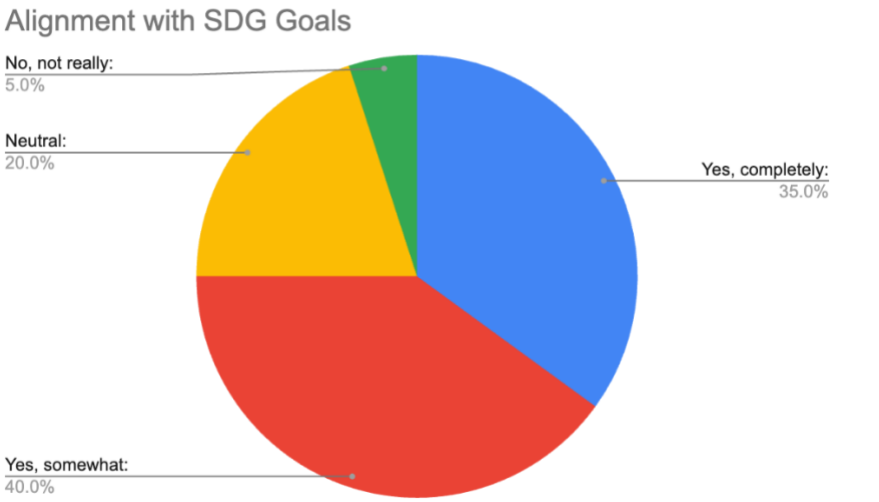
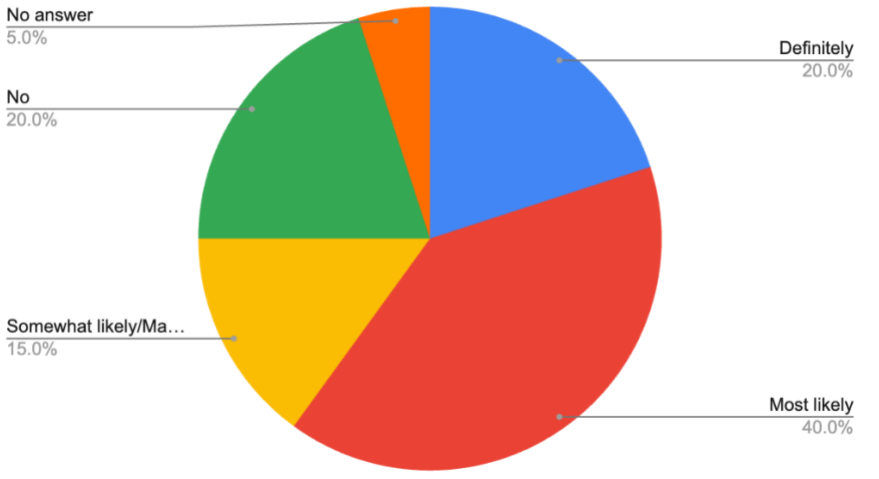
3. **Environmental (EN) Considerations Perceptions**
    - EN1: Stakeholder Perspectives on Environmental Benefits
    - EN2: Environmental Risks and Concerns
    - EN3: Alignment with Climate Change Mitigation Goals
4. **Community Engagement (CE) Perspectives**
    - CE1: Level of Community Engagement
    - CE2: Community Needs and Preferences
    - CE3: Strategies for Effective Community Involvement
    - CE4: Communication with Local Communities
    - CE5: Local Community Concerns and Priorities
5. **Policy and Regulation (PR) Perspectives**
    - PR1: Stakeholder Views on the Role of Government Policies
    - PR2: Regulatory Barriers to Implementation
    - PR3: Policy Measures for Supporting Green Technologies
    - PR4: Collaboration Between Government and Industry
    - PR5: Strategies for Effective Policy Implementation
6. **Barriers and Enablers (BE) Analysis**
    - BE1: Key Barriers to Sustainable Transition
    - BE2: Key Enablers for Sustainable Transition
    - BE3: Stakeholder-Specific Challenges
    - BE4: Opportunities for Collaboration and Support

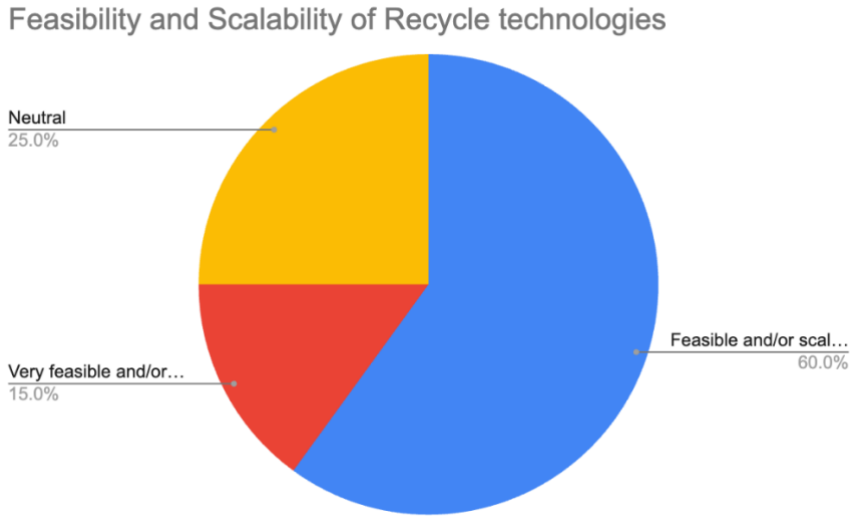
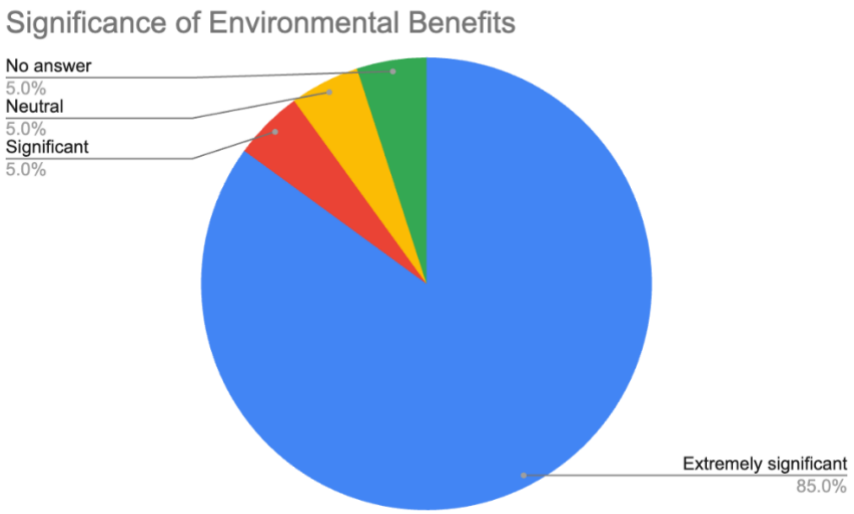
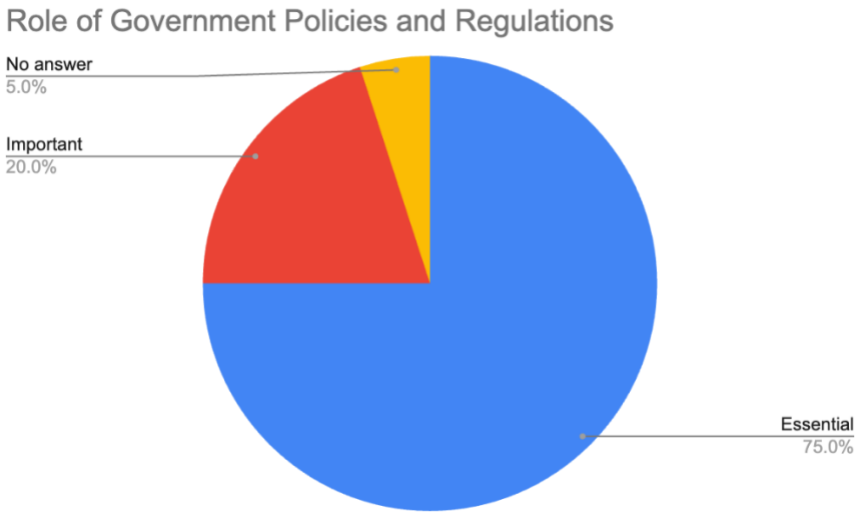
4 Analysis

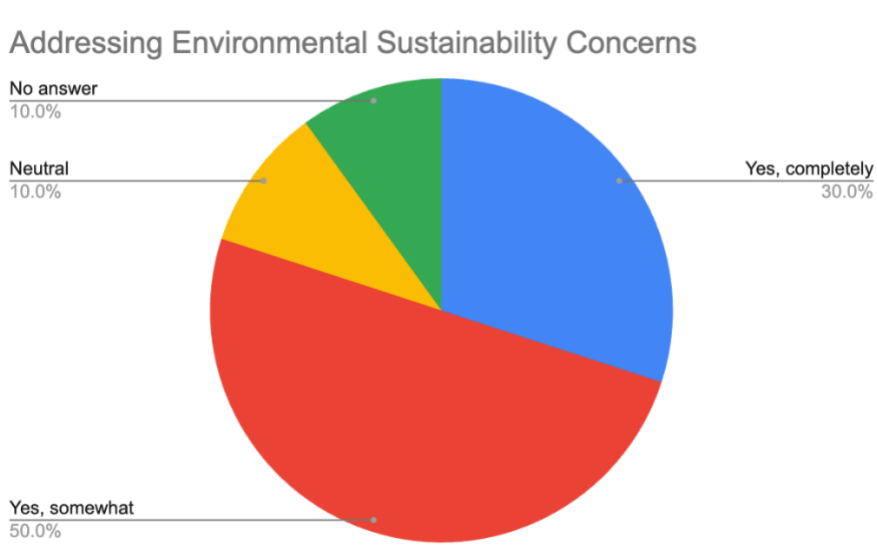
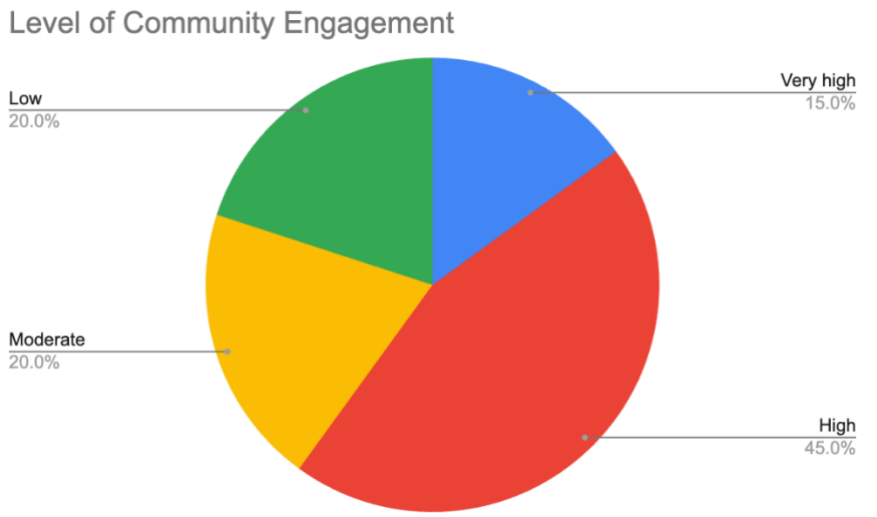
4.1 Closed part

Each of the 8 topics bellow correspond to the specific question from the main part[3] that was asked during the interviews and can be found in the Annex 7.1 In brackets there are references to them – Q(x). Only those options that were chosen at least once are shown.

[3] For the more robust analysis in the closed part questions that all of the respondents were asked are being considered.

1.RecHycle's Technological Risks and Benefits comparison (Q2) **- More benefits:** 13 **- Mostly benefits:** 5 **- Neutral:** 2 **- More risks:** 1	
2. Alignment of RecHycle with SDG Goals (Q3) **- Yes, completely:** 7 **- Yes, somewhat:** 8 **- Neutral:** 4 **- No, not really:** 1	
3. Job Creation or Economic Growth from RecHycle (Q5) **- Definitely:** 4 **- Most likely:** 8 **- Somewhat likely/Maybe:** 3 **- No:** 4 **- (No answer):** 1	

4. Feasibility and Scalability of the project's technologies (Q7) **- Feasible and/or scalable:** 12 **- Very feasible and/or scalable:** 3 **- Neutral:** 5	
5. Significance of Environmental Benefits resulting from RecHycle (Q8) **- Extremely significant:** 17 **- Significant:** 1 **- Neutral:** 1 **- (No answer):** 1	
6. Role of Government Policies and Regulations in sustainable transition (Q10) **- Essential:** 15 **- Important:** 4 **- (No answer):** 1	

7. Addressing Environmental Sustainability Concerns by the project (Q11) **- Yes, completely:** 6 **- Yes, somewhat:** 10 **- Neutral:** 2 **- (No answer):** 2	
8. Level of the Community Engagement in discussions about sustainable transitions (Q12) **- Very high:** 3 **- High:** 9 **- Moderate:** 4 **- Low:** 4	

The further short analysis is divided in three categories that correspond to the frequency of particular answer options chosen by the respondents.

In two categories **(topics 5 & 6),** the overwhelming majority (75% or more) emphasized the significant environmental benefits of the innovations of the RecHycle project and highlighted the crucial role of government policies and regulations for the successful green transition in the steel industry (both rated as the top choices). This underscores the importance of projects like RecHycle towards environmental sustainability, and the necessity of government involvement in promoting sustainability.

The majority of the stakeholders agreed (over 50%) in three areas **(topics 1, 4 & 7)** where they rated their confidence levels as the second highest. They generally believe that the RecHycle project provides more significant advantages than risks, that its technologies are practical, scalable and/or feasible, and that it addresses environmental sustainability concerns to some extent.

Opinions varied across three remaining categories assessed by respondents **(topics 2, 3 & 8),** but all received positive ratings overall. There was an equal divide in perceptions regarding RecHycle's adherence to SDGs goals (35% "yes entirely" versus 40% "yes, to some extent"). Regarding employment generation and economic advancement, most participants selected the highest option

(40%), while 20 % favoured the second highest option. The level of community involvement showed a pattern; 45 percent described it as "high," whereas 15 percent said it was "very high."

4.1.1 Overview by Type of Organization

Branch Organizations (7 interviews):

The branch organizations praised the potential and effectiveness of the proposed strategies, their coherence with the SDG goals, and the environmental potential of the changes being made. These stakeholders believe that policy interventions are key to facilitating transitions. The level of engagement was generally judged to be high, with some organisations highlighting the importance of communities in achieving successful and inclusive strategies.

Industry (3 interviews):

The industry participants focused on the technological benefits and economic development prospects of the proposed changes, and their attitudes and perceptions of community involvement and sustainability were ambiguous. Job creation was identified as 'most likely', but the nature, extent and certainty of job creation varied. This is based on the level of engagement with the local community, which was found to be moderate to low across the industry.

Universities/Research Centres (3 interviews):

The universities and research centres focused on the environmental advantages of RecHycle technologies and how they align with the SDGs. While they were optimistic about the feasibility and scalability of the technologies, their participation in community efforts was rated moderate to low. Technical feasibility and scalability were identified as key factors that would facilitate effective transitions by institutions.

Environmental Organizations (2 interviews):

The environmental organizations were not very convinced of the technological and financial returns of the proposed changes and stressed the ecological sustainability goals. They pointed out a very high level of community participation, as the change management process cannot be effective without involving the community. Discourses on the possible misuse of biomass and resource management were also held, and both stakeholders viewed these as significant concerns.

NB: Regarding the specific question about the changes' effects on the local community, both stakeholders assessed it as positive.

NGOs (2 interviews):

The NGOs in general welcomed the technological advantages of the proposed changes but responded with a certain degree of interest towards job creation and environmental viability. Despite the positive perception towards the concept of achieving the SDGs, their views on community engagement were quite diverse with some considering the local and global consequences while the others didn't.

Trade unions (3 interviews):

The trade unions emphasized environmental gains and considered feasibility and community participation essential. They also stressed the policies the government must undertake to facilitate the shifts. However, they paid less attention to job creation or economic development. All the stakeholders felt that the proposed changes' effect on workers' jobs and livelihoods was inconclusive.

NB: In the targeted question about the proposed changes' effect on workers' jobs and livelihoods, all the stakeholders chose 'neutral.'

In general, the closed-part analysis showcases predominantly positive evaluations of the RecHycle's direct and indirect impacts.

4.2 Open Part (ATLAS.ti)

Based on the questionnaire and the research questions, the following code scheme for ATLAS.ti was created.

NB: The distribution of codes is directly connected to the design of the questionnaire and later to the introduction of codes. Although the goal was to learn about all aspects to varying degrees, some categories of issues could receive more attention. This infographic shows the overall distribution of codes in this study.

4.2.1 Differences between stakeholder groups.

The following section corresponds with the 7th research question *(Differences between stakeholder groups)* **summarising the main patterns for each group of stakeholders.**

NB: on all further diagrams with the distribution of codes from the open-part analysis, only 5 top codes are shown.

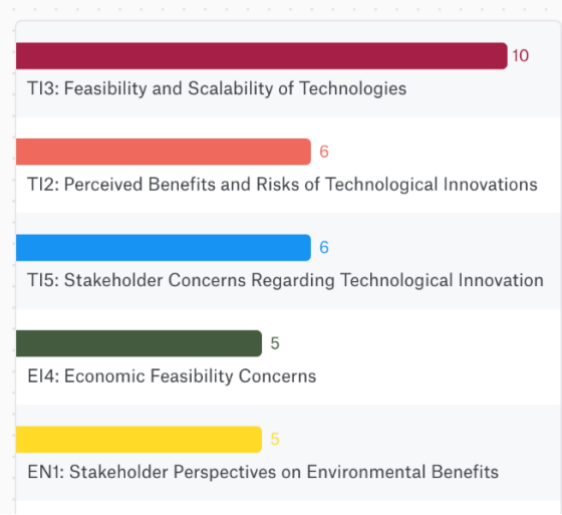
4.2.1.1 Branch organizations

Branch organizations highlighted the key trends in the pursuit of carbon-neutral steelmaking. These include the adoption of technologies such as hydrogen as a reducing agent, biomass utilization, and carbon capture. They also emphasized the importance of maintaining competitiveness in the global market while focusing on environmental sustainability and achieving circularity. Some of the key challenges identified by the branch organisations include the need for infrastructure development, a shortage of skilled labour, and the high costs of green technologies currently being developed and implemented. This is where EU policies and support for the sector has a crucial role to play in addressing these issues.

Perceptions tend to focus on the scalability of solutions, their economic viability and the willingness of consumers to pay for the products. These stakeholders also emphasised the need for international cooperation and information sharing, as well as ensuring that efforts are made in the best interests of local and regional areas. They also highlighted how the transition could stimulate technological progress,

employment and Europe's capacity for sustainable steel production. They see public engagement and stakeholder involvement as essential for further progress and acceptance.

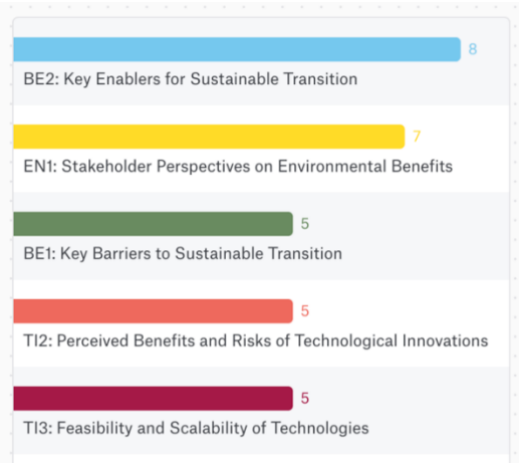
4.2.1.2 Industry



According to the findings of the analysis, the industrial stakeholders see the shift as a double-edged sword, offering opportunities for development while also posing risks of setbacks. They believe that success will depend on achieving technological advancements, ensuring financial feasibility, and complying with environmental standards. Green hydrogen is considered as the most viable solution, but it has a number of issues to be solved, including how to secure a stable and large supply of hydrogen, how to reduce its costs and how to address water consumption. According to these stakeholders, the proposals for the RecHycle modifications are doable and can be applied on a large industrial level, thus, the suggested changes are considered as the steps towards the future development. However, there are still some challenges that need to be addressed such as CAPEX, logistics, and the availability of the raw materials.

From the industry's point of view, some positive aspects include the expectation of job creation, economic stimulation and a reduction in CO_2 emissions, while other issues include the ability to compete with non-European imports and the need for political intervention. It is important to note that transparency and early involvement of the local community are considered crucial. However, public involvement is mainly seen as informative rather than collaborative. The ability of industry to achieve adequate environmental impact, continued economic development and technological readiness will be the key factors that define the success of the transition, with government policy and international co-operation as the main enablers.

4.2.1.3 Universities/research organizations

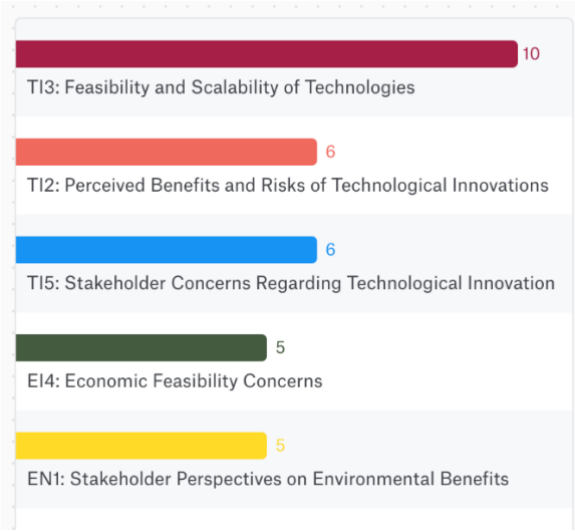


The stakeholders from universities and research organisations were very supportive of the technological advancements that have been made in reducing CO_2 emissions in steelmaking and considered them as relevant to the concept of sustainable development and fight against climate change. They noted that the environmental gains are significant, while underlining the flexibility of the solutions for other plants and manufacturers. However, some issues remain with regards to the challenges that include the cost of

hydrogen and electricity, safety concerns, and the issues with process improvement and quality of the product.

The stakeholders stressed the need to secure hydrogen from sustainable sources, meaning they preferred “green hydrogen” to achieve the best environmental results. Economic aspects are also similarly considered, with hopes and expectations of job creation and the growth of the regional and European economies through local collaborations. However, some of the issues identified include the ability to attract human capital, the viability of the economy, and the management of high investment costs. Stakeholders have therefore called for improved community engagement, enhanced communication, and governmental support through subsidies and policies to improve recognition of the transition. In the face of these challenges, these stakeholders emphasized the importance of a gradual approach to address the technical, economic, and societal issues, ensuring that innovative solutions are implemented effectively and sustainably.

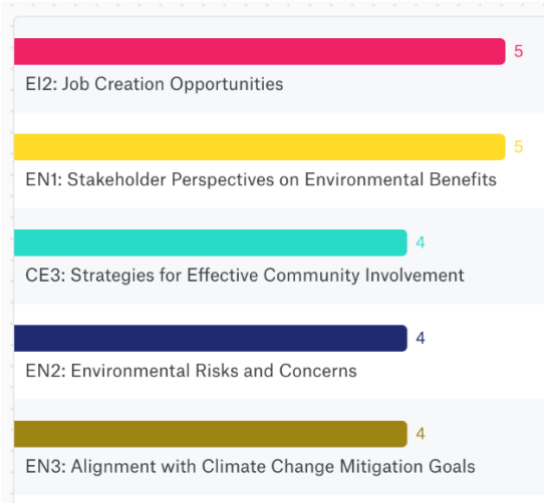
4.2.1.4 Environmental organisations



The environmental organisations focused on the environmental benefits of low-carbon steel technologies, such as reduced CO_2 emissions and improved air and water quality. According to the results, green hydrogen is considered a game changer by the environmental organisations, but it is expensive and depends on the development of infrastructure and policies for its deployment. The following risks have been identified: dependence on blue hydrogen, energy consumption, impacts of resource extraction, the necessity of life cycle assessment, and due diligence. This means that there is a need for strong government policies to direct and support the industry shifts as well as to enforce the companies.

Another key issue highlighted was the need for continued efforts in community engagement. While many stakeholders acknowledged that communication with the public is already well-established, some suggested further improvements through advisory boards, site visits, and enhanced dialogue to strengthen transparency and address any remaining concerns. It is, however, essential to note that the transition can create more jobs and boost the economy while raising issues of regional disparity and market competition. Thus, collaboration between different sectors is essential to ensure the transition is just and sustainable.

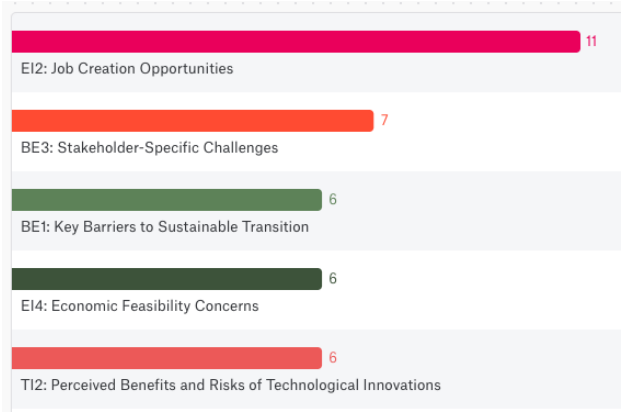
4.2.1.5 NGOs



Recognising the potential of the proposed Recycle steelmaking technologies to achieve the desired carbon reduction targets, the NGOs have welcomed the developments with hydrogen. Some of the opportunities that they identified include the viability and the potential for growth of these technologies, but they also point out the challenges that include the volatility of hydrogen, material degradation and investment. The problems of scaling the solutions include the need to develop strong R&D and clear regulatory frameworks so that the solutions become economically viable and do not create other social and economic issues such as development of obsolete infrastructure.

NGOs highlighted some key points, such as the need for government intervention through policies and guidelines to guide the transition process. It is also important to further continue improving the communication process, involve the community in decision making and meet their needs in terms of employment, environmental assessment etc. Another positive impact is the creation of jobs in hydrogen technology and adjacent sectors, while shifts in traditional roles and advances in automation are some of the challenges. NGO representatives point out collaboration, accountability, and industrial demonstrations among the most needed to address the challenges and achieve a sustainable transition.

4.2.1.6 Trade Unions



According to the findings, the trade union stakeholders are hopeful but still rather conservative regarding the technological advancements in steel production. They pointed out the safety issues regarding hydrogen usage and stressed on the importance of proper supervision and planning. Some of the technologies were deemed feasible by them while others posed a problem due to scalability since the infrastructure and the availability of green hydrogen were an issue.

The economic impact was identified as crucial, with projects being necessary to maintain employment, but the projects would not lead to the creation of many new jobs. Automation and digitalisation, while offering benefits, also pose threats, hence the need for retirement and relocation programmes. Other issues mentioned were the high investment costs and the economic viability of the projects. The need for government intervention in the provision of infrastructure, green energy and efficient regulation was also highlighted. The trade unions acknowledged the fact that the communication has improved over

the last few years, but they still demanded the early union involvement in decision-making, particularly on safety and labour issues. The social licence was seen as improved, although there was a need to improve communication and address issues such as traffic and noise concerns.

4.2.2 Main highlights from each category of codes

The following six sections correspond roughly to the first six research questions. Each summary is based on the quotations coded accordingly. Sub-sections and occasional bullet points have been introduced for ease of reading.

*NB: The filter **"has any of"** was applied in ATLAS.ti to all of the following sections. This allows us to see all quotations in which codes from a particular code group are mentioned. Hence, some diagrams in the top five codes may include codes from another code group. The diagrams show the most frequent codes associated with each specific theme, which can help us to better understand the interrelations between different topics mentioned simultaneously by the stakeholders.*

4.2.2.1 Perceptions of Technological Innovations

This code group can be considered as the "most important" one: about one third of all quotations fall into this category. In addition, it is the most relevant for this assessment, as its main aim is to investigate the perceptions of the technologies developed in the RecHycle project. Therefore, this section provides summaries for each of the stakeholder groups..

Branch organisations (42 identified quotations)

Branch organizations provided a combined perspective of opportunity and obstacles regarding the technological advancements in steelmaking, the principles of sustainability, viability, and the realities of the market. All the stakeholders shared the understanding on the necessity to move towards climate-neutral steel and identified hydrogen, electrification, and carbon capture as the most promising approaches. However, they emphasized certain limitations, including high costs, technical risks, and the lack of necessary infrastructure. Thus, incremental changes, for example, the use of hydrogen injection, are useful for the time being but they are inadequate for the complete decarbonisation; on the other hand, radical changes are necessary, but they are also risky.

They believe that economic issues, such as high costs and competition from other companies, make the technologies challenging to implement, highlighting the importance of government support in the form of financing, carbon pricing and trade measures. This is because it is crucial to work with universities and clusters and ensure that trade is pretty done and that there is adequate human capital.

Although there are some risks, Europe has the potential to be at the forefront of industrial decarbonization by implementing both incremental changes and radical innovations to meet sustainability goals and remain competitive and socially acceptable.

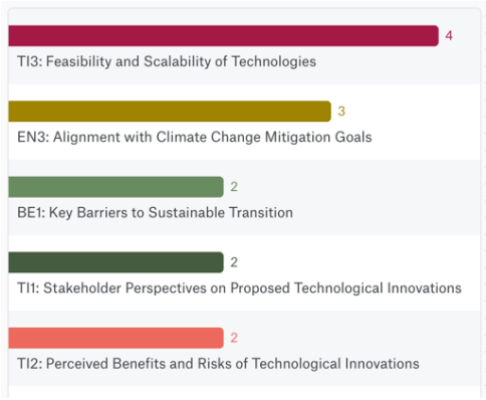
Environmental organizations (10 identified quotations)

Environmental organisations are hopeful, albeit cautious, about technological advances in steel production, with efforts such as green hydrogen and carbon capture showing promise in meeting green goals. The innovations are seen as sustainable and effective, especially in the transition economies, as they have the potential to shift industries towards circular economies. However, there are still concerns about blue hydrogen, which increases energy consumption, and the issue of raw material sourcing, which could counteract environmental gains.

Industry sectors (21 identified quotations)

Stakeholders in the industrial sector see technological advancements in steelmaking as a positive development but at the same time identify challenges in the issue of scalability and the consumption of resources. As for (high-volume) green hydrogen, it is considered as the most viable solution for decarbonization, however, concerns over the costs, supply, and infrastructure remain. They also identified DRI and electrolysis as examples of innovative technologies that are scalable and sustainable and recognized the potential of these technologies in achieving sustainability goals, but pointed out that large-scale application of industrialization is currently in the initial phase. Risks are viewed as being low, but growth depends on large capital investments, the availability of raw materials, and an enabling policy environment. The current projects are seen as milestones, but the authors pointed out that there is still a need to develop a hydrogen supply chain and enhance the industrial processes to make such projects feasible and economically viable.

NGOs (10 identified quotations)

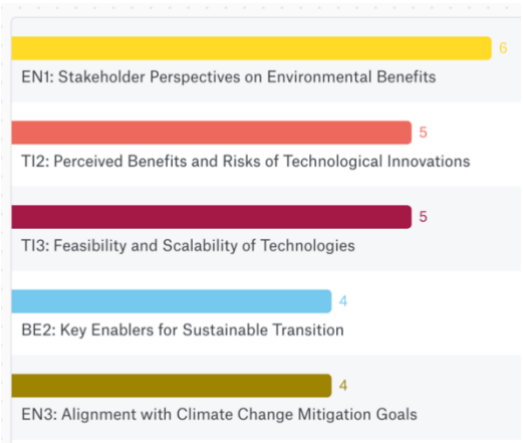


NGOs see hydrogen-based innovations in steelmaking as crucial for the decarbonisation of the industry where CO_2 emissions can be cut by large amounts in line with the Paris Agreement goals. They see more advantages than disadvantages but at the same time they identified some challenges such as scaling, durability of equipment, and legal uncertainties. The further advancement of the technology, the continuous R&D, the support of the regulation and the large-scale testing are considered as vital for the feasibility and the scalability of the matter. The initiatives are commended for targeting hard-to-abate emissions, but the NGOs call for careful integration to avert negative impacts.

Trade Unions (14 quotes identified)

The trade union stakeholders have welcomed technological advancements especially when it comes to steel production for its ability to support the labour union's goals of reducing CO_2 emissions and meeting the sustainability goals. While appreciating the focus on innovation, they stressed the need for a proper strategy and making sure that the economy and the infrastructure is capable of handling such shifts. Some issues were identified with the safety of hydrogen use which underlines the need to enforce proper supervision and control risks. Some of the issues that were highlighted included the fact that although the technologies seem viable, the scalability of the same may be a concern due to dependence on infrastructure and the current issues regarding green hydrogen. They also called for a proper management of the innovation pace in order to achieve proper preparedness, safety, environmental friendliness and minimum worker and social disruption.

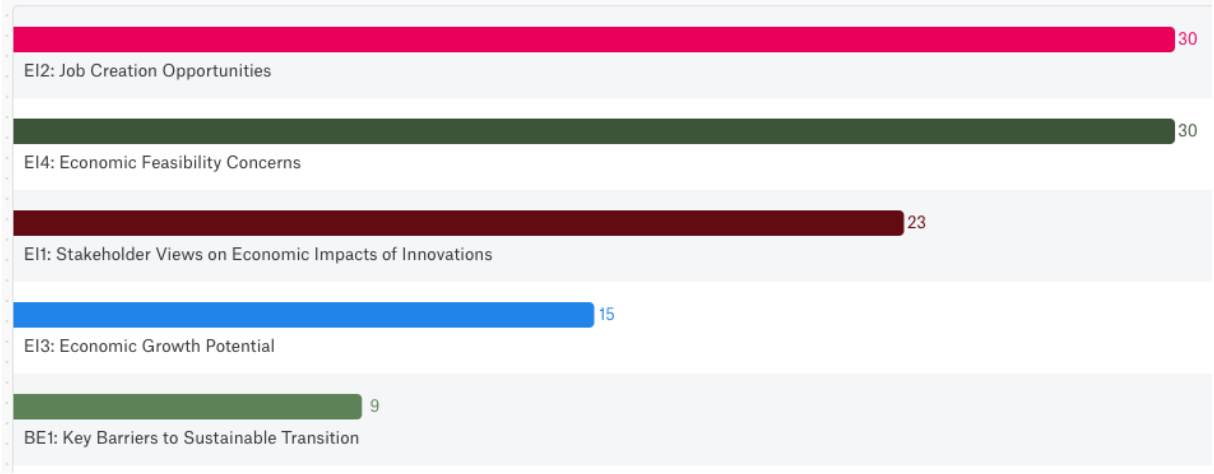
Universities/research organizations (17 identified quotes)



Scholars and researchers also stressed on the need for hydrogen-based technologies in steelmaking, the ability to reduce CO_2 emissions significantly and to meet climate change targets. They considered the technology to be viable and flexible, but at the same time they identified some issues such as safety, supply chain and cost. Thus, while recognising the high ambition and innovation of such projects, they underlined the problem of switching from current technologies and the importance of thorough research and policy support. The issue of

availability of green hydrogen and the huge energy requirements are often debated, but in general all innovations are seen as essential for the decarbonisation of the steel industry.

4.2.2.2 Economic Impacts



1. Job Creation and Workforce Implications

Direct and Indirect Employment: The general expectation of stakeholders is that new technologies will be created. This means creating jobs for installation in engineering, operation of hydrogen technology, scrap handling and other knowledge-based jobs. Secondary employment may be created through supply chain needs and circularity measures.

Long-Term Stability: Although automation and digitalisation will increase employment in the short term, they may offset the long-term effects. For example, maintaining or slightly shifting employment from the BF level to the DRI and EAF levels may result in some jobs being lost, while at the same time creating new jobs that require retraining. All stakeholders agree that maintaining the workforce and efficient retraining will be crucial to managing these changes, with the aim of maintaining safety and avoiding redundancies wherever possible.

Reskilling Needs: Many workers will need to be retrained, especially those working in new jobs in digitalised and hydrogen-based processes. It is also important to note that the preservation of local expertise is considered necessary.

2. Economic Growth Potential

Multiplier Effects: Projects at local sites could become models for scaling up such innovations across Europe, thereby generating further economic benefits. However, stakeholders pointed out that infrastructure constraints, such as the lack of integrated facilities and hydrogen supply chains, are barriers to scalability.

Circular Economy Opportunities: Progress towards minimizing coal use and developing green hydrogen markets may positively impact the economy and position the steel industry as a catalyst for sustainable growth.

Supply Chain and Quality Risks: There are fears that the market will be flooded with cheap and substandard materials coming outside of Europe, which may not be economical in the long run. All the stakeholders are keen on establishing the operations within the proximity and ensuring that the materials and technologies are of the best quality.

3. Challenges to Economic Feasibility

High Costs and Scaling Issues: The high CAPEX and OPEX required for CO_2-neutral technologies is a major challenge. Although the pilot plants show that it is possible, industrial scale pilots are expensive and complicated. According to stakeholders, it is difficult to pass on the production costs to consumers, and it is doubtful whether consumers will be willing to pay the so-called 'green premium'.

Hydrogen Availability and Cost: Stakeholders have identified the high cost and limited availability of green hydrogen as major challenges. It is therefore necessary to address the issue of viability.

Global Competitiveness: Renewable energy production by European and steel hydrogen producers can be more expensive to scale up than that of their counterparts in economically developed non-European countries. Policies such as CBAM and subsidies are essential to maintain the premium price for green products and maintain market competitiveness.

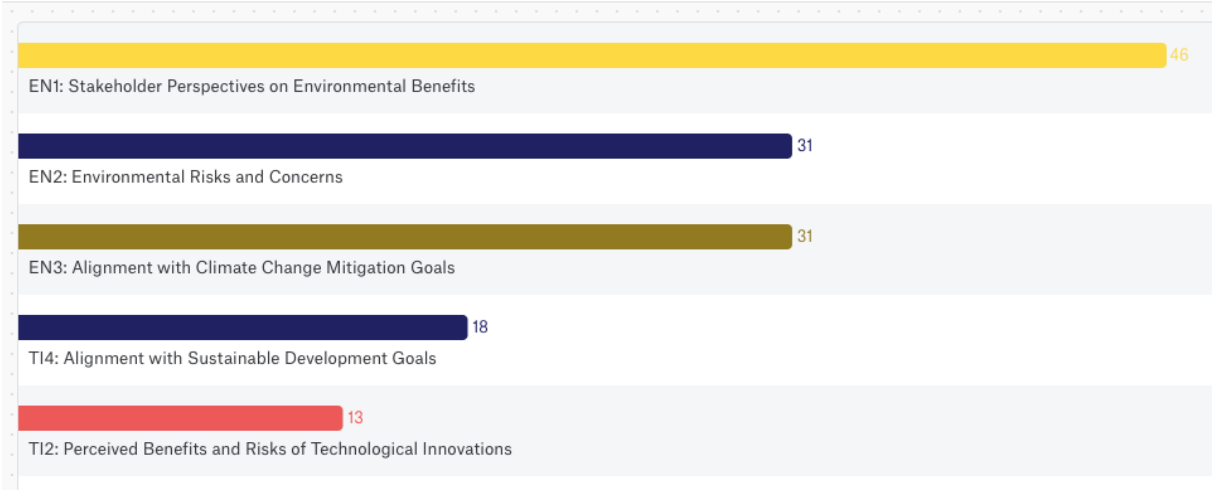
Risk of Relocation: Without proper policies in place, investments can be made in the unregulated regions which may harm the local labour market and the overall economy. This is where lack of action from the regulators such as the slow adoption of CBAM or no clear EU steel action plan also poses the same threat of relocation.

4. Policy and Investment

Subsidies and Support Mechanisms: The stakeholders believe that the major barrier that can be identified as the key factor to affect the feasibility of the solution is government policies and subsidies. The presence of a strong policy is important in the encouragement of the use of green technology. These early and robust EU interventions including steel action plan are important for managing economic consequences and enhancing industrial competitiveness

Community Engagement: Effective community involvement is essential for public acceptance and for projects to take root. In this way, it is possible to meet the challenges of environmental impact on public health and to secure the community's support for the project for many years to come.

4.2.2.3 Environmental Considerations



Environmental Benefits

The implementation of carbon-neutral steel production is crucial to the paradigm of combating greenhouse gases and thus slowing down the process of climate change. Interviewees pointed to the opportunity to reduce carbon emissions and emphasised that decarbonising steel production could support efforts to meet climate change targets. It also helps improve air and water quality by minimising the pollution associated with traditional steelmaking methods.

There is also another significant benefit in the system as a whole, i.e. the industrial value chain, as the transition away from the use of fossil fuels can help prevent environmental degradation at the stage of resource extraction, transport and processing. This approach makes RecHycle's recommendation to implement sustainable production methods even more relevant. Some stakeholders have also emphasised CO_2 emissions, arguing that tackling this 'giant' is a shared responsibility. Incremental solutions such as hydrogen injection are seen as viable measures towards the overall goal of decarbonisation.

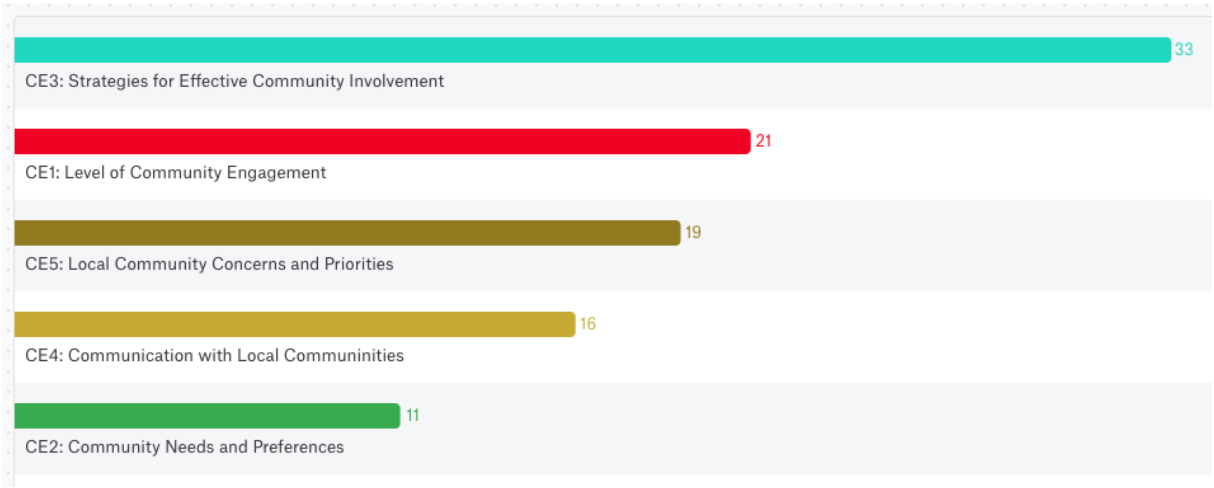
Environmental Risks

Although most of the stakeholders have some concerns about the environmental impact of new technologies. Hydrogen, the main option for CO_2 neutral steel production, has problems with production, storage and transport. This issue raises questions about the sustainability of green hydrogen production, especially in areas with limited water supplies, as large amounts of water are used for electrolysis.

There are also risks associated with the transition of existing infrastructure. The introduction of new technologies may affect existing structures and make some of them infeasible, resulting in waste and the need for significant investment to upgrade or replace them. Risks highlighted by stakeholders include the safety risks associated with hydrogen, such as its flammability and the need for effective incident prevention and control systems. Overcoming these challenges includes the enforcement of safety protocols to help address these issues. In addition, the demand for energy and materials for advanced

technologies, hydrogen production, and carbon capture may offset some of the positive environmental impacts and create more problems. Stakeholders also stressed that hydrogen technologies should be integrated in a way that does not harm the environment or create new hazards. It can therefore be said that stakeholders are more or less in agreement that the transition to carbon-neutral steelmaking is necessary, but only if it is done properly. The sustainability of the transition depends largely on society's ability to ensure that, for example, hydrogen is produced properly. They stressed the need to use renewable energy sources to prevent the environmental gains of the process from being cancelled out. While all stakeholders agree that innovation in steelmaking supports long-term climate change goals, they also agree that the transition to these goals is not straightforward. Decarbonisation, for example, cannot be achieved quickly and will require the management of various trade-offs such as energy, resource efficiency, and technology. It is seen as one of the most important elements of the sustainability transition, but one that needs to be managed and fine-tuned to avoid negative impacts.

Community Engagement



Effectiveness of Current Strategies

Stakeholders generally perceive community engagement as moderate to high, with successful examples of proactive communication and stakeholder involvement. Effective strategies include:

- **Early Engagement:** Involving communities and authorities early in the process helps mitigate resistance and fosters collaboration.
- **Simplified Communication:** Adapting technical language for non-experts is seen as critical to ensuring public understanding.
- **Transparency:** Regular updates on project progress and environmental impacts are key to maintaining trust.

However, the level of societal involvement is still quite low, and discussions are usually more technical and economical in nature. There were some comments that the communication could also be enhanced, particularly, for the public. Some of the stakeholders have pointed out that trade unions and the local

residents are well engaged in the projects through meetings and visits, but there is still room for improvement, especially on the communication aspect which includes providing earlier and clearer updates on the project progress.

Strategies for Improvement

To enhance community engagement, stakeholders recommend:

- **Localized Communication:** Organising informal meetings, plant visits, and advertising in local media.
- **Community Representation:** Establishing advisory boards with local representatives to incorporate community voices.
- **Clear Messaging**: Framing plans in relatable terms, highlighting environmental benefits, economic opportunities, and job security.
- **Information Sharing:** Stakeholders stress the importance of adequately informing communities and involving unions earlier in decision-making processes to address employment and safety concerns effectively.

Community Needs and Preferences

The following key community priorities have been identified:

- **Employment Opportunities:** Preserving existing jobs and creating new roles during the transition process.
- **Environmental Concerns:** Addressing local impacts such as noise, traffic, and air quality.
- **Transparency in Decision-Making:** Ensuring clear and consistent communication about project benefits, risks, and timelines.
- **Information Access:** Stakeholders note that adequately informing neighbourhoods is sufficient for most cases, but ensuring timely responses to their concerns is also critical.

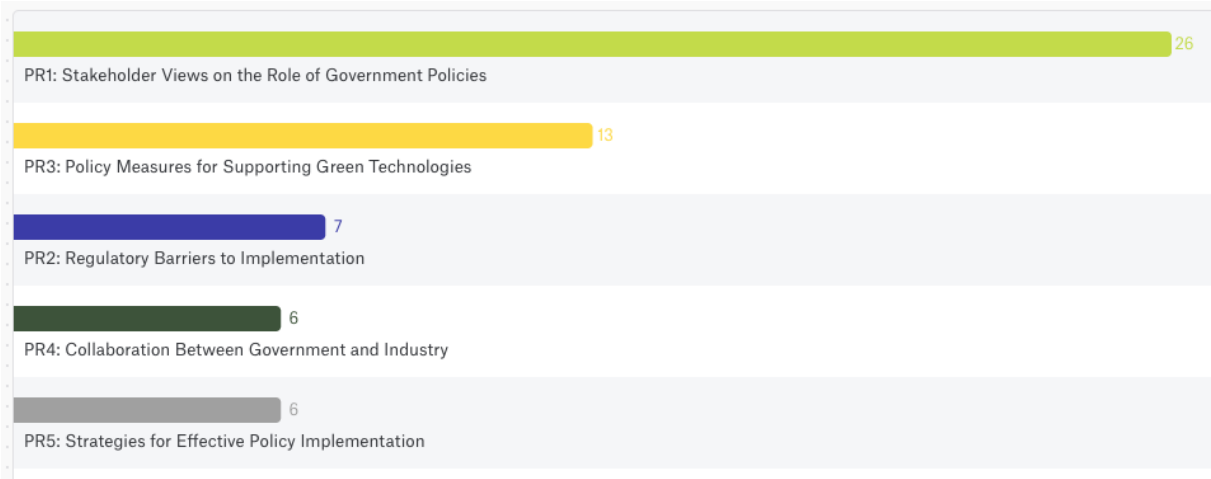
Challenges to Engagement

While there are many positive efforts, stakeholders highlight several **barriers**:

- Limited public involvement in technical decision-making due to the complexity of the subject matter.
- A need for better dissemination of information to a broader audience beyond immediate stakeholders.

- While local communities may not require direct involvement in technical decisions, stakeholders emphasize the need for enhanced communication and early union involvement to balance technical, safety, and employment priorities.

4.2.2.4 Policy and Regulation



Role of Government Policies in Supporting the Transition

The government policies on decarbonization are very competitive and crucial in supporting steel, as the industry's climate-neutral steel needs production. In the Interviews, participants noted that these strategies have to include research, technology, green energy, funding, trade, and infrastructure such as hydrogen pipelines and CO_2 transportation systems. A significant issue is how to achieve the so-called “carrot and stick” approach – providing subsidies on the one hand and introducing penalties on the other hand. When no clear and firm policies are in place, the industry loses confidence, hampering growth.

Some interview respondents urged the EU to develop a steel action plan to guide investments. Delays in implementing measures such as the Carbon Border Adjustment Mechanism (CBAM) enhance uncertainty and adversely impact the safeguarding of local competitiveness. Green the steel government market and ensure that competition is regulated, for instance, by banning the import of non-green steel and setting global standards on sustainability.

It is also important to note that the government should support implementing collaborative projects that include industry, academia, and other stakeholders. Partnerships are believed to be more effective than strict regulations because they not only encourage development but also foster innovation, facilitate knowledge-sharing, and ensure alignment among all stakeholders. Trade unions also demanded their early involvement to address safety, employment, and socio-economic concerns accordingly.

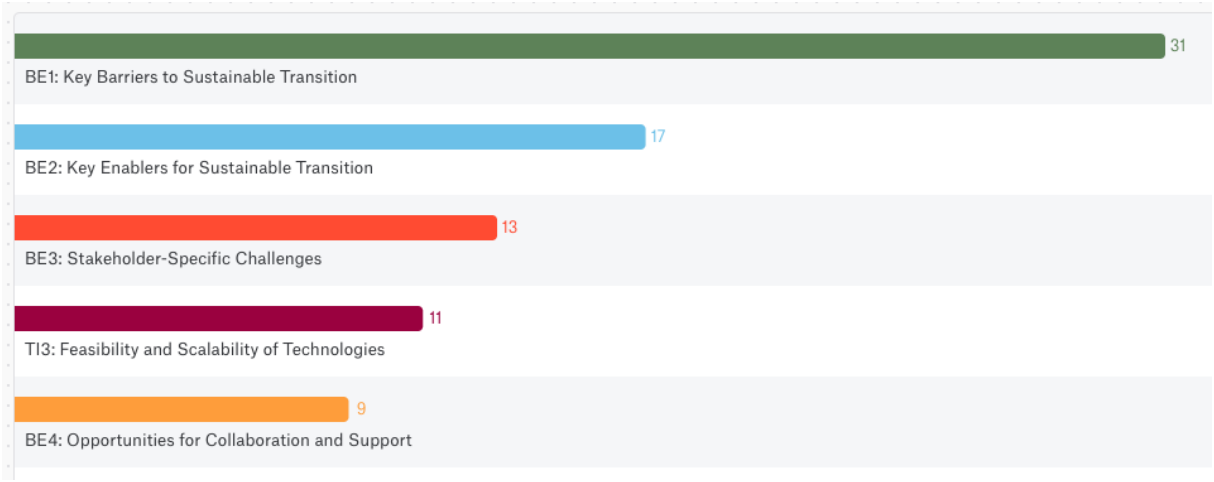
Regulatory Barriers Identified by Stakeholders and Proposed Improvements

Stakeholder requirements have pointed to disjointed policies that lack integration and coordinated approvals across processes, hindering unattainable regions in the regulatory transition. Significantly,

some of this complexity is centrally time-consuming. For example, permitting systems for measures such as CO_2 transport pipelines and green hydrogen from new wind power projects are seen as misaligned with the current technology and economic environment. In addition, the cost of producing green steel and EU inaction increase the likelihood that industries will relocate to areas with stringent requirements, jeopardising both economic and sustainability goals.

Rigid regulatory regimes are a major threat to innovation and research, which are essential to progress. Stakeholders emphasized the need for simplified bureaucratic procedures, consistent policies between different countries and uniform sustainability standards for projects to encourage international cooperation. Some measures that can be taken include streamlining the authorisation process, supporting collective projects and providing financial incentives and rigorous targets. A proper EU Steel Action Plan is essential to address the economic and regulatory issues that will create the basis for the stable development of the industry and its competitiveness.

4.2.2.5 Barriers and Enablers



Key Barriers

The stakeholders identified several barriers to the shift to climate-neutral steel production. Technological barriers are the most prominent, and hydrogen is an issue in steelmaking processes. Concerns such as the wearing of materials, shortening of the equipment life, and the problems with the scaling up of the operations are some of the challenges that hinder the transition. The constraints of renewable hydrogen supply and infrastructure development for its production and transmission only worsen these problems. Also, the current infrastructure, for instance, in Belgium, is inadequate for implementing renewable energy and hydrogen at an industrial level.

Economic feasibility is another critical factor. The compounded issues of CAPEX and OPEX present significant barriers, especially given the challenge of absorbing the green premium into market prices. Uncertain policies and measures further exacerbate these issues, affecting investment decisions, carbon pricing, and competition for resources.

Other considerations are social aspects and workforce, which are also crucial. According to the respondents, to meet the transition requirements, reskilling is needed to fill skill gaps and ensure the industry is well-stocked with personnel, especially given the high turnover rates. Automation and digitalization are changing the nature of work, and, therefore, effective management is needed to ensure that the right workforce is in place while at the same time being aware of technological advancements. Moreover, the stakeholders underscored the project's significance in informing the public and mitigating environmental and health concerns due to decarbonization.

On a global level, the variation in the decarbonization strategies of different places poses a threat to plant relocation to areas with minimal regulatory barriers, hence hampering progress at the local and continental technology levels. It was also noted that suppliers could present a challenge by limiting the flexibility of producers in adopting innovations on large scales.

Key Enablers

However, the stakeholders identified some opportunities as possible stimuli to the progression of the transition. Cooperation was recognized as a key factor, with cooperation between steel makers, governments, and other sectors of the economy being crucial. Forming strategic consortiums and joint R&D can address the funding, technology, and policy gaps for constructing large-scale demonstration projects and thus reduce risk.

Other key factors such as policy and financial instruments are also crucial. All the focus groups agreed on the need for clear and well-defined regulations, subsidies, carbon pricing, and well-designed trade safeguards to enhance competitiveness and promote hydrogen adoption. Developing hydrogen pipelines for the renewable energy infrastructure is vital for the shift. Technological innovation is also another critical enabler. The efficiency and scalability of hydrogen integration for processes such as blast furnaces need to be enhanced for hydrogen adoption. Circular economy strategies, such as efficient recycling, can be used alongside emissions reduction and resource use efficiency strategies. The same goes for workforce and community aspects. Thus, transparency helps to gain people’s confidence and meet their concerns, while the training and reskilling programs provide employees with the necessary skills and flexibility. A just transition that encompasses decarbonization's social and economic effects is crucial to engage the public and workforce.

Finally, the current developments in European green steel technologies present an opportunity. The stakeholders view successful European projects as templates that can be adopted in other regions, putting Europe in a favourable position as the hub of sustainable and green industries. By applying these enablers, the steel industry will be able to manage its transition towards climate neutrality more effectively.

5 Preliminary conclusions

5.1 Main observations from the open part of the interviews

5.1.1 Conclusions for each research question

The following categories correspond with research questions and summarise the main findings in the analysis part.

5.1.1.1 Technology

General Conclusion:

The parties involved have converged on the view that technological advancements in steelmaking are necessary to attain sustainability and climate objectives. Despite the positive outlook on options like green hydrogen, electrification, and carbon storage, issues such as cost, scale-up ability, safety, and infrastructure remain. To ensure an effective and successful transition, closer cooperation between different parties, solid political support, and a proper strategy that would imply the simultaneous development of incremental and radical innovations are needed.

Key Differences in Perception:

The stakeholders are also different in their approaches and emphasis. Environmental non-governmental organizations pay much attention to the life cycle analysis and do not forget about possible negative environmental impacts. At the same time, industrial companies concentrate on the scalability and feasibility of the new technologies. NGOs are concerned with the lack of clarity in the regulations and the need for large-scale trials. In contrast, trade unions are concerned with the safety of workers, loss of employment, and the general impact on the community. Branch organizations display optimism coupled with doubts regarding the realizability and competitiveness on the international level, thus underlining the importance of governmental and intersectoral cooperation.

5.1.1.2 Economy

Stakeholders consider CO_2-neutral steelmaking technologies revolutionary and game-changers while recognizing the economic impacts as ambiguous. That is why they identify numerous opportunities for job creation, economic development, and local multiplier effects. However, all these advantages are conditioned by the ability to address issues such as high costs, the lack of hydrogen, and competitiveness in the global market. This means that a just transition is possible only with strong policy support, skills development, and essential, coherent planning for the shift that will also minimize short-term setbacks.

5.1.1.3 Environment

The shift toward reducing the impacts of the transition and achieving CO_2 neutrality is seen as essential. While these changes aim to lower emissions, stakeholders view steelmaking as an opportunity to tackle pollution and resource consumption. At the same time, there are gains to be made in ensuring the process is environmentally and economically advantageous.

Nevertheless, the transition involves numerous challenges, including the need to adjust existing infrastructure and address specific technological, environmental, and economic hazards. It is crucial to take well-planned steps in a sensible direction, ensuring that environmental management aligns with the fight against climate change.

5.1.1.4 Community

The respondents also believe that the current strategies for engaging the various stakeholders in the transition to CO_2-neutral steelmaking can be described as made. Instead, to increase trust and effective participation, it is essential to improve the transparency of communication and involve more people from the community. To meet the community's needs and expectations and to address issues on job security and the environment, among others, the efforts of the stakeholders must be well coordinated. In conclusion, it can be stated that to achieve effective strategies for stakeholder engagement, there is a need to balance the technical aspects with the ability to communicate in a way that is understandable and involves everyone in the community.

5.1.1.5 Policies & regulations

Stakeholders see government policies as crucial in achieving the shift towards the production of green steel. Some essential responsibilities include setting goals, providing a legal framework, facilitating infrastructure development, and meeting international standards. However, regulatory challenges, policy gaps, and unreasonable conditions are significant hurdles. To address these challenges, governments must simplify procedures, cooperate, and harmonize their policies with other countries so that the steel production sector can transition quickly and efficiently.

5.1.1.6 Barriers & enablers

Collaboration is identified as a linchpin for overcoming barriers in the transition to CO_2-neutral technologies. By pooling resources, expertise, and funding, stakeholders can address shared challenges such as hydrogen supply, technological scalability, and market readiness. Joint ventures between governments and industries can facilitate the development of green hydrogen infrastructure and mitigate economic risks. Moreover, engaging communities and workforce stakeholders ensures a socially inclusive transition, while partnerships across industries foster innovation and shared ownership of solutions. In conclusion, a multi-stakeholder approach, underpinned by clear policies and technological advancements, can drive the steel industry's decarbonization while safeguarding its economic and social viability.

5.1.1.7 Differences between stakeholder groups

The variations among the stakeholder groups with regard to the shift to CO_2-neutral steelmaking can essentially be distinguished by their attitudes toward technological changes, financial aspects, environmental factors, and societal aspects. Branch organizations stress the need for the adoption of new technologies including hydrogen injection and carbon capture while at the same time underlining the need for governmental intervention to overcome obstacles such as high costs and skill gaps. On the other hand, industry stakeholders are more concerned with the viability of these technologies and the issues of competition and the economics of green steel production. Environmental organizations and NGOs are conservative, focusing on environmentalism and social responsibility, and the trade unions are concerned with the employment and safety implications of the transition process. In general, there is an understanding that change is inevitable, and that society has to move towards sustainable practices; however, the focus and concerns differ based on the stakeholder group's position and perspective on the steel industry

Differences in answers between "closed" and "open" parts:

The main and most evident difference is that the closed part was not able to provide crucial insights into the stakeholder's perspective but rather showed the "surface" overview. While after the closed-part analysis, it might seem that stakeholders are rather satisfied with different aspects of the RecHycle project, the open-part revealed numerous concerns and suggestions, especially on the broader level (steel industry as a whole). Hence, both parts complement each other and should be considered together for a better understanding of the complex perceptions of the investigated issues.

5.2 Initial recommendations

The following recommendations are made based on the insights of the interviews held in 2024.

1. Strengthening Government Policies and Regulations

The stakeholders pointed out that governments have a key role in ensuring the successful implementation of green steel production. Therefore, it is important for governments to set goals and objectives, comply with legal requirements, and support the creation of required infrastructure, including hydrogen pipelines and CO_2 transportation systems. Improving the regulatory environment and converging the policies of different countries can also assist the steel industry in navigating the challenges associated with adopting sustainable practices.

2. Promoting Technological Innovation

It is important to invest in research and development of new technologies. All the stakeholders agreed that there is a need to adopt both incremental changes, such as hydrogen injection, and changes, such as carbon capture and storage, are needed. This should be complemented by public-private

partnerships in which different parties contribute to solving problems that affect everyone, including hydrogen supply and technological scalability.

3. Enhancing Community Engagement

Effective community engagement strategies are crucial for building trust and ensuring public acceptance of new technologies. Stakeholders recommended involving local communities early in the decision-making process and improving communication about the benefits and risks associated with the transition. Establishing advisory boards with community representatives can help incorporate local voices and address concerns related to job security and environmental impacts.

4. Addressing Economic Feasibility

Among the policies that stakeholders mentioned were the support of job creation and economic growth to ensure the economic viability of CO_2-neutral steelmaking technologies. Primarily, it includes providing financial incentives for companies to invest in green technologies to ensure that the transition does not disproportionately affect different categories of workers. To help the steel industry to evolve and to prepare for new job opportunities, a focus on reskilling and upskilling the workforce should be one of the main priorities.

5. Fostering Collaboration Across Sectors

Collaboration among various stakeholders — including industry, academia, and environmental organizations — is essential for overcoming barriers to the transition. Joint ventures can facilitate the development of green hydrogen infrastructure and promote innovation. Stakeholders noted that a multi-stakeholder approach, underpinned by clear policies and technological advancements, can drive the decarbonization of the steel industry while safeguarding its economic and social viability.

***

While the initial findings from the 20 stakeholder interviews provide valuable insights into the challenges and opportunities for sustainable transitions in the steel industry, there still might be a need for further investigations. Conducting additional interviews with a broader range of stakeholders and utilizing an updated questionnaire can help capture emerging trends and perspectives that may not have been addressed in the initial study. Furthermore, follow-up surveys with the original participants can provide longitudinal data, allowing researchers to assess changes in attitudes and experiences over time. This iterative approach will enhance the robustness of the findings and ensure that the recommendations remain relevant and actionable as the industry evolves. The need for additional research will be decided upon later in 2025. In any event, the existing study is sufficient enough and can act as a completed one.

6 References

1) European Commission. (n.d.). *The European Green Deal*. Retrieved from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
2) Recycling Today. (n.d.). ArcelorMittal steel mills in France face EAF conversion delays. Retrieved from https://www.recyclingtoday.com/news/arcelormittal-steel-mills-france-eaf-conversion-delays-recycling-xcarb/
3) EUROFER. (n.d.). *European Steel Industry on the Brink: The EU Must Act Now or Risk Losing Manufacturing, Warns EUROFER*. Retrieved from https://www.eurofer.eu/press-releases/european-steel-industry-on-the-brink-the-eu-must-act-now-or-risk-losing-manufacturing-warns-eurofer
4) European Commission. (n.d.). *Green Deal Industrial Plan*. Retrieved from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan_en
5) Steel Action Plan. (n.d.). *Steel Action Plan: Securing the Future of Steel in Europe*. Retrieved from https://www.steelactionplan.eu/
6) European Parliament. (2014). *A-7-2014-0028: European Parliament Report on Steel*. Retrieved from https://www.europarl.europa.eu/doceo/document/A-7-2014-0028_EN.html
7) EUROFER. (n.d.). *Sustainability and Social Affairs in the European Steel Industry*. Retrieved from https://www.eurofer.eu/issues/sustainability/social-affairs/european-s
8) Clean Hydrogen Observatory. (n.d.). *Cost of Hydrogen Production: Production, Trade, and Cost Overview*. Retrieved from https://observatory.clean-hydrogen.europa.eu/index.php/hydrogen-landscape/production-trade-and-cost/cost-hydrogen-production
9) NOS. (2023). *Massaclaim tegen Tata Steel: Omwonenden willen schadevergoeding* [Mass Claim Against Tata Steel: Residents Demand Compensation]. Retrieved from https://nos.nl/artikel/2487766-massaclaim-tegen-tata-steel-omwonenden-willen-schadevergoeding

7 Annexes

7.1 List of Questions

Technological Innovation:

1. What are your thoughts on the proposed technological innovations in the steelmaking process that were presented? **Describe in 2-4 sentences.**

2. How do you perceive the potential benefits and risks associated with implementing these technologies? **Explain your choice in 1-2 sentences if possible.**

    - *Mostly benefits*
    - *More benefits*
    - *Neutral*
    - *More risks*
    - *Mostly risks*

3. Do you think the proposed modifications align with the goals of sustainable development and climate change mitigation? **Explain your choice in 1-2 sentences if possible.**

    - *Yes, Completely*
    - *Yes, Somewhat*
    - *Neutral*
    - *No, Not Really*
    - *No, Not at All*

Economic Impacts:

4. How do you anticipate the proposed changes in steelmaking processes will impact the local and regional economy? **Describe in 2-4 sentences.**

5. Are there any potential opportunities for job creation and/or economic growth resulting from these initiatives? **Explain your choice in 1-2 sentences if possible.**

    - *Definitively*
    - *Most likely*

- *Maybe*
- *Somewhat likely*
- *No*

6. What are the potential challenges or drawbacks in terms of economic feasibility and investment required for implementing these changes? **Describe in 2-4 sentences.**

7. How do you assess the feasibility and/or scalability of the proposed technological solutions considering the current market situation? **Explain your choice in 1-2 sentences if possible.**

   - *Very Feasible and/or Scalable*
   - *Feasible and/or Scalable*
   - *Neutral*
   - *Not Very Feasible and/or Scalable*
   - *Not Feasible and/or Scalable at All*

Environmental Considerations:

8. From your perspective, how significant are the environmental benefits of transitioning to CO_2-neutral steelmaking? **Explain your choice in 1-2 sentences if possible.**

   - *Extremely Significant*
   - *Significant*
   - *Neutral*
   - *Insignificant*
   - *Negligible*

9. What potential environmental concerns or risks do you foresee with the proposed modifications and technologies if any? **Describe in 2-4 sentences.**

10. How do you view the role of government policies and regulations in facilitating the transition towards CO_2-neutral steelmaking? **Explain your choice in 1-2 sentences if possible.**

    - *Essential*
    - *Important*
    - *Neutral*

- *Somewhat Irrelevant*
- *Completely Irrelevant*

11. Do you believe the proposed strategies in the project **adequately** address environmental sustainability concerns? **Explain your choice in 1-2 sentences if possible.**
    - *Yes, Completely*
    - *Yes, Somewhat*
    - *Neutral*
    - *No, Not Really*
    - *No, Not at All*

Community Engagement and Participation:

12. How would you assess the level of community and social engagement in discussions about the transition to CO_2-neutral steelmaking? **Explain your choice in 1-2 sentences if possible.**
    - *Very High*
    - *High*
    - *Moderate*
    - *Low*
    - *Very Low*
13. Are there any strategies that would effectively engage and involve local communities in decision-making processes related to proposed changes? **Describe in 2-4 sentences.**
14. Are there any specific community needs or preferences that should be considered in the implementation of proposed initiatives? **Describe in 2-4 sentences.**

Questions, tailored for specific groups of Stakeholders

Local Community Representatives

15. How do you think the proposed changes in steelmaking processes will impact the local community? **Explain your choice in 1-2 sentences if possible.**
    - *Very Positively*
    - *Positively*

- *Neutral*
- *Negatively*
- *Very Negatively*

16. What are the primary concerns or priorities of the local community regarding these initiatives? **Describe in 2-4 sentences.**
17. How can the steelmaking company better communicate and engage with the local community throughout the implementation process? **Describe in 2-4 sentences.**

Industry Experts and Researchers

18. Based on your expertise, what do you see as the most significant challenges and opportunities in transitioning to CO_2-neutral steelmaking? **Describe in 2-4 sentences.**
19. What additional research and/or development efforts do you believe are necessary to support the successful implementation of these initiatives?

Government Officials and Policy Makers

20. What policy measures or incentives could be implemented to support the adoption of green technologies in the steel industry? **Describe in 2-4 sentences.**
21. How can government agencies collaborate with industry stakeholders to address societal concerns and ensure a smooth transition process? **Explain your choice in 1-2 sentences if possible.**

- *Facilitate regular dialogue between government and industry.*
- *Form joint task forces to tackle societal concerns.*
- *Offer funding for collaborative projects.*
- *Share best practices through workshops.*
- *Mandate corporate social responsibility initiatives.*
- *Own Option (Explain)*

Environmental Advocacy Groups:

22. From your perspective, what are the key environmental benefits of transitioning to CO_2-neutral steelmaking? **Describe in 2-4 sentences.**

23. What are your main concerns or criticisms regarding the proposed strategies for achieving carbon neutrality? **Describe in 2-4 sentences.**

24. How can environmental advocacy groups contribute to shaping and monitoring the implementation of these initiatives to ensure alignment with sustainability goals? **Describe in 2-4 sentences.**

Trade Unions and Workers' Representatives

25. How do you anticipate the proposed changes in steelmaking processes will affect workers' jobs and livelihoods? **Explain your choice in 1-2 sentences if possible.**

    - *Positive Impact*
    - *Neutral Impact*
    - *Negative Impact*

26. What measures do you think should be taken to address potential employment impacts and ensure a just transition for workers? **Explain your choice in 1-2 sentences if possible.**

    - *Provide retraining programs.*
    - *Establish a social safety net.*
    - *Create job transition plans.*
    - *Promote job creation in alternative sectors.*
    - *Ensure transparent decision-making.*
    - *Own option (Explain)*

27. How can labour unions and workers' representatives actively participate in decision-making processes related to these changes? **Describe in 2-4 sentences.**

7.2 Excel table with answers from the closed part (screenshots)

	1	2	3	4	5	6	7	8	9	10
Type of Organisation	Branch Organis	Industry - H2	Industry - H2	NGO	Branch Organis	Branch Organis	Branch Organis	Environmental c	Branch Organis	Branch Organis
Technological risks and benefits	More benefits	More benefits	Mostly benefits	More benefits	More benefits	Mostly benefits	More benefits	More benefits	Mostly benefits	Neutral
Alignment with SDG goals	for green hydrogen	Yes, somewhat	Yes, completely	Yes, somewhat	Yes, somewhat	Neutral	Neutral	Yes, somewhat	Yes, completely	No, Not Really
Job creation or economic growth	Definetely	Most likely	Most likely	Maybe	Somewhat likely	Most likely	Most likely - growth; jobs - maybe	Most likely	Most likely	No
Feasibility and scalability	Feasable and/or scalable	Very feasable and/or scalable	Feasable and/or scalable	Feasable and/or scalable	Neutral	Feasable and/or scalable	Feasable and/or scalable	Neutral	Neutral	Very feasible and/or scalable
Significance of the environmental benefits	Extremely Significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant	-	Neutral	Extremely significant	Significant
Role of government policies and regulations	Essential	Important	Essential	Essential	Essential	Essential	Essential	Essential	Essential	Important
Addressing environmental sustainability concerns	Yes, Somewhat	Yes, completely	Yes, completely	Neutral	Yes, Somewhat	Yes, completely	Yes, Somewhat	Yes, somewhat	Yes, Somewhat	Yes, somewhat
Level of community engagement	Moderate	Moderate	Moderate	High	Low	High	High	High	Moderate	Very High

	11	12	13	14	15	16	17	18	19	20
Type of Organisation	University	Environmental c	Industry - Steel/I	Branch Organis	NGO	University	Research Center	Labour Union	Labour Union	Labour Union
Technological risks and benefits	More risks	More benefits	Neutral	Mostly benefits	-	More benefits	Mostly benefits	More benefits	More benefits	More benefits
Alignment with SDG goals	Yes, completely	Yes, somewhat	Neutral	Yes, completely	Yes, somewhat	Yes, completely	Yes, completely	Yes, somewhat	Yes, somewhat	Neutral
Job creation or economic growth	Definetely	-	No	Definetely	Most likely	Most likely	Definetely	No	No	Maybe
Feasibility and scalability	Feasable and/or scalable	Neutral feasability/Very scalable	Feasable and/or scalable	Neutral scalable/Very feasable	Feasable and/or scalable	Feasable and/or scalable	Feasable and/or scalable	Very feasible and/or scalable	Feasable and/or scalable	Feasable and/or scalable
Significance of the environmental benefits	Extremely significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant	Extremely significant
Role of government policies and regulations	Essential	Essential	Important	Essential	Essential	Essential	Essential	Essential	Important	Essential
Addressing environmental sustainability concerns	Yes, somewhat	-	Yes, somewhat	Yes, completely	Yes, somewhat	Yes, somewhat	Yes, somewhat	Neutral	Yes, completely	Yes, completely
Level of community engagement	Low	Low	Very High	Very High	High/Moderate	Low	High	High	High	High

7.3 Relevant quotes from 20 Interviews with codes assigned in ATLAS.ti

quotation	codes
“The complication is that carbon is needed to make steel… AMG is also working with biomass, but they are against using biomass that could be used for the food industry.”	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EN2: Environmental Risks and Concerns, TI4: Alignment with Sustainable Development Goals
“We must have the ambition to come to climate-neutral steel… It’s like laying out a big puzzle where many pieces need to fit: R&D, technology, energy, environment, financing, circularity, international trade.”	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EN3: Alignment with Climate Change Mitigation Goals, PR1: Stakeholder Views on the Role of Government Policies
“Mostly benefits… the shift from coal to gas means H_2O instead of CO_2, which the public will understand… But pricing and availability are risks.”	TI2: Perceived Benefits and Risks of Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits, EI4: Economic Feasibility Concerns
“Green steel could cost 20-70% more, and convincing consumers to pay that is a challenge.”	EI4: Economic Feasibility Concerns, PR2: Regulatory Barriers to Implementation
“Looking at the whole LCA is key… something working fine at the plant level might cause upstream or downstream issues.”	TI4: Alignment with Sustainable Development Goals, EN2: Environmental Risks and Concerns
“Assessing hydrogen’s impact on high-end quality steel is crucial… customers need the same quality.”	TI4: Alignment with Sustainable Development Goals, BE1: Key Barriers to Sustainable Transition
“Technologically, it is feasible… But economically, there are many ifs. The Commission is focusing on competitiveness.”	TI3: Feasibility and Scalability of Technologies, TI4: Alignment with Sustainable Development Goals
“Lead markets and willingness to pay are critical for scalability.”	EI4: Economic Feasibility Concerns, PR2: Regulatory Barriers to Implementation
“Climate means heating the Earth, while environment focuses on local aspects.”	EN1: Stakeholder Perspectives on Environmental Benefits, EN2: Environmental Risks and Concerns
“We are not experts, but the climate will benefit.”	EN1: Stakeholder Perspectives on Environmental Benefits
“The EU sets the goals and timeframes; we need policymakers’ help.”	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies
“Most puzzle pieces are designed by legislation.”	PR1: Stakeholder Views on the Role of Government Policies
“Using recycled resources reduces environmental impact… Circularity is one of the steel industry’s strengths.”	EN1: Stakeholder Perspectives on Environmental Benefits, TI4: Alignment with Sustainable Development Goals
“The more scrap we use, the better and cheaper the decarbonization.”	EN1: Stakeholder Perspectives on Environmental Benefits, EI4: Economic Feasibility Concerns
“A lot of infrastructure needs to be built, both at the mill and externally… It will be big locally and regionally.”	EI1: Stakeholder Views on Economic Impacts of Innovations
“If investments come from Europe, there will be a boost… But competitiveness must be maintained.”	EI1: Stakeholder Views on Economic Impacts of Innovations, EI4: Economic Feasibility Concerns
“Extra manpower will be needed during installation… but operational jobs will remain the same.”	EI2: Job Creation Opportunities, EI1: Stakeholder Views on Economic Impacts of Innovations
“We can’t finance it alone… EU imports 25% of its flat steel, which pressures profit margins.”	EI4: Economic Feasibility Concerns
“In Ghent, they’re doing an excellent job informing stakeholders.”	CE1: Level of Community Engagement, CE3: Strategies for Effective Community Involvement
“High engagement, but more focus on informing society about what we’re doing and its impact.”	CE1: Level of Community Engagement, CE3: Strategies for Effective Community Involvement

• "This type of project fits very well with what also an industrial cluster needs: to decarbonize quickly but also generate as much value as possible… By doing it with the existing assets we really need less capital. We will have less risks… And I think that aspect of that breakthrough innovation also requires working with your current assets and being able to stepwise bring it to the scale that we reach today."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EI4: Economic Feasibility Concerns, TI3: Feasibility and Scalability of Technologies
• "Such an approach is more on the low-risk side. … You can start small. You don't need to build a complete new plant, you can gradually start small… If you fail, okay, you have just failed and spent some costs on those trials. You have not built a new plant that you can't use."	TI2: Perceived Benefits and Risks of Technological Innovations, TI3: Feasibility and Scalability of Technologies
• "I would rather be neutral in my answer… As long as we have a blast furnace, we will still need some hard coke… However, sustainability is more than only not using fossil coal. Sustainability means also having activities which are economically viable and socially helping."	TI4: Alignment with Sustainable Development Goals, BE1: Key Barriers to Sustainable Transition, EN3: Alignment with Climate Change Mitigation Goals
• "It can have a really positive impact on the local economies… A blast furnace technology has still a place in the future even if we would have a lot of renewable electricity available, for reasons that it's an enabler. It's really quite an efficient enabler to recycle resources."	EI1: Stakeholder Views on Economic Impacts of Innovations, EN1: Stakeholder Perspectives on Environmental Benefits
• "I think most likely… If we will develop the blast furnace more into a kind of recycle project where hydrogen-rich gases are recycled and also bio waste or plastic waste is recycled, this will regionally require additional activities. … If you create jobs, do them where it has the most added value, and I think that's the argument to create the jobs here with the steel plants."	EI2: Job Creation Opportunities, EN1: Stakeholder Perspectives on Environmental Benefits
• "The most challenging is… will you get support for keeping the blast furnace running… If there is no public support for blast furnaces, just because they say, 'You use coal, so you are out,' then we have a problem."	EI4: Economic Feasibility Concerns, PR1: Stakeholder Views on the Role of Government Policies
• "I would say feasible and scalable… But we underestimate how big the scale is that we are working on today… Decarbonizing a project that you need to run at such a big scale in one place will be the biggest challenge everywhere in the world."	TI3: Feasibility and Scalability of Technologies, BE1: Key Barriers to Sustainable Transition
• "It's extremely significant on CO2. … If you could also recycle plastic waste by gasifying it… it's a potential big or extremely big impact that you could have."	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals
• "Hydrogen, and definitely high-temperature hydrogen, could have a huge hazard if something goes wrong. … Another risk is around coke making and the difficult-to-avoid emissions that could have some health impact."	EN2: Environmental Risks and Concerns
• "It will never happen… All those transitions are only there because some laws and regulations have been made… For me, it's essential to facilitate pathways that are more economically feasible while having the same environmental impact."	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies
• "Yes, completely, or between 'Yes, completely' and 'Yes, somewhat.' There are a lot of positive elements… But there could be concerns with other emissions that we have."	EN1: Stakeholder Perspectives on Environmental Benefits, EN2: Environmental Risks and Concerns
• "Community engagement around ArcelorMittal Ghent… I see a lot of efforts… There is a high level of engagement with stakeholders and the local community, and they are very active in the local dialogue."	CE1: Level of Community Engagement, CE3: Strategies for Effective Community Involvement
• "If we could get engagement, for example, from the city of Ghent… that waste could also be turned back into hydrogen-rich gases compatible with Recycle… Then you have a direct engagement of each citizen."	CE3: Strategies for Effective Community Involvement, EN1: Stakeholder Perspectives on Environmental Benefits
"Looking at sustainability as not only CO2 or climate neutrality but also economic and social value is key… Having a robust strategy that doesn't depend on one approach is another important aspect."	CE5: Local Community Concerns and Priorities, TI4: Alignment with Sustainable Development Goals

"We always go for technological innovation…it brings certainty for public support in the future. Our region can be a positive experiment that can be exported worldwide."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies
"If these technologies allow a 35% reduction by 2030 and zero emissions by 2050, I am completely positive. I don't see many risks, especially technological risks."	TI2: Perceived Benefits and Risks of Technological Innovations, EI1: Stakeholder Views on Economic Impacts of Innovations
"It is important to have a steel-making factory here as a lead plant…to export technological improvements around the world."	EI1: Stakeholder Views on Economic Impacts of Innovations, TI3: Feasibility and Scalability of Technologies
"Definitely. To continue steel production here, it must grow fast, be innovative, and reduce environmental impact…it plays a crucial role in employment and innovation."	EI3: Economic Growth Potential, TI1: Stakeholder Perspectives on Proposed Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits
"The main risk is if they do not succeed, ArcelorMittal might find it easier to produce steel in regions with fewer regulations, like India."	EI2: Job Creation Opportunities, PR1: Stakeholder Views on the Role of Government Policies
"Extremely significant. The impact of one plant can change national emissions."	EN1: Stakeholder Perspectives on Environmental Benefits
"I don't really see any risks. Alternative energy sources are better for the environment, and indications are that CCS is safe."	EN2: Environmental Risks and Concerns
"Essential. Without regulations, our steel industry would be blown away by cheaper, less green steel."	PR1: Stakeholder Views on the Role of Government Policies
"[…]. ArcelorMittal is top of mind in the region for its efforts."	CE1: Level of Community Engagement
"If ArcelorMittal reduces emissions significantly, it eases the pressure on other economic actors and will be appreciated by the public."	CE3: Strategies for Effective Community Involvement
"Ensure no factory closures during new constructions and minimize environmental impact during transitions."	CE2: Community Needs and Preferences, EN2: Environmental Risks and Concerns
"You have to make fundamental rules that non-green steel industry can't enter Europe anymore…The criteria for steelmaking factories in Europe should also apply globally…Innovation and collaboration between steelmaking and universities should be supported by government funding."	PR1: Stakeholder Views on the Role of Government Policies, CE2: Community Needs and Preferences, TI1: Stakeholder Perspectives on Proposed Technological Innovations
"I would prefer offering funding for collaborative projects. ArcelorMittal collaborates with societal stakeholders and does its best…It would be better for the government to fund these collaborations to show their importance. Direct collaboration between industry and societal stakeholders is more fruitful than heavy regulation."	CE3: Strategies for Effective Community Involvement, PR1: Stakeholder Views on the Role of Government Policies
[…] Renewable energy fluctuates"	TI3: Feasibility and Scalability of Technologies, EI1: Stakeholder Views on Economic Impacts of Innovations
"Using hydrogen in existing processes is not a new idea, but to have it implemented at high TRL or even at industrial scale, this is to be done and to be seen. […] It's very important to showcase its benefits and its feasibility.	TI3: Feasibility and Scalability of Technologies, TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI2: Perceived Benefits and Risks of Technological Innovations
"Sustainability goals—if it's not at the first page visible, how it's really climate neutral and not just a transition element, I don't pick the first box."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals
I consider hydrogen injection or hydrogen-rich gas injection as a contribution to secure jobs, not to generate new jobs."	EN1: Stakeholder Perspectives on Environmental Benefits
"I don't see any growth opportunity in Europe, no matter what kind of technology you implement."	EI3: Economic Growth Potential
"I consider both feasibility and scalability. Scalability is not an issue, whether smaller or larger blast furnaces."	TI3: Feasibility and Scalability of Technologies
"Significant, but not very significant. The immediate action is doable and impactful, but longer-term impact is uncertain."	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals

“I don’t see any risks. The project will reduce the CO2 footprint, and I consider emissions like dust or NOx tackled.”	EN1: Stakeholder Perspectives on Environmental Benefits
“Policymakers misuse their power by adding hurdles for research. They provide nightmares of frameworks, not supportive ones.”	PR2: Regulatory Barriers to Implementation
“Yes, somewhat. Immediate actions are important, but their long-term impact on 2050 goals is less clear.”	EN3: Alignment with Climate Change Mitigation Goals
“The level of being informed and at least a medium expert of the people discussing is very heterogeneous.”	CE1: Level of Community Engagement
“I believe the best way forward would be a European transformation roadmap with collaborative efforts among all players.”	CE3: Strategies for Effective Community Involvement
“If we had a general roadmap, the contribution of these intermediate steps would be clear and not questioned.”	CE5: Local Community Concerns and Priorities
“The challenge is for Europe to survive the transition without being put out of business due to different decarbonization paces globally. […] Opportunities are limited because ownership of green technologies is mostly with plant builders, not producers.”	BE1: Key Barriers to Sustainable Transition, BE3: Stakeholder-Specific Challenges
“Projects like Recycle with one steel producer are a no-go; collaboration among producers in research should be mandatory.”	BE4: Opportunities for Collaboration and Support
“If we are looking at 2030, I would give a very positive reply. But if it’s about climate neutrality in 2050, I don’t see this technology as rather supportive.”	TI2: Perceived Benefits and Risks of Technological Innovations
“Any investment has a hurdle; reducing penalties is always difficult in regard to putting it on the balance sheet.”	EI5: Investment Challenges and Drawbacks
"I think it's good that the steel sector is looking into these kinds of technologies. It fits within North Sea Port's strategic plans, including hydrogen, CCS, electrification, and circular economy."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI4: Alignment with Sustainable Development Goals
I would emphasize more benefits than risks. Risks are linked to infrastructure and market readiness (chicken and egg problem). However, once decisions are made, progress is possible."	TI2: Perceived Benefits and Risks of Technological Innovations, BE1: Key Barriers to Sustainable Transition, BE2: Key Enablers for Sustainable Transition
Yes, completely—especially with green hydrogen. For other types, alignment might vary."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals
"These transitions are crucial for companies like ArcelorMittal to remain in Europe, preserving direct and indirect jobs that are significant to the region."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI2: Job Creation Opportunities
Challenges include finding skilled labor and securing significant investments. Support from authorities and funds is essential."	PR3: Policy Measures for Supporting Green Technologies, EI4: Economic Feasibility Concerns, EI5: Investment Challenges and Drawbacks, PR4: Collaboration Between Government and Industry, BE1: Key Barriers to Sustainable Transition
Extremely significant. Benefits span the entire value chain, from mining to production."	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals
"Concerns depend on the chosen technology. Green hydrogen impacts freshwater resources; importing hydrogen has shipping and energy demands. Each path has an environmental footprint."	EN2: Environmental Risks and Concerns, TI2: Perceived Benefits and Risks of Technological Innovations
Yes, somewhat. Each strategy has pros and cons, but they can significantly reduce footprints compared to current processes."	EN3: Alignment with Climate Change Mitigation Goals, TI2: Perceived Benefits and Risks of Technological Innovations
"Moderate. There’s a need to simplify technical language to make plans understandable for the community."	CE1: Level of Community Engagement, CE3: Strategies for Effective Community Involvement
"Information sessions to inform and educate the public can prevent delays due to objections."	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communinities

"Consider local community concerns to ensure smooth implementation and avoid resistance."	CE2: Community Needs and Preferences, CE5: Local Community Concerns and Priorities, CE3: Strategies for Effective Community Involvement
I think if some reasonable contributions can already be done by injecting hydrogen or biogas in the current blast furnaces, that's of course an interesting step to do. With the biomass, I always have some…feeling, well, are we really doing something good there? … There I have always the feeling, is this really a sustainable solution?"	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EN2: Environmental Risks and Concerns
"I think there are benefits. … But yeah, it's still limited… If you are always for technical reasons limited to 10%…you need very much other innovations to get where you want to be. So it's useful on the short term, but it's still limited."	TI2: Perceived Benefits and Risks of Technological Innovations, TI5: Stakeholder Concerns Regarding Technological Innovation
"Somewhat, because also with the remarks before, what is the origin of the biocoal, and if it's limited to only a few percent of replacement, then yeah, is it worth the effort and the investments?"	TI4: Alignment with Sustainable Development Goals, EN2: Environmental Risks and Concerns
I think the most important thing is that we want to keep steelmaking as much as possible here, of course. So every step in making it more sustainable and making it fit into the European climate plan is a good step."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI4: Economic Feasibility Concerns
I think somewhat likely. … Every innovation can at least get to some extra work opportunities for a certain period, if it works out."	EI2: Job Creation Opportunities
"The potential drawbacks are of course the cost, both the cost and the source of the alternative gases and biomass or biogas you want to inject. … Having low-cost hydrogen available is one of the main risks."	EI4: Economic Feasibility Concerns, TI5: Stakeholder Concerns Regarding Technological Innovation
"I would say neutral because I really have, yeah, I cannot have too much faith in it for the moment because of the cost price… And also what I always hear from the steel is that it's not possible or very difficult to transfer the extra cost to the customer."	TI3: Feasibility and Scalability of Technologies, EI4: Economic Feasibility Concerns
"If you could, of course, make it 100% zero emission, then of course it's very significant. … If you say that 10% of the CO2 emissions in Flanders are coming from ArcelorMittal, so if you could find a solution there, it's very significant, of course."	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals
The extra emissions from the biocoal or from the…blue hydrogen…we have to make sure that what you put into it…is actually better… That you don't have hidden other sources of CO2."	EN2: Environmental Risks and Concerns
I think their role is important because they have to facilitate support for all CO2 reducing technologies. … The governments will have to give support and also to reduce support on fossil alternatives."	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies, PR2: Regulatory Barriers to Implementation
I think it's somewhat, but not much…because of the limitations, I see, but that's still the unknown."	EN1: Stakeholder Perspectives on Environmental Benefits, BE1: Key Barriers to Sustainable Transition
"Low. … If you ask me, how is the public engagement in steelmaking, for me it is high, but for the general public, limited, I think."	CE1: Level of Community Engagement, CE2: Community Needs and Preferences
"Correct dissemination about the project informing the public, that's already the only thing you can do. … Persuading the public that these kinds of innovations are required to keep this industry here and link it with employability."	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communities
"The climate impact is the most important. … The CO2 reduction is impactful, that it's not a drop on a hot stone… It should be a real contribution."	CE5: Local Community Concerns and Priorities, EN1: Stakeholder Perspectives on Environmental Benefits
"We have to see what is the maximum. The research should be what is the maximum contribution you can have with an existing blast furnace."	BE1: Key Barriers to Sustainable Transition, TI3: Feasibility and Scalability of Technologies
Research has to be done whether you can reach the final emission goals with this choice…if all these measures together can make you reach the targets."	BE2: Key Enablers for Sustainable Transition, TI3: Feasibility and Scalability of Technologies

"And then where we try to use internally the gas or to use the gas from steelmaking in order to make added value product that can be used, for example, in the chemical industry. There we are talking about carbon capture and usage. And then also the next one is just to go out of using fossil carbon... one way of doing it is to use electricity. Either directly or indirectly via hydrogen."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI4: Alignment with Sustainable Development Goals
"Now, that is if you look at what you want to achieve, it's also how you want to do it and the availability in terms of also considering also the cost, not only the quantity, but also the cost of the hydrogen. And so that is where you go and look at the risk for your business."	TI2: Perceived Benefits and Risks of Technological Innovations, EI1: Stakeholder Views on Economic Impacts of Innovations
"If you have hydrogen today, don't wait. Use it in the blast furnace. And then work on your strategy, on technology that you will be using when everything will be ready. Enough hydrogen and equipment and all those things."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits
"When you start using hydrogen to replace fossil carbon, then the point is availability of this hydrogen. And this availability, when we talk about availability, is quantity, quality, and price. Those three elements."	EI2: Job Creation Opportunities, BE1: Key Barriers to Sustainable Transition
"Most likely if we address the skills. So we need to make sure that we can have the skills or the people that we are using get the new skills that it takes for this transition."	EI3: Economic Growth Potential, BE2: Key Enablers for Sustainable Transition
"So, the point is that this transformation will cost money. So, in terms of investment, we are talking about CAPEX and then in terms of OPEX. And then the OPEX will be much higher than the OPEX that we're looking into now, because we are talking about hydrogen."	EI4: Economic Feasibility Concerns, BE1: Key Barriers to Sustainable Transition
"It is scalable. It is scalable. But somehow also limited because of the target data set... you can put more and more hydrogen into the blast furnace, but there are limitations, technical limitations."	TI3: Feasibility and Scalability of Technologies, BE2: Key Enablers for Sustainable Transition
"If you look at 2030, in your strategy for 2050, how you go to 2050. Then I would say it's very significant because you need to start with what is doable and prepare to what can be doable later on."	EN1: Stakeholder Perspectives on Environmental Benefits, TI1: Stakeholder Perspectives on Proposed Technological Innovations
"It's essential. It's essential because the design of the policies will impact. Let's take alone the price of this allergen... Legislation will also impact investment."	PR1: Stakeholder Views on the Role of Government Policies, PR5: Strategies for Effective Policy Implementation
"Whether to say address completely, I don't think that it should be addressing completely, but it addresses... You take an aspect of it, a very important aspect of this, and then you address it rightly."	EN3: Alignment with Climate Change Mitigation Goals, PR5: Strategies for Effective Policy Implementation
"I would be by neutral. And I will not blame society. I would say it's up to us that are in this business to make sure that society received the right information."	CE1: Level of Community Engagement
"We need to make sure that we're not only talking about technicians or people that know what our industry is doing technically... We need to make sure that we convey in simple words, make it simple to people."	CE2: Community Needs and Preferences, CE3: Strategies for Effective Community Involvement
"When we talk about some support, we need to make sure that those supports are accessible. So for implementation, we have instruments at EU level. But generally speaking, what we have is really access to these supporting schemes."	CE4: Communication with Local Communities

“When you talk about the technicalities of steelmaking, Europe is ahead. And then the rest of the world is looking at Europe. If we can make it happen, then the rest of the world will follow. If we cannot, then the others will not make it. So they’re looking at what Europe will be doing. If we can make it, then we can also export those technologies outside and keep the leadership. […] The challenge will be financing this research and implementation. That is one point. The second challenge will be when we do it, we need to make sure that we can have the people that we need for this—to run those technologies, starting by skilling the people, gaining those people, attracting those people, and maintaining them so that they stay. […] The other challenge will be to have the right policies in place. Policies will shape and have an impact on the prices. The policies can make sure we avoid circumventions when it comes to ensuring that European companies or non-European companies face the same carbon price and have fair trade. […] Opportunities are there. Whenever there are issues, I like to see opportunities. Let’s make sure we can take those opportunities. Don’t miss the opportunity.”	TI5: Stakeholder Concerns Regarding Technological Innovation, EI5: Investment Challenges and Drawbacks, BE4: Opportunities for Collaboration and Support
“There are issues when you start using hydrogen in direct reduction, for example, sticking. Those are the things you need to look into. Those are fields of research […] When you start using more gas, and particularly hydrogen, you need to look at the distribution—the right distribution of gas within your reactor to avoid cold spots and other similar issues. […] It will be in the details.”	TI3: Feasibility and Scalability of Technologies, EN2: Environmental Risks and Concerns
"Whenever you have to use the hydrogen, you need to make sure that you can use it safely. Safety. It's a very important point... There are some technical risks, but engineers in operation, they know how to address those risks."	EN2: Environmental Risks and Concerns, TI3: Feasibility and Scalability of Technologies
"I think it's a very nice project that you are doing here. The steel manufacturing is emitting a lot of CO2, so every step you can do in order to reduce the CO2 emission is nice. I think also the ideas behind this are also very valuable and can also be extended to other plants of Arcelor and other steel manufacturers. So, yeah, I think it's a very nice project and a very nice concept."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits, BE2: Key Enablers for Sustainable Transition
"I think many benefits. I think so. [...] Yeah, of course there will be some risk I can imagine, but from the other side, if you see the reduction in CO2 emission from the site, it's huge, 7%. So I think there are much more opportunities than seeing the risks here."	TI2: Perceived Benefits and Risks of Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits, BE1: Key Barriers to Sustainable Transition
"Yes completely. If you see, I think at this moment, cokes are used. Now the idea is to replace cokes by hydrogen, whether it's a rich flow of rich cost stream with hydrogen or hydrogen made by electrolyzers. In the end, if it's a recovery or if it's hydrogen made out of renewable electricity, it has a huge impact on the CO2 emissions. In the end. So I think it's very valuable."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals, BE2: Key Enablers for Sustainable Transition
"I think at least these new technologies need to be installed. Probably it's done by Flemish companies. Maybe some of the technologies are coming from Flemish companies. So I think already locally there is already more employment, I can imagine. And then also same, I think, for the bigger area. Some of the technologies need to come from abroad, not within Flanders, but maybe within Belgium or within Europe. So that's also extra employment."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI2: Job Creation Opportunities, EI3: Economic Growth Potential
"And then I can imagine that there's also a multiplication towards other sides of Arcelor. So they are equipped with a lot of plants all over Europe and maybe also for the other steel manufacturers like Tata Steel or other companies that have installations, they can also in the future be equipped with this new technology."	EI2: Job Creation Opportunities, BE2: Key Enablers for Sustainable Transition
"Do you have an idea, because you are talking about hydrogen gases, from which gases the hydrogen is coming or these hydrogen rich gases are coming? Because is it hydrogen produced with an electrolyser that you are going to use here or is it some other products that comes from steel manufacturing that contains hydrogen?"	EI4: Economic Feasibility Concerns, BE1: Key Barriers to Sustainable Transition

"I think it's beneficial to start this type of projects and to try to reduce the CO2 emission on the site with different and I think this option seems to be also very interesting to further research and to try on site."	TI3: Feasibility and Scalability of Technologies, BE2: Key Enablers for Sustainable Transition
"If you see the reduction in CO2 emission from the site, it's huge, 7%. So I think there are much more opportunities than seeing the risks here."	EN1: Stakeholder Perspectives on Environmental Benefits, TI2: Perceived Benefits and Risks of Technological Innovations
"Yeah, of course there will be some risk I can imagine, but from the other side, if you see the reduction in CO2 emission from the site, it's huge, 7%."	EN2: Environmental Risks and Concerns
"I think it's not that in the end, Arcelor has an idea on hydrogen. I can imagine in the wider industry, they are also looking to do alternatives in order to reduce the CO2 emissions."	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies
"So I think it's very valuable and can also be extended to other plants of Arcelor and other steel manufacturers."	EN1: Stakeholder Perspectives on Environmental Benefits, TI1: Stakeholder Perspectives on Proposed Technological Innovations
"I try to find internally within someone that has maybe more expertise in these topics related to that. But unfortunately, I couldn't find someone that has some time and other colleagues have quite a lot to do."	CE1: Level of Community Engagement
"Probably within [our organisation] we have also quite a lot of expertise in hydrogen production and other topics. But unfortunately these people have other duties or had no time for this stakeholder."	CE3: Strategies for Effective Community Involvement
"Related to these aspects, we have also a group working on sustainable chemistry, a group working on materials. Probably there is more expertise available to judge certain aspects related to the questions you have."	CE2: Community Needs and Preferences
"Because in the end, if you want to replace coal or cokes by hydrogen, it needs to come from somewhere, the hydrogen. And that was just out of curiosity. How do you see in this project the hydrogen input then?"	BE1: Key Barriers to Sustainable Transition, BE3: Stakeholder-Specific Challenges
"I think going to the root of hydrogen, it's common knowledge. I think it's not that in the end, Arcelor has an idea on hydrogen. I can imagine in the wider industry, they are also looking to do alternatives in order to reduce the CO2 emissions."	BE3: Stakeholder-Specific Challenges, PR3: Policy Measures for Supporting Green Technologies
“So and then specifically you’re talking about injecting hydrogen in a blast furnace. I think that should not be a problem.”	TI1: Stakeholder Perspectives on Proposed Technological Innovations
“Using hydrogen, there’s, of course, a safety risk. Which needs to be addressed. There’s a supply risk which needs to be addressed. There is a cost issue which needs to be addressed.”	TI2: Perceived Benefits and Risks of Technological Innovations, BE1: Key Barriers to Sustainable Transition
“I would say yes completely on the conditions that the hydrogen which is being used is hydrogen which is indeed green hydrogen.”	EN3: Alignment with Climate Change Mitigation Goals, TI4: Alignment with Sustainable Development Goals
“If you impact the steel industry, it’s still going to have a huge impact upstream and downstream. Whatever we do to make the steel industry competitive in Flanders has a huge leverage effect on all the other industries.”	EI1: Stakeholder Views on Economic Impacts of Innovations, EI3: Economic Growth Potential
“Potential challenges to find the people. You have a huge problem with attracting people to this type of field.”	EI5: Investment Challenges and Drawbacks, BE3: Stakeholder-Specific Challenges
“It’s feasible and scalable, I would say. Scalable meaning that it can be done in different places. If it’s commercially feasible, I’m not sure.”	TI3: Feasibility and Scalability of Technologies, EI4: Economic Feasibility Concerns
“Safety issues potentially could be a problem, although gas companies have figured out how to work with hydrogen, of course, for a long time.”	TI2: Perceived Benefits and Risks of Technological Innovations, EN2: Environmental Risks and Concerns
“All types of communication by people who are communication experts, not necessarily metallurgists, but who have the art of communication as their profession.”	CE3: Strategies for Effective Community Involvement
“We’ve hired somebody at a higher level so we can coach people, experts, people who are active doing research in the field, coach them to bring out their message.”	CE5: Local Community Concerns and Priorities

“We need to actually have more of these projects where we’re actually also training young people, young engineers, young scientists, but also social scientists.”	BE2: Key Enablers for Sustainable Transition, BE4: Opportunities for Collaboration and Support
“I think it’s really a very ambitious technological innovation… the complexity is so high, and there need to be so many investigations. It is absolutely needed, and the presented work plan seems to include the key elements necessary for a successful realization of the innovation.”	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies, TI4: Alignment with Sustainable Development Goals
“There are a lot of benefits in terms of the high CO2 reduction potential. However, it is very risky, as steelmaking is already such a mature technology that has taken a long time to optimize. Transitioning to a fully new technology may take significant time and effort.”	TI2: Perceived Benefits and Risks of Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits, TI3: Feasibility and Scalability of Technologies, TI5: Stakeholder Concerns Regarding Technological Innovation
“Yes, completely. We need to modify the technology because there is no alternative; steelmaking is critical, and we need to drastically change it for the sake of the climate.”	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals
“It’s crucial to innovate to keep steelmaking economically feasible in Europe. If not, production might shift to Asia or other regions, leading to job losses and negative economic impacts locally and regionally.”	EI1: Stakeholder Views on Economic Impacts of Innovations, EI4: Economic Feasibility Concerns
“It’s more about keeping the jobs here. If the technology is successful, it will likely lead to job security in the region and in Europe.”	EI2: Job Creation Opportunities, EI3: Economic Growth Potential
“Access to sufficient hydrogen—either green or hydrogen-rich gases—is very challenging and costly. Optimizing the steelmaking process again will require high investments and might reduce the portfolio of steel types, impacting profits.”	EI4: Economic Feasibility Concerns, EI5: Investment Challenges and Drawbacks
“Feasible and/or scalable. The ambitions and goals of European countries support this route, and many steelmaking companies are looking into similar technologies.”	TI3: Feasibility and Scalability of Technologies, BE2: Key Enablers for Sustainable Transition
“Extremely significant. We need to reduce CO2 emissions, and this is a clear route to achieve that. However, every technology has its disadvantages, such as the need for enormous amounts of electricity or hydrogen.”	EN1: Stakeholder Perspectives on Environmental Benefits, TI5: Stakeholder Concerns Regarding Technological Innovation, EN3: Alignment with Climate Change Mitigation Goals
“I am in favor of recycling, but I feel a bit insecure about commenting on specific environmental risks of the recycled technologies due to a lack of technical background.”	EN2: Environmental Risks and Concerns, TI5: Stakeholder Concerns Regarding Technological Innovation
“Essential. Policymakers can push forward costly innovations through subsidies, regulations, and by educating the public on why paying more for environmentally friendly products is necessary.”	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies, PR4: Collaboration Between Government and Industry
“Yes, somewhat. This is a demonstrator project, and it’s important to be realistic about it being a first step in a broader transition.”	EN1: Stakeholder Perspectives on Environmental Benefits, BE2: Key Enablers for Sustainable Transition
“Low. It is still a discussion limited to the steelmaking community. Broader debates are needed, involving different industries and societal aspects.”	CE1: Level of Community Engagement, CE3: Strategies for Effective Community Involvement
“Engaging media and explaining small steps to society could help. This reduces the perception of a ‘climate disaster’ and helps people understand progress.”	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communities
“Engage students and young people to ensure they are motivated to collaborate on innovations in matured industries. This would be a significant area to focus on.”	CE2: Community Needs and Preferences, CE5: Local Community Concerns and Priorities
“Controlling the new process with new input materials like hydrogen, while ensuring the desired quality of steel products, is the most significant challenge.”	BE1: Key Barriers to Sustainable Transition, BE3: Stakeholder-Specific Challenges
“Further optimizing the process and the model, ensuring the availability of sufficient hydrogen, and addressing gaps across the whole value chain are key R&D needs.”	BE2: Key Enablers for Sustainable Transition, BE4: Opportunities for Collaboration and Support
"I think it's a very nice project that you are doing here. The steel manufacturing is emitting a lot of CO2, so every step you can do in order to reduce the CO2 emission is nice. I think also the ideas behind this are also very valuable and can also be extended to other plants of Arcelor and other steel manufacturers."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies

"I think many benefits. [...] Of course there will be some risk I can imagine, but from the other side, if you see the reduction in CO2 emission from the site, it's huge, 7%. So I think there are much more opportunities than seeing the risks here."	TI2: Perceived Benefits and Risks of Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits
"Yes completely. If you see, at this moment, cokes are used. Now the idea is to replace cokes by hydrogen, whether it's a rich flow of rich cost stream with hydrogen or hydrogen made by electrolyzers. In the end, if it's a recovery or if it's hydrogen made out of renewable electricity, it has a huge impact on the CO2 emissions."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals
"I think at least these new technologies need to be installed. Probably it's done by Flemish companies. Maybe some of the technologies are coming from Flemish companies. So I think already locally there is already more employment, I can imagine."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI2: Job Creation Opportunities
"And then I can imagine that there's also a multiplication towards other sides of Arcelor. They are equipped with a lot of plants all over Europe and maybe also for other steel manufacturers like Tata Steel or other companies that have installations."	EI2: Job Creation Opportunities, EI3: Economic Growth Potential
"I think it's beneficial to start this type of projects and to try to reduce the CO2 emission on the site with different options that seem to be also very interesting to further research."	TI3: Feasibility and Scalability of Technologies
"If you see the reduction in CO2 emission from the site, it's huge, 7%. So I think there are much more opportunities than seeing the risks here."	EN1: Stakeholder Perspectives on Environmental Benefits
"Risks: hydrogen is very explosive and is not easy to transport, but do we have a choice? The risk of doing nothing is a lot bigger."	EN2: Environmental Risks and Concerns
"The government should help the industry; if you look at China, then the state is helping industry a lot. But if the government helps, then why is it only return to the private sector and not to the government again?"	PR1: Stakeholder Views on the Role of Government Policies, PR4: Collaboration Between Government and Industry
"Yes somewhat: using gases that you already have and trying to be more efficient and reducing carbon dioxide is a good idea."	EN1: Stakeholder Perspectives on Environmental Benefits
"Moderate: between high and moderate. The communication has improved... As a community they know that AM is an important company."	CE1: Level of Community Engagement
"It could be better but he understands that it's not easy... Possible to involve the community, but have to think about how to word it, how to explain the project."	CE3: Strategies for Effective Community Involvement
"Involving the neighbourhoods. Explain the impact on their environment (explaining reducing fine dust). Focus on these aspects."	CE2: Community Needs and Preferences
"I think already locally there is more employment; I can imagine some technologies need to come from abroad... So that's also extra employment."	EI2: Job Creation Opportunities, CE1: Level of Community Engagement
"Many people work here: so keeping their job, having a good income... That part of the company closing and losing jobs is their biggest concern."	CE5: Local Community Concerns and Priorities
"Implementation phase for DRI for example: create 3000 jobs (most likely not people from Ghent): where will they stay, what is their impact... Make up a plan and talk about it with the population."	CE4: Communication with Local Communities, CE3: Strategies for Effective Community Involvement
"Steel is a hard-to-abate sector, and the proposed innovations, especially involving hydrogen, are necessary steps towards decarbonization. Austria's steel industry alone accounts for around 15% of national CO2 emissions, so these innovations are crucial."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EN3: Alignment with Climate Change Mitigation Goals
"There are typical issues like equipment lifespan and erosion of new materials, but the benefits definitely outweigh the risks. It's a complex process, but absolutely necessary for achieving climate targets."	TI2: Perceived Benefits and Risks of Technological Innovations, BE1: Key Barriers to Sustainable Transition, EN3: Alignment with Climate Change Mitigation Goals
"Yes, somewhat. The initiatives align with climate goals, but there may be blind spots. We need to remain cautious and ensure that implementation doesn't overlook unintended consequences."	TI4: Alignment with Sustainable Development Goals, EN2: Environmental Risks and Concerns

"Engineers will need to be retrained, and there will be shifts in the labor market. In the short term, the economic impact could be mixed, but in the long term, it will be transformative."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI2: Job Creation Opportunities
"Maybe. Jobs will be created in areas like hydrogen technology and process management, but we also have to account for potential losses in traditional roles due to automation."	EI2: Job Creation Opportunities, EI3: Economic Growth Potential
"Scaling from small to large installations is often where surprises arise, and the investments needed are significant. Material erosion is another big challenge."	EI4: Economic Feasibility Concerns, TI5: Stakeholder Concerns Regarding Technological Innovation, BE1: Key Barriers to Sustainable Transition
"These solutions are feasible and scalable, but the success will depend on continuous R&D and legal certainty. Companies won't invest without clear regulatory frameworks."	TI3: Feasibility and Scalability of Technologies, PR3: Policy Measures for Supporting Green Technologies
"The environmental benefits are extremely significant. Decarbonizing the steel industry would make a huge difference in Austria's overall emissions."	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals
"There's a risk that existing facilities will become obsolete, creating waste. That's a significant concern when it comes to transitioning infrastructure."	EN2: Environmental Risks and Concerns
"Government policies are crucial. Companies need legal certainty to invest, and without harmonized regulations, efforts could become fragmented."	PR1: Stakeholder Views on the Role of Government Policies, PR2: Regulatory Barriers to Implementation
"Mostly. The strategies address sustainability concerns, but there's always a need to ensure we're not overlooking any important issues."	EN1: Stakeholder Perspectives on Environmental Benefits, EN2: Environmental Risks and Concerns
"The level of engagement is already high in Austria. We have an established hydrogen strategy, and stakeholders are actively involved in discussions."	CE1: Level of Community Engagement, CE3: Strategies for Effective Community Involvement
"National roundtables and workshops are effective. A unified national strategy that brings stakeholders together and allows them to share best practices would be ideal."	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communities
"Communities need transparency and regular updates. They need to feel informed and involved in the process, with clear communication on progress and risks."	CE4: Communication with Local Communities, CE5: Local Community Concerns and Priorities
"Scaling and investment risks are significant challenges, but Austria has the opportunity to lead in hydrogen innovation. If done correctly, it could be a model for the world."	BE1: Key Barriers to Sustainable Transition, BE3: Stakeholder-Specific Challenges
"We need large-scale demonstration projects to address uncertainties. Testing solutions at an industrial scale is essential to fully understand the challenges."	BE2: Key Enablers for Sustainable Transition, TI3: Feasibility and Scalability of Technologies
"Very good for energy efficiency and ability to create CO2 reduction. Some concerns around safety when using hydrogen à constant monitoring needed to eliminate risk of incidents."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI2: Perceived Benefits and Risks of Technological Innovations, TI5: Stakeholder Concerns Regarding Technological Innovation
"Hard to answer because I do not have the full knowledge, but all safety measures should be taken. If this is the case, I only sees advantages"	TI2: Perceived Benefits and Risks of Technological Innovations, TI5: Stakeholder Concerns Regarding Technological Innovation
"Yes as an intermediate step, the aim should be to be fully CO2 neutral after 2050. It is necessary to continue with investments and move towards a mix of other steel production processes (e.g. recycling: keep scrap in EU, not export),. It remains important to keep certain production processes from start to finish, this is necessary to respond to the process and improve the quality of the production process."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals
"Anything that contributes to meeting the 2030 targets is positive, this is one of the links needed to achieve the 35% reduction."	EN1: Stakeholder Perspectives on Environmental Benefits
"Everything will continue to be carried out by the same teams, there will be no additional maintenance people. These initiatives are important for employment retention, though, which plays a big role."	EI2: Job Creation Opportunities

"COG production is going to stay as long as you are with 2 blast furnaces, question if this will stay if we go to 1 blast furnace [is it] still useful to produce coke itself? This will have an impact on this project. Towards coke gas injection itself, I sees no immediate major challenges, but hydrogen is currently not possible. This is both due to its high cost and low availability."	EI4: Economic Feasibility Concerns, EI5: Investment Challenges and Drawbacks, TI5: Stakeholder Concerns Regarding Technological Innovation
"Very feasible to implement/to make the investment. After 1 year in service, we will have to see how much CO2 has been effectively reduced. Scalable: difficult to judge whether it is possible at other sites because you need a coking plant to do this project (integrated plant needed) scalability limited. Green hydrogen: if certain countries have better energy sources, they can work with green hydrogen, but this is still limited at present."	TI3: Feasibility and Scalability of Technologies, BE2: Key Enablers for Sustainable Transition
"Essential because of three aspects. 1) infrastructure needed to get all the necessary energy here, 2) what is needed of energy to be able to deliver/available effectively 3) objectives around green energy: it is the government's responsibility that it gets there. So overall, the government plays a very big role."	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies, PR4: Collaboration Between Government and Industry
"Neutral: because this project is an intermediate step."	EN1: Stakeholder Perspectives on Environmental Benefits
"There are many opportunities for the community to be informed, much is already being communicated and explained at the moment. AMB is already organising info moments.	CE1: Level of Community Engagement, CE4: Communication with Local Communities
"Informing the community about the plans and how it will be addressed. Listening to their concerns, addressing them and communicating how we have addressed them. Communication is already good but can be improved."	CE3: Strategies for Effective Community Involvement, BE4: Opportunities for Collaboration and Support, CE5: Local Community Concerns and Priorities
"Neutral effect: preserving jobs but not creating new ones."	EI2: Job Creation Opportunities
"Hard to estimate because each choice has its impact. Eg EAF means the HO will be retained and thus employment will remain, but more maintenance will be needed (is a new plant, not as well known yet) à who will do this? More will have to be provided to accommodate this. Nowadays there is a lot of automation and digitalisation leading to job reduction. Those people could then be deployed here. So in the short term, perhaps a little more employment, but due to automation and digitalisation, the number of jobs will probably remain stable or even decrease slightly. Scrap handling: at the EAF, there will be a high demand for scrap. This will reach Ghent via water or traffic, indirectly causing a lot of extra employment. Circularity in general has a positive effect on employment (direct and indirect). It is important to provide the necessary guidance in this transition so that people can do another job under the same working conditions. The environment of company is also very important, namely the health of employees and local residents."	EI2: Job Creation Opportunities, EI4: Economic Feasibility Concerns, BE1: Key Barriers to Sustainable Transition, BE3: Stakeholder-Specific Challenges
"Social dialogue: there is the works council, but also sub-committees, CPBB, etc. Overall, there are enough bodies. We are all well organised but it is important to make use of what we have."	CE3: Strategies for Effective Community Involvement, BE4: Opportunities for Collaboration and Support
"Not clear what impact coke gas will have on blast furnace emissions (dust, etc)."	EN2: Environmental Risks and Concerns
"positive that we are constantly looking for what is possible. Investments for alternative technology (such as the DRI, for example) are very high, so we also need other alternatives to enable CO2 reduction. It is good that we do not stop innovating, but everything has to be done at the right speed. […] Our environment is also very important. Noise and other nuisances have to be monitored when we install new installations.""	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies, TI4: Alignment with Sustainable Development Goals, EN2: Environmental Risks and Concerns, CE5: Local Community Concerns and Priorities

everything has to be done at the right speed. […] Our environment is also very important. Noise and other nuisances have to be monitored when we install new installations."	
innovating is definitely necessary. This project reduces imports of external coke consumption, so it has a positive contribution.	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI2: Perceived Benefits and Risks of Technological Innovations
If we change anything, we still need to be sure that everything is maximally safe. Everything ultimately involves risk, but good preparation and risk assessment is crucial. The risks around hydrogen are less known to us, but we assume that when we implement a new project that all safety standards are met and that when implementing the project, safety is No1."	TI2: Perceived Benefits and Risks of Technological Innovations, TI5: Stakeholder Concerns Regarding Technological Innovation
"Safety is also very important for the people at HOG itself. Whenever we try something new, we always have to observe safety standards. If there is an incident→anticipate, automate shut-off valves as much as possible in zones that are risky for our employee, etc."	TI2: Perceived Benefits and Risks of Technological Innovations, BE3: Stakeholder-Specific Challenges
"Yes, the intention of the project is to save CO2 and evolve, but again, this has to be done at the right speed. We need to make sure the economy is ready for it."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals, BE1: Key Barriers to Sustainable Transition
eye on employees themselves: making sure they are informed and feel good about it. Making sure they also know the risks. Informing people in the workplace."	BE3: Stakeholder-Specific Challenges, CE1: Level of Community Engagement
every project that goes ahead is important, not only for Ghent itself but also nationally. These projects have a big impact on employment: not only direct employment, but also a lot of indirect employment. The moment a company stops investing: not a good sign"	EI1: Stakeholder Views on Economic Impacts of Innovations, EI2: Job Creation Opportunities
it is positive to realise project by project, even if it is small. Every little bit is important."	EI1: Stakeholder Views on Economic Impacts of Innovations
"this project is unlikely to lead to additional recruitment, have no visibility on this yet."	EI2: Job Creation Opportunities
The project does not necessarily create more employment, but it does create job security".	EI2: Job Creation Opportunities
The evolution of prices is a risk for economic viability. These are always very large investments that only get more expensive."	EN1: Stakeholder Perspectives on Environmental Benefits
"There is also a risk of choosing the cheapest supplier when ordering materials. As a result, the materials may be a lesser quality."	EI5: Investment Challenges and Drawbacks
"very important, if we do nothing, we risk getting negative feedback from the environment (see Tatasteel IJmuiden). The media also plays a big role."	EI4: Economic Feasibility Concerns
"We see, for example, that we used to have hardly any questions from the surrounding area. Now a lot more, even from just across the border in NL."	CE5: Local Community Concerns and Priorities
No risks."	EN2: Environmental Risks and Concerns
Government support is very important, but unfortunately it is also very complex. For example, obtaining the necessary permits is not an easy process, is not efficient. Eg CO2 pipeline from Zeebrugge: it will take a long time before the entire procedure is complete (every municipality, every private owner will have reactions like "I don't want this in my land/ garden→ government should facilitate more to speed up the procedure. The Belgian system is very unwieldy."	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies
high otherwise pernicious. Now involvement is already much higher than before but of course it can always be better. However, there are already many initiatives from AMB to involve communities. What could be better: communicating earlier. For instance, in case of an incident, it is better to communicate immediately rather than having it come to light a few months later. Keeping communication high is important."	CE1: Level of Community Engagement, CE4: Communication with Local Communities

important to involve them, is positive that they are informed. Ensure community impact is properly assessed (e.g. traffic→ mobility working group set up to minimise impact). But really involve them in decision-making is not possible (not technical enough)."	CE3: Strategies for Effective Community Involvement, CE5: Local Community Concerns and Priorities
There is a risk that if the blast furnace disappears that jobs will also disappear, people will have to switch jobs, etc."	EI4: Economic Feasibility Concerns
a lot of training will be needed, retraining people (HO→ EAF) will be needed. Here there is then always overlap in time, so important to know how many people will be needed. Only then will we get a picture of the impact (positive or negative). For example, in the beginning many more people will be needed, but in the long run no additional employment, rather temporary employment."	EI4: Economic Feasibility Concerns, EI2: Job Creation Opportunities
It will take a lot of training and also training people in time."	BE2: Key Enablers for Sustainable Transition
"We need to retain people to also retain experience. However, now we see more rotation, so a lot of loss of knowledge. We need to find solutions for this, for example rewarding/giving benefits to people who work in heavy industry for a long time. What is positive within our company, however, is that there have never been any rounds of redundancies. People have always been redeployed internally."	BE3: Stakeholder-Specific Challenges
the unions are already involved a lot in consultations now, but we are not going to be decisive. It's important that they do listen to us, e.g. on social/environmental issues, and also include the feedback from the unions in the decision. But they are never going to play the deciding factor. Management often has a short-term vision while unions think more long-term. (e.g. patching up a plant versus a bigger investment to fix it right immediately→ smaller cost now (often accompanied by a big cost later) versus immediately a big cost and no worries later."	BE4: Opportunities for Collaboration and Support, PR2: Regulatory Barriers to Implementation
"No risks."	EN2: Environmental Risks and Concerns
"Traffic and noise are 2 important elements for the community."	CE5: Local Community Concerns and Priorities
"I think that it's, from a technological point of view, probably a little bit less innovative than DRI route, etc. But I think it's still innovative, very innovative, and complementary to the other technological routes."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies
I would go for the more benefits because I think the pure technological aspect will be and is being investigated. And up to a certain limit, I think the risk should be very much under control."	TI2: Perceived Benefits and Risks of Technological Innovations, TI5: Stakeholder Concerns Regarding Technological Innovation
"Depending on that number, if that's the exact order, then I would say instead of yes completely, yes somewhat."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals
"I think it will not hugely impact due to the fact that it's not a small scale, but it's not the scale, the end scale neither, where you would save millions of tons of CO2."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI4: Economic Feasibility Concerns
"I would say most likely. For two aspects, I think there will work some people on the project itself from Arcelor and then in the vicinity or the knowledge partners."	EI2: Job Creation Opportunities, EI3: Economic Growth Potential
"Challenges on CAPEX, and I do know the CAPEX, is that you will, I hope you benefit from subsidies."	EI4: Economic Feasibility Concerns, PR3: Policy Measures for Supporting Green Technologies
"Green hydrogen, you could ask questions about the water use, because you will use a lot of water for electrolysis and producing the hydrogen."	EN2: Environmental Risks and Concerns
"Important, because these are new technologies that probably in the phases like the recycle project cannot have a positive business case on their own."	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies
"I would say moderate. Why? Because personally, I know it a bit, but let's say I'm not bombarded with info on this."	CE1: Level of Community Engagement, CE4: Communication with Local Communities
"I think Arcelor has good strategies on that, on communication, like for several other projects."	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communities

“Taking into account the impact on our neighbours or neighbouring companies or processes…would there be an impact or not?”	CE5: Local Community Concerns and Priorities
“I think it will be a huge challenge to find the hydrogen at the one find it and to add an affordable etcetera price.”	TI5: Stakeholder Concerns Regarding Technological Innovation, BE1: Key Barriers to Sustainable Transition
“What could be an additional one is how to scale up, for example, also supplier-wise, because you will now use the CAPEX technology for this scope.”	TI3: Feasibility and Scalability of Technologies, TI4: Alignment with Sustainable Development Goals
“Extremely, yes. We need today and will need in the future lots and lots of steel. So if we can or Arcelor can find a way to make this carbon neutral…it has a huge impact.”	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals
“The risks are not so high…taking into account the amount produced by eight megawatts of electrolysis compared to the hydrogen input in the blast furnace, it is very low. The target is to understand the impact before scaling up to DRI and EAF.”	TI2: Perceived Benefits and Risks of Technological Innovations, TI3: Feasibility and Scalability of Technologies
“The blast furnace will not be the production plant in the future…It will be DRI and EAF…so less than neutral.”	EI1: Stakeholder Views on Economic Impacts of Innovations, TI2: Perceived Benefits and Risks of Technological Innovations
“No…for the blast furnace project…this is just to understand the process impacts with a small amount of hydrogen.”	EI3: Economic Growth Potential, TI3: Feasibility and Scalability of Technologies
“This project is small but expensive…not done if we had the best solution already…the challenge is scaling up.”	TI2: Perceived Benefits and Risks of Technological Innovations, EI2: Job Creation Opportunities
“In the future, scaling requires one gigawatt of power…considering transport of hydrogen in large volumes to the plant.”	TI3: Feasibility and Scalability of Technologies, EI2: Job Creation Opportunities
“Electricity price differences across Europe and competitiveness against non-European imports are major concerns.”	EN2: Environmental Risks and Concerns, EI4: Economic Feasibility Concerns
“Policy barriers, like requiring green hydrogen produced by new wind parks…are unrealistic given current timelines.”	PR1: Stakeholder Views on the Role of Government Policies
“Yes, somewhat…but still reliance on natural gas and water issues during summer.”	EN1: Stakeholder Perspectives on Environmental Benefits, TI2: Perceived Benefits and Risks of Technological Innovations
“Very high…we engage with neighbours and authorities early to explain benefits and impacts.”	CE1: Level of Community Engagement
“We are obliged to invite communities early and explain projects…discussions continue with authorities for best solutions.”	CE3: Strategies for Effective Community Involvement
“Opportunities lie in massive CO2 reduction…challenges include timely decisions to meet the 2030 targets.”	EN1: Stakeholder Perspectives on Environmental Benefits, PR1: Stakeholder Views on the Role of Government Policies
“Investigating high-volume hydrogen use in blast furnaces…starting with natural gas to reduce emissions by 50-60%.”	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI2: Perceived Benefits and Risks of Technological Innovations, EN3: Alignment with Climate Change Mitigation Goals, BE1: Key Barriers to Sustainable Transition
“We are doing at [our premises]a very similar project…implementing a 10 MW electrolyzer to produce green hydrogen and inject it into the blast furnace…also for finishing in cold rolling and galvanizing lines.”	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies
"Regarding biomass, I'm not sure it will be feasible on a large scale. Green hydrogen is probably the way to go, along with some alternative processes. But it’s still early days, so today, green hydrogen seems the most viable route."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies, TI5: Stakeholder Concerns Regarding Technological Innovation
"Mostly benefits. There are definitely technical challenges, but the technology exists. It's a matter of scaling it up. Pilot plants already exist for both hydrogen production and the DRI process, so it’s about achieving scale to optimize economies."	TI2: Perceived Benefits and Risks of Technological Innovations, TI3: Feasibility and Scalability of Technologies, EI4: Economic Feasibility Concerns
"Yes, completely. It's currently the only commercially viable route to decarbonize the steelmaking process."	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals

"It's difficult to say what geographical relocation these changes might cause. In Flanders, it's about anchoring operations locally, but how this plays out in the coming decades remains uncertain."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI3: Economic Growth Potential, CE5: Local Community Concerns and Priorities
"Most likely. Having a plan in place and positioning it as a front-runner in technology will help maintain expertise locally and support the plant's expansion."	EI2: Job Creation Opportunities, EI3: Economic Growth Potential, CE3: Strategies for Effective Community Involvement
"Currently, the technology has only been deployed in relatively few instances on an industrial scale. The challenge will be procuring green hydrogen at a commercially viable cost, depending on cost reductions from scaling and sourcing hydrogen."	EI4: Economic Feasibility Concerns, TI5: Stakeholder Concerns Regarding Technological Innovation, BE1: Key Barriers to Sustainable Transition
"Feasible and scalable. The project's current size is already significant, serving as a stepping stone toward larger industrial rollout."	TI3: Feasibility and Scalability of Technologies
"Extremely significant. The Flemish CO2 footprint highlights the importance of this transition, especially given that it's already one of the more efficient plants internationally."	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals
"There are challenges related to raw materials for hydrogen production, such as rare metals. Carbon capture can face issues with leaks. Circular carbon usage is a 'double cycle,' delaying but not eliminating carbon emissions."	EN2: Environmental Risks and Concerns, TI5: Stakeholder Concerns Regarding Technological Innovation
"Yes, completely. The goal is clear: to reduce CO2 emissions while balancing cost efficiency with environmental impact."	EN1: Stakeholder Perspectives on Environmental Benefits
"Moderate. While I'm well-informed due to proximity to the project, the broader public tends to focus more on economic aspects than decarbonization."	CE1: Level of Community Engagement, CE4: Communication with Local Communities
"In this case, it's more about informing communities rather than involving them in decision-making. This project is primarily a techno-economic discussion."	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communities
"Technology and logistics are the key challenges. Belgium and Flanders don't have enough electricity to produce renewable hydrogen locally, so sourcing and transporting it will be crucial."	TI5: Stakeholder Concerns Regarding Technological Innovation, BE1: Key Barriers to Sustainable Transition
"The industrialization of hydrogen production processes, especially electrolysis, still needs to mature. The industry isn't yet ready for full-scale industrial rollout."	TI3: Feasibility and Scalability of Technologies, BE2: Key Enablers for Sustainable Transition
"Essential. Given the international nature of the market, proper legislation is needed to level the playing field and guide the industry in the right direction."	PR1: Stakeholder Views on the Role of Government Policies, PR3: Policy Measures for Supporting Green Technologies
"Not that I'm aware of."	CE5: Local Community Concerns and Priorities
"Well, I was thinking about my conversation with your… AMB CEO, ArcelorMittal actually has a well-thought-through, a well-calculated plan to achieve the goals. And I have no trouble in believing that it's true. […] Well, I'm getting quite enthusiastic from the short explanation that Joke [AMB project coordinator] gave me right now, because it seems to, once again, fit in that plan. So, my first thoughts are enthusiasm, I think."	TI1: Stakeholder Perspectives on Proposed Technological Innovations
"If you look at it from the point of view of the 9.6 million tons, then 200,000 tons is not a lot. But if you look at it from the scale of the city of Ghent and all its economic activity, then a reduction of 200,000 tons is huge and is very, very, very valuable. As for the risks… I think there would be minor. So I think mainly beneficial."	TI2: Perceived Benefits and Risks of Technological Innovations, EN1: Stakeholder Perspectives on Environmental Benefits
"I do think that ArcelorMittal is ahead… of our governments in rethinking how economy works in a more circular way. […] Reducing coal consumption… could potentially boost that whole [hydrogen] market."	EI1: Stakeholder Views on Economic Impacts of Innovations, EI3: Economic Growth Potential, TI3: Feasibility and Scalability of Technologies
"I would think very scalable… if this works, it would also work in, I don't know, hundreds, thousands of other plants around the world, provided that governments… guide companies to that direction." […] As for feasible… that sounds a bit more having to do with, is it technically doable? So I wouldn't know about that. But scalable, I would think definitely."	TI3: Feasibility and Scalability of Technologies, PR1: Stakeholder Views on the Role of Government Policies

“I would write facilitating slash demanding the transition… They need to provide… but they also need to expect.”	PR1: Stakeholder Views on the Role of Government Policies
“I think we at our organization are filling a gap that actually should be filled by ArcelorMittal itself… ArcelorMittal could do a lot more in communicating with the Ghent citizens.”	CE1: Level of Community Engagement, CE2: Community Needs and Preferences
“I’m not sure I see a lot of possibilities for communities to have an impact on [decision-making]… It would require a whole lot of training.”	CE3: Strategies for Effective Community Involvement
“It’s always a good idea to talk to the immediate surroundings, the immediate neighbours, to tell them what’s going on… make them embrace the transition process. So inform them would basically be my answer.”	CE5: Local Community Concerns and Priorities, CE3: Strategies for Effective Community Involvement
“Do no harm, obviously. Get people informed, get people on board as well.”	CE5: Local Community Concerns and Priorities
“Organize informal meetings… in the centre of Ghent. […] Buy advertising space in the local Ghent newspaper to inform about projects. […] More plant visits.”	CE3: Strategies for Effective Community Involvement
“The challenge is clear: we need a swift transition towards climate neutrality. There are still hiccups, such as innovation and technological research, particularly in steelmaking. […] Producing low-carbon steel like replacing 5 million tons of ArcelorMittal’s production is a massive task. […] If green hydrogen is proven feasible in a blast furnace, it could be a game-changer.”	TI1: Stakeholder Perspectives on Proposed Technological Innovations, TI3: Feasibility and Scalability of Technologies
“More benefits. The advantage here is keeping the blast furnace operational. […] Green hydrogen, while expensive now, poses a cost problem rather than a feasibility issue. […] Carbon capturing is a potential route, though costly.”	TI2: Perceived Benefits and Risks of Technological Innovations, TI5: Stakeholder Concerns Regarding Technological Innovation
“Yes, somewhat. Zero CO2 might not be achieved. […] Life Cycle Assessment (LCA) is crucial to understand the full impact, especially regarding blue hydrogen’s CO2 risks.”	TI4: Alignment with Sustainable Development Goals, EN3: Alignment with Climate Change Mitigation Goals
“The steel industry faces job risks, especially with high-cost technologies like DRI. […] European steel will face higher costs, but mechanisms like CBAM and subsidies could support the green premium.”	EI1: Stakeholder Views on Economic Impacts of Innovations, EI4: Economic Feasibility Concerns
“Somewhat likely. New value chains could emerge, such as producing renewable energy or managing electrolyzers, creating job opportunities. […] However, the European steel market might shrink, leading to job losses in less integrated regions.”	EI2: Job Creation Opportunities, EI3: Economic Growth Potential
“The cost of green hydrogen is a significant challenge. […] Internal competition for investment within ArcelorMittal plants will also be fierce. […] Energy availability and cost remain major hurdles.”	EI5: Investment Challenges and Drawbacks, BE1: Key Barriers to Sustainable Transition
“The feasibility depends on the market’s ability to absorb the green premium. […] Scalability is tied to energy infrastructure and policy support. Without these, the transition will be slow.”	TI3: Feasibility and Scalability of Technologies, BE1: Key Barriers to Sustainable Transition
“The environmental benefits are substantial, especially in reducing emissions. […] However, the transition must be managed carefully to avoid unintended consequences, such as increased emissions in other sectors.”	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals
“One concern is the reliance on blue hydrogen, which still has CO2 emissions. […] Another is the potential for increased energy consumption, which could offset some of the environmental gains.”	EN2: Environmental Risks and Concerns, TI5: Stakeholder Concerns Regarding Technological Innovation
“Government policies are crucial. They can provide the necessary incentives and frameworks to support the transition. […] Without strong policy support, the transition will be much slower and more difficult.”	PR1: Stakeholder Views on the Role of Government Policies, PR5: Strategies for Effective Policy Implementation
“The strategies are a good start, but more work is needed to ensure they fully address sustainability concerns. […] Continuous monitoring and adjustment will be key.”	EN1: Stakeholder Perspectives on Environmental Benefits, PR5: Strategies for Effective Policy Implementation
“Community engagement is currently limited. […] More efforts are needed to involve local communities in the decision-making process.”	CE1: Level of Community Engagement

"One strategy could be to establish local advisory boards that include community representatives. […] This would ensure that community voices are heard and considered in the decision-making process."	CE3: Strategies for Effective Community Involvement
"Yes, understanding the specific needs and preferences of local communities is crucial. […] This could include job opportunities, environmental concerns, and other local priorities."	CE2: Community Needs and Preferences, CE5: Local Community Concerns and Priorities
"Burning of fossil fuels results not only in CO2 but also environmental pollution, like NO2 and benzene and formaldehyde. […] Stopping this will result not only in countering climate change but also improve air and water quality. […] It is not only the improvement of the site alone, but also the whole value chain of coal/gas/oil will be tackled: this means less land destruction (due to mining and extraction), less transport (and leakage), and less scope 3 emissions."	EN1: Stakeholder Perspectives on Environmental Benefits, EN2: Environmental Risks and Concerns
"There could be a prolongation of gas-extraction as RecHycle could use blue hydrogen. […] At the moment, the grid electricity is still not 100% renewable, the question will always be how the energy is generated. […] The climate transition is also a material transition: from oil and coal to batteries/electrolysers/heat pumps. […] We need new resources for that, and this comes with an environmental price. […] The question is where the resources/minerals for RecHycle will come from and how the project team is looking towards due diligence of the value chain."	TI5: Stakeholder Concerns Regarding Technological Innovation, EN2: Environmental Risks and Concerns, BE1: Key Barriers to Sustainable Transition
"Regular meetings with strategic consortium meetings about the content and determination of mutual goals. […] Contribution via elaboration of position papers on different subtopics (blue hydrogen, grid electricity, energy infrastructure, low-carbon steelmaking). […] Seat in steering groups or boards (in the future, e.g., North Sea Port)."	PR5: Strategies for Effective Policy Implementation, BE4: Opportunities for Collaboration and Support
"Positive, can only contribute to CO2 reduction. Will of course depend on the cost of hydrogen."	TI1: Stakeholder Perspectives on Proposed Technological Innovations, EI4: Economic Feasibility Concerns
"I hope this implementation will bring mostly benefits. Transition still needed for blast furnace. These projects can only contribute to environmental goals, so positive. As a union, we mainly look at employment and safety. Even with the arrival of the EAF, we hope that employment will improve. This does require timely training of people. Safety and employment are most important."	TI2: Perceived Benefits and Risks of Technological Innovations, EI2: Job Creation Opportunities, EN3: Alignment with Climate Change Mitigation Goals
"Technical knowledge around this project is limited to properly assess the impact. We hope to reduce to zero, but not so sure. Trade unions are little/less involved at the technical level. We are often only informed once the idea is worked out. We would also prefer to be involved beforehand to highlight issues such as safety."	TI4: Alignment with Sustainable Development Goals, PR4: Collaboration Between Government and Industry, BE3: Stakeholder-Specific Challenges
"Problem with the steel industry: prices cannot be passed on to customers + big question whether customers will want to pay for more expensive steel. Impact on the economy will depend on what the EU decides. Concern about steel action plan: will it be there soon enough? What will it entail? Adjustment of CBAM? Fear that EU works very slowly and we are going to be late. On the economic front, we hope that the EU reacts fast enough so the steel industry does not disappear locally and in Europe."	EI1: Stakeholder Views on Economic Impacts of Innovations, PR1: Stakeholder Views on the Role of Government Policies, BE1: Key Barriers to Sustainable Transition
"I hope so, the more employment the better. We know too little about the technology to estimate how many people are needed to make it work. Generally, automation reduces employment. When EAF starts up, there will be more people. In the first phase, there will probably be more employment, but later this will probably reduce again. Therefore, 'maybe' as an answer."	EI2: Job Creation Opportunities, EI3: Economic Growth Potential, BE3: Stakeholder-Specific Challenges
"Since we will effectively implement this project (after conducting a feasibility study by our engineering department), I still assume that this project is feasible. Whether it is scalable or not is harder to estimate, less visibility into other sites and what they are capable of."	TI3: Feasibility and Scalability of Technologies, BE1: Key Barriers to Sustainable Transition
"Convinced that we need to do something about the environment and CO2 is the biggest culprit. We all need to work on this."	EN1: Stakeholder Perspectives on Environmental Benefits, EN3: Alignment with Climate Change Mitigation Goals

“Problems are not there; risks are, but rather in terms of safety. Hydrogen is a new technology for us. ‘What if…?’ scenarios need to be drawn up. Hydrogen is highly flammable, and we will have to ensure nothing can happen by detecting leaks, for example. We have already built up expertise around blast furnace gas, coke gas, etc., but pure hydrogen is something completely different.”	EN2: Environmental Risks and Concerns, BE1: Key Barriers to Sustainable Transition
“If the government is not convinced, the steel industry is going to disappear. The impact on the economy will depend on what the EU decides. Concern about the steel action plan: will it be there soon enough? Adjustment of CBAM? Fear that the EU is very slow and unwieldy.”	PR1: Stakeholder Views on the Role of Government Policies, PR2: Regulatory Barriers to Implementation, BE1: Key Barriers to Sustainable Transition
“I suppose so, because these types of projects require an environmental impact assessment. These are very bulky documents that have to be approved by the authorities.”	EN3: Alignment with Climate Change Mitigation Goals, PR5: Strategies for Effective Policy Implementation
“Both unions and local residents are closely involved in projects. If there are questions, they can forward them and also get answers. Sessions have been held in several neighbourhoods to explain projects. A repeat of these sessions can certainly be useful. Company visits are also organized for neighbourhood residents.”	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communities
“I find less need to involve local communities in decision-making. Decision-making is at management level, which is normal. What could be better is to inform and involve trade unions before decision-making, as they look at employment and safety. For neighbourhoods, informing is enough.”	CE3: Strategies for Effective Community Involvement, CE4: Communication with Local Communities
“Same as above. Making sure the neighbourhood is adequately informed.”	CE2: Community Needs and Preferences, CE4: Communication with Local Communities
“Initially, there will be a positive impact (additional employment due to the construction of the EAF), but rather neutral later on.”	EI2: Job Creation Opportunities, BE3: Stakeholder-Specific Challenges
“Training people in time is very important. A social safety net must also be provided when needed. At ArcelorMittal Gent, they always try to keep people on board, avoiding redundancies. People are moved internally as much as possible.”	EI2: Job Creation Opportunities, BE2: Key Enablers for Sustainable Transition
“Getting involved earlier would be better, but social consultation is currently good. Enough information is shared, and normal consultation bodies work well. I would like unions to co-decide, focusing on safety and employment, but decisions are often made on the economic front	PR4: Collaboration Between Government and Industry, BE4: Opportunities for Collaboration and Support