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Comparative analysis of pilot results and joint lessons learnt

Activity 2.4

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Short description

H2MA brings together 11 partners from all 5 Interreg Alpine Space EU countries (SI, IT, DE, FR, AT), to coordinate and accelerate the transnational roll-out of green hydrogen (H2) infrastructure for transport and mobility in the Alpine region. Through the joint development of cooperation mechanisms, strategies, tools, and resources, H2MA will increase the capacities of territorial public authorities and stakeholders to overcome existing barriers and collaboratively plan and pilot test transalpine zero-emission H2 routes.

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CONTENT

1. EXECUTIVE SUMMARY

This report provides a comprehensive overview of the H2MA project, focusing on the development of a transalpine hydrogen mobility network and the associated pilot projects. The primary goal of this initiative is to design a cohesive and integrated hydrogen infrastructure system across the Alpine region, ensuring alignment with both local and EU-wide hydrogen strategy objectives. The project adopts a multi-step approach to achieve its goals, including the preparation of the H2MA tool, development of individual regional routes, and the establishment of a transalpine masterplan.

The report begins with an introduction (Section 1) of the project and outlines the scope and goals of Activity 2.4, providing context for the evaluations conducted.

The pilot process section (Section 3) outlines the steps taken to prepare and develop the hydrogen mobility infrastructure. This includes the preparation of the H2MA tool for data analysis, the development of individual regional routes, and the peer review process that ensured each route's alignment with project objectives. The section concludes with a description of the development of the transalpine masterplan, which synthesises the individual routes into a unified network.

The comparative evaluation (Section 4) examines the results of the pilot projects, assessing hydrogen demand, coverage, infrastructure, cost feasibility, and environmental impact across the regions involved. The goal is to evaluate how each pilot contributes to the broader hydrogen strategy and identify areas for improvement.

In the Section 5, the H2MA Masterplan's progress is assessed, including insights gained from the final Local Working Group (LWG) meetings and stakeholder feedback. These discussions provide a clearer understanding of policy alignment and the potential impact of the hydrogen routes on the region's mobility and environmental goals.

The report concludes with lessons learned and recommendations for future hydrogen route designs and implementations (Section 6). This includes reflections on the development of the H2MA tool, insights from the pilot development, and strategic recommendations for improving hydrogen mobility infrastructure.

2. INTRODUCTION

2.1 Outline of the activity 2.4

Activity 2.4 focuses on conducting a comprehensive comparative evaluation of the results of the pilot actions implemented across the participating territories. The goal of this activity is to assess the effectiveness and impact of the individual pilot actions and the Masterplan in the context of the broader Alpine hydrogen mobility infrastructure deployment. The evaluation considers various aspects of the pilots, including their alignment with the project objectives, the regional hydrogen infrastructure needs, and the challenges experienced during the development of the Masterplan.

The key steps of this activity included:

- Presentation of the Masterplan: The consolidated Masterplan, created by merging regional routes and resolving compatibility issues, has been presented to relevant national and EU bodies for their feedback and recommendations.
- Final Local Working Group (LWG) Meetings: Each project partner reached out to their members of the LWG, either via physical meetings or via surveys, to integrate the feedback from national and EU bodies, evaluate the overall impact of the pilot actions, and gather additional stakeholder insights.

2.2 Partner's involvement

All partners have been involved in Activity 2.4 through the conduction of the LWG meetings and contacting relevant national/EU bodies to discuss the transalpine Masterplan and how it can promote hydrogen mobility in the Alpine region (details provided in the following sections). The feedback from these meetings is included in the present document to support further development in the roll out of green hydrogen infrastructure in project territories.

3. DESCRIPTION OF THE PILOT PROCESS

The section will provide an overview of the pilot process, and briefly (since more details have been included in past deliverables) discuss the different steps of the pilot action to provide the necessary context for the following sections.

3.1 Preparation of H2MA tool

For the design of the hydrogen routes the partnership developed a dedicated tool to support the decision-making of local authorities in the areas of hydrogen mobility planning and H2 infrastructure placement. To this end the H2MA tool integrates spatial analysis to manage geographic and infrastructural variables like population density, renewable energy sources, and transportation routes.

The tool was developed by Fondazione Politecnico di Milano, with project partners providing feedback for its development. It integrates a comprehensive dataset covering the Alpine Space region, which includes economic, demographic, and hydrogen infrastructure data (existing and planned). This data-driven approach allows users to model different hydrogen demand scenarios based on a number of factors, such as vehicle penetration rates and available supply options (via pipelines or road transport).

Key features of the tool include:

- Scenario-based analysis: Users can create and evaluate multiple scenarios for hydrogen demand and infrastructure planning, adjusting variables such as hydrogen production capacities and transport methods.
- Flexibility for updates: The tool allows for the input of new data over time, ensuring that infrastructure planning can evolve with changing regional demands and technological developments.
- Interactive visuals: Results are displayed on interactive maps, enabling users to identify optimal site locations for hydrogen production, refuelling stations, and delivery routes.

3.2 Development of individual routes

Process overview

The development of the individual routes for the Alpine Space took place through the Local Working Groups (LWGs) in each region, bringing together project partners and local stakeholders, including government representatives, industry experts, and other regional players who have a deep understanding of the area's specific needs and resources. These LWGs focused on creating regional routes that addressed local needs, while supporting the broader transalpine vision for green hydrogen mobility.

The LWGs facilitated a bottom-up approach by organising participatory meetings to discuss hydrogen mobility routes and gather feedback from local stakeholders. This collaboration ensured that the developed strategies were practical and aligned with the H2MA project's goals.

To support the LWGs, project partners provided training materials, tutorials, and resources for using the H2MA tool. Each LWG played a vital role in shaping the individual regional hydrogen mobility routes, gathering stakeholder input, considering local challenges, and ensuring that the project remained aligned with the specific needs of the regions involved.

During the pilot action, partners identified and analysed multiple scenarios to optimise the design of the hydrogen network. These scenarios considered not only regional mobility needs but also the demand for hydrogen from industrial sectors. This multi-scenario approach ensured that the tool was versatile and capable of adapting to a range of potential future developments.

The final scenario selections were based on optimising both economic efficiency and environmental impact, ensuring the infrastructure was designed to meet regional needs for green hydrogen mobility while being scalable and future-proof.

The process resulted in a hydrogen infrastructure plan, identifying the need for 153 hydrogen refuelling stations at all the selected regions, including 73 along critical European transportation routes. These stations, alongside strategically placed production sites, form the backbone of a robust transalpine hydrogen mobility system. While the proposed plan successfully outlined regional solutions, it also highlighted areas needing further work, particularly in enhancing connectivity between regions, in order to ensure the masterplan remains both regionally relevant and transnationally cohesive.

3.3 Peer review of the hydrogen routes

The peer-review process for developing the transalpine green hydrogen masterplan was a collaborative and iterative effort designed to ensure the quality, compatibility, and environmental soundness of the proposed hydrogen mobility routes. The process aimed to align individual regional plans with the objectives of the transalpine masterplan, facilitating knowledge exchange among partners and refining the network for optimal performance.

The peer-review process focused on key aspects to refine the hydrogen mobility routes. Territorial coverage was assessed to ensure strategic placement of hydrogen refuelling stations (HRSs) across key regions, addressing gaps or inefficiencies. Cost-effectiveness was evaluated by analysing production and distribution costs, avoiding overlaps, and aligning infrastructure with future demand. The network’s scale and alignment with projected growth were reviewed to ensure resilience and adaptability. Furthermore, the compliance with EU policies was examined, including adherence to spacing and capacity standards for HRSs. An environmental impact review assessed the carbon footprint and potential effects on biodiversity. Lastly, compatibility and integration challenges across borders were addressed, identifying areas for harmonisation.

3.4 Development of the transalpine Masterplan

This Masterplan outlines proposed hydrogen routes and infrastructure to create a cohesive, sustainable network that supports regional and European decarbonisation goals. The Masterplan synthesises insights from regional pilot projects and addresses key challenges, including cross-border integration, infrastructure feasibility, and alignment with policy frameworks.

To ensure the Masterplan reflects the perspectives and needs of diverse stakeholders, partners discussed the Masterplan with local stakeholders to evaluate the Masterplan's practicality, its potential to accelerate the deployment of green hydrogen infrastructure, and its effectiveness in addressing regional mobility challenges.

Feedback was systematically gathered using a standardised template (ANNEX II), which included a SWOT analysis to identify strengths, weaknesses, opportunities, and threats associated with the Masterplan. This structured approach helped pinpoint the advantages and challenges of implementing hydrogen infrastructure and highlighted potential impacts on heavy-duty mobility within the Alpine region.

The refined Masterplan was also submitted to key national and European bodies, including EUSALP and Hydrogen Europe. These organisations reviewed the document to ensure its alignment with both regional policies and EU-wide strategies for sustainable mobility and energy transition. Stakeholder feedback from these reviews will guide further refinements of the Masterplan.

4. COMPARATIVE EVALUATION OF PILOT RESULTS

The section provides a comparative evaluation of the pilot results, focusing on the individual routes developed by H2MA partners and assessing aspects such as coverage and reach, infrastructure, cost feasibility, hydrogen demand, and environmental impact.

4.1 Coverage, reach, and demand

Coverage and reach concern the extent to which the hydrogen network routes connect key industrial, economic, and transit hubs across regions. The criterion considers both the geographic span of routes and their ability to integrate major economic hubs and cross-border corridors. Additionally, understanding future hydrogen demand in these regions ensures that coverage prioritises areas with the highest projected needs, optimising infrastructure investments and utilisation rates. The comparative analysis highlights the importance of strategic positioning to maximise regional impact, address projected demand, and support sustainable growth of the hydrogen ecosystem.

Each route is designed to align with the specific economic and strategic priorities of its region while addressing varied demand projections:

Austrian hydrogen routes

Vienna (AT13) and Styria (AT22): Austria's routes are not only well-integrated into the TEN-T network, enhancing their significance within the national and European contexts, but also align with high hydrogen demand projections around Vienna due to its status as a major industrial and transit hub. Styria, while generating lower overall demand, benefits from cross-border connections with Slovenia, emphasising freight mobility along transalpine corridors, and thus prioritising regional links over extensive internal coverage.

Slovenian hydrogen routes

Slovenia East (SI03) and West (SI04): Slovenia's East and West routes adopt a focused approach to connectivity by emphasizing regional integration and strategic transalpine connections. Slovenia West connects to Italy's Friuli Venezia Giulia region, serving critical industrial and economic hubs, while Slovenia East links to Hungary, facilitating east-west trade. Unlike routes that prioritize extensive national coverage, these routes align with Slovenia's strategy to strengthen targeted economic corridors and cross-border collaboration, balancing infrastructure investment with phased development goals reflective of its conservative demand projections.

Italian hydrogen routes

Lombardy (ITC4) and Piemonte/Turin (ITC1): Northern Italy demonstrates strong hydrogen demand driven by its industrial base in Lombardy and Turin. These regions' extensive coverage facilitates connections within the North Sea-Mediterranean and Mediterranean TEN-T corridors, emphasising their role in supporting Italy's hydrogen needs and cross-border trade with Switzerland and France.

German hydrogen routes

Stuttgart (DE11) and Freiburg (DE13): Stuttgart's industrial sector and heavy freight activity drive substantial hydrogen demand, supported by its strategic position along the Rhine-Danube TEN-T corridor, which ensures critical connectivity for freight and logistics in the proposed route. Freiburg route, while projecting more moderate hydrogen demand, is key for cross-border transport routes with France and Switzerland, strengthening regional collaboration through enhanced connectivity.

French hydrogen route

Strasbourg (Bourgogne-Franche-Comté (FRC2) and Alsace (FRF1)): Positioned between France, Germany, and Switzerland, Strasbourg aligns its coverage strategy with moderate hydrogen demand driven by cross-border freight traffic. Its role as a transit route within the North Sea-Mediterranean TEN-T corridor highlights its strategic importance for connecting heavily trafficked routes.

Discussion

Overall, the hydrogen network routes are strategically designed to connect key economic centres while fostering cross-border collaboration to meet future hydrogen demand.

Regions with high hydrogen demand, like Vienna, Stuttgart, and Lombardy, focus on creating extensive and scalable corridor designs to meet both current and future needs. These areas are key locations where the development of hydrogen infrastructure (such as refuelling stations and supply networks) is prioritised to address immediate and large-scale demand. Their coverage strategies reflect an urgency to connect high-demand industrial regions and ensure robust infrastructure for freight transport. In contrast, regions like Freiburg and Slovenia adopt more modest approaches that align infrastructure development with measured demand growth. This ensures financial viability while maintaining flexibility for future expansion.

Slovenia's East and West routes, for example, demonstrate a careful balance between enhancing transalpine trade connections and avoiding overextension, aligning with its phased investment strategy. Similarly, cross-border routes such as Strasbourg and Freiburg focus on linking specific regions with moderate demand to foster collaboration, while supporting targeted freight routes. These routes serve as critical points for ensuring seamless connectivity between countries, even as their development remains adaptable to evolving market conditions.

4.2 Infrastructure

While the presence or absence of existing infrastructure influences decision-making, the emphasis of this analysis is on the planned infrastructure associated with each route. This approach highlights the diverse strategies for hydrogen infrastructure deployment, reflecting variations in regional readiness, economic priorities, and geographic considerations.

Austrian hydrogen routes

Vienna (AT13) and Styria (AT22):

The Vienna (AT13) hydrogen route focuses on establishing strategic hydrogen infrastructure along key transit routes and logistical hubs. The primary route follows the A21 motorway, part of the Baltic-Adriatic and Rhine-Danube corridors. Four (4) new HRS are proposed, with two (2) featuring onsite production. One station is near the Danube River to facilitate inland transport, and another is near Vienna Airport, a crucial logistics hub. The plan aims to cover primary economic centers and ensure alignment with EU hydrogen infrastructure guidelines.

The Styrian hydrogen route in Austria aims to integrate hydrogen into the region's transportation system by 2040, with a projected demand of 17,000 tonnes per year. The plan includes sixteen (16) new hydrogen refuelling stations (HRS), with nine strategically located on the TEN-T corridors The plan benefits from Austria's existing infrastructure, particularly the Trans Austria Gas Pipeline (TAG), which will be repurposed for hydrogen transport by 2030. The proposed routes cover major highways and freight corridors, including: Route 1: A9 highway from the Slovenian border to Graz, extending along the A2 toward Vienna. , Route 2: Serving transit and domestic traffic. , Route 3: Connecting Graz to Lower Austria via the S35-S6 highways. , Route 4: A2 highway from Graz toward Carinthia, focusing on high-volume transit to Italy. , and Route 5: Linking St. Michael to the A10, with potential onsite hydrogen production.

Slovenian hydrogen routes

Slovenia East (SI03) and West (SI04):

In eastern Slovenia, the KSENNA hydrogen route (SI03) aims to establish a comprehensive refuelling network along key highways that are part of the Baltic Sea - Adriatic Sea TEN-T corridor. The plan proposes twenty-one (21) new HRSs, with a mix of locations near major highways, cities, and rural areas. Hydrogen will be distributed through a combination of pipelines and on-site production, with truck delivery as a short-term solution. However, the high number of stations in low-demand areas could lead to inefficiencies, and the current production capacity may not be sufficient to meet future demand. To optimize the network, it is recommended to reduce the number of stations in low-demand areas and increase production capacity.

In the western region of Slovenia, the BSC hydrogen route (SI04) focuses on integrating hydrogen infrastructure along the Baltic to Adriatic and Western Balkans to Eastern Mediterranean TEN-T corridors. The plan includes ten (10) new hydrogen refuelling stations (HRS), strategically placed to support both local and transit traffic. Onsite green hydrogen production facilities are being developed in Gorenjska (Lesce) and Goriška (Deskle). However, some stations currently fall short of the EU directive minimum capacity of 1 tonne per day. To address these challenges, it is recommended to increase the capacities of these stations and improve cross-border links with neighbouring countries like Italy and Austria.

Italian hydrogen routes

<u>Lombardy (ITC4) and Piemonte/Turin (ITC1):</u>

Lombardy's plan includes the establishment of sixteen (16) new hydrogen refuelling stations (HRS) strategically placed along major highways such as the A1, A7, A8, and A9. These highways are part of the North Sea-Rhine-Mediterranean and Mediterranean TEN-T corridors, ensuring that the network supports major economic zones and facilitates cross-border mobility, particularly for heavy-duty trucks. A key feature of the plan is the development of a hydrogen valley near Mantova, which will serve as a central hub for hydrogen production and distribution in the region. Additionally, the H2-Iseo project aims to connect Brescia to Edolo with hydrogen trains and bus refuelling stations, further enhancing the region's hydrogen infrastructure. The hydrogen production sites are strategically located close to renewable energy sources, ensuring a sustainable supply of green hydrogen to meet future demand. The placement of the HRS is well-distributed across the region, particularly along major roads, ensuring availability for logistics operations and aligning with EU targets for the TEN-T core network by 2030, which requires a minimum of one station every 200 km.

The Turin (ITC1) hydrogen route plan envisions the establishment of four (4) new HRS, carefully positioned along key routes to ensure comprehensive coverage and accessibility. These routes include the E70 from Turin to Bologna, the E25 from Mont Blanc to Turin, and the E717 from Turin to Vado, which are vital for both light and heavy-duty vehicles. A notable feature of the plan is the redundancy approach, which includes a second HRS in the Turin urban area to guarantee reliable fuel availability under all conditions. This ensures that the network remains resilient and capable of meeting the region's hydrogen demand. The infrastructure strategy embraces a decentralised production model, with local hydrogen production at select HRS and distribution via tube trailers. This approach allows for rapid deployment of infrastructure without the immediate need for extensive pipeline construction. Additionally, the plan includes collaborations with ongoing projects in France (HYMPULSION) and Switzerland (HYDROSPIDER), enhancing cross-border hydrogen mobility and ensuring a seamless integration with neighbouring regions.

German hydrogen routes

Stuttgart (DE11) and Freiburg (DE13): Germany's southwestern hydrogen strategies for Stuttgart and Freiburg present distinct approaches to infrastructure planning, tailored to regional demands and challenges.

The Stuttgart (DE11) hydrogen route is set to be a key part of Germany's hydrogen network by 2030, meeting the region's growing hydrogen demand. Central to the plan is the development of H2-route 1, which follows the A8 highway, a critical part of the Rhine-Danube TEN-T corridor. This route ensures that key economic and industrial hubs in the Stuttgart region are well-served, facilitating seamless connectivity for heavy-duty vehicles and passenger cars. The infrastructure strategy includes a significant number of hydrogen production sites, positioning Stuttgart as a future leader in hydrogen supply. The emphasis on pipeline delivery as the preferred mode of hydrogen transportation underscores the plan's commitment to long-term cost efficiency and scalability, reducing transportation costs and energy losses compared to truck-based delivery. Moreover, the plan aligns with EU hydrogen policies, ensuring that the network meets targets for HRS distance, storage capacity, and overall infrastructure deployment by 2030. This alignment not only supports regional mobility but also enhances cross-border hydrogen trade and connectivity, particularly with France.

The Freiburg (DE13) hydrogen route aims to develop a robust hydrogen infrastructure to meet an estimated annual mobility demand of 18,000 tonnes, with Ortenaukreis expected to see the highest daily consumption at 9 tonnes. The proposal includes twenty-six (26) new hydrogen refuelling stations (HRS), with 16 positioned near major routes and 8 planned for rural areas that need further evaluation. Key routes include the Rhine River and A5 highway corridor (part of the North Sea-Rhine-Mediterranean TEN-T network), a critical west-east connection, and a route linking Stuttgart with Lake Constance and Switzerland. The plan prioritizes pipeline delivery, leveraging the approved RhynInterco pipeline, which will connect Freiburg to Offenburg with potential expansion to Kehl. However, building additional rural pipelines will require strong business cases to justify the investment.

French hydrogen route

Strasbourg (Bourgogne-Franche-Comté (FRC2) and Alsace (FRF1)):

The Strasbourg hydrogen route plan, encompassing the Bourgogne-Franche-Comté (FRC2) and Alsace (FRF1) regions, focuses on developing a robust hydrogen infrastructure along key transportation routes. The plan emphasizes truck delivery for hydrogen in the short term due to limited pipeline infrastructure.

In Bourgogne-Franche-Comté, five (5) new hydrogen refuelling stations (HRS) are proposed, three (3) of them strategically located near main hubs like Besançon, Belfort, and along the A36 highway, part of the North Sea-Rhine-Mediterranean TEN-T corridor. The other two (2) stations are planned in more remote areas, requiring further feasibility evaluation.

In Alsace, the plan aims to meet a hydrogen demand of 12,000 tonnes per year, with the highest daily demand in the northern areas. Seven (7) new HRS are proposed, with three near major routes connecting Alsace with Switzerland and Bourgogne-Franche-Comté, and four in rural areas needing detailed planning. The main H2 routes include the A5 highway, following the river Rhine, which is critical for cross-border transport. The plan strategically places hydrogen production sites near renewable energy sources, particularly hydroelectric power, to minimize energy transportation losses and support environmental goals. The HRS are well-distributed along major transportation corridors, improving accessibility for cross-border trade and long-distance travel, especially with Germany and Switzerland. The focus on on-site hydrogen production in Alsace enhances short-term cost efficiency and supports economic activities by ensuring HRS availability along major trade routes.

Discussion

The planned infrastructure varies significantly between routes, influenced by the region's existing infrastructure and strategic goals. In the discussion the hydrogen routes are categorised into advanced, moderate, and limited infrastructure, based on the comprehensiveness of their plans, the number of proposed hydrogen refueling stations (HRS), and the integration with existing transport corridors.

Regions with **advanced infrastructure**, such as Germany and Italy demonstrate a strong commitment to hydrogen infrastructure, with comprehensive plans that integrate multiple HRS, pipeline delivery systems, and strategic collaborations. These regions are well-positioned to meet current and future hydrogen demands, facilitating cross-border mobility and economic growth.

Regions with **moderate existing infrastructure**, like Austria and Slovenia are making significant strides in developing hydrogen infrastructure, but they face challenges related to efficiency and capacity. While they have proposed numerous HRS, the integration with existing transport networks and optimisation of station placements are critical for success.

Regions with **limited infrastructure**, such as France's hydrogen infrastructure is still in its infancy, with a reliance on truck delivery and limited pipeline connections. The proposed HRS need further development to ensure they meet the growing demand for hydrogen and align with EU directives.

4.3 Cost feasibility

Cost feasibility refers to the financial viability of the proposed hydrogen routes, focusing on the initial investment required. This criterion is crucial for evaluating the economic sustainability of the hydrogen supply chain in relation to the unique characteristics of each route.

Austrian hydrogen routes

Vienna (AT13) and Styria (AT22): Vienna route's strengths include efficient HRS placement along key logistics corridors and compliance with EU guidelines, reducing initial investment needs. Challenges involve logistical complexities in densely populated areas, potential inefficiencies from overlapping HRS locations, and a lack of cost analysis for production and transportation options. Styria route's strengths include benefiting from existing infrastructure like the Trans Austria Gas Pipeline (TAG) and aligning with key transit routes and industrial hubs to ensure high consumption. However, challenges such as infrastructure overlaps near borders, high costs for on-site hydrogen production in rural areas, and insufficient cost comparisons between transportation methods impact economic viability.

Slovenian hydrogen routes

Slovenia East (SI03) and West (SI04):

The Western Slovenia hydrogen route (BSC) aims to strategically place hydrogen refuelling stations (HRS) along major transportation corridors for cost efficiency. However, the high number of planned HRS may not be justified by initial low demand, leading to high operational costs. To enhance cost feasibility, the plan should adopt a phased approach, starting with fewer HRS and expanding as demand grows. Improving cross-border connectivity with Italy and Austria will also support a more integrated and cost-effective network. The Eastern Slovenia hydrogen route (KSENNA) aims to establish a comprehensive HRS network along key highways, integrating centralised and on-site hydrogen production to reduce transportation costs. To improve cost feasibility, the plan should reduce the number of HRS in low-demand areas, increase production capacity, and focus on urban centres and high-demand corridors.

Italian hydrogen routes

Lombardy (ITC4) and Piemonte/Turin (ITC1):

The Lombardy hydrogen route aims to meet the growing demand for hydrogen in Milan by establishing 16 new HRS along major highways. However, the reliance on truck-based hydrogen delivery may increase transportation costs and carbon footprint. To improve cost feasibility, the plan should consider expanding existing refuelling stations and exploring alternatives to truck transport, such as onsite production facilities or future pipeline infrastructure. Strengthening partnerships with neighbouring regions like Emilia Romagna and Piedmont will enhance coverage and cost efficiency. The Turin hydrogen route focuses on developing a strategic hydrogen refuelling infrastructure, including 4 new HRS along key transportation routes and economic hubs. However, reliance on tube trailers and limited large-scale production capabilities may lead to future supply constraints and higher transportation costs. To enhance cost feasibility, the plan should consider increasing storage capacities at HRS, expanding onsite hydrogen production, and re-evaluating the long-term feasibility of pipelines. Coordinating decentralized network design with neighbouring regions will ensure seamless integration and cost efficiency.

German hydrogen routes

Stuttgart (DE11) and Freiburg (DE13): The Stuttgart hydrogen route, which uses pipeline delivery, offers long-term cost efficiency by reducing transportation costs and energy losses compared to truck delivery. However, high construction costs and pipeline development time present challenges, especially with the 2030 deadline. The plan also fails to address high-demand industries like steel, cement, and chemicals, requiring substantial investment. The lack of cross-border connections with Austria and Switzerland limits its effectiveness within the European hydrogen network. The Freiburg route aligns with EU hydrogen goals but reliance on truck delivery leads to energy losses and higher transportation costs. Coverage gaps between Freiburg, Stuttgart, and Italy could hinder hydrogen flow, necessitating further infrastructure investment.

French hydrogen route

Strasbourg (Bourgogne-Franche-Comté (FRC2) and Alsace (FRF1)): Strasbourg's route financial viability of this initiative faces several challenges. The reliance on truck delivery can lead to higher transportation costs and energy losses, impacting the economic sustainability of the hydrogen supply chain. Additionally, there are issues of redundancy with multiple production sites in Bas-Rhin and inadequate infrastructure in Haut-Rhin. Storage capacities at the proposed HRS are below EU recommendations for heavy-duty vehicles (HDVs), necessitating costly upgrades. The current focus on personal vehicles may also limit long-term growth, making it essential to prioritize HDV infrastructure. To improve cost feasibility, recommendations include exploring pipeline development, reassessing HRS locations, increasing storage capacities, conducting environmental assessments, and prioritizing HDV infrastructure.

Discussion

Each route's financial feasibility is shaped by the availability of funding, existing infrastructure, and regional collaboration opportunities. Routes that rely on existing infrastructure or phased development strategies tend to offer better cost feasibility, while routes requiring large-scale infrastructure investments, such as pipelines or heavy-duty vehicle support, demand more substantial upfront investments.

Some routes are financially viable due to their strategic placement and low initial investments. These include Vienna (AT13), Slovenia East (SI03), and Freiburg (DE13). They use existing infrastructure and align with EU goals, minimizing upfront costs. Their efficient placement of refuelling stations in high-demand areas enhances cost-effectiveness and reduces logistical challenges.

Several routes require moderate investments to improve infrastructure but have strong potential for future growth. These include Styria (AT22), Lombardy (ITC4), Piemonte/Turin

(ITC1), and Slovenia West (SI04). While they need initial capital for additional refuelling stations or production capacity, they are well-positioned for scalability and regional integration, making the upfront costs more justifiable.

In contrast, some routes face substantial costs related to infrastructure development, transportation logistics, and large-scale production. Stuttgart (DE11) and Strasbourg (FRC2/FRF1) are among the most challenging in terms of cost feasibility. Their reliance on expensive infrastructure, such as pipelines, and the need to support heavy-duty vehicles (HDVs) in areas with inadequate storage or refuelling capacity create significant financial pressure. Additionally, the high dependence on truck delivery increases operational costs and energy losses, necessitating considerable investment for long-term viability.

4.4 Environmental impact

Environmental impact assessments play a key role in shaping the design of the proposed hydrogen mobility routes, with a focus on ensuring that infrastructure development aligns with broader regional and EU climate goals. These assessments were particularly concerned with minimising the environmental footprint of each route, considering factors like emissions reductions, land use, and protection of natural habitats. The goal was to design routes that not only contribute to decarbonisation but also respect and preserve the environmental integrity of the regions they pass through.

In areas with heavy industry, the goal was to reduce the carbon footprint of high-traffic corridors, but also ensure that the development of hydrogen infrastructure did not lead to negative environmental impacts like air and water pollution or land degradation. These areas also required careful planning to avoid disrupting local agricultural or green spaces during construction.

The environmental impact analysis of each route considered potential reductions in greenhouse gas (GHG) emissions. Areas with heavy industrial and transport activity are expected to see significant GHG reductions due to the transition from fossil fuels to hydrogen, especially in high-emission corridors.

5. H2MA MASTERPLAN: PROGRESS, INSIGHTS AND THE ROAD AHEAD

The green Hydrogen Mobility Masterplan for Alpine Space has been developed as a strategic framework to accelerate the deployment of hydrogen infrastructure across the transalpine region. Its preparation builds on the individual regional route plans to merge them into a cohesive hydrogen mobility network, that aligns with the H2MA goals of decarbonising transportation, fosters cross-border collaboration, and uses renewable energy for green hydrogen production. The masterplan addresses both current transportation needs, and future mobility demands through a phased and scalable approach, informed by extensive data inputs and stakeholder collaboration.

Key features of the masterplan include its focus on freight transport and heavy-duty vehicles, critical to the trans-European trade corridors. It embraces the principles of additionality and temporal and geographical correlation, ensuring hydrogen production relies on newly developed renewable energy capacity, while maintaining alignment with energy availability. Developed using the H2MA tool, the plan incorporates adaptable scenarios to balance ambition with feasibility and account for the varying territorial characteristics. This strategic flexibility enables a phased, scalable infrastructure rollout, fostering efficient cross-border connectivity and alignment with EU energy and mobility strategies.

Challenges of fragmented transportation networks and underdeveloped hydrogen pipeline infrastructure were identified as key obstacles to scaling up hydrogen mobility. However, these challenges also present valuable opportunities for innovation and targeted investment. The Masterplan highlights the need for cross-border collaboration to bridge these gaps, optimise logistics, and facilitate the integration of hydrogen infrastructure with existing energy systems.

5.1 Stakeholder feedback on the H2MA Masterplan

The final Local Working Group (LWG) meetings and stakeholder feedback sessions provided critical insights into the H2MA Masterplan's strengths, challenges, and future direction. These discussions across the Alpine region highlighted key themes and actionable recommendations to enhance the plan's effectiveness and alignment with stakeholder needs.

The feedback from stakeholders reveals a shared understanding of its value as a foundational tool for hydrogen infrastructure development across the Alpine region. Stakeholders widely recognise its alignment with European policies, such as the TEN-T network and REPowerEU[1], which underscores its relevance in supporting decarbonisation efforts. Many see it as an essential first step toward fostering cross-border collaboration

[1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

and establishing a coherent hydrogen network. However, the feedback also highlights significant challenges and regional issues that require attention.

Key themes and takeaways

1. Collaboration and regional coordination

Stakeholders emphasised the importance of cross-border partnerships and integration between regional and interregional planning. Regions like Alsace, Turin, and Lombardy stressed the need for synergy among institutions, industries, and transport operators to address regulatory and logistical challenges. However, areas such as Styria and Slovenia noted that the current plan lacks sufficient coordination and risks treating regions in isolation. Stakeholders from Turin and Vienna specifically highlighted the plan's ability to integrate with regional and national policies, which could help accelerate hydrogen adoption and offer both financial and environmental benefits.

2. Accessibility and practicality

Concerns were raised about the masterplan's complexity and length, particularly by stakeholders in Styria and Slovenia, who called for a concise, action-oriented document to better guide local implementation. Regular updates were also deemed necessary by Freiburg and Vienna to keep pace with the rapidly evolving hydrogen market. Stakeholders in Vienna praised the plan's adaptability and presentation, viewing it as a smart tool to guide hydrogen adoption across the region, while also stressing the need for updates to reflect the changing market conditions and evolving demand.

3. Alignment with demand

Many stakeholders felt the plan underemphasized industrial hydrogen demand. Regions like Styria and Upper Rhine Valley argued that industrial uses are the primary drivers of hydrogen development, and failing to integrate these needs could misalign infrastructure with actual demand trends. While the focus on mobility and transit corridors is appreciated, stakeholders advocated for a comprehensive approach that includes both industrial and mobility applications. This focus on industrial demand was seen as a critical area for improvement, with stakeholders emphasising the need for a balanced approach to meet both mobility and industrial needs.

4. Economic viability and financial barriers

Financial concerns were a recurring theme, with stakeholders from Vienna, Slovenia, and Turin highlighting high infrastructure costs and insufficient incentives. Most regions rated the plan's economic feasibility as moderate, emphasizing the need for public-private partnerships, streamlined permitting processes, and targeted subsidies. Pilot projects were seen as a promising way to build market ecosystems and validate hydrogen's viability. The need for incentives to stimulate demand, particularly for green hydrogen and vehicles, was stressed by stakeholders from Lombardy and Slovenia. Addressing financial barriers and building a financially viable hydrogen ecosystem remains an essential component of the plan's success.

5. Environmental and regulatory considerations

Environmental impact reviews highlighted the importance of minimizing the carbon footprint and preserving biodiversity. Stakeholders also underscored the need for the plan to align with EU regulations, including the TEN-T network and the Alternative Fuels Infrastructure Regulation (AFIR). However, some regions, such as Upper Rhine Valley and parts of France, noted gaps in addressing Switzerland's transit role and other key regulatory elements. Environmental concerns were raised alongside the need for the plan to ensure compliance with regulations to achieve its sustainability goals.

Strengths, Weaknesses, and Opportunities

The regional analyses revealed both strengths and areas for improvement within the H2MA Masterplan.

On the positive side, the plan's cross-national perspective and alignment with key EU policies, such as the TEN-T network, are viewed as valuable assets. Stakeholders in Turin and Vienna expressed strong optimism, praising the plan's potential to integrate with regional and national policies. They highlighted its capacity to accelerate the adoption of hydrogen-powered logistics, with benefits including compliance with ETS II regulations and improved ESG ratings. Vienna also appreciated the plan's analytical approach, seeing it as a flexible and adaptive tool for promoting hydrogen adoption across the region.

However, several weaknesses were identified. Key concerns include inconsistent regional data, a lack of detailed economic analysis, and insufficient focus on industrial hydrogen demand. Stakeholders in regions like Styria emphasised the need for reliable data and pilot projects to support effective planning. In Freiburg, stakeholders pointed out the lack of actionable recommendations and the need for regular updates to keep pace with rapidly changing market conditions.

Additional challenges included high production costs for green hydrogen and vehicles, as well as slow permitting processes and regulatory uncertainty, which hinder progress. Regions like Lombardy and Slovenia stressed the importance of incentives to stimulate demand and support timely infrastructure deployment. Without clearer frameworks and stronger transnational cooperation, stakeholders warned that progress could become fragmented.

Despite these challenges, the potential of hydrogen remains clear. Stakeholders in Slovenia and Lombardy noted hydrogen's transformative role in reducing emissions and enabling zero-emission logistics, especially for heavy-duty transport in challenging terrains. The long-term vision of a comprehensive hydrogen network offers the promise of economies of scale, enhanced sustainability, and improved regional connectivity.

Looking ahead, the plan offers opportunities to refine strategies, integrate industrial and mobility sectors, and build a more cohesive hydrogen ecosystem. However, risks remain, such as regional disparities, regulatory delays, and the potential overestimation of hydrogen demand, which could lead to misguided investments.

Ultimately, the H2MA Masterplan is viewed as a critical first step in developing a green hydrogen future. Its success depends on addressing regional differences, improving data accuracy, and creating incentives to drive demand. By remaining flexible and closely aligned with local needs, the plan can serve as a catalyst for a more sustainable, connected hydrogen network across the Alpine region.

5.2 Feedback from national and EU bodies

The feedback received from national and regional authorities regarding the H2MA Masterplan reflects a diverse range of engagement, challenges, and opportunities. Some partners reported constructive discussions and alignment with regional strategies, while others faced challenges in obtaining responses, which were often attributed to time constraints, limited established contacts, or insufficient involvement of public authorities. These varied responses reveal important insights into the complexities of advancing hydrogen strategies across different regions.

Effective engagement strategies

France (Strasburg)

In Alsace and Franche-Comté, the approach taken by PVF and EMS, which engaged a wide range of stakeholders, including local authorities, energy agencies, and infrastructure operators, proved particularly effective. The feedback received emphasised the need for expanding initial hydrogen infrastructure and underscored the critical importance of planning for the integration of future hydrogen pipeline networks. This expansion would not only address local needs but also facilitate smoother cross-border collaboration, which was identified as a key factor for the success of transnational hydrogen mobility.

Italy (Piemonte)

In Piemonte, the Turin Metropolitan City worked closely with the Piedmont Region, gathering valuable input that confirmed the Masterplan's alignment with the region's existing hydrogen and environmental strategies. Local authorities recognized the potential of hydrogen to decarbonize logistics, particularly along highways, in line with regional decarbonization targets. However, feedback also highlighted the ongoing challenge of hydrogen's high production costs, which remain a significant barrier to large-scale implementation and could impact the broader scalability of hydrogen infrastructure across the region. This feedback prompted discussions on potential cost-reduction strategies and market incentives to stimulate production and use.

Slovenia

In Eastern and Western Slovenia, KSSENA and BSC Kranj engaged with the Ministry for Environment, Climate, and Energy, receiving feedback that affirmed the Masterplan's alignment with both European guidelines and Slovenia's regional hydrogen initiatives. The stakeholders stressed the importance of developing a comprehensive pipeline network and investing in seasonal storage capacities to support large-scale hydrogen production and distribution. However, they also raised concerns about the slow pace of national decision-making, which could delay progress despite the local enthusiasm and commitment to hydrogen development.

Challenges in public authority collaboration

Austria

In Austria, despite efforts to share the Masterplan with public authority, no feedback was received until the finalization of the deliverable. Reasons could be that the Masterplan is a very comprtehensive document, which was also pointed out by other stakeholders, and that the submission of the document coincided with the period in which government negotiations were being conducted in Austria on national as well as on regional level (Styria). The composition of the future government remained uncertain at that time.

Italy (Lombardy)

The regional administration of Lombardy is a partner of H2MA, so in this case the dialogue with the regional authority was not a point. The DG Environment and Climate, in particular, is responsible for the regional hydrogen strategy. However, a direct dialogue channel with the national authorities was not found.

Key insights

Regions such as Alsace and Piemonte, where direct communication and presentations were prioritised, experienced more substantial feedback. In Alsace and Franche-Comté, stakeholders emphasised the need for planning future pipeline integration and expanding initial infrastructure to meet growing demand. Similarly, in Piemonte, the Masterplan's alignment with regional decarbonisation goals and the potential to address highway logistics were highlighted, although challenges such as hydrogen's high production costs were also acknowledged.

In Slovenia, stakeholders identified the importance of pipeline networks and seasonal storage capacities but expressed concerns about slow national decision-making. Across all regions, feedback consistently underscored the critical role of targeted infrastructure development and strategic alignment with regional and national priorities.

6. LESSONS LEARNT AND RECOMMENDATIONS

6.1 Critical reflections from the H2MA tool development

The H2MA planning tool received mixed feedback from stakeholders, highlighting both its potential and its limitations. While it offers a useful overview of existing and planned hydrogen infrastructure, including production sites and HRS locations, several areas for improvement have been identified.

The H2MA planning tool experience revealed several key lessons for improvement, especially around usability, data integration, and functionality.

- The tool could be improved by **adding real-world data**, such as up-to-date information on logistics and industrial hydrogen demand. This would make the planning scenarios more realistic and useful for better route and infrastructure planning.
- Another consideration is improving the tool's **user-friendliness**. If redesigned, it should offer more flexibility, allowing users to easily save, revisit, and modify scenarios to support long-term planning. A more intuitive and adaptable interface would make the tool more effective in meeting the evolving needs of hydrogen infrastructure planning.
- Additionally, while the tool is effective in many areas, its ability **to prioritise routes based on specific user needs**—such as industrial demand or renewable energy availability—could be further improved. Enhancing this functionality would increase its versatility and make it even more useful for addressing a wider range of requirements.
- **Geographic and legislative gaps** were also noted. The tool didn't fully account for regulations like the EU's AFIR or cover all relevant regions, such as areas near the Swiss border. Expanding its scope and incorporating key legislation would improve cross-border coordination.
- Finally, stakeholders found the tool's **interface challenging and time-consuming to use**. Moving to a web-based platform with a simpler interface would make it more user-friendly and accessible to a broader audience.

If the process were to be repeated, a more collaborative and iterative approach involving stakeholders from the outset would be beneficial. Engaging users earlier in the design process to gather their needs and expectations could prevent some of the technical and usability issues that arose. Furthermore, focusing on developing a tool that integrates real data, includes robust scenario planning, and can easily adapt to evolving hydrogen infrastructure needs would lead to more impactful results. The H2MA tool has strong potential, particularly for mapping and identifying hydrogen infrastructure, however it needs substantial improvements in data integration, flexibility, and user experience to be fully effective.

6.2 Lessons learned from pilot actions

The development of the transalpine green Hydrogen Masterplan has provided valuable insights into the challenges and opportunities that arise when planning and deploying hydrogen infrastructure in the Alpine region. These lessons not only highlight the importance of careful and context-specific planning but also emphasise the need for strategic collaboration across borders to ensure the success of hydrogen initiatives.

Adapting hydrogen production approaches to local needs

Initially, stakeholders considered both centralised and decentralised hydrogen production approaches, envisioning that either approach could work effectively depending on the context. The practical challenges of using these models became clear as the project progressed. Centralised production, while efficient in areas with abundant renewable energy and strong transportation links, proved less feasible in remote regions. Decentralised models, on the other hand, offered flexibility in meeting the needs of scattered industrial users but required significant local investment and coordination.

Through peer reviews and scenario simulations, the partnership recognised that a one-size-fits-all approach to hydrogen production was impractical. It was concluded that hydrogen production methods must be carefully adapted to local industrial needs, energy resources, and infrastructure. This understanding is now central to future route planning in the region.

Addressing challenges in transportation and refuelling infrastructure

The pilot development revealed the challenges of designing an effective hydrogen transportation and refuelling network. Initially, infrastructure plans were broad and lacked specificity, leading to inefficiencies and potential service gaps along critical routes. This issue became especially pronounced in transnational corridors, where coordination between regions was insufficient.

By closely examining operational scenarios, stakeholders gained first-hand experience of the practical challenges and the fact that hydrogen infrastructure must be designed with precision, reflecting the unique logistical, industrial, and geographical characteristics of each region. Scalable and strategically located refuelling stations, aligned with transportation demand and hydrogen flow, emerged as critical components of an efficient network. This insight will guide more robust planning in the future, ensuring seamless connectivity and reliability.

Aligning cross-border infrastructure

During the project, aligning hydrogen infrastructure across national borders proved to be one of the most complex challenges. Differences in regulations, standards, and administration often caused delays. While collaboration was recognised as essential, the full extent of these barriers only became apparent during the pilot's implementation.

Through regular engagement in Local Working Groups (LWGs) and structured dialogue, the partners identified practical solutions and mechanisms for cooperation. This process highlighted the importance of trust, transparency, and shared strategic goals for successful integration.

Planning for future growth

Another key takeaway from the pilot was the need to future-proof the hydrogen network. Initially, there had been a tendency to focus on current hydrogen demand, but the pilot demonstrated that future demand, especially from sectors like steel production, chemicals, and heavy-duty vehicles (HDVs), would grow substantially. Partners realized that the infrastructure needed to be flexible and scalable, able to accommodate increasing demand in the future. As a result, the focus shifted to designing infrastructure that could expand and evolve in line with technological advancements and market growth. Ensuring that hydrogen networks are adaptable and resilient will be key to meeting future needs without requiring complete overhauls of the system as demand increases.

Boosting policy support and public awareness

The importance of policy support and public awareness was another critical lesson. While the pilot partners had initially included policy and public engagement in their plans, feedback from stakeholders revealed that efforts in these areas were not as robust as needed. Increased political support and better public understanding of hydrogen technology were identified as essential for accelerating hydrogen adoption. Without sufficient policy backing and public recognition of the benefits of hydrogen, the deployment of hydrogen infrastructure could be significantly delayed. To address this, the pilot experience highlighted the need for more targeted efforts to engage politicians, educate the public, and create greater awareness of hydrogen's role in the green transition.

Developing tailored engagement strategies

Experiences from the pilot actions underscore the importance of developing tailored engagement strategies to facilitate effective collaboration. Regions such as Alsace and Piemonte, where direct communication and presentations were prioritised, demonstrated the value of proactive relationship-building. In contrast, regions that relied primarily on generalised communication experienced limited responses and engagement. To foster more meaningful feedback and collaboration, future strategies should:

- Prioritise direct outreach to stakeholders.

- Establish dedicated communication channels with key national and regional bodies.
- Allocate sufficient time for detailed reviews and active engagement with stakeholders.

These approaches will ensure that regional and national perspectives are adequately incorporated into planning, leading to stronger partnerships and more robust outcomes for hydrogen infrastructure development.

6.3 Recommendations for designing and implementing hydrogen routes

Building on the lessons learned from the pilot development, the following recommendations are aimed at guiding public authorities and stakeholders in the successful planning and implementation of hydrogen routes in the Alpine region. These recommendations are designed to address the technical, logistical, and policy challenges identified during the pilot phase, ensuring the creation of a robust and adaptable hydrogen infrastructure.

Integrating real-time, region-specific data for informed policymaking

Public authorities should prioritise the collection and integration of real-time, region-specific data to inform hydrogen infrastructure planning. Comprehensive data on industrial hydrogen consumption, renewable energy availability, transportation demand, and logistics routes is essential for developing accurate and effective planning tools. Public authorities can facilitate data-sharing agreements among different regions and sectors, enabling a more coordinated and informed approach to hydrogen infrastructure deployment. By using this data, policymakers can allocate resources effectively, avoid unnecessary investments, and ensure that the infrastructure aligns with actual market needs. Additionally, real-time data integration will allow for dynamic adjustments in planning, ensuring that infrastructure remains responsive to changes in demand and technological advancements.

Strengthening cross-border coordination through policy alignment

To address the challenges of cross-border hydrogen infrastructure deployment, public authorities should take a proactive role in fostering transboundary collaboration. In this context, harmonising standards for hydrogen refuelling stations (HRS) and aligning permitting processes are critical steps.

Establishing a central coordinating body, supported by national governments would be useful for managing the planning, deployment, and operation of cross-border hydrogen infrastructure. This body could streamline decision-making, oversee the harmonisation of technical standards and operational procedures, and ensure consistent and efficient deployment of hydrogen infrastructure across borders. Additionally, it could address regulatory and logistical challenges, minimise resource duplication, and ensure compliance with diverse national regulations. Such coordination is essential for achieving seamless, cross-border hydrogen mobility and enabling the full integration of hydrogen networks across regions.

Scaling hydrogen networks to meet future needs

To accommodate future growth in hydrogen demand, public authorities should prioritise the development of scalable and flexible hydrogen infrastructure. This includes modular hydrogen refuelling stations (HRS), adaptable production facilities, and integrated storage solutions that can evolve with increasing demand from heavy-duty vehicles (HDVs) and industrial users. Policies should encourage long-term planning that accounts for market dynamics, technological advancements, and changing industrial needs.

Equally important, authorities must ensure the economic viability of this infrastructure, balancing the need for scalability with cost-effectiveness. Strategic investment and careful planning are crucial to prevent overbuilding in areas with slower demand growth while still enabling rapid expansion where required. Policymakers should also focus on fostering innovation in hydrogen production, storage, and distribution technologies to ensure that infrastructure is resilient, economically sustainable, and capable of adapting to future needs.

Using advanced planning tools

To integrate hydrogen planning into policymaking, public authorities should adopt advanced tools that are easy to use, cloud-based, and capable of running simulations, using real-time data, and assessing policy impacts. These tools can help align infrastructure development with sustainability goals by providing clear insights into different strategies. By using such tools, governments can make smarter decisions, quickly adapt to challenges, and plan more effectively for hydrogen infrastructure.

Aligning deployment with national and EU regulations

Public authorities must collaborate with regulatory bodies early in the planning process to ensure that hydrogen infrastructure is compliant with national and EU regulations, such as the Alternative Fuels Infrastructure Regulation (AFIR). Streamlining the approval process for hydrogen refuelling stations (HRS) and production facilities will help reduce delays and accelerate deployment. Clear regulatory pathways will also help build investor confidence, attracting both public and private sector funding for hydrogen infrastructure projects. Additionally, ensuring that national and EU strategies are aligned will help streamline the integration of hydrogen infrastructure into Europe’s broader energy transition plans.

Expanding infrastructure to less-connected areas

To ensure the success of hydrogen networks across the Alpine region, public authorities must extend infrastructure to less-connected rural and remote areas. These regions are often overlooked in initial infrastructure plans, yet they are critical to achieving a fully integrated hydrogen network. Policymakers should prioritise strategic investments in refuelling stations and production facilities in these areas, ensuring that hydrogen infrastructure is accessible across key logistics corridors. However, the economic viability of such investments must be carefully assessed, as lower demand in rural areas could challenge cost-effectiveness. Addressing this concern through targeted subsidies, shared infrastructure, or phased implementation could help balance network connectivity with economic feasibility, promoting hydrogen adoption beyond urban centres and ensuring that no region is left behind in the energy transition.

Balancing environmental and community impacts

Public authorities must also prioritise environmental sustainability and community acceptance when planning hydrogen infrastructure. Comprehensive environmental assessments should be conducted to assess the potential impacts of hydrogen infrastructure on ecosystems, particularly in sensitive areas like the Alps. Additionally, local community engagement is crucial for addressing concerns and building public support. Transparent communication about the environmental benefits of hydrogen adoption and the long-term sustainability of infrastructure projects will help foster positive public perceptions and reduce resistance. Public authorities should implement policies that strike a balance between environmental protection and the need for infrastructure development, ensuring that the hydrogen transition benefits both the environment and local communities.

Building strategic partnerships for effective implementation

Finally, public authorities should foster strategic partnerships with key stakeholders, including logistics operators, industrial players, renewable energy providers, and local authorities. These partnerships can facilitate data sharing, resource pooling, and joint investments in hydrogen infrastructure. By forming public-private consortia, governments can leverage the expertise and funding of both sectors, creating a strong foundation for scaling hydrogen networks. Collaboration among stakeholders will also ensure that infrastructure development aligns with market demands, fostering an environment in which hydrogen solutions can thrive.

ANNEX I HYDROGEN DEMAND AND REFUELLING STATION INFRASTRUCTURE

Region	Year	Regional H2 Demand	Number of Planned HRSs	Key features and challenges
SI03	2030	1 kt/y	21	Covers key highways; high number of HRS in low-demand areas; insufficient production capacity.
SI04	2030-2050	2 kt/y	10	Strategically placed along major corridors; challenges with meeting EU storage capacity requirements.
ITC4	2030	21 kt/y	16	Connects major highways and economic centres; challenges with industrial sector needs and overlaps in infrastructure.
FRC2/FRF1	2030	12 kt/y	7	Emphasises truck delivery; well-distributed along major corridors; challenges with cross-border connections.
ITC1	2030	2 kt/y	4	Focuses on strategic routes, challenges with coverage in western regions and reliance on tube trailers.
DE13	2030	18 kt/y	26	Covers key regions; challenges with high-altitude areas and cross-border infrastructure.
AT22	2040	17 kt/y	16	Utilises Trans Austria Gas Pipeline (TAG); challenges with onsite production in rural areas and cross-border connections.
AT13	2030	7 kt/y	4	Focuses on key transit routes and logistical hubs; significant gap near Vienna Airport.
DE11	2030	27 kt/y	30	Focuses on pipeline delivery; challenges with high-demand industries and cross-border connections.

ANNEX II TEMPLATE FOR THE LWG REPORTS OF ACTIVITY 2.4

Interreg Co-funded by the European Union

Alpine Space

H2MA

Final Local Working Group Evaluation of H2MA Masterplan Template

Activity 2.4

October, 2024

Introduction

This template serves as a comprehensive tool for summarising the feedback gathered from LWG members as part of Activity 2.4 in WP2.

Please follow the instructions below to ensure a full and detailed report.

The document was filled by:

Partner: PPXX - NAME

Region:

Author(s):

- NAME
- NAME
- …

Methodology:

Please shortly describe the methodology used to gather the feedback for your region.

Feedback from nation / regional authorities

To which national / regional authorities have you submitted the H2MA Masterplan for feedback?

Did you receive feedback from regional / national bodies responsible for the development of H2 strategies?

YES

NO

If yes, please provide a summary:

If no, please provide a brief explanation why you have not yet received any feedback:

Feedback from LWG on the H2MA Masterplan

In your stakeholders 'view, how effective is the plan in facilitating the transalpine green H2 roll-out?

What were the comments made on reviewing the region specific outputs integrated into the H2MA masterplan? How do the stakeholders rate the impact of the results of the H2MA masterplan to support infrastructure development in their region?

How feasible do your stakeholders believe the proposed hydrogen routes and infrastructures are for implementation in your area?

( ) Very feasible

( ) Feasible

( ) Somewhat feasible

( ) Not feasible

SWOT

Strengths	Weaknesses
Opportunities	**Threats**

Policy planning

Relevance:

- **How relevant is the H2MA masterplan and the regional suggestions for your stakeholders?**

Potential impact:

- **What do you perceive as the potential impact of these planning suggestions of the H2MA masterplan on heavy-duty transport in the Alpine Space / in your territory?**

- **Positive Impacts:**

- **Challenges/Concerns:**

Conclusion

Summarise the key lessons learned during the final LWG meeting.

Questions raised from participants:

-
-
-

Other comments: