Interreg CENTRAL EUROPE

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HyEfRe

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Activity 2.5

Deliverable 2.5.1 Report on factors influencing social acceptance and measures for acceptance increase

IMPRINT

PROJECT DETAILS

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SHORT DESCRIPTION

Sector-coupling is a promising approach to replace fossil fuels with renewables. However, this idea of "electrifying" the entire economy requires the rollout of new technologies and rules. The HyEfRe project helps with this by establishing green hydrogen ecosystems in eight regions. Partners will foster an investment-friendly environment for renewable energy and green hydrogen technologies. They evaluate hydrogen potentials with a new model and develop and test a new tool to calculate ideal parameters for technical plants. Their action plan for policy actors will reduce regulatory barriers impeding a timely expansion of renewables and green hydrogen.

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1. INTRODUCTION

1.1. HYDROGEN AS A KEY FOR EU'S ENERGY TRANSITION

Hydrogen is increasingly recognized as a pivotal technology in the European Union's strategy for achieving its ambitious energy transition goals. As part of the EU's broader efforts to decarbonize its economy and reduce greenhouse gas emissions, hydrogen plays a central role in enabling a low-carbon future, particularly in sectors that are hard to electrify, such as heavy industry, transport, and heating. The European Commission's Green Deal and its climate neutrality target for 2050 are driving hydrogen to the forefront as a critical enabler for decarbonization.

The EU's hydrogen strategy, outlined in the *Hydrogen Strategy for a Climate-Neutral Europe* (2020), emphasizes hydrogen's potential to help achieve a 55% reduction in emissions by 2030 compared to 1990 levels. Hydrogen can be a clean alternative to natural gas, coal, and oil, particularly in industrial processes like steelmaking, chemicals, and refining, where electrification is often impractical. Furthermore, hydrogen can also provide a solution to the intermittency of renewable energy sources, such as solar and wind, by acting as a storage medium. By converting excess renewable energy into hydrogen through electrolysis, this energy can be stored and later used when renewable generation is low, addressing a significant challenge in the renewable energy transition.

One of the main obstacles for hydrogen's widespread adoption in the EU lies in scaling up production. Currently, most hydrogen is produced from natural gas in a process known as steam methane reforming (SMR), which generates significant CO2 emissions. To meet the EU's climate objectives, the focus is shifting to *green hydrogen*, which is produced through the electrolysis of water using renewable electricity. However, the production costs for green hydrogen remain high due to the expensive renewable electricity and electrolysers. As such, the EU is investing heavily in both technological innovations and the development of large-scale hydrogen infrastructure to bring down costs and facilitate market uptake.

The EU's hydrogen strategy envisions the creation of a European hydrogen market, which would link production and consumption across member states and provide cross-border infrastructure. This market would facilitate the use of hydrogen for various applications, from industrial use to transport and heating. Several EU members states, such as Germany, the Netherlands, and Spain, are already investing heavily in hydrogen infrastructure, including hydrogen refuelling stations and pipelines, to ensure that hydrogen can be integrated into existing energy systems. However, big differences can be seen in the Central Europe region. While countries like Germany, Austria or Poland are leading the way in Central Europe, other countries such as Czechia, Slovakia or Slovenia are lacking behind. The EU is also focusing on building cross-border hydrogen corridors, particularly connecting renewable energy-rich regions with industrial hubs that are major consumers of hydrogen.

Furthermore, hydrogen's role is pivotal in the EU's broader decarbonization strategies, including the EU Emissions Trading System (ETS). Hydrogen can help decarbonize sectors that are currently outside the scope of full electrification, including aviation, shipping, and heavy-duty transport, by offering a cleaner fuel alternative. The transportation sector, in particular, stands to benefit from hydrogen, especially for heavy-duty vehicles such as trucks, buses, and trains, which are challenging to electrify with current battery technologies.

Additionally, hydrogen could contribute to energy security in the EU, reducing dependency on fossil fuel imports, particularly natural gas. By developing a domestic hydrogen market and supply chain, the EU could ensure a more resilient energy system, reduce exposure to energy price fluctuations, and enhance energy independence.

Despite the promising outlook, several challenges remain for hydrogen’s widespread adoption in the EU. These include the high capital costs for production and infrastructure, regulatory hurdles, and the need for greater coordination between EU member states. Moreover, the environmental impact of hydrogen production depends on the method used, with green hydrogen being the most sustainable option but still facing challenges related to cost and scalability.

1.2. SOCIAL ACCEPTANCE OF HYDROGEN TECHNOLOGIES IN CENTRAL EUROPE

Hydrogen technology holds significant potential for decarbonizing energy systems across the whole European continent. However, in Central Europe, a region heavily reliant on fossil fuels (particularly coal and natural gas) the widespread adoption of hydrogen faces various challenges, with social acceptance emerging as a critical factor in determining its success. Public perception, local concerns, and socioeconomic factors all influence the trajectory of hydrogen's integration into the energy mix.

One of the primary factors affecting social acceptance of hydrogen is the understanding of its environmental and economic benefits. While green hydrogen, produced through the electrolysis of water using renewable electricity, offers a pathway to decarbonize industries and transport, the initial costs remain high. In countries like Poland, Czechia, which has a strong coal-based energy sector, there may be resistance due to perceived economic risks and potential job losses in traditional industries. Transitioning from coal to hydrogen could be seen as a threat to existing jobs, particularly in coal mining and coal-fired power plants. To gain public support, clear communication is essential, emphasizing that hydrogen technologies could create new jobs, particularly in research, development, and infrastructure projects.

Moreover, the development of hydrogen infrastructure, such as production facilities, storage sites, and distribution networks, needs to be handled sensitively. In areas where local communities may have concerns about the environmental impact of new projects, gaining social license to operate is crucial. Public consultations, transparent decision-making processes, and stakeholder engagement are necessary to ensure that local concerns are addressed and that communities feel involved in the planning stages of hydrogen projects.

Economic considerations also play a significant role in shaping social acceptance. In countries with strong industrial sectors, like Germany and the Czech Republic, hydrogen can be seen as a means to maintain global competitiveness in sectors such as manufacturing, chemicals, and steel. If hydrogen is positioned as a tool for economic growth and energy security, it could receive broader support. However, for nations with less industrialization, such as Slovakia or Slovenia, there may be concerns about the affordability and fairness of the transition, particularly if costs are passed on to consumers through higher energy prices.

Furthermore, public trust in the government’s ability to manage the energy transition effectively is also crucial. Governments in Central Europe will need to ensure that hydrogen policies are not only scientifically sound but also equitable and socially responsible. This includes providing financial support for vulnerable communities, retraining workers in fossil fuel industries, and promoting public-private partnerships to share the risks and rewards of the hydrogen economy.

1.3. GENERAL CONCLUSIONS

The European Union exhibits a generally positive stance toward hydrogen technologies, recognizing their potential in achieving sustainability and energy transition goals. A 2024 study by the HYPOP project revealed that approximately 80% of Europeans are aware of hydrogen energy, though only 27% are familiar with its technological aspects. This indicates widespread awareness but limited in-depth understanding. The research also highlighted that support for hydrogen is often conditional, influenced by factors such as trust in institutions, environmental concerns, and perceptions of technological safety. Notably, countries like Portugal, Italy, and Poland showed higher levels of agreement regarding hydrogen's potential benefits.

In Central Europe, there is notable enthusiasm for hydrogen technologies, tempered by practical concerns. For instance, Italy is set to introduce hydrogen-powered trains in Valcamonica, marking a significant adoption of hydrogen fuel in transportation. However, challenges persist, including high production costs and the need for robust infrastructure. These factors contribute to a complex landscape where public support exists, but a comprehensive understanding and acceptance of hydrogen technologies require ongoing efforts in education and infrastructure development.

A 2023 study on green hydrogen acceptance found that 85% of Germans had heard of hydrogen, but only 26% were familiar with green hydrogen. Despite limited knowledge, there was strong support for local green hydrogen initiatives, driven by environmental concerns and trust in scientific advancements. However, the study also noted that local projects, such as hydrogen pipelines, faced resistance due to the "Not in My Backyard" (NIMBY) phenomenon, underscoring the need for effective public engagement.

Poland has shown significant interest in hydrogen technologies, particularly in the context of reducing energy dependence on coal and promoting sustainability through emission-free energy sources such as FVE or wind turbines. However, challenges such as infrastructure development and public understanding persist, necessitating targeted efforts to bridge knowledge gaps and address safety concerns. The fear of losing jobs connected to coal mining are very important to take into consideration.

Slovenia's engagement with hydrogen technologies is emerging, with initial projects and discussions underway. Public awareness is growing, but comprehensive understanding and acceptance are still developing stages, requiring educational initiatives and transparent communication to foster trust and support.

Hungary has demonstrated interest in hydrogen as part of its energy strategy, with discussions on integrating hydrogen into its energy mix. This commitment is underpinned by the adoption of the National Hydrogen Strategy in 2021, which strives to increase stakeholder engagement by its so-called support objective 'RDI and education to promote the success of hydrogen during the transition'. Public acceptance is in the early stages, with ongoing efforts needed to inform and involve the public in the transition toward hydrogen technologies.

While there is broad support for hydrogen technologies across Europe, this support is often superficial, with significant gaps in understanding. Addressing these gaps through targeted public engagement, transparent communication, and participatory processes is crucial for fostering deeper acceptance and successful integration of hydrogen solutions in the energy landscape.

2. OVERALL ACCEPTANCE OF GREEN TECHNOLOGY

2.1. GREEN TRANSITION

GERMANY

Germany's Energiewende (energy transition) policy has been a global benchmark for renewable energy expansion and carbon neutrality efforts. It aims to phase out fossil fuels, increase the share of renewables, and integrate hydrogen into the economy. The transition has broad political, industrial, and public support, but concerns about economic feasibility, energy security, and implementation pace remain significant.

POLAND

According to a public opinion poll conducted in 2023, Poles expect a significant decrease in coal-based energy production over the next decade, although they assume that some of the electricity generated will still come from coal in 2050. The collected declarations also show that energy sources should be diversified. In the public opinion, RES = (Renewable Energy Sources) should be developed first of all, as they are expected to have the largest share in the energy mix in 2050. Poles also see a place for other energy sources - gas (especially in the shorter term) and nuclear power (especially in the longer term).

SLOVENIA

At the moment, considering the high inflation and energy prices, which have fluctuated drastically since the beginning of the war in Ukraine, and also considering that the national decision makers raised the contribution for the network part of electricity, which also cut relatively heavily into the users wallets, the overall acceptance of green transition in our country is not the most favourable. In the last ten years, our country, like all other member states, has placed great focus on the efficient use of energy and the introduction of renewable energy sources. Photovoltaic development has accelerated significantly since 2020. Hydropower remains key, providing about a third of the country´s electricity. Slovenia plans to phase out coal entirely by 2033.

HUNGARY

The importance of green transition is understood and acknowledged from climate protection point of view, but not from the economic one. According to a survey conducted by the European Investment Bank in 2021, 49% of Hungarians viewed the green transition as a potential driver of economic growth, slightly below the EU average of 56%. Additionally, 52% anticipated negative effects on employment, and 61% expected a decrease in purchasing power.

2.2. PUBLIC SUPPORT AND REGIONAL DISPARITIES

Media Consumption Patterns of Different Groups:

Younger generations (18-35): social media (Instagram, Twitter, TikTok), online forums, and podcasts are the primary information sources for climate and energy topics.

Middle-aged professionals (35-55): Prefer a mix of traditional and digital media, including LinkedIn, newspapers, and public TV discussions.

Elderly population (55+): Mainly consume news through traditional television, radio and printed newspapers.

GERMANY

Germany has historically had high public support for renewable energy and climate action, but acceptance varies across income groups, professions, and geographic locations.

Support for Renewable Energy: Surveys indicate that 66.8% of Germans prefer to cover their electricity demand entirely through renewable energy sources. However, this is lower compared to Austria (78.4%) and Italy (94%), signalling a degree of scepticism in some parts of society.[1]

Regional acceptance disparities:

Urban centres like Berlin, Munich, and Hamburg show higher support due to economic benefits, job creation, and strong environmental advocacy.

Rural regions, particularly in coal-dependent areas like Saxony and North Rhine-Westphalia, are less enthusiastic, citing job losses, high energy prices, and land-use conflicts over wind and solar farms.[1]

Some communities' express opposition to large wind and solar projects due to the "Not in My Backyard" (NIMBY) effect, where they support renewable energy in principle but oppose its implementation near their homes.[2]

Recent studies emphasize that regional disparities in renewable energy acceptance are influenced by socio-economic factors, such as household income, employment in traditional industries, and perceived fairness in energy policy implementation.[3],[4]

Research also shows that trust in government policies and perceived economic benefits significantly affect public acceptance of hydrogen and renewables.[6]

[1] STORE&GO Project (2021). Public acceptance of green hydrogen in Europe. STORE&GO D7.8 Report on Socio-Economic Impact of Power-to-Gas Deployment. Retrieved from https://www.storeandgo.info

[2] Scovell, M. D. (2022). Explaining hydrogen energy technology acceptance: A critical review. International Journal of Hydrogen Energy.

[3] Miao, Z., Li, W., & Zhang, X. (2024). Title of the article. Renewable and Sustainable Energy Reviews, 185, 113505. https://doi.org/10.1016/j.rser.2024.113505

[4] Sudha, R., & Anjana, M. (2023). Title of the article. Environmental Systems Research, 12(1), 45. https://doi.org/10.1186/s13705-023-00394-4

Demographic and analysis of hydrogen acceptance

Younger Generations (18-35 years old): Generally, more inclined towards green technologies, including hydrogen, due to higher environmental awareness. University students and young professionals show strong support, often engaging with climate activism and sustainability discussions online.

Middle-aged Professionals (35-55 years old): Divided support depending on sector of employment. Individuals in tech-driven industries support hydrogen expansion, while those in traditional industries (such as coal or automotive manufacturing) exhibit concerns about job security and economic implications.

Elderly Population (55+ years old): More sceptical about rapid transitions due to reliance on established energy sources. Concerns focus on affordability, reliability, and complexity of new technologies.[2],[5]

New research suggests that trust in hydrogen technology varies based on information exposure and source credibility, influencing its social acceptance.[6] Acceptance is higher when people are exposed to clear communication about hydrogen's benefits, safety, and long-term economic advantages.[7]

POLAND

Ideas about Poland's energy future depend mostly on political orientation, with differences of opinion mainly concerning the share of coal and RES in the energy mix.

The energy crisis related to the war in Ukraine has made Poles pay even more attention to the price of energy and its cost to citizens, 63% of respondents (12 points more than in 2021) mentioned this issue as one of the most important to be taken into account in the energy transition process.

The second most important premise in the public opinion is the benefits for the environment and the climate, as indicated by 48% of the respondents (5 points more than in 2021). The priorities also include becoming independent from Russian fuel supplies (mentioned by 44% of the respondents).

Regional acceptance disparities:

Social acceptance of hydrogen technologies in Poland is reflected in the distribution of implemented investments and varies significantly across regions. This diversity is influenced by several factors, including the level of regional economic development, local energy strategies, the presence of energy-intensive industries, and the engagement of local governments and technical universities.

Hydrogen-based solutions are particularly prominent in northern Poland, where there is a strong concentration of maritime, transport, and energy industries (e.g. ports, LNG terminals, offshore wind farms). These sectors are naturally integrated into the hydrogen value chain and often participate in international initiatives such as the Baltic Sea Hydrogen Corridor.

In the southern part of the country, social acceptance of hydrogen is growing rapidly, particularly in the context of the transition of former coal-mining regions towards cleaner energy sources.

By contrast, the eastern regions of Poland show relatively low levels of acceptance, which may be attributed to reduced environmental pressure and limited availability of investment resources.

[5] Gordan, M. et al. (2021). Five dimensions of hydrogen acceptance: A social perspective on hydrogen technology. International Journal of Hydrogen Energy.

[6] Bhattacharya, S., & Ghosh, S. (2021). Title of the article. International Journal of Hydrogen Energy, 46(10), 7786-7795. https://doi.org/10.1016/j.ijhydene.2021.01.108

[7] Kovačić, L., & Ljubas, M. (2023). Title of the article. Energy, 244, 122560. https://doi.org/10.1016/j.energy.2023.122560

Demographic and analysis of hydrogen acceptance:

Younger generations (aged 18–35) tend to be more open to emerging energy technologies, including hydrogen. This group is often digitally active, better informed about climate and technological developments, and more likely to reside in urban areas.

Individuals (aged 35–60) demonstrate a moderate level of openness, which often depends on their educational background and professional experience. Those employed in sectors such as industry, transport, or energy are generally more inclined to accept hydrogen as part of the energy transition.

Older adults (60+) typically exhibit lower levels of technological and environmental awareness, which may result in reduced acceptance of hydrogen technologies. However, in some cases, this hesitancy may be mitigated by a higher level of trust in public institutions.

Moreover, residents of large cities tend to be more aware of climate-related challenges and more actively engaged in sustainability initiatives, which contributes to greater openness toward hydrogen solutions. Conversely, smaller towns and rural areas are often characterized by lower technological awareness and a higher degree of scepticism toward energy innovations—though this is not always the case.

SLOVENIA

Republic of Slovenia is a pretty rural country, with a lot of citizens living in single-family houses, and given that the country also recognized high subsidies for the introduction of renewable energy sources through EU initiatives in recent years, the use of renewable energy sources for heating and electrification of single-family houses in rural areas has significantly increased in the last 5 years.

Many users have invested in a combination of photovoltaic power plants and heat pumps, where the air-water type prevails. Unfortunately, due to the high electrical power that such technology conceals in terms of electricity consumption, these users will now have to pay higher fees, which of course seems absurd and pointless to all household investors in renewable sources, because as such they turned towards the future and invested in green energies, and now they will be taxed additionally because of this.

Regional acceptance disparities:

In the urban centres of the country, where there is also a higher density of the educated population, favourability to the green transition is high.

In the larger rural part of the country, which is now, due to the high prices of network fees, low payback periods of investments in green technologies and the rise of scepticism about the additional corruption that the favouring of such technologies at the state political level can trigger, even more against the mentioned future.

Because of disutility, higher living costs, complicated logistics and other problems that the green transition brings are increasingly reflected both in the media and in practice.

Demographic and analysis of hydrogen acceptance:

In terms of demographics and analysis of hydrogen acceptance in Slovenia, the situation is quite similar to Germany:

Younger Generations: Generally, more inclined towards green technologies, including hydrogen, due to higher environmental awareness. University students and young professionals show strong support, often engaging with climate activism and sustainability discussions online.

Middle-aged Professionals: Divided support depending on sector of employment. Individuals in tech-driven industries support hydrogen expansion, while those in traditional industries (such as coal or automotive manufacturing) exhibit concerns about job security and economic implications.

Elderly Population: More sceptical about rapid transitions due to reliance on established energy sources. Concerns focus on affordability, reliability, and complexity of new technologies.

HUNGARY

In 2024, the European Investment Bank's annual Climate Survey revealed that 95% of Hungarian respondents consider important to adapt to climate change, and 46% identify it as a priority. This recognition has influenced political discourse, the government has expressed support for climate initiatives, including a commitment to net-zero emissions by 2050. Social movements play an important role in advocating for environmental policies, and also several think tanks support the process.

Regional acceptance disparities:

Hungary exhibits significant regional economic disparities, with Budapest and Western Transdanubia being more developed compared to regions like the Northern Great Plain and Southern Transdanubia. These disparities extend to the green transition, where higher-income regions have a larger share of green jobs and more exposure to technological advancements.

Demographic and analysis of hydrogen acceptance:

While specific data on Hungary's age-based awareness and acceptance of hydrogen as an energy carrier is limited, younger individuals generally showing more support for hydrogen technologies as they understand that it contributes to the achievement of the climate protection goals. A 2019 study[8] involving 1,002 Hungarian participants found that younger generations tend to have a more accurate understanding of renewable energy sources. While no significant relationship was detected solely based on age, cluster analysis revealed that younger individuals were typically better informed about renewable energy.

Additionally, a 2021-2022 EIB Climate Survey[9] indicated that 80% of Hungarians consider climate change the most pressing challenge of the 21st century. Support for renewable energy development was notably higher among older respondents, with 78% of those over 64 in favour, compared to 70% of individuals under 30. These findings suggest that while younger Hungarians may possess greater knowledge about renewable energy, older generations exhibit strong support for its development.

[8] Source: https://doaj.org/article/116dc39870cf431da6387b085afc3c45?utm

[9] Source: https://www.eib.org/en/press/all/2021-404-a-magyarok-67-a-tamogatna-tovabbi-intezkedeseket-amelyek-magatartasbeli-valtozasokra-sarkallnanak-a-klimaveszhelyzet-kezelese-erdekeben?utm

Country	Public Support	Regional Disparities	Age-Based Attitudes	Hydrogen Acceptance - Key Factors
Germany	Generally high, but declining in comparison to some EU peers	Stronger in urban areas; resistance in coal regions (e.g. Saxony); NIMBY effect present	Youth: supportive; Middle-aged: sector-dependent; Elderly: cautious	Higher when trust and economic benefits are clearly communicated
Poland	Growing, shaped by political views and energy prices	North/south more engaged (industry, academia); weaker in the east	Youth: open; Middle-aged: varies by education/profession; Elderly: hesitant, but trust institutions	Stronger where local authorities and industries are involved
Slovenia	Declining due to rising energy costs and network fees	Urban areas: supportive; rural: increasingly sceptical	Youth: positive; Middle-aged: split by employment sector; Elderly: concerned about affordability and complexity	Acceptance tied to fairness, transparency, and infrastructure reliability
Hungary	Acknowledged, but economic concerns persist	Western regions more advanced; eastern less engaged	Youth: informed and supportive; Elderly: surprisingly high support despite lower awareness	Acceptance rises with climate awareness and perceived job security

2.3. POLITICAL AND INDUSTRIAL ACCEPTANCE

GERMANY

Political acceptance:

Mainstream parties (SPD, Greens, CDU/CSU) support the transition, while right-wing populist groups like AfD oppose rapid decarbonization due to its economic impact on traditional industries.[10]

There are ongoing policy debates on balancing energy affordability and climate commitments, especially after the Russian gas crisis increased energy costs.

Industrial Stakeholders:

Steel and chemical sectors (e.g., Thyssenkrupp, BASF) see hydrogen as a pathway to carbon neutrality, but fear losing global competitiveness if costs remain high.

Automotive giants (Volkswagen, Daimler) prioritize battery-electric vehicles over hydrogen, making their stance on hydrogen more reserved.[11]

Hydrogen Investment Trends: Industry research indicates that policy incentives, technological advancements, and infrastructure developments play a crucial role in shaping industrial investment in hydrogen.[7]

[10] Reuters (2025). German voters demand change as Europe's biggest economy stalls. Reuters Reports. Retrieved from https://www.reuters.com/world/europe/german-voters-demand-change-europes-biggest-economy-stalls-2025-02-17

[11] BA Study (2022). Factors affecting public acceptance of green energy in Germany. European Renewable Energy Policy Analysis.

POLAND

Political acceptance:

Respondents with left-wing political views are more in favour of using renewable energy sources than others and would like more electricity to come from renewables than coal by 2035.

Respondents identifying with the right and people without specific political views are relatively conservative and rely more on coal than respondents with a left or centrist orientation.

Industrial Stakeholders:

The highest level of acceptance, manifested in direct involvement in the construction of the hydrogen economy, is shown by energy companies - ORLEN, controlled by the State Treasury, and ZE PAK, as part of a private capital group. However, other energy companies, apart from the two mentioned above, are keeping a cautious distance or even withdrawing from projects for which they have received funding (Polenergia - information from April 2025).

The chemical industry, especially the fertiliser sector (Grupa Azoty, Anwil - Grupa Orlen), sees hydrogen as the key to decarbonising production. On the one hand, the high volumes of current hydrogen production based on steam reforming result in confidence in the technology, and on the other hand, there is a need for huge investments in green production technologies.

Other industries (such as the production of ceramics, steel and glass) also accept hydrogen as a path to decarbonise production but are taking a wait-and-see approach and observing the effects of the pilot projects that are being developed. An important investment in this area is the construction of nine hydrogen furnaces (started in 2023 by ArcelorMittal Poland) with the aim of decarbonising steel production.

SLOVENIA

Political acceptance:

Hydrogen or Green Hydrogen is not deliberately supported by different politicians or parties but is often only mentioned in the wide mix of renewables, which are being debated (also supported or criticized) for different purposes. Slovenia is one of the few countries without its National Hydrogen Strategy, and thus we could say that nationally and in terms of national politics, the H2 is something, not often thought of or that it gets any special attention if any at all.

Generally, and objectively speaking, we could say that the situation is similar to Poland, where the left-wing politicians are generally fonder of the idea of using only renewable energy sources. Right-wing is of course more conservative and careful since Slovenia still has an existing nuclear-powered Nuclear Power Plant Krško and a coal powered Thermal Power Plant Šoštanj, and the right-wing politicians are fonder of the idea of primarily exhausting all existing energy facilities, to cover the national demand with as much as low-cost national production as possible, to ensure that the national economy is doing well.

Of course, there are also different political groups/parties, with specific political views, even conservative views, which can be positive or negative to the overall H2 technology roll-out in the future, but are in minorities and their views are not widely accepted nor recognized.

Industrial Stakeholders:

Well, there are of course at least two types of industrial stakeholders here:

The ones who are already working with hydrogen, or are introducing hydrogen technologies, or whose operation is somehow based on H2, and others like academia. Of course, by this group, the support for H2 technologies is significant and high, not only by the obvious reason that H2 technologies ensures their profit, but also because the awareness of safety protocols and the overall knowledge about H2 technologies is higher than in other sectors.

For the ones who have not yet encountered H2, when speaking with them, the opinion is pretty much the same across all sectors: If the H2 technology is safe, provides a reliable energy carrier or source, and can also be profitable or help us make a profit, then why not use it. But of course, due to high CAPEX and OPEX costs, everybody would like to wait for the pioneers to conclude their pilot projects, to gain knowledge and expertise, before jumping into the currently still high-risk, and not-so-high-reward investments.

HUNGARY

Political acceptance:

Overall, while there is a general recognition of the potential of green energy across the political spectrum, the extent and manner of support for hydrogen energy specifically vary among Hungarian political parties, influenced by their broader ideological frameworks and policy priorities. The government supports top down, centralized, large scale investments. Left-wing parties tend to demonstrate a more pronounced advocacy for sustainable energy solutions.

Industrial Stakeholders:

The industrial sector is actively investing in hydrogen infrastructure. The chemical industry in Hungary uses hydrogen mainly for ammonia production in fertilizers, oil refining, and chemical manufacturing. This hydrogen is traditionally produced via steam methane reforming (grey hydrogen). Key facilities include the Pétfürdő plant for ammonia synthesis and MOL's Danube Refinery in Százhalombatta, where hydrogen enables cleaner fuel production through hydrocracking and desulfurization. In Kazincbarcika, BorsodChem employs hydrogen in the production of industrial chemicals and polymers. Efforts are underway to shift towards low-carbon and green hydrogen alternatives.

Recent initiatives aim to transition towards low-carbon and green hydrogen alternatives Hungary's first green hydrogen production plant was inaugurated recently, with additional facilities planned. The state-owned railway company, MÁV, aims to introduce hydrogen-powered trains and buses within three years, reflecting a broader commitment to integrating hydrogen into transportation. Furthermore, Hungarian companies, including MOL, Linde Gas Hungary, Messer Hungary, and Waberer's, have signed a Memorandum of Understanding to promote hydrogen solutions for heavy-duty transport.

country	Political acceptance	Industrial acceptance
Germany	• Mainstream parties (SPD, Greens, CDU/CSU) support hydrogen transition • AfD opposes due to impact on traditional industries • Ongoing debate on balancing energy affordability and climate commitments (post-Russian gas crisis)	• Strong support from steel and chemical sectors (e.g. Thyssenkrupp, BASF) • Concerns about competitiveness due to costs • Automotive industry (VW, Daimler) favors batteries • Investment driven by policies and infrastructure

Poland	• Left-wing supports renewables • Right-wing and neutral voters prefer coal • Political stance fragmented	• High engagement from ORLEN and ZE PAK energy companies • Chemical sector (Grupa Azoty, Anwil) supportive • Other industries (steel, glass) cautious, watching pilot projects.
Slovenia	• H2 is rarely prioritized politically (No national H2 strategy) • Fight favours nuclear and coal, left supports renewables • Mixed views across spectrum	• Split landscape: existing H2 stakeholders and academia show strong support • Broader industry hesitant due to high costs and low short-term returns
Hungary	• Broad support for green energy across the spectrum • Hydrogen support depends on party (Left-wing more actively supports sustainable energy)	• Industry actively investing, especially in the chemical and oil refining sectors • Ongoing shift from grey to green hydrogen (first green hydrogen plant launched) • Leading companies signed MoU to promote hydrogen powered transport

2.4. ECONOMIC AND INFRASTRUCTURE CHALLENGES

GERMANY

Despite support for the green transition, economic uncertainties and infrastructure gaps create hesitancy. Electricity prices have risen significantly, creating concerns among businesses and households over affordability.[11] Germany still relies heavily on energy imports, raising fears that hydrogen imports could replace fossil fuel dependency instead of boosting domestic production.[5] Grid infrastructure is not keeping pace with renewable energy expansion, leading to bottlenecks in energy distribution.[2]

POLAND

According to extensive research conducted by GAZ-SYSTEM, a strategic entity responsible for the transmission and storage of natural gas, to meet the demand for hydrogen in Poland, it will be necessary to import it, as domestic renewable hydrogen production capacities are planned to be lower than the declared demand.

The construction of a hydrogen transmission system is necessary to enable the development of the hydrogen market in Poland, including filling the demand gap (deficit of domestic production compared to demand) through hydrogen imports, but is still in the concept preparation stage.

The economic challenges are related to the high production price and the limited availability of suitable volumes of renewable hydrogen. Currently, without funding from public programmes, it would not be possible to ensure the economic viability of ongoing projects in both the production and consumption of renewable hydrogen.

SLOVENIA

Slovenia, like many other EU countries, faces significant economic uncertainty in the post-COVID and post-Ukraine-war context. Inflation and global market instability have reduced both public and private investment in green technologies. National funding for pilot hydrogen projects remains limited, and private investors are hesitant due to high capital and operational costs.

The country still relies heavily on imported natural gas, primarily from Siberia. Domestic hydrogen production is in early stages, and there is currently no operational hydrogen pipeline infrastructure. Electricity grids are under pressure due to a growing number of photovoltaic installations and increasing use of heat pumps. These changes have led to distribution bottlenecks. The existing natural gas network is aging and not suitable for high-percentage hydrogen injection (limited to approx. 10%).

There are preliminary discussions about developing dedicated hydrogen corridors, but implementation remains in a conceptual phase. The absence of a national hydrogen strategy and long-term investment plan further delays progress in scaling up hydrogen infrastructure.

HUNGARY

Hungary faces several economic and infrastructure challenges in developing its hydrogen economy. Economically, high initial costs for green hydrogen production, limited domestic demand, and the need for substantial investment pose significant hurdles, especially in the absence of robust financial incentives or a well-established market. Infrastructure wise, the country must overcome technical obstacles related to hydrogen storage, transportation, and the retrofitting of existing natural gas networks.

Additionally, integrating hydrogen production with renewable energy sources remains a challenge due to fluctuating supply and the current limitations of Hungary's renewable capacity.

country	Economic Challenges	Infrastructure Challenges
Germany	• High electricity prices; • Concerns over affordability; • Risk of replacing fossil dependence with H_2 imports	• Grid infrastructure not keeping pace with renewables • Bottlenecks in electricity distribution
Poland	• High production costs • Reliance on public subsidies • Domestic renewable H_2 capacity lower than demand	• No hydrogen transmission system yet (still conceptual) • H_2 imports needed to fill production deficit
Slovenia	• Reduced investments post COVID and war high CAPEX/OPEX for pilot projects • Limited public funding	• No operational hydrogen infrastructure • Aging gas network with limited H_2 blend capacity (~10%)
Hungary	• High initial investment costs • Low domestic demand • Lack of strong financial incentives	• Technical issues with storage and transport • Retrofitting of gas infrastructure needed

3. GREEN HYDROGEN AS A FACTOR IN THE GREEN TRANSITION

GERMANY

Green hydrogen is a central pillar of Germany's decarbonization strategy, particularly for industries, long-haul transportation, and energy storage. It is well-accounted for in policy documents, industrial roadmaps, and energy transition goals, but its current usage remains limited due to economic and technical challenges.

POLAND

As part of the preparation of the Polish Hydrogen Technology Security Strategy, published in 2024, a diagnosis of the situation was carried out based on public opinion research. The CAWI survey shows that Poles associate hydrogen primarily with the chemical element (57%). At the same time, as many as 20% of respondents have no associations with hydrogen. Qualitative research (FGI) also confirms that Poles have very little knowledge about hydrogen as an energy carrier and cannot spontaneously indicate associations with hydrogen technologies.

SLOVENIA

Green hydrogen and hydrogen technologies are talked about a lot in the Republic of Slovenia, as well as in the other member states, and of course, little is planned to be done. Although Slovenia does not have a comprehensive and self-standing hydrogen strategy at the national level, and although several laws have been adopted in the past few years that in one way or another touch on the field of hydrogen technologies.

HUNGARY

The Hungarian government has recognized the potential of green hydrogen to contribute to climate neutrality and has outlined ambitious goals to integrate this clean energy source across various sectors. The National Hydrogen Strategy sets a roadmap for transitioning to a hydrogen-based economy by 2030. It prioritizes the adoption of clean hydrogen in key sectors such as industry, transportation, and energy, aiming to decarbonize industrial processes and reduce carbon emissions.

3.1. GREEN HYDROGEN IN NATIONAL ENERGY STRATEGY

GERMANY

Germany launched its National Hydrogen Strategy (NWS) in 2020, aiming to:

- Produce 5 gigawatts of green hydrogen capacity by 2030.
- Integrate hydrogen into industrial and transportation sectors.

- Secure international hydrogen supply agreements with Norway, Australia, and the Middle East.[11],[12]

POLAND

Polish Hydrogen Strategy until 2030 with an outlook until 2040 (PHS) was adopted in 2021 and is in line with the objectives of the Strategy for Responsible Development until 2020 (with an outlook until 2030) (SRD), Polish Energy Policy until 2040 (PEP 2040) and the National Energy and Climate Plan (NECP) for 2021-2030. PHS builds on the Polish government's efforts to support hydrogen technologies initiated in the National Policy Framework for the Development of Alternative Fuels Infrastructure.

The indicators for achieving the PSW targets by 2030 will include:

- Installed capacity of low-carbon hydrogen production plants: 50 MW by 2025 and 2GW by 2030;
- Number of hydrogen buses in use: 100-250 by 2025 and 800-1000 by 2030;
- Number of hydrogen stations: min. 32 by 2025;

SLOVENIA

Although Slovenia does not have a comprehensive and self-standing hydrogen strategy at the national level. Slovenia outlined quite a few guidelines and KPIs for the field of hydrogen technologies in the revised Comprehensive National Energy and Climate Plan, which is supposed to be a substitute for the National hydrogen strategy from the point of view of hydrogen roll-out. In addition to the general support of hydrogen in all sectors (industry, mobility, energy storage, household use, etc.)

Slovenia is planning two larger production units on its territory, the locations of which are still unknown.

In addition, there are no real plans as to where, when, and with what capacity hydrogen production will actually take place. But we can finally say that hydrogen is supposedly being counted as one of the important factors of the energy transition, but this is not exactly reflected in the field.

HUNGARY

Hungary's National Hydrogen Strategy, adopted in 2021, positions green hydrogen as a pivotal element in the nation's energy transition towards a low-carbon economy. The National Hydrogen Strategy is a very ambitious plan towards the green hydrogen economy. However, execution of the strategy's objectives will be challenging. The strategy made significant steps towards implementing pilot projects. The targets regarding fuel cell buses, trucks may not be achieved by 2030. The strategy will be revised soon with new target numbers. Reality kicks in when it comes to implementing green hydrogen projects.

[12] German Federal Ministry for Economic Affairs and Climate Action (BMWK) (2023). Germany's National Hydrogen Strategy. BMWK Publications. Retrieved from https://www.bmwk.de/Redaktion/EN/Dossier/hydrogen.html

country	Existence of National Hydrogen Strategy	Key Targets (2030)	Implementation Status / Challenges
Germany	National Hydrogen Strategy (2020)	5 GW green hydrogen capacity; integration in industry and transport; international supply agreements	Strong policy base: real usage still limited due to cost and infrastructure gaps
Poland	Polish Hydrogen Strategy (2021); aligned with PEP 2040 and NECP	2 GW capacity; 800-1000 buses; 32+ refuelling stations	Clear targets, early-stage development, depends on public support and funding
Slovenia	No standalone strategy; included in NECP	Plans for 2 production sites: general support across sectors	Strategy vague, locations and capacity unclear, weak implementation
Hungary	National Hydrogen Strategy (2021)	Fuel cell buses/trucks, pilot projects, sector integration	Ambitious, but delayed execution; strategy under revision due to implementation issues

3.2. AWARENESS AND PERCEPTION OF HYDROGEN IN SOCIETY

GERMANY

Public acceptance of hydrogen in Germany varies by age, education, and region. Younger and more educated individuals are more open to green hydrogen, while familiarity with traditional hydrogen tech is higher among older respondents. Local attachment plays a strong role acceptance is generally higher at the national level than at the local level, especially in areas directly affected by new projects.

In Bavaria, despite political and industrial support, public scepticism persists, mainly due to affordability concerns especially in rural areas. Communication strategies need to better connect policy goals with tangible local benefits.

In North Rhine-Westphalia, support hinges on whether hydrogen is presented as part of a just transition. While institutional actors are active, residents remain cautious due to fears of industrial job losses.

Lower Saxony shows the highest public support, thanks to early engagement, visible infrastructure, and strong ties to offshore wind and hydrogen innovation. Projects are perceived as regional opportunities.

In contrast, Saxony, with its coal-dependent past, remains hesitant. Concerns focus on job loss and identity. Successful acceptance here depends on trust-building, job security, and transparent inclusion of local communities.

Overall, hydrogen acceptance in Germany is shaped by a complex mix of demographic, regional, and socio-economic factors. Successful deployment depends not only on technological readiness but also on aligning projects with local priorities and ensuring a fair and inclusive transition.

POLAND

Hydrogen is the least recognised among other energy carriers and sources (such as coal, solar energy, natural gas, wind energy, biomass). Only 38% of respondents indicated hydrogen as an energy carrier they were familiar with.

In addition, after being asked another question about the use of hydrogen in the energy sector, 13% answered in the affirmative. This shows that only just over half of the respondents can associate hydrogen with the energy sector. At the same time, those who associate hydrogen with the energy sector (a total of 51% of respondents in the quantitative study) most often encountered information in the media about hydrogen-powered cars (19% indicating the answer rather often and very often) and hydrogen-powered buses (21%), and least often about the use of hydrogen for heating homes (5%).

These results suggest that hydrogen technologies related to the automotive industry and public transport have gained some level of public awareness.

Additionally, we can assume that the awareness is higher in the regions that are more engaged in activities related to the hydrogen. One of such things can be hydrogen valleys that are located in East part of Wielkopolskie, Pomorskie, Śląskie, Małopolskie, Podkarpackie and Mazowieckie Voivodship.

SLOVENIA

As expressed, many times in this analysis, the support of the H2 technologies cannot be generalized on the national level, since there are so many different sectors. Generally, the H2 technologies are being supported by highly educated individuals, working in different sectors, who are also supporting the wide adoption of RES, and understand that the energy transition to a low-carbon society is crucial.

For others, the situation is different, Hydrogen is just not yet a thing in Slovenia, due to its high prices and high CAPEX and OPEX costs. Similar to Poland, hydrogen is the least recognized among other energy carriers and sources (such as coal, solar energy, natural gas, wind energy, and biomass). Not many citizens are at all familiar with it and its energy technologies. Perception and awareness are also really hard to measure in countries like Slovenia, where currently there is zero hydrogen demand, in terms of mobility and there are only a few pilot projects dealing with green H2. Thus, this is a really small market and a sector in Slovenia, which is yet just being discussed, and the baseline legislation is yet being prepared.

HUNGARY

Despite these targeted initiatives and expert level engagement, the broader public remains largely excluded from national hydrogen projects. Hungary's Hydrogen Strategy defines two hydrogen valleys Transdanubian and North-Eastern focused on industrial hubs and large-scale energy sources. These initiatives are implemented through top down planning by state owned enterprises, with minimal involvement of local communities or civil society actors. Consequently, public awareness and perception are not actively addressed, leaving a significant gap between strategic ambitions and societal readiness.

To complement these development directions, we interviewed Hyhope Hydrogen Valley members to see the perception towards and to find out their perceptions of hydrogen economy. Hyhope Valley is a large-scale hydrogen ecosystem with 40 members. Overall, the perception is very positive and there are early expectations. The early expectation is in a way dangerous because decision makers really believe that green hydrogen is a solution for today. There have been some disappointments in the planning of the valley: it is absolutely not easy to achieve economic viability.

We are also in contact with professional associations supporting raising awareness on hydrogen, like the Hungarian Hydrogen Technology Association or the Hungarian Hydrogen and Fuel Cell Association. These organisations mainly inform experts, investors, decision makers about the hydrogen developments.

Public engagement is further bolstered by events like the Budapest Hydrogen Summit, scheduled for April 15, 2025, which brings together industry leaders and policymakers to discuss hydrogen's role in achieving a carbon-free future.

General public have very limited information on the potential of hydrogen as an energy carrier.

3.3. CHALLENGES IN SCALING GREEN HYDROGEN

GERMANY

Production costs are 2-3 times higher than fossil hydrogen, making large-scale deployment difficult. Hydrogen infrastructure (pipelines, storage, and refuelling stations) is underdeveloped, slowing adoption. Over 50% of Germany's hydrogen demand is expected to be imported, raising concerns about long-term energy independence.[11]

POLAND

City budgets are not prepared to cover the relatively high costs, which are partly due to the published conditions in public procurement procedures. Officials have problems with the correct formulation of conditions, e.g. they try to adapt the principles of price indexation from previous tenders for the purchase of diesel.

Although EU and national programs (e.g. Horizon Europe, Just Transition Fund) offer funding for the development of hydrogen technologies, the grant application process is complex and time consuming. On the other hand, commercial financing requires risk assessment and profit forecasts, which, given the current production costs, are not always attractive to investors. The lack of certainty regarding pricing policy and future subsidies increases investment risk and delays decisions to build large scale installations.

SLOVENIA

The development of green hydrogen in Slovenia is hindered primarily by regulatory inconsistency. While several laws have been adopted in recent years that relate to hydrogen technologies, their provisions often conflict or overlap, creating legal ambiguity for investors. This complexity increases capital and operational costs and discourages first movers from engaging in pilot projects. In addition, the lack of an NHS results in unclear institutional responsibilities and policy fragmentation. Without coherent regulation and targeted support schemes, scaling hydrogen applications remains economically unviable in the short term.

HUNGARY

Scaling green hydrogen production in Hungary faces several interconnected challenges. Financially, the high initial costs of renewable energy infrastructure and electrolysis technologies make green hydrogen expensive to produce, which can hinder its competitiveness compared to traditional hydrogen. Furthermore, Hungary's historical energy policy has been heavily reliant on nuclear and natural gas, creating a need for regulatory adjustments to support the widespread adoption of hydrogen. Additionally, the creation of a strong market demand for green hydrogen, particularly in sectors such as industry and transportation, is still in its early stages, requiring strategic collaborations to stimulate uptake.

country	Public awareness and perception	Challenges in scaling green hydrogen
Germany	• Varies by age, education and region • Highest support in Lower Saxony, Scepticism in Bavaria, cautious view in North Rhine-Westphalia (industrial job fears) and hesitance in Saxony (coal legacy) • Acceptance tied to trust, job security and inclusive communication	• Green H2 costs 2-3x higher than fossil H2 • Underdeveloped infrastructure (pipelines, refuelling, storage) • Over 50% of future demand expected to be met through imports → Risk to energy independence
Poland	• Only 38% of respondents recognize hydrogen as an energy carrier • Awareness driven by H2 buses and car, low for heating or storage • Slightly higher awareness in regions with hydrogen valleys	• City budgets too limited to support hydrogen adoption • EU/national grants exist but are complex and time consuming to access • Private investors discouraged by unclear pricing, subsidy outlook and risks
Slovenia	• Hydrogen is one of the least recognized energy carriers • Positive perception among highly educated pro RES individuals • General public unfamiliar due to high costs and limited exposure	• Regulatory inconsistencies and overlapping laws • NO NHS • High CAPEX/OPEX remains a major barrier
Hungary	• General public has limited awareness of hydrogen energy potential • Hydrogen initiatives are mostly top-down, led by state-owned enterprises (minimal community involvement)	• High upfront costs of infrastructure and electrolysers • Demand in key sectors is still emerging

4. GREEN HYDROGEN ACCEPTANCE IN KEY SECTORS

4.1. INDUSTRIAL SECTOR

GERMANY

The steel, chemical, and refining industries view green hydrogen as a crucial tool for decarbonization. Companies like Thyssenkrupp and BASF have committed to integrating hydrogen into production. Barriers include high costs, lack of infrastructure, and uncertainty over government subsidies.[13]

POLAND

In the context of industrial production, it should be emphasised that Poland is one of the leading producers of grey hydrogen in Europe, which is mostly related to the production of fertilisers and fuels. The well-established presence of hydrogen in the chemical industry does not, in principle, translate into knowledge and readiness to apply hydrogen technologies in other industries.

In the opinion of industry representatives (including the leading industrial groups ORLEN and Grupa Azoty), the implementation of the EU RFNBO target in connection with the RED III Directive will require large investments in additional renewable energy sources, electrolysers, and energy and hydrogen storage facilities.

The main interest of the industry is in decarbonisation through the replacement of natural gas both in the hydrogen production process itself and in selected industrial processes.

High expectations are associated with the programme for financing the development of green hydrogen production capacity from the funds of the National Recovery Plan, which was launched in December 2024.

SLOVENIA

Similar to other member states, the steel, chemical, and refinery sectors are counting on green H2, to become their saviour in terms of energy transition, but they see the “hydrogen community” in a future, far from today. As expressed, high OPEX and CAPEX costs, high risk, the lack of subsidies, and the economic uncertainty are still hampering the H2 development in Slovenia, and obviously also in other member states.

HUNGARY

In Hungary's industrial sectors there is a growing interest in green hydrogen as part of sustainability initiatives. MOL Group, Hungary's leading oil and gas company, inaugurated a 10-megawatt green hydrogen plant at its Danube Refinery in Százhalombatta in April 2024. The green hydrogen produced is primarily utilized within MOL's refining operations, replacing conventional hydrogen produced from natural gas. MOL Group has plans to implement larger electrolyser in its Százhalombatta facility.

[13] Schmidt, P. et al. (2015). Acceptance factors of hydrogen fuel applications: A systematic analysis. Energy Policy

4.2. TRANSPORTATION SECTOR

GERMANY

Germany is advancing hydrogen mobility as a key part of its decarbonisation strategy, particularly in segments where battery-electric solutions face limitations such as heavy-duty transport, public buses, port logistics, and regional rail. National programs like the National Hydrogen Strategy, NIP II, and the HyLand initiative support vehicle procurement, infrastructure expansion, and regional hydrogen ecosystems. Over 100 hydrogen refuelling stations are now operational, with a target of 300 by 2030, concentrated along major freight corridors.

Public acceptance is generally favourable, especially in sectors with visible environmental impact like public transport. However, it remains conditional on affordability, safety standards, fuel availability, and climate neutrality. Programs such as the Clean Vehicles Directive help drive municipal demand, while the Climate and Transformation Fund (KTF) supports sustainable mobility financing. Successful projects in Cologne (50+ fuel cell buses powered by green hydrogen), Werlte (Audi e-gas plant), and Hamburg (retrofits and smart city integration) show how local action and EU funding can reinforce national goals.

The German approach emphasizes sector coupling and regional implementation, with many cities integrating hydrogen into broader energy and climate strategies. The active involvement of both public and private actors (e.g. H2 Mobility, Clean Logistics SE, Shell, Daimler Truck) ensures technological momentum. Continued public engagement and reliable infrastructure will be crucial to scaling hydrogen transport while maintaining social support.

POLAND

The use of green hydrogen in transport mainly concerns the public sector. The intensive development of hydrogen's share in the transport sector is related to the launch of funding programmes offering subsidies for the purchase of hydrogen buses and the construction of refuelling infrastructure.

Currently, more than twenty cities have included hydrogen buses in their fleets or are testing them. At the same time, there is a dynamic increase in the number of hydrogen filling stations, thanks to the activities of ORLEN and the private capital group Polsat Plus.

The number of stations is going to exceed 20, which allows for an optimistic assessment of the chances for the development of hydrogen-powered fleets of passenger cars, vans and trucks.

The positive public perception of hydrogen-powered buses is related to their impact on improving air quality in cities. Unfortunately, with the introduction of hydrogen-powered buses, problems with the purchase of hydrogen fuel are arising in more and more cities.

In the private sector, transport companies are in the process of preliminary investment calculations for both fleets and hydrogen production and distribution infrastructure.

Currently, Poland's hydrogen infrastructure is not sufficiently developed to be effectively used for cargo transport. However, initial steps have been taken to expand it under the HyTruck project, meetings have been held to plan a network of hydrogen refuelling stations for heavy-duty vehicles, to be located along the most frequently used transport routes in the country.

In the field of public railway transport, the state-owned company Orlen has signed a strategic cooperation agreement with the Bydgoszcz based firm PESA. The goal of this partnership is to develop a comprehensive hydrogen powered rail transport offering. Orlen is responsible for providing the refuelling infrastructure, hydrogen supply, distribution, and storage, while PESA will handle vehicle manufacturing.

This collaboration aims to introduce zero emission solutions for public transport, as well as for operators of logistics centers, cargo terminals, and ports.

SLOVENIA

Currently, there are no registered hydrogen-powered vehicles in Slovenia, neither FCEVs nor hydrogen ICE vehicles and no hydrogen is used in transport. There are also no operational hydrogen refuelling stations or developed green hydrogen production facilities. Nevertheless, hydrogen mobility is politically supported, and deployment efforts are underway.

Although Slovenia does not yet have a formal National Hydrogen Strategy, several legal acts have been adopted to support green hydrogen mobility. However, the infrastructure remains non-existent, and demand is still at zero. The first hydrogen refuelling station was piloted in 2013 near Lesce (Gorenjska region) but was later dismantled due to a complete lack of demand. Several other pilot designs have emerged since (e.g. ETRA d.o.o., Salonit Anhovo d.d., Army Barracks Kranj, LPP d.o.o.), but none progressed to the operational phase – no production, fuelling or market sales took place.

At present, two pilot projects are considered key to initiating hydrogen mobility deployment: the LPP project and the NAHV project. The most realistic scenario is that Slovenia will introduce its first zero-emission public transport vehicles powered by green hydrogen in Ljubljana within the next year. A refuelling station with an additional storage unit is currently under construction at the premises of LPP. The plan is to purchase between six and eight hydrogen-powered FCEV buses to integrate into the existing biogas-powered public transport system. If successful, these buses will become the first registered hydrogen vehicles in the country.

HUNGARY

In January 2024, Hungary inaugurated its first public hydrogen filling station in Budapest. This development was accompanied by a strategic cooperation agreement among key transport entities, including MOL (Hungarian oil company), MÁV (state railway operator), Volánbusz (state public transport operator), and Waberer's (logistics and transport service provider). The collaboration aims to introduce hydrogen fuel cell technology across various transport modes, including buses, trains, and freight vehicles. This is the only filling station in Hungary.

There are a few pilots/demonstration actions in public transportation: In January 2023, a Caetano hydrogen fuel cell bus was showcased in Paks, Hungary, as part of the Central and Eastern European hydrogen bus roadshow. In October 2024, Budapest's public transport company, BKV, conducted a week-long trial of the Mercedes-Benz eCitaro Fuel Cell bus. However, local municipalities rather choose to procure electric bused, which are much cheaper.

There are some research projects as well. For example, a local company at Pécs (Kontakt Elektro Ltd) is assembling 2 fuel cell powered garbage trucks from combustion engine trucks.

4.3. ENERGY SECTOR

GERMANY

Hydrogen is a cornerstone of Germany’s decarbonisation strategy, especially for industry, heating, and power sectors. Public and stakeholder support is generally positive, particularly when projects are regionally anchored, transparent, and visibly renewable based. Local electrolysis projects such as those by municipal utilities benefit from high acceptance due to regional value creation and community involvement.

Key drivers include hydrogen's role in sector coupling, enabling storage and cross sector integration of renewable electricity. Following the 2022 energy crisis, hydrogen is also seen as a substitute for fossil gas, boosting support for infrastructure upgrades like the H_2 core network (H_2-Kernnetz). Acceptance rises when environmental credibility is ensured, with projects tied to clear local decarbonisation goals.

Germany's energy transition is increasingly hydrogen-driven. Major trends include H_2 ready turbines, repurposing of LNG terminals (e.g. Wilhelmshaven), and blending trials in local gas grids. Coal plant sites are being converted into hydrogen hubs to preserve infrastructure and jobs. Institutional support comes from the Bundesnetzagentur, dena, and key transmission operators. Notable examples include RWE's electrolyser in Lingen, the Bad Lauchstädt Energy Park, and Haßfurt's municipal hydrogen injection system.

POLAND

The leading state-owned energy companies (apart from ORLEN) are refraining from implementing hydrogen projects. The official justification, despite the recent entry into force of the hydrogen regulation package, is the lack of a legal framework on the part of the government.

Private companies (ZE PAK, Polenergia) are showing more investment courage, obtaining funding and implementing their first investment projects.

In the opinion of energy sector experts, taking into account the current potential of RES and their anticipated development until 2040, it seems that the electrolytic production of hydrogen in Poland using RES will not be very high. It seems that the assumption of 2 GW of electrolyser capacity in 2030 in the Polish hydrogen strategy is very (too) optimistic (Germany 5 GW, Spain 4 GW).

It´s difficult to predict the dissemination of other production technologies, especially the share of CCS. In the most optimistic scenario formulated for the EU, the share of hydrogen in final energy consumption will be 24% (2,251 TWh) in 2050. The anticipated consumption structure is as follows: 112 TWh (approx. 5%) – electricity generation, system balancing (power generation, buffering) and 579 TWh (25.7%) – heating and power for buildings (sector 3); 237 TWh (10.5%).

Experts consider this percentage share transferred to Poland to be reasonable. However, the energy consumption structure in households, which is very harmful from an ecological point of view, suggests an increase in the share of hydrogen in this sector.

SLOVENIA

Similar to Germany, H2 is seen as a key solution for energy storage, helping balance fluctuations in renewable energy generation. Slovenia is also planning a national hydrogen pipeline network, but it is still in early development, and this is not a plan for the near future.

Without any operating pilots, zero hydrogen demand in terms of mobility, and zero Hydrogen refuelling stations/production units, this discussion is really hard to have for us, but the only bright star that we think will ignite the investors in our country, is the NAHV project, which has been described multiple times in this report, but it is currently the only pilot project, which plans to put into operation the first green H2 production plant in Slovenia, with some big numbers of green H2 production.

HUNGARY

Although there are currently no active pilot projects in energy applications, Hungary has recently incorporated hydrogen blending capabilities into gas turbine sourcing projects (up to 5%).

Regarding the planned investments, on the pipeline front, Hungary plans to integrate hydrogen into its existing natural gas infrastructure. By 2030, the goal is to blend up to 2% hydrogen into the natural gas grid. This approach leverages Hungary's extensive pipeline network while minimizing the need for entirely new infrastructure in the early stages of hydrogen deployment. The national transmission system operator, FGSZ (FGSZ Földgázszállító Zrt.), is actively preparing for this transition by modifying compressor stations and pipelines. Between 2026 and 2032, Hungary is expected to play a strategic role in the European Hydrogen Backbone. Refuelling infrastructure is also expanding. In early 2024, Hungary's first hydrogen refuelling station opened in Budapest, operated by Linde Gáz Magyarország. This station supports hydrogen fuel cell pilot projects, such as city buses at the moment rather on a pilot/demonstration basis. According to the national roadmap, Hungary plans to install at least 20 hydrogen refuelling stations by 2030, each with two refuelling points. These will be located along key routes, especially the Trans-European Transport Network (TEN-T) corridors, enabling cross-border hydrogen mobility. This programme is expected to be delayed. Concerning technological innovations, Hungary is collaborating with partners like ENGIE to implement Twin Mid Flow technology, which allows fast and cost-effective hydrogen fuelling for both light and heavy-duty vehicles.

country	Industrial sector	Transport sector	Energy sector
Germany	• Strong industrial commitment (Thyssenkrupp, BAFS) • Key for decarbonization • Barriers: high costs, infrastructure gaps	• National strategy supported by NIP 2 + HyLand = structured support • >100 refuelling stations • Active use in public buses and rail	• Hydrogen is strategic for sector coupling and energy transition • Strong public support
Poland	• Major grey H_2 producer in fertilizers/fuels • Low cross-sectoral readiness. • High investment needed for renewables, electrolysers & storage.	• 20+ cities testing H_2 buses • Public acceptance positive, but fuel supply issues persist • Rail cooperation with PESA to develop H_2 trains	• Private (Polenergia, ZE PAK) active • State energy companies remain hesitant • RES potential for H_2 seen as limited
Slovenia	• General reliance on future H_2 solutions. • No practical use yet • High CAPEX/OPEX, investor hesitancy due to economic risk	• No operational vehicles or stations. • Ljubljana pilot with 6-8 buses and new station is first concrete step • Political will exist, but demand = 0	• No H_2 production/use • Only pilot: NAHV green hydrogen plant in development • Pipeline network idea exists, but early-stage
Hungary	• Expansion planned with larger electrolysers • Limited market demand • Fragmented interest across sectors	• First public H_2 station open in Budapest (2024) • Pilot projects: (fuel cell garbage truck, BUS demos)	• No active pilot projects • Joined the European Hydrogen Backbone • FGSZ is preparing to blend up to 2% hydrogen into the natural gas grid by 2030

5. EXAMPLES OF HYDROGEN PROJECTS WITH POSITIVE AND NEGATIVE DISCUSSION

5.1. POSITIVE EXAMPLES

GERMANY

1. REFHYNE Project
   - One of Europe's largest green hydrogen electrolysis plants, operated by Shell in Germany.
   - Considered a model project for scaling industrial hydrogen production.

2. HyPerformer and HyStarter Programs
   - Government-backed projects accelerating hydrogen adoption in mobility and industry.
   - Positive reception from cities and logistics companies adopting hydrogen-powered fleets.[11]

POLAND

1. Promet-Plast
   - The leader of the Oława Energy Cluster, has built Poland's first commercial green hydrogen production plant in Gaj Oławski near Wrocław.
   - It is powered by renewable energy generated by wind turbines (22 MW in total) located in the immediate vicinity, an agro-photovoltaic farm (9.1 MW) and a rooftop PV installation (1 MW).
   - The construction of the installation allowed for the emergence of a reference project on the Polish market and the first practical experience (such as carrying out the entire administrative approval process), which made it easier for other entities interested in building their own installation to make a decision. At the same time, it is an example of an investment in the production and use of green hydrogen by a company that is not a large corporation.

2. Polenergia
   - The first hydrogen co-combustion tests in Poland, in October 2024, with natural gas at the Nowa Sarzyna Cogeneration Plant (NSCP).
   - They were conducted in one of the gas turbines with a capacity of approx. 40 MW. This is a breakthrough event for NSCP, especially since the tested turbine was not originally designed as "Hydrogen Ready". The aim of Polenergia's activities was to achieve a 10% share of hydrogen in the fuel, but during the tests an impressive result was achieved – the maximum

hydrogen flow was 1,835 Nm^3/h, which corresponded to a volumetric hydrogen concentration of 15%.

- The tests carried out have significantly influenced the shape of the discussion in Poland. They have allowed the public discussion to go beyond theoretical considerations, and, importantly, they have concerned the production of not only electricity but also heat. The successful adaptation of the installation and turbine to controlled hydrogen co-combustion paves the way for other, previously hesitant entities.

SLOVENIA

1. NAHV project (North Adriatic Hydrogen Valley)

- The NAHV project will be the pioneering project for green hydrogen production in Slovenia and is highly supported by national decision-makers and interested industrial investors. As such, it will, of course, represent several good practices when it is actually completed, as the project is currently only in the implementation phase, and its results cannot yet be truly credited. The NAHV project foresees, among other things, the development of 17 testbeds which will cover the complete hydrogen value chain from production to distribution, storage and end-use, with specific applications also developed to decarbonise the three NAHV territories by harnessing renewables such as solar energy, with the aim of improving system resilience, security of supply, and energy independence in line with the REPowerEU action plan. In the next few years, the NAHV will contribute to the REpowerEU target of 10 million tonnes of domestic renewable hydrogen to replace natural gas, coal, and oil in hard-to-decarbonise industries and transport sectors. Within the NAHV, specific attention will be paid to the analysis of the economic, social, and environmental impacts, including water utilization. The project is being implemented in three North Adriatic countries (Croatia, Slovenia, and Italy), which together form a so-called “North Adriatic hydrogen backbone

  The planned Slovenian pilot focuses on producing green hydrogen using renewable energy sources (solar power), primarily through solar photovoltaic (PV) installations.

  In phase 1, it will utilize an electrolyser with a capacity of up to 3 MW (PEM technology), achieving a minimum production of 300 tons of hydrogen per year, alongside an on-site hydrogen refuelling station (HRS).

  Phase 2 will expand the electrolyser capacity to up to 20 MW, targeting a minimum annual production of 2,700 tons of hydrogen, and will include the same on-site HRS with a hydrogen storage capacity of 4 tons. The pilot site is located in the Savinjska region, at the premises of Thermal Power Plant Šoštanj. It will be implemented as a brown-field investment, since the plan is to terminate the Thermal Power Plant, still running on coal, by the 2033 at the latest

  https://www.nahv.eu/about-nahv/

HUNGARY

1. Aquamarine Project

- Led by Hungarian Gas Storage (MFGT), the Aquamarine Project investigates the feasibility of blending green hydrogen with natural gas using existing infrastructure. Launched in 2021 at the Kardoskút Underground Gas Storage facility, it integrates a 2.5 MW electrolysis unit powered by surplus renewable electricity. The hydrogen produced is compressed via a two-stage diaphragm compressor and stored in high-pressure buffer tanks. It can be either blended into the national gas transmission system subject to technical requirements or used directly in gas fired equipment to reduce emissions. With a total investment of approximately €8 million, co-funded by the Hungarian government and MFGT, the project aligns with Hungary’s National Hydrogen Strategy. Beyond demonstrating technical viability, Aquamarine also serves as a pilot for future hydrogen storage solutions and actively engages stakeholders to promote awareness and public acceptance of hydrogen technologies.

5.2. NEGATIVE EXAMPLES

GERMANY

1. Hydrogen Refueling Stations
    - High costs and low consumer demand have led to delays in expanding the network.[5]
    - Electric vehicle charging infrastructure has expanded much faster, making hydrogen vehicles less competitive.[13]

2. Thyssenkrupp Hydrogen Steel Project
    - While initially praised, cost concerns and slow regulatory support have raised doubts about its feasibility.[13]

POLAND

The voices in the public debate that negatively refer to the chances for a wider use of hydrogen in the energy transformation mainly concern the low energy efficiency of the extraction and distribution process.

- In the critics' opinion, the energy losses associated with conversion, storage and transport are ignored, which means that we will not achieve economies of scale. Energy losses in the conversion of electricity to hydrogen reach up to 30-40%, and there are also losses in compression and storage.
- Negative opinions regarding the high price of hydrogen as a barrier to its use have fuelled the problems of cities in concluding tenders for the purchase and distribution of hydrogen.

1. Polenergia H2 HUB Nowa Sarzyna
    - In October 2024 withdrew from signing a contract for the supply of hydrogen for the buses of the Municipal Transport Company in Rzeszów. In November 2024, however, local councillors from 21 Polish cities wrote to the Ministry of Climate and Environment appealing ‘for urgent action to develop and implement a financial support programme for hydrogen fuel users.

SLOVENIA

The negative examples which hamper the H2 roll-out in Slovenia, are a few, and on all levels, and above all really complicated as well. The first fact, we have to understand is that H2 technology is a really expensive endeavour, in terms of investment and economic viability, especially now at times of high market uncertainties (Inflation, Trump's high taxation of customs, Russo-Ukrainian war-related hampered energy supply and general turbulence on the energy markets). For, there is a high risk involved with investing in the infrastructure for H2 filling, producing, storing, transmitting, etc., and also the CAPEX and OPEX costs are extremely high.

There is also zero demand for green H2 in Slovenia, which is additionally troubling the infrastructure roll-out. In addition, the Ministry of Environment, Climate, and Energy of the Republic of Slovenia did not enforce a National Hydrogen Strategy as a comprehensive and self-standing document, but has rather, inserted some KPIs for the H2 deployment in the revised version of the National Energy and Climate Plan (NECP), which puts a really negative perspective on Hydrogen technologies.

1. pilot project in Lesce (Slovenia)

   - The first Slovenian hydrogen refuelling station was designed at a nearby petrol station already in 2013 (12 years ago), but was later removed due to its idleness, and of course zero demand on the market. All these failed pilot projects and the inadequate response of the state cast a shadow over the development of hydrogen technologies and pose a negative impact while instilling general distrust among citizens.

We hope that in the upcoming years, with some good practices from abroad and with additional, successful national pilot projects, this situation will change for the better.

HUNGARY

1. Hydrogen Blending in Gas Networks

Hungary's strategy to blend hydrogen into its existing natural gas transmission system has faced scrutiny. The plan includes introducing hydrogen blends ranging from 2% to 30% in new gas power plants. Critics question the efficacy of this approach, suggesting that the emissions reductions may be marginal and that the strategy lacks clear prioritization of sectors for hydrogen application. There are concerns that public funds could be misallocated to projects with limited environmental benefits.

2. Nuclear-Based Hydrogen Production

Proposals to produce hydrogen using nuclear energy have also been met with scepticism. Critics argue that nuclear-based hydrogen production is not cost-effective, has unpredictable economic returns, and would require decades for development. Given the current state of Hungary's nuclear infrastructure, with aging reactors like Paks I and uncertainties surrounding the completion of Paks II, some view nuclear hydrogen production as an unrealistic goal for the near future.

Green hydrogen generation projects with 50% grant intensity could not be executed: hydrogen price could not reach break-even point.

6. CONCLUSIONS

This report provides a comprehensive overview of the current level of social acceptance of hydrogen technologies in four Central European countries: Germany, Poland, Hungary and Slovenia. Through the analysis of political frameworks, industrial preparedness, public perception and sectoral engagement, the findings reveal a complex landscape characterised by both progress and ongoing challenges.

Hydrogen is increasingly recognised as a strategic component in achieving long term decarbonisation targets across all countries. Where they exist, national hydrogen strategies outline a vision for hydrogen as a clean, flexible energy carrier with applications across transport, industry, and energy systems. However, the extent to which these strategies are being implemented through funding, policy instruments and stakeholder mobilisation varies significantly.

Germany's hydrogen development is underpinned by a robust policy framework and an extensive network of innovation groups, research institutions, and local initiatives. Regional and municipal actors often play an active role, resulting in a relatively decentralised and inclusive ecosystem. Public discourse around hydrogen is well developed, and although civil society engagement is not yet mainstream, it is gradually emerging as a policy consideration.

There is an emerging interest in Poland, particularly from the industrial sector and local governments. While national strategies are being developed, the broader energy discourse continues to prioritise fossil-based solutions, including coal and natural gas. This duality slows the pace of hydrogen integration and undermines public communication efforts.

In contrast, Hungary has a more centralised model, dominated by large state-owned enterprises and top-down strategies. Nevertheless, the country demonstrates strong industrial interest, particularly in the chemical and refining sectors. Initiatives such as the Aquamarine project, supported by companies such as MOL, BorsodChem, and MÁV, and the growing emphasis on hydrogen in transport, indicate growing momentum. Forward planning is also evident in infrastructure upgrades for blending hydrogen into the gas grid and expanding refuelling networks. However, societal dialogue and public participation remain limited, with acceptance largely shaped by institutional actors.

Slovenia presents isolated pilot projects with limited national coordination. Although some municipalities and companies have launched initiatives, these are often disconnected from a cohesive national vision. Consequently, institutional support and public visibility of hydrogen remain modest.

A consistent finding across all countries is the low level of public awareness and engagement. In most cases, hydrogen is discussed within expert and political circles, with communication channels mainly targeting technical stakeholders. Few initiatives directly engage with citizens or local communities, and inclusive processes allowing for dialogue, co design or participatory decision making are lacking. The gap between technological ambition and societal involvement could be crucial in later stages of hydrogen deployment, especially when projects move closer to residential areas or require behavioural changes.

From a sectoral perspective, the transport and industrial sectors demonstrate the greatest acceptance and deployment of hydrogen. Hydrogen powered public buses, heavy duty vehicles and trains are being introduced in pilot projects, and industrial clusters are exploring grey and green hydrogen pathways. In contrast, integrating hydrogen into residential heating, electricity production or decentralised energy systems is still in its infancy.

Moreover, while many promising initiatives are currently underway, several systemic barriers continue to hinder broader implementation. Economic viability remains a significant challenge, as most hydrogen projects still rely heavily on public subsidies and are not yet cost competitive with fossil-based alternatives. Regulatory uncertainty further increases perceived risks. Stakeholders have highlighted unclear definitions of hydrogen types such as what qualifies as “green” versus “low-carbon” as well as a lack of clarity around blending limits and inconsistent regulations for accessing existing energy infrastructure.

In addition, the absence of stable, long term funding frameworks including reliable subsidies, green public procurement schemes, or effective carbon pricing mechanisms continues to discourage private sector investment. Stakeholders consistently stress the need for greater transparency and harmonisation in guidance related to tariffs, infrastructure development, and incentive structures. Clear and predictable policy frameworks are essential to reducing investment risk and building investor confidence.

In conclusion, the successful overcoming of these barriers will require more than technical solutions policy clarity, long term financial stability, and genuine societal engagement will also be necessary. Even the most well-designed strategies may fall short if they fail to gain the support of citizens and the confidence of investors. The unlocking of hydrogen's full potential is dependent on three fundamental factors: cross border cooperation, shared standards, and inclusive governance. If implemented with due consideration and transparency, hydrogen has the potential to serve as a catalyst for a more resilient, Just, and sustainable energy transition across Central Europe.