



Supply Chain



SYNTHESIS REPORT OF WP 1.2 SUPPLY CHAIN
10.08.2026



INTRODUCTION

The introduction of hydrogen into airport operations requires a comprehensive understanding of the entire supply chain. This report provides a summary of the results from the Supply Chain working group in the project BSR HyAirport. The work package 1.2 Supply Chain consists of three individual sub-packages which include WP 1.2.1 Demand Analysis, WP 1.2.2 Local Production and WP 1.2.3 Transport. For detailed procedures and results for each subtopic, please visit the BSR HyAirport website under “Solutions”:

<https://interreg-baltic.eu/project/bsr-hyairport/>

The three work packages form interrelated elements of a joint strategy for supplying hydrogen to airports. First, future hydrogen demand is assessed to determine the scope and timeline of hydrogen deployment. Based on this demand forecast, the feasibility of local hydrogen production will be assessed. Finally, potential transportation solutions will be analyzed to determine how airports can be supplied with hydrogen if local production is not possible or economically viable. Together, these perspectives provide a comprehensive overview of future hydrogen supply chains for airports in the Baltic Sea region.

The **WP 1.2.1 Demand Analysis** has shown that future hydrogen requirements at airports will be driven by two distinct but interrelated application areas: aviation and ground operations. The developed methodology provides a robust and transferable framework to estimate hydrogen demand under varying conditions, combining scenario-based approaches with real operational data. The results indicate that hydrogen demand for aircraft is expected to grow significantly in the long term, particularly driven by regional aviation and the gradual introduction of hydrogen-powered aircraft. The transition will be slow and uncertain due to long fleet lifetimes and technology development cycles. In contrast, airport equipment represents an immediate and scalable use case, with comparatively low technological and certification barriers and clear conversion pathways from existing fossil-based systems. The demand analysis highlights that hydrogen deployment at airports will likely follow a phased development: starting with ground operations as an early adoption segment and progressively expanding

towards aviation as technologies mature. This dual perspective enables airports to derive realistic demand scenarios ranging from short-term entry levels to long-term high-demand cases, thereby forming a critical foundation for planning hydrogen production, storage, and transport infrastructure within the broader supply chain.

Regarding **WP 1.2.2 Local Production**, the project group concluded from their findings that on site production of green hydrogen is a feasible and strategically robust option for the BSR HyAirport airports. The analyses show that commercially available electrolysis technologies allow hydrogen to be produced directly at the airport within realistic technical, spatial, and operational constraints, independent of external hydrogen logistics chains. For small and medium sized airports, current hydrogen demand levels can be covered with relatively compact electrolysis systems in the sub megawatt range, while larger hub airports may require multi megawatt installations under higher demand scenarios. Even in these cases, associated requirements for land use, water supply, and electricity consumption remain manageable and compatible with typical airport infrastructure. The availability of technical or utility zones at airports where no aircraft operation takes place enables on site integration without interference with airside operations. The project group further identified that local hydrogen production is particularly advantageous when combined with on site renewable electricity generation. While photovoltaic and wind installations alone are generally insufficient to cover full hydrogen demand, hybrid energy concepts incorporating renewable generation, storage and selective grid interaction provide a flexible and reliable solution. The ability to operate electrolyzers flexibly in response to renewable availability and electricity price fluctuations is considered essential for both technical reliability and economic performance.

Regarding **WP 1.2.3 Transport**, the project group concluded from their findings that truck transport is currently the best and most practical solution for almost all BSR HyAirport airports examined. Since the expected demand in the introductory phase is very low

at around 1 ton per week and the regional hydrogen infrastructure in the Baltic Sea region is still largely decentralized, road transport proves to be the most flexible option both economically and operationally. Most airports are located within a radius of less than 200 kilometers of existing or planned hydrogen hubs, making the delivery of gaseous hydrogen by truck with a 350-bar trailer clearly superior in terms of cost. However, if the nearest hub is significantly more than 200 kilometers away, the use of liquid hydrogen in road transport can offer economic advantages over gaseous hydrogen due to its higher energy density and larger delivery quantities per trip, if the necessary infrastructure and storage options are available and high demand is expected.

RESULTS OF WP 1.2.1

DEMAND ANALYSIS

OBJECTIVE

As part of Work Package 1.2 “Supply Chain” of the BSR HyAirport project, a comprehensive demand analysis was carried out within Working Group 1.2.1. The objective was to develop a robust and transferable methodology for estimating future gaseous hydrogen demand at airports. The analysis deliberately distinguishes between two key demand areas: hydrogen demand for aircraft and hydrogen demand for airport equipment and infrastructure. Together, these perspectives provide a holistic view of future energy needs within the airport ecosystem.

HYDROGEN DEMAND FOR AIRCRAFT

The analysis of hydrogen demand in aviation follows a scenario-based and data-driven approach. Rather than aiming for a precise forecast, the methodology is designed to outline plausible development pathways under conditions of significant uncertainty. Two main market segments are considered: scheduled flights and non-scheduled flights, particularly general and business aviation.

For scheduled aviation, the methodology is based on the identification of potential future routes by project partners. These routes are analysed in terms of distance, flight frequency, and aircraft category. Special focus is placed on smaller aircraft with 10 to 30 seats, as hydrogen-powered aircraft are expected to enter service first in this segment. Demand is calculated using a straightforward approach that combines annual flight frequency, route distance, and hydrogen consumption per nautical mile depending on aircraft type. A key insight from this analysis is the significant potential for hydrogen adoption in regional aviation, particularly through the reactivation of former routes and the creation of new connections.

The results indicate a notable increase in flight movements within the scenarios analysed. Approximately 42,000 annual departures are projected for 2030, increasing to around 61,700 departures by 2035, provided that suitable aircraft are available. The resulting hydrogen demand varies considerably between air-

ports, depending on route characteristics and operational intensity.

For non-scheduled aviation, a detailed bottom-up analysis was conducted based on a comprehensive dataset from Hamburg Airport’s General Aviation Terminal (GAT). Starting from around 18,000 recorded movements in 2024, a refined dataset of approximately 6,600 relevant outbound flights was established after filtering out flights exceeding the expected hydrogen aircraft range as well as non-relevant categories such as military operations. Based on this dataset, fuel consumption was calculated at the level of individual flights and subsequently converted into potential hydrogen demand. The analysis differentiates between several aircraft categories, including small piston aircraft, turboprops, and business jets, reflecting the heterogeneous nature of general aviation.

The analysis results indicate a theoretical maximum hydrogen demand of approximately 495,000 kg per year if all relevant flights are converted to hydrogen propulsion. However, due to the long service life of aircraft and gradual fleet replacement rates, a slow transition is expected in practice. Scenario-based projections up to 2050 estimate a realistic demand range between approximately 76,000 and 184,000 kg of hydrogen per year, depending on the pace of technology adoption. In addition, the analysis highlights strong seasonal variations, with significantly higher demand during the summer months compared to winter periods.

Full report on Hydrogen demand for aircraft:

https://interreg-baltic.eu/wp-content/uploads/2026/06/BSR_HyAirport_WG_1_2_1_Demand_Analysis_Aircraft.pdf

HYDROGEN DEMAND FOR AIRPORT EQUIPMENT

The analysis of hydrogen demand for airport equipment follows a structured, bottom-up and scenario-based methodology aimed at estimating future GH₂ requirements for all non-aircraft applications at

airports. It complements the aircraft's demand assessment by focusing on ground operations, including mobile ground support equipment (GSE), vehicles, as well as stationary and semi-stationary energy systems. This ensures a comprehensive and non-overlapping view of total airport hydrogen demand.

The methodological approach begins with the compilation of a detailed inventory of existing equipment and its current energy consumption. Airports collect data on fuel use (e.g. diesel, gasoline) or electricity consumption, which is then converted into a consistent energy basis (e.g. kWh or MJ per year). This conversion relies on standard energy content values, such as approximately 35 MJ per litre of diesel (≈ 9.8 kWh/L) or 32 MJ per litre of gasoline, while hydrogen provides around 120–142 MJ per kilogram (≈ 33 kWh/kg). Based on these values, total energy consumption can be calculated for each equipment category. For example, an annual consumption of 100,000 litres of diesel corresponds to roughly 980,000 kWh of energy, forming the baseline for subsequent hydrogen demand calculations.

For mobile equipment, hydrogen demand is estimated by converting this baseline energy demand into equivalent hydrogen consumption, while explicitly accounting for differences in technology efficiency. Hydrogen fuel cell systems are assumed to be significantly more efficient than conventional combustion engines. As an initial approximation, 1 kg of hydrogen in a fuel cell vehicle can replace around 3–4 litres of diesel. To reflect technological uncertainty, the methodology applies efficiency ranges across different propulsion systems.

The methodology supports both partial and full conversion scenarios, enabling airports to derive realistic transition pathways as well as theoretical maximum demand levels. This approach reflects uncertainties in technology adoption and fleet replacement while providing scalable results depending on fleet size, utilisation rates, and selected equipment categories. In addition to mobile applications, the analysis also includes stationary and semi-stationary energy uses, such as backup generators, heating systems, and potential hydrogen-based power generation. Although currently less prominent, these applications are assessed by converting existing fuel or energy consumption into hydrogen equivalents, while account-

ing for both annual usage and potential peak demand scenarios (e.g. emergency generator operation). This ensures that all relevant energy demands within the airport system are captured.

Finally, the estimated hydrogen demand serves as a key input for hydrogen supply chain planning. By translating annual and peak hydrogen requirements into implications for production, storage, and distribution, the methodology supports infrastructure design and investment decisions. A simulation tool developed in the project further links hydrogen demand to renewable energy availability, enabling airports to assess the feasibility of local hydrogen production and thus optimise supply configurations.

The tool can be accessed here:

<https://interreg-baltic.eu/wp-content/uploads/2026/08/BSR-HyAirport-tools-supply-chain.zip>

Overall, the analysis identifies airport equipment as a highly suitable early application for hydrogen deployment. Due to its operational feasibility and comparatively lower technological barriers, this segment offers significant potential for early adoption, allowing airports to gain experience, reduce emissions, and prepare for the gradual scale-up of hydrogen use in aviation.

Full report on Hydrogen demand for airport equipment:

https://interreg-baltic.eu/wp-content/uploads/2026/08/BSR_HyAirport_WG_1_2_1_Demand_Analysis_Airport_equipment.pdf

CONCLUSION

Overall, the demand analysis provides a robust and transferable framework for estimating future hydrogen demand at airports, covering both aviation and ground operations. It shows that hydrogen demand in aviation has significant long-term potential, particularly in regional and general aviation, but will grow gradually due to technological and fleet-related constraints.

In contrast, airport equipment represents an immediate and scalable use case, with clear conversion pathways and lower implementation barriers. As a result, hydrogen deployment is expected to follow a phased

approach, starting with ground operations and expanding to aviation as technologies mature, allowing airports to gain experience, and prepare for the gradual scale-up of hydrogen use in aviation

Once the level of demand and potential development pathways have been identified, the next step is to examine how this demand can be met. For this reason, the following chapter examines the technical feasibility of producing hydrogen directly at airports and assesses the infrastructure requirements associated with local production.

RESULTS WP 1.2.2

LOCAL PRODUCTION

OBJECTIVE

The objective of this chapter is to establish a structured analytical basis for assessing on site production and storage of green hydrogen at airports, with a specific focus on ground operations and supporting infrastructure. These applications represent the most immediate and operationally relevant entry point for hydrogen deployment at airports, as they can be addressed independently of wider aviation fuel supply chains. The analysis aims to define transparent system boundaries, methodological assumptions and scenario frameworks that enable a consistent evaluation of hydrogen demand, production requirements and infrastructure implications under both current and future operating conditions. The chapter seeks to provide a robust and transferable framework for evaluating airport specific hydrogen deployment options.

METHODOLOGICAL FRAMEWORK AND SYSTEM BOUNDARIES

The analysis is limited to gaseous hydrogen produced via on site water electrolysis. Liquid hydrogen pathways, off site hydrogen production and external hydrogen logistics chains are explicitly excluded.

The system boundaries include hydrogen production, compression, on site storage and consumption in airport operations. To reflect both near term applicability and long term planning perspectives, the methodology distinguishes between current operating conditions and future high demand development scenarios, representing increased hydrogen penetration and traffic growth. These scenario definitions apply consistently throughout all subsequent analyses.

The assessment focused exclusively on commercially available or near market technologies, ensuring realistic and implementable pathways for hydrogen deployment.

LOAD ASSUMPTIONS AND HYDROGEN DEMAND MODELLING

Temporal load profiles

As a first step, the temporal load distribution must be understood, as they directly influence system sizing and operational reliability. Monthly flight movement statistics are used to estimate seasonal fluctuations in operational intensity. For most of the airports, the data shows a clear seasonal pattern: the winter months account for a lower percentage of the annual flight movements, while spring and summer typically have a high share of the yearly movements. The month with the highest activity is chosen as the reference value for peak load. This conservative assumption ensures that the hydrogen and electricity infrastructure is designed for realistic maximum demand and not for annual averages, thus guaranteeing operational reliability.

Hydrogen demand modelling based on operational efficiency

The developed methodology is based on actual fuel consumption data converted into energy units (MJ or kWh) and adjusted according to Fuel Cell Electric Vehicle (FCEV) and internal combustion engine (ICE) efficiency factors. This makes it possible to determine how much hydrogen would be required for a specific fleet of vehicles or equipment. These results also serve as the basis for calculating the electricity demand for hydrogen production via electrolysis, taking into account system efficiency (approximately 0.8) and safety margins, such as 1% losses and an additional 5% reserve. The calculation approach is easily adaptable to airports of different scales and climatic conditions, as it relies on actual energy consumption and operational data rather than theoretical models. Therefore, this method serves as a practical tool for determining the extent to which hydrogen can replace fossil fuels, as well as for estimating the required electrical capacity and production potential for a sustainable and climate-neutral transition.

Applying this methodology provides quantitative insights into hydrogen demand across different airport sizes and development scenarios. Annual fossil fuel consumption at the analysed BSR airports

ranges from a few gigawatt-hours at small regional airports to approximately 20 GWh at larger hubs. These values are converted into energy units and corrected for drivetrain efficiency differences between ICE- (Internal Combustion Engines) and FCE (Fuel Cell Electric) - applications. On this basis, annual hydrogen demand under present operating conditions lies in the range of approximately 40 to over 300 t GH₂ per year, while future high-consumption scenarios yield values between roughly 100 and more than 700 t GH₂ per year.

For technical sizing, annual hydrogen demand (gaseous) is converted into monthly and daily values by assuming that the peak month accounts for 10% of annual consumption. Under the assumption of a 31 day month, peak daily hydrogen demand in the baseline scenario ranges from approximately 0.15 t H₂ per day at small airports to around 0.9 t H₂ per day at large airports – assuming a high replacement rate of vehicles, equipment, and aircraft. These baseline peak values constitute the primary basis for determining electrolyser power and on site storage capacity. Under future high-consumption scenarios, including expanded hydrogen use and traffic growth, peak daily demand at large hub airports may exceed 2 t H₂/day, which serves as an upper-bound dimensioning case. All demand values are based on simple assumptions. For detailed demand assessment, please refer to the BSR HyAirport reports on demand assessment.

HYDROGEN PRODUCTION AND SYSTEM SIZING

Electrolyser performance and electricity demand

Based on this demand profile, the corresponding hydrogen production and electricity requirements can be derived. Hydrogen production is assumed to be based on PEM electrolysis. Taking a system efficiency of approximately 80%, the specific electricity consumption is assumed to be about 41.7 kWh per kg H₂, which is consistent with values reported in the literature and industrial datasheets. Accordingly, in the baseline scenario, daily electricity demand ranges from approximately 6–7 MWh at small airports to around 35–40 MWh at medium to large airports, depending on airport size and operational scale. Electrolyser capacity is determined using a capacity factor of 70%, representative of mixed renewable energy supply with grid support. Based on the baseline demand

profile, the resulting electrolyser power requirements range from approximately 0.3–0.4 MW for small airports to around 2 MW for larger airports. Under higher demand scenarios, required electrolyser capacities may increase up to 5–6 MW at large airports for GH₂ usage.

Storage requirements and land-use implications

To ensure operational reliability, on site hydrogen storage is included, based on a reserve corresponding to two days of autonomous operation and accounting for minor daily production losses. Under baseline operating conditions, this results in required storage volumes of approximately 0.3–0.4 t H₂ at small airports and around 1.5–2 t H₂ at larger airports. Such storage levels are sufficient to buffer fluctuations in renewable electricity supply and to ensure continuous operation during maintenance periods. In high demand development scenarios, storage requirements increase accordingly and may reach up to 4–5 t H₂ at large hub airports.

The spatial implications of these technical requirements are assessed in the following step. Land requirements are estimated using conservative coefficients derived from industrial reference projects and academic publications. The electrolyser footprint, including balance of plant components, service access and safety clearances, is approximated at 0.035 ha per MW of installed electrolyser capacity, based on typical layouts of containerised PEM systems; similar approximate dimensions are also reported in academic materials, e.g. MDPI publications. Additional land is allocated for hydrogen storage and safety zones, in line with the requirements of ISO 19880 1 and EN 60079 10 1. Based on European Hydrogen Safety Panel data, approximately 0.1–0.25 ha of land is required to store around 1 ton of compressed hydrogen, depending on pressure and layout configuration (European Hydrogen Safety Panel 2023). Even under high-demand scenarios, total land requirements remain within approximately 0.05 to 0.9 ha. Compared to the several hectares commonly available at airports for technical infrastructure, this demonstrates that on-site hydrogen production is spatially compatible with typical airport layouts and allows sufficient margin for future expansion.

Integration of renewable electricity supply

Having established technical and spatial feasibility, the focus shifts toward the integration of renewable electricity supply. The potential for supplying hydrogen production with on-site renewable electricity is assessed using hybrid solar and wind installations typical of Central European conditions. Wind installations are typically not located at or close to airports.

Solar photovoltaic systems are assumed to operate with capacity factors of approximately 11–13%, corresponding to typical annual yields reported for Central Europe by Fraunhofer ISE and the European Commission's PVGIS database (Fraunhofer ISE 2025, European Commission 2025). At the same time, for onshore wind power plants in Central EU countries, the typical CF ranges from 25% to 33%. This is supported by data compiled by WindEurope and Eurostat for 2022–2023, which show that the average CF for onshore wind parks across the EU-27 is around 30% (WindEurope 2024).

Across the analysed airport scenarios, average daily renewable electricity generation amounts to roughly 1.6–1.8 times the electricity demand required for hydrogen production, based on scenario specific calculations. This RES overcapacity reflects the variability of renewable generation; continuous operation therefore relies on hydrogen storage and, where available, grid interaction.

Water requirements for electrolysis

Furthermore, water consumption is taken into consideration, given its fundamental role in PEM electrolysis. While the stoichiometric requirement is 9 L per kg H₂, real systems require additional water for treatment, circulation, and cooling. Reported values therefore range between 15 and 20 L per kg H₂.

Based on the baseline hydrogen demand estimates considered in this assessment, corresponding daily water demand ranges from approximately 2–3 t per day at small regional airports to around 15 t per day at larger airports with higher electrolyser capacities. Under higher demand scenarios, daily water demand increases accordingly. In such cases, water consumption may reach up to 18–20 t per day at large airports. Even under these higher demand conditions, total water consumption remains modest compared to overall airport water use. However, reliable water

availability and appropriate water quality must be ensured, potentially through reuse and advanced purification systems.

Overall, the analysis shows consistently across all scenarios that on-site renewable hydrogen production at airports is technically feasible. Required electrolyser capacities, storage volumes, renewable electricity generation, water demand and land use remain within realistic and manageable limits. Importantly, this conclusion holds not only for current operations but also for substantially higher projected future hydrogen demand. The presented methodology therefore provides a robust and transferable framework for airports seeking to transition toward climate-neutral ground operations.

INFRASTRUCTURE PLANNING AND SAFETY FRAMEWORK

Building on the quantified production and demand analysis, this section addresses the practical implementation of GH₂ infrastructure at airports.

The design of on-site GH₂ production infrastructure at airports requires an integrated consideration of technical configuration, spatial planning, safety requirements and regulatory compliance. The primary objective is to establish modular and scalable systems that ensure secure and continuous hydrogen supply while being fully compatible with airport operational conditions and European safety standards. On-site hydrogen generation is typically based on water electrolysis supplied by renewable or low-carbon electricity, enabling decentralised production and reducing dependency on external hydrogen logistics chains.

Among current mature technologies, alkaline electrolysis (AE) and proton exchange membrane (PEM) electrolysis are identified as the most suitable options for airport applications. AE systems provide cost-efficient large-scale hydrogen production and robust long-term operation, whereas PEM electrolysers offer higher operational flexibility and fast response to fluctuating renewable energy input, which is particularly advantageous for solar- and wind-based electricity supply systems.

A typical on-site GH₂ production system consists of power conversion units (including rectifiers and transformers), modular electrolyser containers or

skid-mounted units, cooling and water treatment systems, compression and drying equipment, buffer storage and automated process control and monitoring systems.

Modular configurations allow stepwise expansion by adding electrolyser or compressor units without requiring a complete redesign of the installation. Spatial planning follows a functional sequence from electricity input and electrolysis to compression, storage and distribution. The layout aims to minimise hydrogen pipeline lengths in order to reduce pressure losses and potential leak points, while ensuring unrestricted access for maintenance and emergency response.

GH₂ production facilities are generally located outside the immediate airside operational area but within secured airport utility or technical zones, allowing efficient connection to the refuelling infrastructure and internal hydrogen distribution networks. Benchmark values indicate that a multi megawatt installation requires several hundred square metres for the core process area, while the total land demand including balance-of-plant, safety distances and access infrastructure typically remains below one hectare even for larger systems. These design principles are consistent with industrial hydrogen infrastructure layouts reported in academic literature and industrial practice.

Storage systems and refuelling related infrastructure are designed in accordance with the safety and layout principles defined in ISO 19880 1, which specifies separation distances, layout requirements, and operational safeguards for gaseous hydrogen installations. Environmental aspects of GH₂ infrastructure include noise emissions, vibration, and wastewater generation from electrolysis and auxiliary systems.

Risk and hazard assessment identifies threats related to hydrogen leaks, ignition, overpressure events, electrical failures, risks of fire/ jet fires and external mechanical impacts. High-pressure storage systems represent the highest-severity risks, although the likelihood of major incidents remains low when appropriate design, inspection and maintenance practices are applied. Additional risks arise from human factors, insufficient training and cybersecurity vulnerabilities in highly automated and interconnected control systems.

Risk mitigation strategies therefore combine administrative controls and emergency preparedness with the engineered safety features described above. In line with European ATEX explosion protection requirements and the hydrogen safety framework defined in NFPA 2 this includes regular safety audits and the integration of hydrogen specific scenarios into airport emergency response plans.

Overall, the assessment demonstrates that on-site GH₂ production infrastructure can be safely and effectively integrated into airport environments when designed in accordance with established international standards and best practices. Modular system architecture, compliance with ISO and ATEX requirements, integration with renewable energy systems and robust risk mitigation measures enable hydrogen infrastructure to become a key component of resilient, low carbon airport energy systems while maintaining high levels of operational safety and reliability.

ASSESSMENT OF ENERGY, WATER AND GRID RESOURCE AVAILABILITY

The assessment of resource availability across the participating airports shows that the feasibility of on-site gaseous hydrogen production is primarily influenced by electricity supply conditions, while water availability and spatial constraints play a secondary role. Although airport-specific conditions vary, common structural patterns can be identified that are representative of many European airports undergoing energy transition. Existing grid connections at airports are often already heavily utilised by current operations, leaving limited capacity for additional high demand loads such as large-scale hydrogen electrolysis. In many cases, further grid expansion is constrained by technical, economic or regulatory limitations, indicating that sole reliance on grid electricity is not a viable long-term strategy for GH₂ production. As a result, electricity supply emerges as the main limiting factor for hydrogen deployment.

The integration of on-site renewable energy sources, particularly photovoltaic systems, is therefore a key enabling measure. Planned or potential renewable installations can significantly contribute to electricity supply for hydrogen production but are generally insufficient to fully cover demand. To ensure stable and flexible operation, hybrid energy concepts combining renewable generation, hydrogen and battery storage

and limited grid interaction are required. At the system level, the ability to adjust electrolyser operation to periods of high renewable generation or favourable electricity prices is considered essential for technical feasibility and economic viability, as highlighted in International Energy Agency analyses on hydrogen and power system integration.

Water availability does not represent a critical constraint for GH₂ production. Municipal water supply systems provide sufficient capacity to meet electrolysis demand, which remains modest relative to overall airport water consumption. Nevertheless, high water quality requirements necessitate appropriate treatment and monitoring, and the use of recycled or treated water can further enhance sustainability.

Overall, the analysis indicates that airports generally possess adequate water resources and renewable energy potential to support on-site GH₂ production. However, overcoming electricity supply constraints through strategic energy planning, renewable integration and flexible system operation is essential. When these conditions are met, on-site hydrogen production can be implemented without compromising airport operations, supporting long-term decarbonisation and the development of resilient, low-carbon airport energy systems.

CONCLUSION

This chapter demonstrates that local green hydrogen production and storage at airports is technically feasible and spatially compatible. Based on a comprehensive techno economic assessment, real operational data and current international standards, the analysis confirms that airports can transition operations from fossil fuels to hydrogen without encountering fundamental technological or safety barriers.

The evaluation of renewable energy potential shows that hybrid photovoltaic and wind configurations can supply a significant share of the electricity required for hydrogen production. In most assessed scenarios, local renewable generation exceeds average daily energy demand for hydrogen production by a factor of approximately 1.5–1.8, creating favourable conditions for flexible electrolysis operation and energy buffering through hydrogen storage. While seasonal variability and grid capacity constraints remain relevant, these challenges can be effectively mitigated

through hybrid energy systems, storage integration and adaptive electrolyser control strategies.

Hydrogen demand modelling based on realistic efficiency assumptions indicates that airport scale electrolyser capacities in the range of 0.3–6 MW, coupled with short term storage volumes of up to several tonnes of GH₂, are sufficient to cover current and projected ground operations. Corresponding land requirements remain modest and are well within the technical and spatial reserves typically available at airports. This confirms that on site hydrogen infrastructure is compatible with existing airport layouts and allows for phased expansion as demand grows.

From an infrastructure and safety perspective, the analysis confirms that mature, commercially available technologies, particularly PEM and alkaline electrolyzers, can be deployed at airports in compliance with established international standards. Hydrogen storage and handling risks are well understood and can be effectively managed within existing airport Safety Management Systems through appropriate zoning, monitoring, ventilation, emergency shutdown mechanisms and staff training. No intrinsic safety constraints were identified that would prevent hydrogen deployment in airport environments, including in cold climate conditions relevant to the Baltic Sea Region.

Altogether, the findings confirm that airports are well positioned to act as early adopters and focal points of regional hydrogen ecosystems. Their concentrated energy demand, availability of technical land and role as mobility hubs enable them to serve as anchor consumers for renewable hydrogen, supporting both immediate decarbonisation of ground operations and long term preparation for hydrogen powered aviation. A phased implementation approach, starting with ground support equipment and scaling toward future aviation fuel requirements, offers a technically sound, economically viable and low risk pathway toward climate neutral airport operations and broader integration into Europe's hydrogen economy.

Within the project and assessment for local production, a tool has been developed to calculate first estimations for needed production and electricity demand.

The tool can be accessed here:

<https://interreg-baltic.eu/wp-content/uploads/2026/08/BSR-HyAirport-tools-supply-chain.zip>

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RESULTS WP 1.2.3

TRANSPORT

OBJECTIVE

The aim of the Transport working group was to provide conclusions on possible hydrogen transport solutions that are relevant for airports in the Baltic Sea Region based on scientific principles and project-specific analysis. In particular, the evaluation of economic efficiency was the centre of interest.

METHOD

The Transport working group set out to identify the most suitable options for transporting hydrogen to airports in the Baltic Sea region.

The process began with a comprehensive literature review to assess the current state of research and collect reliable cost data. However, inconsistent assumptions and methods led to large cost differences (~ 0.10-14€) which made comparisons difficult. Cost differences stem mainly from varying transport modes (ship, train, truck and/or pipeline), distances (from 25 to 3,000 km), hydrogen forms (gaseous, liquid, ammonia, methanol and liquid organic hydrogen carriers) and assumed demand levels (up to 30 tonnes per day). Most studies focus on high-demand scenarios, which do not reflect the initially low demand expected at BSR airports. In addition, in some studies the production price of hydrogen was considered whereas others include the costs for compression while ignoring the cost of production.

To address these challenges, the working group developed a tailored criteria system for the BSR HyAirport project. Key cost drivers like transport distance and hydrogen demand were defined using real airport data from project partners.

A study by the Fraunhofer Institute and Hamburg University of Applied Sciences (Solomon et al. 2023) was selected as the basis for cost calculations. The model was adapted to project-specific parameters.

It should be noted that the simplifications made in the studies influence the results. Although these are necessary for the comprehensibility of the models,

they must be carefully taken into account when considering the results. Common simplifications include assumptions such as the neglect of certain variables such as geographical factors and differences in labor costs, the use of idealized models such as no losses during and after transport, and the exclusion of certain complexities in the system such as traffic jams or construction work.

The findings of the Transport Working Group were incorporated into practical guidelines for airports and a step-by-step decision tree designed to help identify the most cost-effective solution for transporting hydrogen.

MEANS OF TRANSPORT

This section provides an overview of the transport options of truck, pipeline and train. Each method presents distinct advantages and challenges, shaped by technical, logistical, and cost-related parameters. Shipping has been excluded as it is primarily used for high-volume international flows over long distances, whereas the focus of this project is on regional supply routes.

Truck

Gaseous hydrogen is commonly transported at 200–300 bar and allows for a payload of 400–1,100 kg per truck. Liquid hydrogen has a higher energy density, allowing for 2,000–4,500 kg to be transported (Xie et al. 2024).

The costs of truck transport consist of investments in vehicles and operating costs for personnel, maintenance and fuel (Ohmstedt et al. 2023). GH₂ is particularly economical for short distances due to its low energy density and heavy tanks. (Xie et al. 2024). According to (Solomon et al. 2023), compression costs account for over 50 % of the total cost of transporting gaseous hydrogen by truck over short distances. As distance increases, the cost priorities shift: while compression costs remain largely constant, truck-related costs such as fuel, personnel and maintenance

increase significantly. The importance of transport costs therefore increases with distance, while compression costs become relatively less important.

Many studies show that LH₂ transport is cheaper than GH₂ transport for distances of 200–400 km and more (Energy Transitions Commission 2021; University of Augsburg n.d.; Alekseev et al. 2023). The reason for this is the already mentioned higher energy density, which allows larger delivery quantities per trip (Xie et al. 2024). It is advised to take the different investment costs for gaseous and liquid hydrogen storage facilities into account. This report is purely focused on the costs of transport, excluding the infrastructure or production costs of the different versions of hydrogen (gaseous or liquid). In order to be able to find the real economic tipping point between transport in liquid or gaseous form of hydrogen, additionally to the needed receiving infrastructure, the costs for production of hydrogen of course need to be taken into account, as the production costs for liquid hydrogen are higher than gaseous hydrogen due to the increased energy demand for liquefaction.

Also, the surrounding synergy effects need to be considered, if liquid hydrogen is used in other applications or if only gaseous hydrogen is needed. It is possible to store the hydrogen in liquid form and re-gasify for the usage, or regasify it at delivery and store it in gaseous, compressed form. Both considerations come with higher investment costs as well as operational costs (e.g. costs for liquefaction) than infrastructure based on gaseous hydrogen delivery.

It should be noted that liquid hydrogen is more cost efficient to scale up, especially for transport and re-fuelling. In the future, the delivery of liquid hydrogen could also be more advantageous when it is introduced as fuel for aircraft.

Pipeline

Pipelines are already a central component of the energy infrastructure, and hydrogen can be transported via pipelines. However, there is a lack of comprehensive pipeline infrastructure for transporting hydrogen (Wang et al. 2021) as of today.

Technically, the system is based on the principle of the existing pipeline network used for natural gas, but the

physical properties of hydrogen make special demands. Two major issues in terms of materials and construction are permeation through non-metallic materials and material embrittlement. Hydrogen molecules are very small and can pass through pipeline walls, which can lead to potential gas losses. Material embrittlement can be caused by hydrogen, which weakens materials such as steel, which are often used in pipelines, making them susceptible to cracks and leaks (Department of Energy Security & Net Zero 2023).

The proposal to repurpose existing natural gas pipelines for hydrogen transport has generated a great deal of interest as it could reduce transport costs. However, the special properties of hydrogen pose a particular challenge compared to natural gas and require necessary modifications. Significant adjustments must be made, such as possible Upgrades of the material, improving the sealing, and adapting the pressure management. This complicates the conversion process and can be costly (Xie et al. 2024). (Koops 2023) additionally states that the repurpose of natural gas pipelines would lead to an increase in operating costs, due to friction-induced pressure loss implied by the surface structure of the old natural gas pipelines. This pressure loss leads to increased energy demand for the compressors while the repurposing of pipelines would lead to a decrease in capital costs by 75-90 %. A more detailed cost analysis of repurposing pipelines would help to evaluate this method. In conclusion, while existing pipelines for hydrogen transport are a viable and potentially cost-effective option for low to medium ranged transport (Koops 2023), it requires careful planning and significant modifications to the infrastructure.

The investment costs for new pipelines are mainly determined by the length and diameter of the pipeline. Operating expenditure, on the other hand, is primarily driven by maintenance work and electricity consumption, which varies depending on throughput and distance (Ohmstede et al. 2023) but will be far less than the operational costs of repurposed natural gas pipelines, which range up to a higher operational cost of 35 % (Koops 2023). Pipelines are generally not practical for low hydrogen demand due to the high investment costs. For large quantities of hydrogen, the higher capital costs for pipelines can be offset by lower operating costs. This suggests that economies of scale for pipelines lead to greater cost reductions

than, for example, trucks (Collis et al. 2020). The width of the pipeline and the pressure influence the volume that can be transported through the pipeline (Wang et al. 2021). Some study results show that for hydrogen demand of more than 10 t/day, it makes sense to invest in the necessary expensive infrastructure for a pipeline (Energy Transitions Commission 2021; Solomon et al. 2023).

It needs to be noted that hydrogen transported by pipeline may not have the purity needed for Fuel Cell applications, that generally need a hydrogen quality of 5,0 (impurities of less than 10 ppm/ Purity of 99.999 Vol %). If hydrogen for Fuel Cell applications is directly taken from a pipeline, a purifier most probably would be needed to reach the required purity of hydrogen. This additional infrastructure may influence the operational and investment costs for this transport mode negatively.

Train

Although hydrogen transport by train is still in the development phase, it represents a promising option due to relatively low technological and regulatory barriers (Bregulla/ Kittler 2023). The current state of knowledge on hydrogen transport by rail is still limited compared to established methods such as pipeline or truck transport.

The already well-developed European rail network can be used to transport hydrogen by rail. A prerequisite for hydrogen delivery is a fully functional rail connection to the end customer. Investments in a comprehensive infrastructure specifically designed for this mode of transport are therefore generally not necessary. However, costs for transshipment, pickup, and storage at the origin and destination may arise. Otherwise, the last mile would have to be covered by truck (Bregulla/Kittler 2023).

In technical terms, hydrogen transport by rail is an expanded form of truck transport but is based on larger quantities per trip. That is why hydrogen transport by train is particularly suitable for medium quantities and medium distances (Bregulla/ Kittler 2023). DB Cargo, for example, is actively involved in the development of hydrogen logistics. They are contributing to the further development of innovative hydrogen containers and testing logistics concepts

for the transport of pure hydrogen. Special multi-element gas containers are used for the transport of gaseous hydrogen by train (DB Cargo n.d.). In a case study commissioned by the Landesenergie Agentur Hessen in which they investigated the potential of hydrogen transport via rail, a flat wagon of the type "Lgns 581" was used, which is designed to transport a 40 ft standard container with a maximum loading capacity of 26.6 tonnes. This has a capacity of 1,108 kg of hydrogen at 500 bar (Bregulla/ Kittler 2023). In June 2025, DB announced that the project partners DB Cargo BTT, Hexagon Purus, Endress+Hauser, Infracore Höchst and Fraunhofer IML had developed a Multi-Element Gas Container (MEGC) for the multimodal transport of gaseous hydrogen by rail. The new MEGC is the first 500 bar container approved for rail use, with an increased load capacity of 1,223 kg. The container is specially designed for transport by rail using flat wagons. The tank has advanced sensors that enable continuous monitoring of pressure, temperature, and vibration, thus enabling new safety standards. The container is scheduled to be tested on rail as part of a pilot project at the end of 2025 (DB Cargo 2025). The transport of liquid hydrogen by rail is fundamentally possible, but there are currently no approved transport containers for this purpose in the EU (Universität Augsburg n.d.).

In terms of economic analysis, factors such as track access fees, personnel costs, and container costs must be considered. Rail transport is the more sustainable hydrogen transport option due to its lower emissions and environmental impact. While trucks may face rising fees soon, rail transport could benefit from additional targeted government subsidies (Bregulla/ Kittler 2023).

INTEGRATION OF HYDROGEN LOGISTICS INTO AIRPORT INFRASTRUCTURE

From the comparisons of hydrogen transport options conducted so far, it can be concluded that the choice of a suitable mode of transport heavily depends on the specific usage context and thus also on the individual airport context. The choice of a suitable mode of transport for hydrogen at airports must be closely linked to the specific conditions of each airport. Factors such as the size of the airport, its geographical location, the expected hydrogen demand, and the existing infrastructure play an important role in deciding which transport solution is practical and efficient.

- High safety standards
- Strict access and control regulations
- Limited space availability, especially for new infrastructure (e.g. storage or production facilities)
- High requirements for supply security and reliability
- Fluctuating hydrogen demand (e.g. seasonal)
- Integration into existing logistics processes such as kerosene supply

To identify suitable hydrogen transport routes for airports in the BSR region, the project partners analyzed the specific local and regional conditions around

In addition, the partners assessed the availability of railway connections at each airport, as these have a strong influence on the short-term feasibility of this transport option.



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Hydrogen hub

Figure 1. shows that the Baltic Sea Region already has a moderate number of hydrogen hubs, but there is still considerable potential for development. Some airports are already relatively close to a hydrogen hub, often within a radius of around 150 to 200 kilometres. Växjö Airport, for example, is particularly well positioned, as there are already two hydrogen hubs in their vicinity (less than 70 km away from the airport). Airports such as Umeå and Kiruna are located within a medium distance range of 250 to 350 kilometres. Despite these existing structures, the expansion of central hydrogen production centres is still in the planning phase in many countries. These planned projects could make a significant contribution to shortening the distances between airports and hydrogen infrastructure in the future. One example of this is the region around Poznan Airport, which currently has no hydrogen infrastructure, but plans to build a hydrogen hub near the airport. At the same time, many of these projects are still subject to uncertainty. Successful implementation depends on multiple factors. In Sweden, for example, the implementation status of individual projects is unclear. The example of Sylt illustrates that proximity to a hub does not automatically guarantee a secure supply: despite the short distance to a hydrogen hub, there's currently no way to transport hydrogen from the mainland to the island. This example shows that if there are no transport options, local production solutions should be considered early on.

Pipeline

Currently, no airport in the Baltic Sea region is connected to a hydrogen pipeline network. Hamburg Airport plans to connect to the city's pipeline network in the future. In 2019, the airport signed a letter of intent with the local gas network operator. The actual construction of the pipeline to Hamburg Airport depends on the future demand for hydrogen at the airport. Other airports have not yet made such efforts.

With the European Hydrogen Backbone (EHB), this could change in the future. The European Hydrogen Backbone project plans to establish a Europe-wide hydrogen network consisting mainly of repurposed natural gas (Van Rossum et al. 2022). Since hydrogen demand at larger airports will increase significantly, it

makes sense to supply airports with these pipelines in the future, which should be considered in the planning process today. The lack of a pipeline connection highlights that pipelines are not a realistic option for transporting hydrogen to airports in the short term due to construction time.

Railway connection

The availability of rail infrastructure is a key factor in assessing rail-based hydrogen delivery. The connection of airports in the Baltic Sea region to the rail network varies greatly. Only a few airports already have rail connections. In most cases, these are exclusively for passenger transport, e.g. in Hamburg, Helsinki, and Stockholm. Vilnius is a positive example with direct passenger and freight connections. Many airports have neither current rail connections nor corresponding expansion plans. Some exceptions are Riga, Kaunas, and Gothenburg. They are planning new passenger connections. Kaunas is also planning a freight connection. Overall, the lack of freight rail connections limits the possibility of delivering hydrogen by train. For most airports, investments in freight terminals would be necessary.

CALCULATION OF TRANSPORT COST FOR BSR AIRPORTS

Criteria system and input parameters for cost calculations

To conduct a comparable assessment of hydrogen transport options for airports in the Baltic Sea Region, several assumptions and framework conditions were defined. These were derived from a combination of insights gained through literature review and discussions within the project's working group. These variables include means of transport, transport distance, hydrogen demand, physical state of hydrogen (mode) and scope and boundaries of the cost analysis. These are used as primary input parameters for cost calculations and decision tools developed in the project.

The analysis considers trucks, pipelines, and rail transport, as they are generally recognized in literature as suitable for regional and national delivery routes. Shipping is excluded from the assessment because the project focuses on last mile delivery to airports rather than transcontinental supply chains. For each airport, the distance to a hydrogen hub that either al-

ready exists, is under construction or is planned was determined. The analysis shows that the scenario primarily considers distance ranges to 400 km. The hydrogen demand for airports was estimated based on the results of the project's working group 1.2.1 Demand Analysis. Assumptions were made for possible routes in 2030 and 2035. A methodology was developed to define the demand for aircraft and vehicles for these scenarios. The assessment of the transport sector also focuses on the short- to medium-term demand volumes that can be expected within the next 10 years. Demand is initially estimated at around 1 ton per week, which is realistic for regional air traffic and ground handling vehicles in early introduction scenarios. The project focuses primarily on the transport of gaseous hydrogen, as this form is currently considered the most accessible and scalable option for early hydrogen applications in aviation, especially regional routes and smaller aircraft. Liquid hydrogen is considered a secondary scenario, as it could be relevant in the future for larger aircraft and long-haul flights, as well as for specific secondary locations where distance and hydrogen demand could lead to a tipping point between the preference for transporting gaseous or liquid hydrogen. To ensure comparability between the different modes of transport, the cost model focuses exclusively on transport-related costs. The costs of hydrogen production, on-site storage, or refuelling infrastructure at airports are not included in the calculation, as other working groups within the project have addressed these aspects.

METHODOLOGICAL BASIS FOR BSR AIRPORTS

To estimate the costs of transporting hydrogen to airports, this section presents and evaluates an important reference study that provides relevant data, assumptions, and methodological approaches. The reference study "Cost optimization of compressed hydrogen gas transport by truck and pipeline" by the Fraunhofer Institute and HAW Hamburg serves as the basis for the subsequent cost calculations. The assumptions made are closely aligned with the framework conditions of the BSR HyAirport project. The aim of the study is to optimize the hydrogen supply chain and improve the cost efficiency of transport. The authors examine various key factors that influence transport costs, including pressure level, transport capacity, trailer capacity, pipeline diameter, pressure drop, and transport distance. Overall, the study provides a detailed methodological basis for evalu-

ating economical transport options. The study considered pressurized gas trucks with 350 and 540 bar and pipelines with three different diameters of 100 mm, 150 mm, and 200 mm as means of transport. Costs were calculated for distances of 25-500 km and a hydrogen demand of 2-30 tonnes per day. The levelized cost of hydrogen transport (LCOHT) in the study ranges from 0.30 to 3.44 € per kg. The study examines the costs associated with hydrogen supply in a European context (Solomon et al. 2023).

While most parameters such as means of transport, type of transport, and distance were in line with the project requirements, the hydrogen demand assumed in the original study was significantly higher than necessary. Within the framework of BSR HyAirport, a weekly hydrogen requirement of only 1 ton per week was considered appropriate. Based on this revised requirement, the Fraunhofer Institute recalculated the relevant cost values, resulting in project-specific transport costs.

EVALUATION OF OPTIMAL TRANSPORT OPTIONS AND COST ESTIMATIONS FOR BSR AIRPORTS

Based on project-defined parameters, transport by truck using a 350-bar trailer is identified as the most cost-efficient solution for supplying hydrogen to BSR airports. Most airports in the BSR region are located within a 200 km radius of a hydrogen hub. Figure 2 shows that this makes the delivery of gaseous hydrogen by truck the most economically viable option. For Umeå and Kiruna, transporting liquid hydrogen by truck could be advantageous due to the greater distances to the next hydrogen hub. In these cases, a switch to liquid hydrogen should be considered depending on actual demand.

The transport costs for the 350-bar trailer are listed below in Table 1. Based on a demand of 1 ton per week; the levelized cost of hydrogen transport is given for distances from 25 to 500 kilometers. These values represent an indicative cost baseline from which BSR airports can estimate the delivery cost per kilogram of hydrogen for their cases. The results show a clear advantage of using regional hydrogen hubs.

Using Hamburg airport as an example for a transport cost scenario, the hydrogen hubs closest to the airport were selected to serve as the supply start. Transport costs were calculated based on the project-deter-

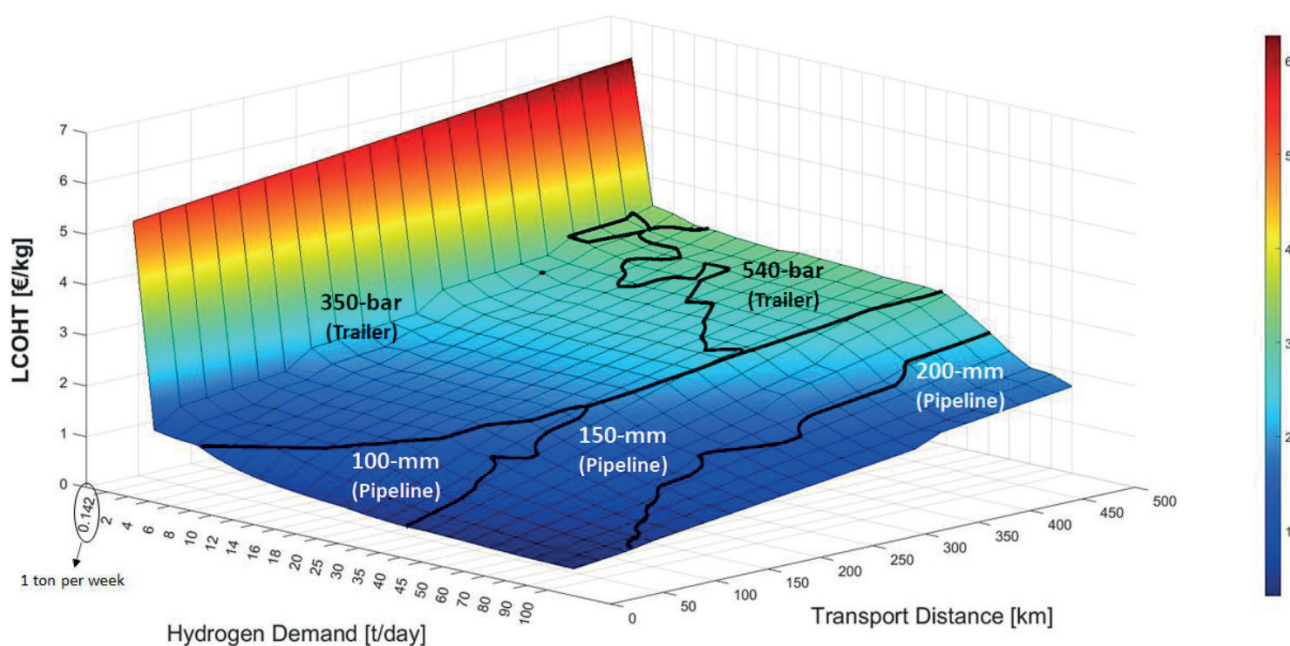


FIGURE 2:
Least LCOHT as a function of hydrogen demand and transport distance created by Fraunhofer IFF.

350-bar Trailer	
Distance (km)	LCOHT (€/kg)
25	5.23
50	5.29
75	5.34
100	5.40
125	5.45
150	5.51
175	5.56
200	5.61
225	5.66
250	5.72
275	5.77
300	5.83
325	5.88
350	5.94
375	5.99
400	6.05
425	6.10
450	6.16
475	6.21
500	6.27

TABLE 1.:
LCOHT for transport distance from 25 – 500 km for 350-bar Trailer for a fixed demand of 1 t/week.

mined LCOHT. Hamburg is currently already benefiting from the presence of nearby hydrogen hubs, and it is expected that further hubs will be added soon. Currently, the planned ammonia import terminal in Brunsbüttel is the closest hydrogen hub with an approximate distance of ~ 85 km to Hamburg airport.

The transport costs by truck would be ~ 5,362 € for a fixed demand of 1 t/week. Assuming the current market price of around 10 € for 1 kg of green hydrogen, transport costs have a share of 1/3 of total expenditure, representing a substantial share. Therefore, they must be carefully considered during the plan-

ning process to ensure economic efficiency. A hydrogen hub that is under construction is the production site at Hamburg Moorburg operated by Hamburger Energiewerke with Luxcara GmbH. With ~ 30 km to the airport, the transport cost would be reduced to ~ 5,242 € in total. If Hamburg Airport were to source hydrogen from the Port of Hamburg in the future, the distance to the airport would be even shorter with only ~ 20 km travel distance and the transport costs would further decrease to ~ 5,219 €.

The results suggest that GH₂ supply via road transport is realistic and optimal for most locations. However, location-specific supply strategies, especially for remote areas where alternative forms of hydrogen such as liquid hydrogen become necessary, always must be considered. For some regions with various possible smaller customers, the transport costs may influence the price too much with the consequence that it is not viable for every customer. With the existence of a larger customer (e.g. airport), that might function as a so-called anchor customer, the hydrogen delivery price can be influenced through the already existing delivery schemes of this larger customer. It might also be worthwhile to build larger storage systems for the aforementioned customer (e.g. airport), than needed, to function as buffer storage / depot for local supply, which would influence the overall costs, as bigger volumes can be transported initially. In this case, it makes sense to estimate if a liquid or gaseous storage would be viable. Influencing factors besides the resulting transport price through liquid or gaseous transport, are for example, resulting investment costs for storage and peripheral infrastructure (different for the different physical states of hydrogen) as well as the different needs of special planning (size).

Due to the lack of data on the transport of gaseous hydrogen by rail, a cost calculation was not conducted for this transport option. However, for airports with existing or potential rail connections, a future shift to rail could be a reasonable option as the volume increases. The synthesis report of the TransHyDE project LNG2Hydrogen, part of the German flagship project TransHyDE, examined the transport of liquid hydrogen by rail and provides a reference point for initial insights. This analysis considered larger transport volumes of 6 tonnes per container, which, compared to the Fraunhofer Institute cost calculation scenario of 1 ton per week, results in economies of scale and

thus lower specific transport costs. The report estimates transport costs of approximately 0.60-1.25 €/kg for distances between 100 and 1,000 km (Hydrogen flagship project TransHyDE 2025).

In general, there is currently a research gap regarding the costs of liquid hydrogen in smaller quantities. This is primarily since the transport of small volumes of liquid hydrogen is associated with disproportionately high specific costs compared to gaseous hydrogen. Assuming rising demand in the future, this situation could change. In this context, the study “Liquid hydrogen distribution to refuelling stations – comparison with other options” published by the Research Institute of Sweden is worth mentioning as it provides initial insights into how transport costs for gaseous and liquid hydrogen could develop and what developments can be expected. In the study, the use of liquid hydrogen (including liquefaction) for transport to and regasification at hydrogen refuelling stations was compared with the compressed hydrogen gas option. The study also compares safety and regulatory aspects. The study compares three stages in the supply chain: 1) liquefaction or compression at the distribution hub, 2) transport of LH₂ or GH₂ to the hydrogen refuelling station (HRS) and 3) the use of LH₂ or GH₂ at the HRS providing 700 bar gaseous hydrogen. The study, although with many uncertainties, shows that in a developed market with a low-cost scenario, the higher liquefaction cost (than compression) in stage 1 is compensated for by the lower transport and HRS cost, especially for longer distances (e.g. 500 km). For the transport stage LH₂ costs are 2.95 and 6.73 SEK/kg (0.26 and 0.60 €) for 200 and 500 km, respectively (based on 10 t/day transport quantity). For gaseous hydrogen, the corresponding values are 9.58 and 21.53 SEK/kg (0.86 and 1.92 €) (Gopalakrishnan et al. 2025).

GUIDELINES FOR PLANNING HYDROGEN LOGISTICS AT AIRPORTS BASED ON PROJECT RESULTS

Building upon the findings in the transport working group, a guidance and a decision tree model was developed to provide a first orientation for selecting suitable hydrogen transport modes for airports.

The guidance provides a structured record of the geographical location and proximity to hydrogen hubs, the availability and suitability of existing infrastruc-

ture, the type and scope of hydrogen requirements, and the framework conditions for implementation. The aim is to obtain well-founded information for the planning of hydrogen transport to the desired destination airport.

Guidance for planning hydrogen logistics to airports:

1. Geographical location

a. Hydrogen hubs

Where are the nearest hydrogen hubs? What is the distance between the hub and the airport? (Hydrogen hubs can be e.g. production sites, import terminals, storage facilities and/or HRS)

2. Existing infrastructure

a. Railway connection

Does the airport have a railway connection? Can it be used for hydrogen transport? If not, could it be adapted for hydrogen transport?

b. Pipeline connection

Does the airport have access to a hydrogen pipeline system? Is there potential to connect it to one in the future (any planned infrastructure projects)? If yes, what needs to be considered in the planning process so the airport can be connected to the pipeline network?

c. Road infrastructure

Is the road infrastructure on and around the airport capable of handling hydrogen transport?

3. Hydrogen demand

a. Form of utilization at airport

Which mode of hydrogen is needed at the airport?

b. Estimate hydrogen demand

How is the demand for hydrogen in the short term and how will the demand increase in the long term (per day, week, and month)? Is the hydrogen demand depending on seasonal fluctuations? Are there peaks? For calculation support, please refer to the report of Working group 1.2.1 Demand Analysis

4. Framework conditions

a. Timeframe for realization

What is the target timeline for implementing hydrogen transport solutions? Are there deadlines given by the government?

b. Willingness to invest in infrastructure

What short- and long-term financial resources are available for the construction of a hydrogen infrastructure at the airport?

c. Stakeholders in the hydrogen field

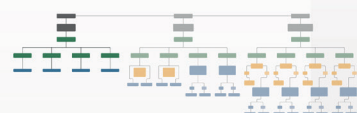
Who are the stakeholders in the region that the airport should collaborate with?

With the information collected in the guidance list, the following decision tree can be used to identify the optimal means of transport. The decision tree is divided into 3 subtrees shown below in Figures 3 - 5. It is based on the following criteria: Demand for hydrogen, distance between hydrogen hub and airport, location-dependent pricing structure and infrastructure availability.

The decision tree has so far only proven to be effective and meaningful to a limited extent. This is mainly due to two factors: firstly, the lack of data and secondly, the currently still low demand, which is, however, considered plausible and expected in the first project phase. The current lack of data on transport costs, particularly rail, means that the decision tree should be used as a preliminary guidance overview. Informed decisions should be made with more available information on the individual situation.

DECISION TREE - HYDROGEN TRANSPORT TO AIRPORTS

Subtree 1/3



HYDROGEN DEMAND

1 - 4 TONNES
PER WEEK

TRANSPORT DISTANCE

< 100 km

TRAILER GH2

100 - 200 km

TRAILER GH2

200 - 300 km

TRAILER GH2

300 - 500 km

TRAILER GH2

FIGURE 3.:

Decision tree to identify the optimal means of transport. Subtree 1/3.

DECISION TREE - HYDROGEN TRANSPORT TO AIRPORTS

Subtree 2/3



HYDROGEN DEMAND

5 - 40 TONNES
PER WEEK

TRANSPORT DISTANCE

< 100 km

DECISION
DEPENDS
ON LOCAL
PRICES

TRAILER GH2

TRAILER LH2

100 - 200 km

DECISION
DEPENDS
ON LOCAL
PRICES

TRAILER GH2

TRAILER LH2

200 - 300 km

AIRPORT
INFRASTRUCTURE
LH2-COMPATIBLE +
FEASIBLE ?

YES

TRAILER LH2

NO

TRAILER GH2

300 - 500 km

AIRPORT
INFRASTRUCTURE
LH2-COMPATIBLE +
FEASIBLE ?

YES

TRAILER LH2

NO

TRAILER GH2

FIGURE 4.:

Decision tree to identify the optimal means of transport. Subtree 2/3.

DECISION TREE – HYDROGEN TRANSPORT TO AIRPORTS

Subtree 3/3

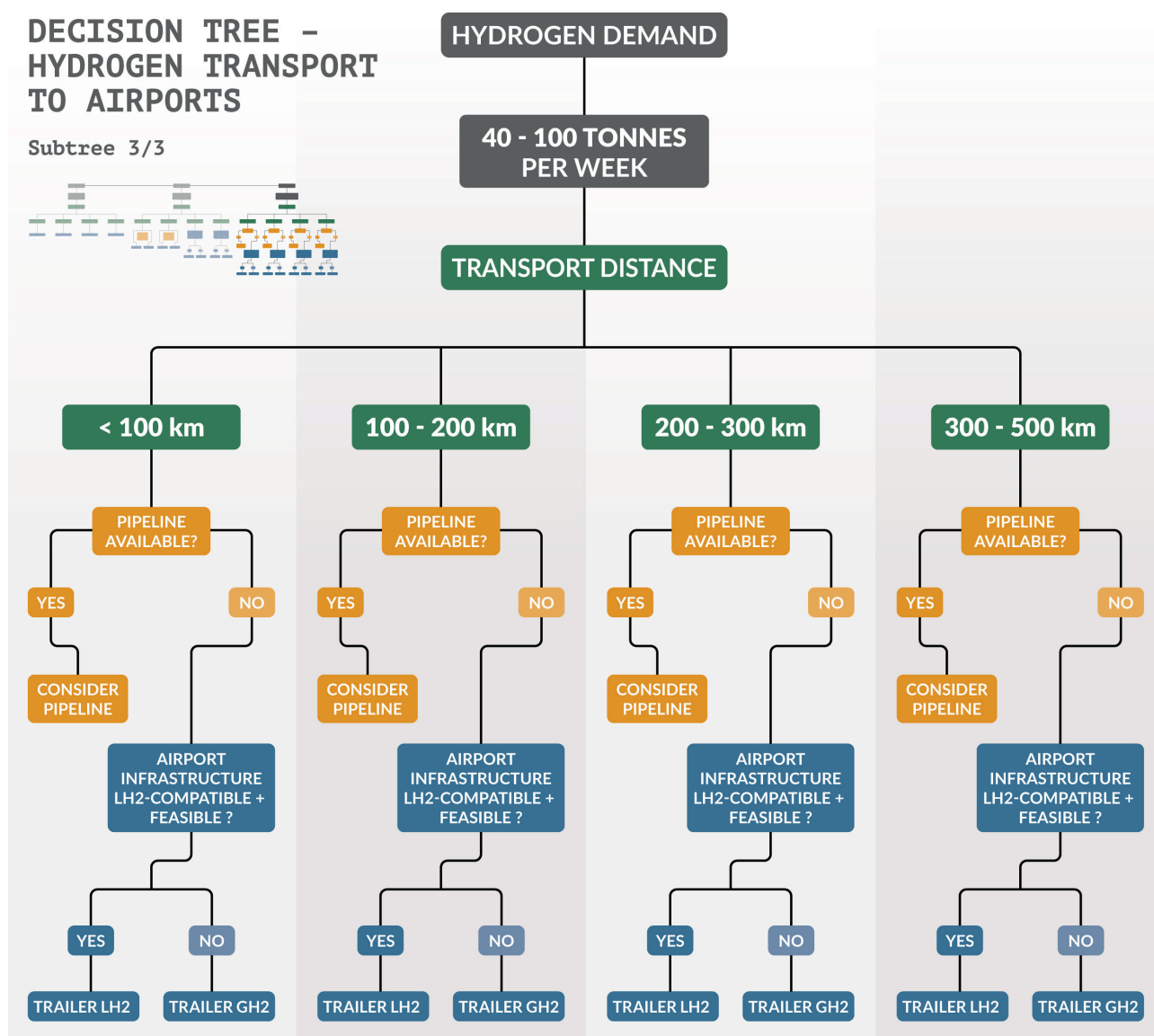


FIGURE 5.:
Decision tree to identify the optimal means of transport. Subtree 3/3.

CONCLUSION

In the short to medium term, the Baltic Sea airports will cover their demand for gaseous hydrogen needs by truck. This approach aligns with the current low demand and the typical transport distances of around 200 km to existing and planned hydrogen hubs. The construction of additional hubs will further simplify supply. Currently, most Baltic Sea airports lack both hydrogen pipelines and rail connections. Therefore, large-scale hydrogen transport by pipeline or rail is not a realistic option at present. The lack of this infrastructure underscores the need for coordinated investment and political support to enable these solutions in the future. In the long term, the expansion of

the European hydrogen pipeline network is expected to improve security of supply and, with increasing demand at airports, enable larger and more efficient transport systems. For economically viable transport logistics it is relevant to reach a certain level of demand, otherwise the associated transport or rental costs for trailers will increase the overall hydrogen price massively.

Full report on Transport:

<https://interreg-baltic.eu/wp-content/uploads/2026/07/Report-on-WP-1.2-Supply-Chain-1.2.3-Transport.pdf>

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CONCLUSION

The synthesis of the Supply Chain work packages demonstrates that the development of hydrogen ecosystems at airports in the Baltic Sea Region is both technically feasible and strategically well-founded but requires a phased and coordinated approach across all supply chain elements. Together, the three work packages form an integrated airport hydrogen supply chain strategy, linking future hydrogen demand with local production options and suitable transport solutions.

The demand analysis shows that hydrogen uptake will evolve unevenly across applications. Aviation demand represents the dominant long-term driver; its development remains uncertain and slow due to technological and regulatory constraints. In contrast, airport equipment and ground operations provide a stable and near-term demand anchor, enabling early deployment and continuous scaling of hydrogen use as well as the building of experience with hydrogen on airside.

Building on this demand structure, the analysis of local production confirms that on-site hydrogen generation via electrolysis is technically feasible and scalable for most airports in the region. Required capacities, land use, water demand, and integration into existing infrastructure remain within manageable limits, even under high-demand scenarios. However, this assessment focuses primarily on technical feasibility. The economic viability of such systems is highly site-specific and must be evaluated individually by each airport, considering factors such as electricity prices, investment capacity, utilisation rates, and local regulatory conditions. The integration of renewable energy sources, particularly hybrid solar and wind systems, is essential, although grid interaction and storage solutions remain necessary to ensure reliable and cost-effective operation.

In terms of transport, the results clearly indicate that road-based delivery of gaseous hydrogen is currently the most practical and cost-efficient solution for the Baltic Sea Region. This reflects both the relatively low initial demand levels and the decentralized nature of emerging hydrogen infrastructure. At the same time,

the analysis highlights the need to consider future transitions toward liquid hydrogen transport, pipeline integration, or rail solutions as demand increases and infrastructure develops.

Several key conclusions can be drawn. First, airports in the Baltic Sea Region are well-positioned to act as early adopters and anchor customers within emerging hydrogen networks. This is due to their concentrated and predictable energy demand, particularly in ground operations, as well as their ability to provide sufficient space and infrastructure for hydrogen production, storage, and refuelling. By creating a stable and continuous baseline demand for hydrogen, airports can play a crucial role in enabling initial investments in supply infrastructure and supporting the gradual development of regional hydrogen value chains. Second, the lack of mature hydrogen infrastructure such as pipelines requires flexible, modular solutions in the initial phase, with truck-based delivery playing a central role. Third, the successful scale-up of hydrogen supply chains will depend on coordinated development across demand, production, transport, and storage, as well as on supportive policy frameworks and cross-sector collaboration.

Another key conclusion is that the successful implementation of hydrogen at airports in the Baltic Sea Region is less limited by individual technologies and more by the integration of different system components across the supply chain. While demand estimation, local production, transport, and storage have each been shown to be technically feasible when considered individually, the main challenge lies in synchronising these elements in terms of scale, timing, and operational interaction. This includes ensuring that infrastructure investments are phased in line with real demand growth. As a result, hydrogen deployment at airports should be approached not as a set of isolated solutions, but as an integrated system that requires coordinated planning, cross-sector collaboration, and adaptive implementation strategies.

Overall, the synthesis highlights that a phased development pathway is essential: starting with small-scale, flexible solutions for ground operations, expanding

through scalable local production and logistics systems, and ultimately enabling large-scale hydrogen to be used in aviation. By aligning these elements, airports in the Baltic Sea Region can not only decarbonize their own operations but also contribute to the broader development of a regional hydrogen economy.

Supply Chain



SYNTHESIS REPORT OF WP 1.2 SUPPLY CHAIN
10.08.2026