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LIHYP

Market exploration of hydrogen filling station Groningen Airport Eelde

Report

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Work Package 2: Pilots
Lead Partner: New Energy Coalition (Netherlands)
Project: LIHYP – Linking Hydrogen Power Potentials

Document Control and Version History

Date	Version	Status	Initials	Changes Marked
1 May 2025	1	Final		

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1 Management Summary

The use of hydrogen vehicles in the Netherlands is still limited, although the number of vehicles is gradually increasing. At present, hydrogen is mainly considered for buses and heavy road transport, while electric battery technology continues to dominate, especially in the public transport sector within the Groningen and Drenthe region. For heavy transport, the available choice of hydrogen trucks remains small, although manufacturers are expected to introduce more models after 2025. There is still uncertainty regarding whether these future vehicles will use gaseous or liquid hydrogen.

Hydrogen fuel cell trucks are currently more expensive to purchase and more sensitive to disruptions than battery electric trucks. Hydrogen combustion engine trucks are expected to be more robust and more competitively priced, although their development is less advanced. Because of these factors, the wider transition towards hydrogen in transport is still in an early stage. In the period between 2025 and 2030, the market is expected to become clearer as commercialisation progresses.

There are opportunities for hydrogen in situations where charging infrastructure is difficult or costly to realise, for example because of congestion in the electricity grid. In such cases, hydrogen can offer a practical alternative. However, financial support is required to help mitigate the additional costs that follow from limited infrastructure availability and the higher current cost of hydrogen vehicles.

It is expected that hydrogen trucks may become commercially viable within three to five years, particularly for logistics companies with larger fleets, government vehicles and operators linked to zero emission commitments. Opportunities may also arise from regional cooperation and government policy, including subsidy programmes. The development of a public transport hub at Groningen Airport Eelde could provide an opportunity to combine refuelling activities with public transport services.

At this moment, a hydrogen refuelling station at Groningen Airport Eelde would not be financially viable without subsidy support. To make progress, the airport should continue to work closely with regional authorities and transport sector partners. Forming a consortium with local carriers is also essential when applying for national subsidy schemes. In addition, the station should be integrated as a broader energy refuelling facility, rather than focusing solely on hydrogen. Existing technologies would help balance the business case during the period in which hydrogen demand is still developing.

2 Glossary

Abbreviation	Meaning
BEV	Battery Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
H2 ICE	Hydrogen Internal Combustion Engine

3 Relevance of this market exploration

Groningen Airport Eelde is progressing its sustainability agenda within the NXT Airport Project. The project drives innovation in aviation and aims to create an energy hub on the airport site. Hydrogen is central to these ambitions. A key initiative is the development of a hydrogen ecosystem at the airport, in which hydrogen is produced, stored, distributed, and used for a range of aviation applications.

A hydrogen refueling station is an important new link in this hydrogen ecosystem on the airport grounds. TEAL Mobility plans to establish such a refueling station just outside the airside area. The facility will be accessible to vehicles operating on the landside as well as to aircraft and ground support vehicles on the airside of the airport.

4 Assignment

Groningen Airport Eelde commissioned Royal HaskoningDHV to map the market demand for hydrogen fuel at the planned hydrogen refueling station at Groningen Airport Eelde, including relevant developments that may influence this demand. We conducted a desk study, interviewed selected experts and stakeholders, and applied expert judgement. This report analyses the following components.

1. A market analysis and an inventory of potential landside users.

2. Perceptions of potential users regarding hydrogen as a sustainable and efficient alternative to conventional fuels.

3. An examination of the main factors that drive interest and willingness of potential users to refuel at GAE.

4. An overview of several relevant future developments.

5. Conclusions and recommendations.

5 Methodology

The market exploration presented in this report is based on several sources of information, as outlined in the schematic of the proposal:

Step 2a, desk research, see the sources on the last page.

Step 2b, interviews.

1. **Public Transport Groningen Drenthe**, Arjo Tibben,
2. **OV-bureau Groningen Drenthe**, Peter Mul
3. **Province of Groningen**, Klaas Stadens
4. **Green Planet Pesse**, Edward Doorten
5. **TLN**, Rob Aarse and Jan de Haan
6. **Province of Drenthe**, Dirk Schaap and George Zonderman.

The information collected is analysed by our experts in hydrogen for road transport and aviation. Their findings are consolidated in this report.

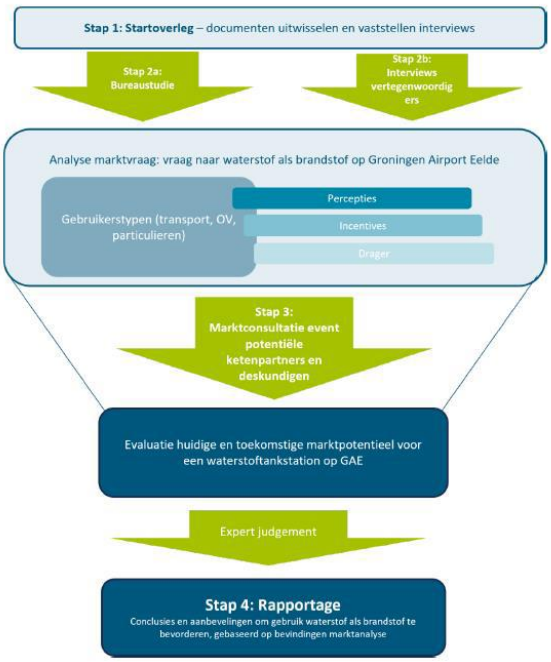

Figure 1 – Methodology

6 Perspectives of Potential Landside Users

The share of zero emission vehicles in the Dutch transport sector continues to grow. The vast majority of these vehicles are battery electric. Hydrogen powered vehicles still represent only a small proportion of the total, but the number has risen steadily in recent years. Most hydrogen vehicles currently in use are passenger cars rather than heavy transport vehicles.

For freight transport, the limited number of hydrogen vehicles is mainly due to a lack of available vehicle models. Manufacturers are working on new hydrogen truck platforms and several models are expected to become available after 2025. It is currently not yet clear whether these trucks will refuel with gaseous or liquid hydrogen. The preferred technology is still in development and depends partly on progress in storage and refuelling infrastructure.

Hydrogen fuel cell trucks are significantly more expensive than battery electric trucks and they are more sensitive to disruptions caused by variations in hydrogen quality. As a result, operators currently face higher operational risk. Hydrogen combustion engine trucks are expected to be more competitively priced and more robust in operation, although this technology is less developed and not yet widely commercialised.

For passenger cars, the number of available hydrogen models remains limited. The main advantage of hydrogen powered cars lies in longer driving ranges at consistent speeds, particularly on longer regional or international routes. For daily commuting and short distances, battery electric cars remain more common due to infrastructure availability and lower energy loss in the supply chain.

Hydrogen offers opportunities in specific public transport contexts. In the Groningen and Drenthe region, buses are predominantly battery electric, complemented by a fleet of hydrogen buses. Hydrogen can play a greater role on longer distance routes with limited layover time, where charging is difficult to organise. In addition, hydrogen powered minibuses can offer advantages in pupil transport, where vehicles are parked at drivers' homes and charging points cannot always be provided due to grid congestion and staff turnover.

Subsidies play an important role in lowering the financial threshold for adopting hydrogen vehicles. They can also help socialise part of the cost associated with grid congestion, where companies are

unable to secure grid capacity for charging. The role of subsidies is therefore not only financial, but also strategic in shaping the early market environment for hydrogen mobility.

Freight transport	Hydrogen can be relevant for heavy-duty transport where vehicle weight and range requirements make electrification difficult. It is also suitable for specialized equipment that cannot be electrified and for routes where charging time or charging infrastructure is not practical.
Passenger transport	For passenger vehicles, hydrogen becomes attractive on long-distance and international routes at higher speeds, where battery-electric solutions may face limitations in range and charging convenience.
Public transport	In regional public transport, such as Qliner services, hydrogen can offer an advantage on long routes with limited opportunities to charge during the day.
Contracted pupil transport	Hydrogen can also play a role in pupil transport services where vehicles are taken home by drivers, since home charging is not always feasible and depot charging may not be accessible.

Table 1 - Opportunities per user category

7 Potential landside users

7.1.1 Zero-emission vehicles

For zero-emission transport, the main options are battery-electric vehicles or hydrogen-powered vehicles.

There are two ways a vehicle can run on hydrogen. One approach uses hydrogen as a direct fuel for an internal combustion engine, similar to engines that run on compressed natural gas. The other approach is fuel cell technology, in which hydrogen is converted into electricity to power the vehicle. In that case, the fuel cell can also function as a range extender for an electric drivetrain, which allows longer distances to be covered.

In 2023, 688 hydrogen vehicles were registered with the RDW out of a total fleet of more than twelve million vehicles. In the chart to the right, the hydrogen category is therefore not yet visible as a separate segment.

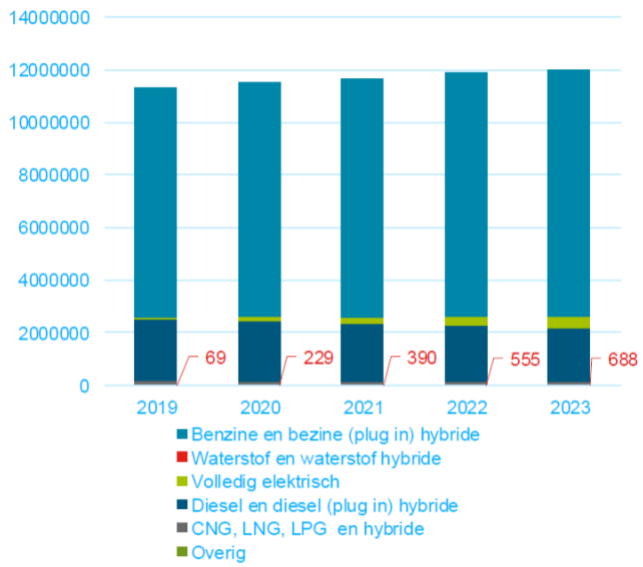

Figure 2 – Development of number of vehicles

7.1.2 Hydrogen vehicles in the Netherlands

Since 2019, the number of (hybrid) hydrogen vehicles in the Netherlands have increased from 69 to 688 in 2023, excluding buses. In a total fleet of around twelve million vehicles, this remains very small, although the trend is upward.

The number of goods vehicles increased from ten in 2019 to forty in 2023, which is 5.8 percent of the total number of hydrogen vehicles.

Most hydrogen vehicles currently on the road, around 86 percent, are passenger vehicles with fewer than nine seats. The limited share of goods vehicles is mainly due to the still limited availability of suitable models on the market.

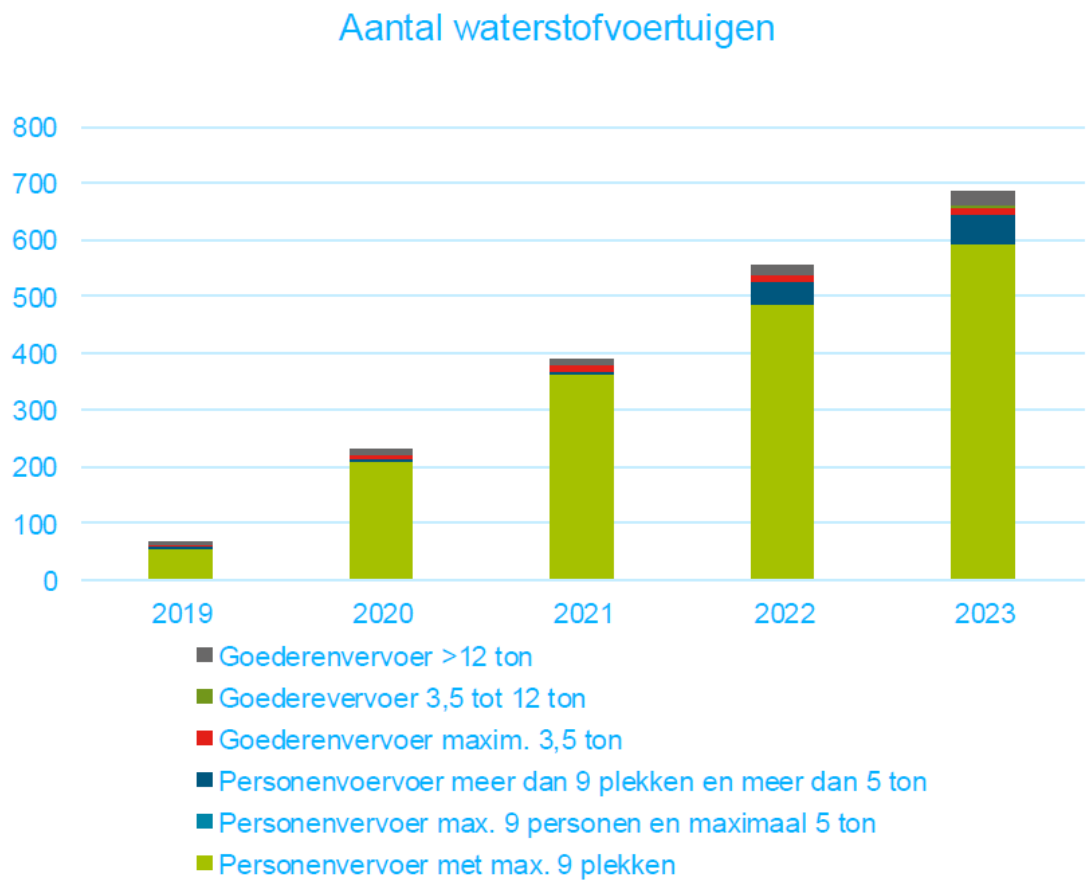

Figure 3 – Development of number of hydrogen vehicles

7.1.3 Expected development of hydrogen vehicles

The number of hydrogen vehicles in the Netherlands has been rising since 2019. This is linked to the introduction of hydrogen vehicles in several categories, including passenger cars and public transport buses, as shown in the accompanying figure. For goods transport, the first suitable models have only recently entered the market.

For most vehicle categories, hydrogen technology has only just been introduced and the path toward commercial deployment is at an early stage. Between 2025 and 2030 it will become clearer whether the expected potential of hydrogen will be realised.

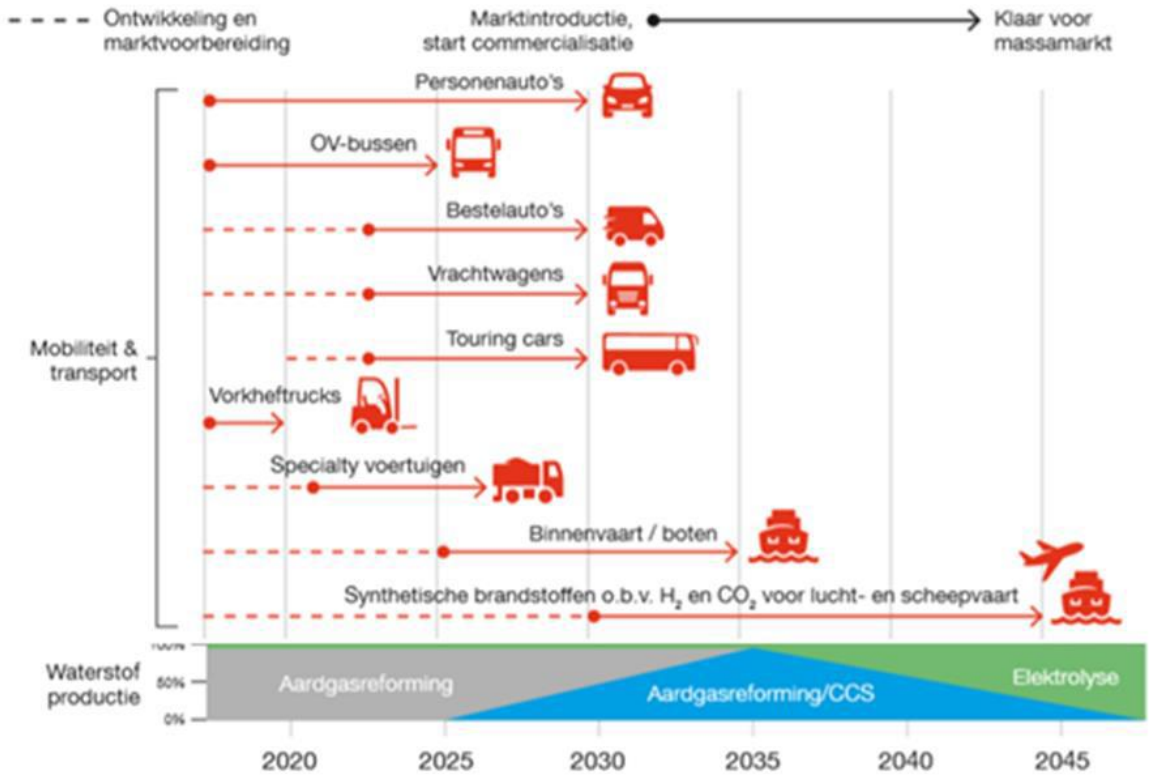

Figure 4 – Development and market commercialisation of hydrogen vehicles

7.2 Hydrogen trucks

7.2.1 Development of hydrogen trucks

Several manufacturers are currently developing new hydrogen-powered vehicles. From the interviews, the following developments for hydrogen fuel cell trucks emerged.

MAN has sold fifteen hydrogen trucks, the MAN hTGX, which can be delivered in the autumn of 2025. IVECO is collaborating with Air Liquide on the development of a fuel cell vehicle. Hyundai can supply vehicles in limited numbers. Mercedes and DAF are still in the development phase, with the DAF model expected in 2028.

Overall, the rollout of hydrogen trucks is growing. The choice between gaseous or liquid hydrogen for the new vehicle models has not yet been made by industry. Based on the interview with TLN, it is still unclear which option will become the most likely route.

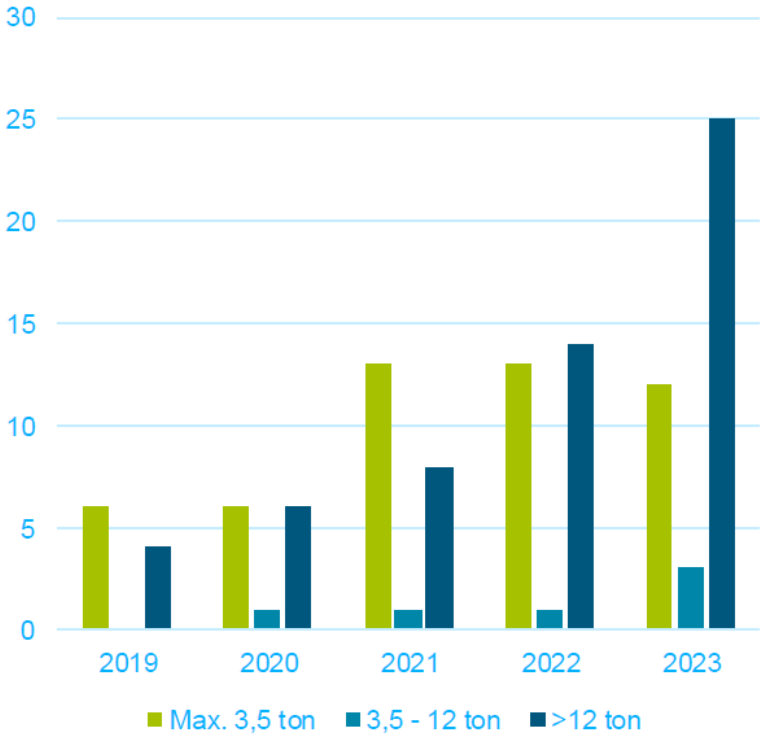

Figure 4 – Number of hydrogen transport trucks

7.2.2 Cost of hydrogen trucks

A further explanation for the currently low number of hydrogen vehicles in freight transport is the cost level. The interviews with TLN indicate the following indicative purchase prices. A diesel tractor that meets Euro VI standards costs about one hundred thousand euro. A vehicle with a hydrogen

combustion engine is expected to cost around two hundred fifty thousand euro. A battery electric truck is roughly three hundred fifty thousand euro. A truck powered by a hydrogen fuel cell is about five hundred fifty thousand euro. Vehicles with a hydrogen combustion engine are not yet widely available on the market.

Battery electric vehicles currently receive more consideration because the technology is already proven. Hydrogen powered vehicles are still in rapid development. As a result, technology can become outdated within a short period, which affects depreciation and residual value. In addition, a complete and reliable dealer and maintenance network for hydrogen vehicles is not yet in place.

The current kilogram price of hydrogen is still too high to compete with charging electric vehicles or driving on diesel, although over time it is expected to become comparable per kilometre to electric driving.

From the interviews it appears that bulk hydrogen will likely not be available in the Northern Netherlands before 2026.

Operating costs per kilometre for hydrogen vehicles are currently relatively high. Smaller operators are therefore hesitant. Opportunities lie more with carriers that run larger fleets, where sustainable entrepreneurship is decisive. These are companies looking for room to experiment, often starting with a small number of vehicles. According to TLN, such companies are not currently coming forward from the Northern Netherlands.

The costs and availability of electric charging infrastructure can influence the choice for hydrogen trucks, since grid congestion is putting pressure on charging capacity.

It is expected to take at least three to five years before hydrogen trucks can potentially be profitable. Near term opportunities are in logistics including supermarkets, organisations participating in the Green Deal for Zero Emission, and government fleets. Realisation will depend heavily on public policy, both purchase subsidies and regulation of access to city centres through zero emission zones.

7.2.3 Outlook for freight transport based on current developments

There are opportunities for heavy-duty transport, for vehicles that are difficult to electrify and for routes with limited time available for charging to shift to hydrogen-powered vehicles. For shorter distances and routes where charging time is available, battery electric vehicles remain the more logical option for now. If the purchase price and cost per kilometre of a hydrogen combustion engine fall, this balance may change.

A favourable market outlook is essential for making the Netherlands a priority market for international truck manufacturers. Government subsidies and coordinated demand development contribute to this.

Grid congestion is already creating challenges for companies that want to install charging infrastructure. Hydrogen vehicles could help address this issue by providing an alternative to charging. In the longer term, hydrogen mobility can also contribute to relieving pressure on the electricity network by shifting part of the demand from charging to refuelling.

It is reasonable to expect that the number of hydrogen vehicles will continue to grow and eventually form a defined share of the market. The scale and timing of this growth depend on the availability of suitable vehicles and the factors described above.

7.3 Passenger transport

7.3.1 Development of passenger transport

At present there are only a few car brands that offer hydrogen passenger vehicles on the market. The Hyundai Nexo and Toyota Mirai are currently available. Manufacturers such as BMW, Honda, Mercedes and Audi are developing new models or adapting existing models to run on hydrogen.

Hydrogen cars are more expensive to purchase than electric alternatives. Organisations that choose them often do so to support and promote hydrogen mobility, for example Resato and Enexis.

Existing models typically carry around 5.6 kilograms of hydrogen and offer a range of about 560 to 660 kilometres. This is higher than most electric cars, although the difference is gradually narrowing as battery-electric vehicles improve. Hydrogen remains particularly advantageous for long-distance travel at higher driving speeds.

Hydrogen cars are less efficient in their total energy chain than electric cars. Battery-electric vehicles use around seventy-seven percent of the supplied energy, compared to about twenty-seven percent in a fuel cell vehicle.

Refuelling infrastructure is still limited and the rollout is progressing slowly. As a result, the chicken-and-egg situation persists.

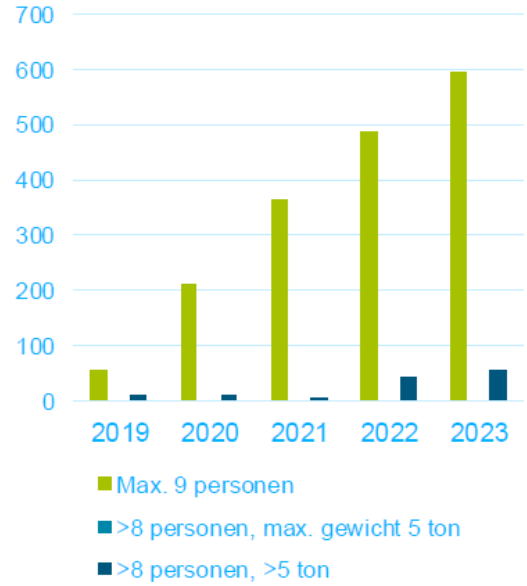

Figure 5 – Number of hydrogen passenger transport vehicles

7.4 Public transport

7.4.1 Development of public transport

Public transport in the Groningen area is mainly operated electrically, with 158 buses compared to 30 hydrogen buses. Hydrogen is primarily refuelled at a dedicated Shell station on the bus depot at Peizerweg in Groningen.

There is willingness to refuel more buses at additional locations, although this depends on vehicle types, station locations, and the ability to use waiting time in combination with cleaning. Opportunities to switch depend on the route profile.

Route type matters. Longer services such as Qliners to Emmen or Heerenveen are promising, because their distance and short breaks make them less suitable for battery electric operation.

Cost per kilometre is decisive. Once hydrogen becomes cheaper per kilometre than other options, deploying hydrogen becomes more attractive.

Creating a public transport hub at the airport could be a valuable coupling opportunity, combining layovers with refuelling, provided it fits the route schedule.

The next vehicle tender is not expected before 2040, although earlier replacement of existing buses with new hydrogen, including hybrid, models is possible.

In the meantime, a number of buses with a hydrogen range extender could be considered, which might refuel at Eelde.

Because charging points are located within built-up areas, they require large grid connections, which are scarce due to grid congestion.

New Groningen–Drenthe concession is expected around mid 2026. It is still too early to define sustainability requirements or the potential role of hydrogen.

For target group transport and small scale public transport, suitable hydrogen vehicles are scarcely available, so sustainability ambitions will likely be met with battery electric vehicles.

Stellantis and HYVIA, as well as Dutch converters, have hydrogen vans on offer.

Given the driving profile, there is a clear opportunity in pupil transport. These services are often driven by chauffeurs who keep the vehicle at home between trips. It is not feasible to provide every driver with a charger, due to relatively high staff turnover and grid congestion, so charging becomes a barrier. Hydrogen refuelling can then be a practical route to decarbonise these vehicles.

8 Incentives for users

For delivery vans, freight transport and public transport there is a clear sustainable business case for hydrogen vehicles. The government can strongly influence the pace of growth, particularly in publicly funded services and tendered services such as public transport and target group transport. The government can also shape the development of light and heavy road transport through policy and subsidy measures.

In the coming years the focus will be on heavy transport, public services, public transport and target group transport. The most immediate potential lies in public transport, while opportunities for heavy transport are expected to increase after 2025.

For users, the availability of vehicles that match operational profiles and the cost per kilometre are the decisive incentives and preconditions for adopting hydrogen vehicles.

Government influence on the growth rate in passenger, light and heavy transport is limited, even though the greatest demand for hydrogen is expected in these segments. The government does have significant influence over vehicles used in public services and its own fleets. Although the demand volume in these fleets is relatively small, a hydrogen fleet could help make a regional refuelling station economically viable at an earlier stage.

The Province of Drenthe has expressed a clear ambition to support the development of hydrogen. They are open to taking initiative and contributing, for example through provincial co-financing, as stated by Dirk Schaap. Interest is also increasing from the perspective of grid congestion. However, the availability of qualified staff for hydrogen operations is currently a challenge.

The European Union has designated the Northern Netherlands as the first Hydrogen Valley. Under the HEAVENN project, work is underway on knowledge development, integration of hardware and software, ecosystem formation and long term impact. The total EU budget available for this programme is approximately eighty-five to ninety-five million euro.

The Province of Groningen has prepared a subsidy scheme. After the national government introduced the subsidy programme Stimulering Waterstof in Mobiliteit (SWIM), the provincial scheme has been put on hold pending further alignment.

8.1.1 SWIM subsidy

The national SWIM scheme concerns an application from a consortium that includes one refuelling station and several transport operators that commit to using hydrogen trucks or vans. The aim is to ensure enough demand from the start to make the station viable. In practice this means an average of around ten to fifteen hydrogen trucks.

The expectation is that this national scheme will result in about forty new hydrogen refuelling stations and several thousand hydrogen vehicles.

The SWIM scheme is a tender. It covers eighty percent of the financial gap. Subsidies are awarded based on the amount of CO_2 avoided per euro of subsidy. This means that additional local subsidies improve the score and increase the likelihood of the subsidy being granted.

Stations located at urban junctions or along major corridors receive a higher score. Because Groningen already has a hydrogen refuelling station, the location at GAE does not provide an advantage in the ranking.

TEAL Mobility has decided not to form a SWIM consortium in Eelde for now, as it is not expected that the minimum daily offtake requirement of thirty percent, which is at least five hundred kilograms per day, can be met.

It has recently been announced that Green Planet in Pesse has successfully applied for this scheme and will receive 7.5 million euro.

9 Key factors

Key factors that drive interest and willingness of potential users to refuel at Groningen Airport Eelde are:

- **Location**
  Hydrogen offers advantages over electric vehicles because it enables longer driving ranges than battery electric. A large share of potential users will therefore operate along major motorway corridors. GAE is at a relatively short distance from the A28.
- **Vehicle supply**
  Availability is still limited, especially for freight vehicles. Sensitivity to faults and the convenience or inconvenience of repair and maintenance for FCEVs also play a role.
- **Price**
  Margins in transport are thin. On a per kilometre basis, hydrogen vehicles are more expensive than battery electric. The advantages of hydrogen, such as the larger range, do not outweigh this because they cannot be monetised on relatively short routes and due to mandatory rest times.

10 Future developments

The rollout of hydrogen in mobility supports a faster transition to a sustainable energy system, with green hydrogen as an energy carrier.

Hydrogen can also help address grid congestion. By using hydrogen instead of electric charging, charging points at key locations in the built environment become less necessary, which frees up grid connections. Because electrolysis for hydrogen can take place decentrally, production does not draw on grid capacity at those crucial urban locations.

Due to grid congestion, operators cannot always add fast chargers to their existing connections. This societal burden for companies that need to purchase vehicles should not rest solely with them. Hydrogen could therefore help prevent further growth in grid demand. For now, hydrogen vehicles are still more expensive than battery electric vehicles. The costs of avoiding grid congestion by switching to hydrogen could be socialised.

An increase in available models, including trucks, passenger cars and special vehicles, can stimulate market progress.

11 Conclusions and recommendations

The limited availability of suitable vehicles is currently the main factor slowing the shift to hydrogen. For most vehicle types, hydrogen models have only recently entered the market, and commercial uptake is only just beginning. Between 2025 and 2030 it will become clearer whether the potential of hydrogen will be realised.

Stimulating the use of hydrogen in mobility is largely outside the direct influence of Groningen Airport Eelde. The recommendation for the airport is to continue building connections with governments and relevant market parties.

A fully commercially operated hydrogen refuelling station at Groningen Airport Eelde is not yet feasible. Subsidies are required to cover the non-viable portion of the business case. TEAL Mobility has already obtained subsidies for this purpose. The national SWIM programme offers an additional opportunity to support the investment. If TEAL Mobility decides not to use this instrument, that is likely to reflect their own investment priorities and their assessment that other locations may offer stronger near-term potential.

A key condition is the formation of a consortium with local transport operators, brought together by an operator or investor such as TEAL Mobility and supported by Groningen Airport Eelde. TLN could play a role from the sector side to bring potential regional operators to the table. The Province of Drenthe should also be involved to help create external urgency and to support strategic partnerships in the region.

If the decision is made to develop the hydrogen station, it is advisable to design it as an integrated energy station. This would include not only hydrogen but also conventional and low-emission fuels and fast charging. These existing technologies will be essential in the coming years, during which hydrogen vehicle uptake remains uncertain. In addition, on-site battery storage could help address local grid congestion.

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