Interreg Baltic Sea Region

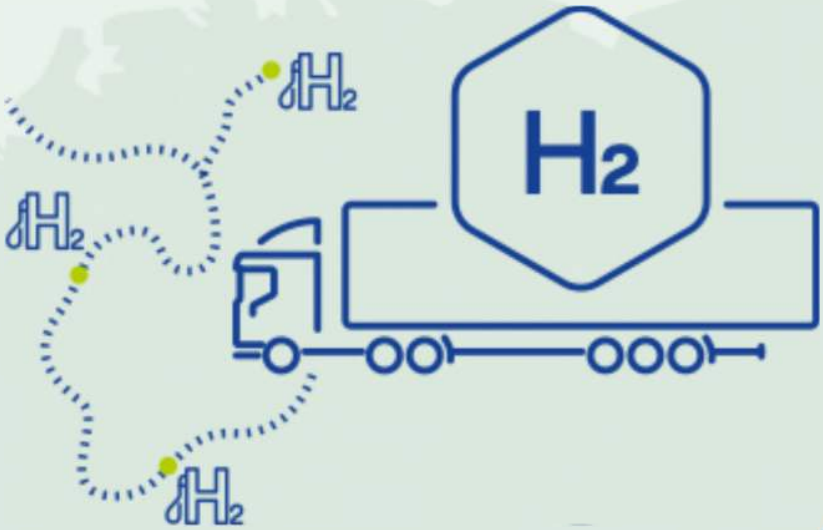
Co-funded by the European Union

SMART GREEN MOBILITY HyTruck

Report

HRS Spatial Development Concept

Rostock Region



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Authors:

Christopher KUTZ, Senior Consultant, Ludwig-Bölkow-Systemtechnik GmbH

Martin ZERTA, Senior Consultant, Ludwig-Bölkow-Systemtechnik GmbH

Sandra GRÄFIN ZU SOLMS-BARUTH, Consultant, Ludwig-Bölkow-Systemtechnik GmbH

Dr Ulrich BÜNGER, Consultant Hydrogen Energy Systems

Ludwig-Bölkow-Systemtechnik GmbH (LBST)
Daimlerstrasse 15 | 85521 Ottobrunn | www.LBST.de

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1.1. Background and motivation

Against the background of European requirements to reduce greenhouse gas (GHG) emissions in the transport sector, heavy-duty transport in particular is facing an enormous challenge. Heavy-duty commercial vehicles are already responsible for 25% of GHG emissions from the transport sector and over 6% of total European CO_2 emissions. In order to change this, on 10 April 2024 the European Parliament officially adopted the stricter CO_2 reduction targets which had already been agreed by the European Commission, Parliament and Council in the trilogue procedure. The new law extends and tightens the existing requirements to almost all new types of heavy-duty commercial vehicles. Accordingly, the targets for reduction of CO_2 emissions are now -45% by 2030, -65% by 2035 and -90% by 2040.[1] Consequently, a significant increase in new registrations of low-emission commercial vehicles in the form of battery-electric as well as fuel cell-electric trucks is required. It should be noted that in the heavy-duty segment (> 12 t permissible total weight, class N3) in particular, the high load to be transported and high vehicle utilization with short downtimes show clear advantages when using fuel cell (FC) vehicles. According to studies for the German Hydrogen Association (DWV),[2] at least 280,000 zero-emission heavy-duty commercial vehicles must be in use by the year 2030 in order to achieve the climate protection targets.

An essential prerequisite for the successful market launch of FC trucks is the availability of a sufficiently dense and comprehensive refuelling infrastructure. The Alternative Fuels Infrastructure Regulation (AFIR),[3] adopted in 2023, forms the regulatory framework in this regard. According to this, a nationwide hydrogen refuelling station (HRS) network is to be built in Europe by the end of 2030. The specifications provide for the construction of hydrogen refuelling stations at all urban hubs as well as every 200 km along the Trans-European Transport Network (TEN-T). It also requires the supply of both, cars and heavy-duty commercial vehicles, which should be ensured by the minimum requirements of at least a 700-bar pump and a minimum quantity of 1 tonne of hydrogen per day.

[1] MEPs adopt stricter CO2 emissions targets for trucks and buses, 10/ 04.2024, link.
[2] LBST on behalf of the German Hydrogen Association: Update of the Study of Hydrogen Mobility in Germany: Environmental Analysis January 2024, link.
[3] Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU, link.

The Ministry of Economics, Infrastructure, Tourism and Labour Mecklenburg-Vorpommern (WMMV) initiated the Interreg B project "HyTruck" in 2022, with the aim of conceptual development of a transnational hydrogen refuelling station infrastructure to ensure emission-free heavy-duty traffic in the Baltic Sea Region.[4] As part of the project, various principles and instruments were laid for the development of this HRS network. These instruments are now to be tested in a second project phase on the basis of five pilot regions. They also shall potentially be further developed for future users from the public sector, planners and refuelling station operators. By combining the partial spatial concepts, an infrastructure corridor for hydrogen-powered heavy-duty transport from Rostock via Berlin to Tallinn or Helsinki will be created. The planning principles developed in the project for a truck HRS network in the eastern part of the TEN-T network will also serve as support for the public sector, planners and refuelling station developers on the ground.

The present study focuses on the German pilot region of Rostock. This includes in particular the region around the Hanseatic city of Rostock, starting from the port of Rostock, along the A19 federal motorway into the area of the A19/A20 motorway junction near Laage in the district of Rostock. Further discussions also cover the transport corridor up to the German-Polish border.

Other HyTruck pilot studies include the following:

- Poznan/Wielkopolskie pilot region, Poland
- Kaunas and Panevezys pilot region, Lithuania
- Vidzeme pilot region, Latvia
- Helsinki region, Finland

1.2. Methodological approach

Pilot implementation plan from the HyTruck project

In order to ensure a high degree of consistency between the five pilot regions, the following structure is based on the specifications of the "Regional pilot implementation plan" (D2.1, June 2024 version), which was created in the HyTruck project. The aim is to ensure uniform and comparable documentation of the results in order to be able to create a supra-regional concept in a further step.

[4] The Interreg B project "HyTruck" - development of a transnational hydrogen refuelling station network for heavy-duty transport in the Baltic Sea region is being coordinated by the Ministry of Economics, Infrastructure, Tourism and Labour Mecklenburg-Vorpommern as lead partner and has a project duration from January 2023 to December 2025 with a project budget of 2.6 million euros.

The processing is then carried out in five sub-steps:

1) HRS preparedness analysis for the Rostock pilot region – Chapter 2

The description of the current initial conditions in the pilot region of Rostock for the development of a hydrogen refuelling infrastructure for heavy-duty traffic is based on a summary of the current legal and political framework conditions as well as the current state of development of hydrogen refuelling stations in the region.

The selection or identification of potentially suitable refuelling station sites in the pilot region was carried out with the help of the Digital Spatial Planning Toolkit of the University of Tartu (EE) (D1.1 Digital spatial planning toolkit) as well as available preparatory work and information (e.g. on possible anchor customers and generation locations), supplemented by in-depth regional analyses and feedback from the stakeholder dialogue (see below).

Whenever relevant, other tools developed in the HyTruck project were also included in the analyses.

2) HRS stakeholder dialogue – Chapter 3

In addition to direct communication with stakeholders, two stakeholder workshops took place (July and September 2024 in Rostock):

1st workshop on 17 July 2024 in Rostock

Objective: Strategic planning and selection of possible principal sites

2nd workshop on 11 September 2024 in Rostock

Objective: Discussion of individual sites and assessment based on criteria for suitability as an HRS site

3) HRS neighbourhood analysis – Chapter 4

The so-called neighbourhood or macroanalysis provides an outlook on the situation and potential with regard to the HRS infrastructure along the corridor from the pilot region of Rostock to the German-Polish border. This facilitates the integration of the five pilot regions into a complete concept.

4) HRS spatial development concept – Chapter 5

The main findings of the pilot study as well as the recommendations derived therefrom for further elaboration of the spatial planning concept within the framework of the HyTruck project are conclusively summarised.

5) Evaluation of tools developed in WP 1 for HRS development – Chapter 6

Separate from the other work packages, in a subsequent step, comments and assessments regarding the design and experiences from the use of the different HyTruck concepts in the specific application of the pilot study are collected. From the authors' point of view, the indications and recommendations can contribute to a further strengthening of the "toolbox" and thus improve its future role in the future planning of the HRS infrastructure for use by regional actors.

2. HRS Preparedness Analysis

2.1. HRS legal and policy framework

2.1.1. Regulatory background/framework

In Germany, there are various direct and indirect regulatory influencing factors that promote the introduction of hydrogen as an energy source for low-emission vehicles and the provision of corresponding refuelling stations. European requirements in the form of regulations and directives as well as their implementation in national law are relevant in this regard.

Direct influencing factors, i.e. aspects that directly promote the use of low-emission energy sources such as hydrogen, include CO_2 pricing, the CO_2 toll for trucks, and potential revenues from a future GHG quota system. In addition, there are regulations on indirect factors aimed either at the introduction of zero-emission vehicles or the development of a refuelling infrastructure. These are the Clean Vehicle Directive (CVD), the Alternative Fuel Infrastructure Regulation (AFIR) and CO_2 fleet specifications. Mention should also be made of the amendment to the Directive on Weights and Dimensions for Heavy-Duty Vehicles, which is intended to regulate the use of heavy and larger commercial vehicles in Europe.

1) CO_2 pricing (German Fuel Emissions Trading Act, BEHG)

Under the BEHG, companies that supply heating oil, natural gas, petrol or diesel to the market have been obligated to pay a CO_2 price per tonne since 1 January 2021. In 2024, the price was at €45/t CO_2 and will increase to €55/t CO_2 for 2025. A price corridor of between €55 and €65/t CO_2 is then set. From 2027, European emissions trading will also be extended to the transport and building sectors, thus replacing national CO_2 pricing.[5]

The corresponding additional costs for CO_2 certificates are allocated to the fuel costs by importers, manufacturers or wholesalers. According to estimates by the FleetGo portal, the additional costs over a distance of approximately 100 kilometres, taking into account the emission values of 2,650 g CO_2/litre of diesel for the year, can be calculated approximately as follows:[6]

- Light commercial vehicle with a total weight of 3.5 t: 1.07 euros
- Light truck with a total weight of 7.5 t: 1.95 euros

[5] The Federal Government (2024): CO_2 price rises to 45 euros per tonne, 1 January 2024, available at https://www.bundesregierung.de/breg-de/aktuelles/co2-preis-kohle-abfallbrennstoffe-2061622.
[6] FleetGo (2024): CO_2 tax: 15 July 2024, available at: https://fleetgo.de/kb/glossar/c/co2-steuer/.

- Medium-duty truck with a total weight of 16 t: 2.42 euros
- Articulated vehicle with a total weight of over 20 t: 3.70 euros
- Heavy truck with a total weight of 40 t: 3.90 euros

In contrast, diesel consumption is around 9 L/100 km (light commercial vehicles), around 25 L/100 km (medium-duty trucks/articulated vehicles with a payload of up to 16 t) and up to 38 L/100 km (heavy trucks, 23.5 tonne payload).[7] Assuming a diesel price for large consumers of 167.6 cents[8] (01/2024-10/2024), this would result in additional costs of approximately 6% for trucks with a total weight of 40 t or a 23.5 t payload.

The pricing therefore makes zero-emission fuels more attractive than fossil fuels. At current hydrogen prices >10 €/kg and a consumption of around 5.5-7 L/100 km, however, the CO_2 prices so far do not appear to be sufficient[9] to make it competitive as an alternative fuel. In direct comparison, the fuel costs for a hydrogen truck would thus be more than twice the figure of a diesel truck.[10]

2) CO_2 differentiated truck toll

The "truck toll" was introduced in Germany in 2005 and has been revised several times since then. It is levied as a route-related road toll for certain commercial vehicles and applies on German federal motorways and federal roads. The legal implementation on the basis of Directive 1999/62/EC on the charging of heavy goods vehicles for the use of road infrastructure (also known as the “Eurovignette” Directive) is anchored in the Federal Highway Trunk Toll Act (BFStrMG).

Since 01 July 2024, all vehicles intended for freight transport whose technically permissible maximum laden mass (TPMLM) exceeds 3.5 t have been subject to tolls.[11] Excluded from the toll are vehicles that do not emit emissions locally, i.e. battery-powered and fuel cell-powered heavy-duty vehicles and, under certain conditions, also vehicles with hydrogen combustion engines. On the contrary, vehicles powered by (advanced) biofuels or e-fuels are not considered zero-emission.

However, by implementing the amended Eurovignette Directive (Directive (EU) 2022/362), zero-emission commercial vehicles can be completely exempted from tolls until 31 December 2025 at the latest. From

[7] See for example https://www.webfleet.com/de_de/webfleet/blog/so-viel-kraftstoff-verbrauchen-lkw/.
[8] Average price of diesel fuel in Germany for October 2024 (refuelling station). Source: Statista.
[9] Field report by Mr Duden / GPJoule on Hyundai XCIENT fuel cell truck at 2nd stakeholder workshop, 11/09/2024 in Rostock.
[10] Estimate: hydrogen: approx. €72/100 km vs. diesel: approx. €33/100 km. Assumptions: hydrogen: consumption 6 kg/100 km at €12/kg vs. diesel: consumption 20 L/100 km at €1.67/L.
[11] NOW (2024): Factsheet: Truck toll – What does it mean for climate-friendly commercial vehicles, 2024-09, available at https://www.now-gmbh.de/wp-content/uploads/2024/09/NOW-Factsheet_Lkw-Maut.pdf.

2026 onwards, this will only be possible long-term for zero-emission vehicles up to 4.25 t. Additionally, it is nevertheless possible to reduce infrastructure fees for zero-emission heavy-duty vehicles by up to 75%. According to NOW GmbH, the cumulative toll savings of zero-emission trucks compared to diesel trucks (Euro VI) will be up to €160,000 from 2024.[12]

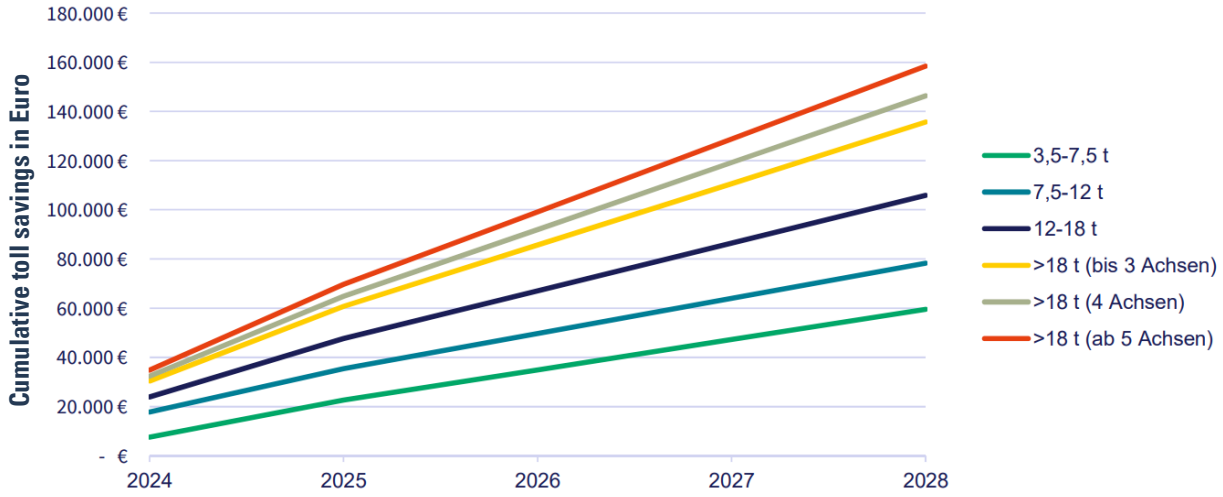


Figure 1 Depiction of the cumulative toll savings of zero-emission trucks compared to diesel trucks (Euro VI) from 2024 (Source: Lohrer (NOW)[13]).

According to data from Toll Collect, only 528 trucks in Germany are currently exempt from tolls (pure electric drives, including hydrogen). This corresponds to a proportion of only about 0.07% based on the approximately 800,000 commercial vehicles operated in Germany (>7.5 t).[14]

3) Revenues from GHG quota trading

In addition to CO_2 pricing, the GHG reduction quota is an important lever to reduce GHG emissions in the transport sector. According to §37a of the Federal Emission Control Act (BImSchG), marketers of fuels in

[12] According to Lohrer, M. (NOW). With a toll mileage of 100,000 km per year and a holding period of five years. NOW's own calculations, toll rates from: Third Act to amend tolling regulations dated 21/11/2023.
[13] Lohrer, M. (NOW) (2024): Current status and outlook of the ramp-up of the hydrogen economy in the transport sector. Presentation at HyWays for Future – Network Meeting on 21/08/2024, available at https://www.energiecluster.de/projekte_aktivitaeten/Hyways%20for%20Future/Netzwerktreffen_21082024/1_NOW_Lohrer.pdf.
[14] Gutmann, D. (Bundesverband Güterkraftverkehr Logistik und Entsorgung (BGL) e.V. BGL-MV, Fachvereinigung Güterverkehr des Landes Mecklenburg-Vorpommern (Gü MV) e.V.): Drive system transition on the road: Hydrogen alternative or open to technology?, Presentation at the 2nd stakeholder workshop of the HyTruck project - Rostock pilot region on 11/09/2024 in Rostock.

the transport sector are obligated to gradually increase the proportion of renewable fuels. The GHG reduction quota will therefore increase from 7% to 25% from 2022 to 2030. If the quota is not reached, a levy of 600 euros per tonne of CO_2 equivalent (§37c paragraph 2 sentence 5 BImSchG) will be due for shortfalls since 2022.

Under certain conditions with regard to sustainability (e.g. direct connection to renewable energy generation or at least 70% CO_2 emission reduction along the entire supply chain compared to a fossil fuel comparison value), hydrogen and other renewable fuels of non-biological origin (RFNBOs) can be credited against the GHG reduction rate in §37a BImSchG.[15] For hydrogen, as well as for renewable electricity, there is currently multiple crediting with a factor of 3 (exception: biogenic hydrogen factor 2).

The GHG quota trading to meet the quota takes place bilaterally between quota-obligated companies and quota service providers. Further information on how hydrogen refuelling stations can also participate in quota trading can be found in, for example, the NOW factsheet on GHG quota trading.[16]

Note: In a current amendment, the new RFNBO quotas in the transport sector defined under the Renewable Energy Directive (RED III) will also be implemented in national law in 2024.[17]

4) Vehicle tax exemption for zero-emission vehicles

A final element for reducing the operating costs of zero-emission vehicles is the exemption from vehicle tax for zero-emission vehicles (§3d Motor Vehicle Tax Act (KraftStG)).

Pure electric vehicles (including hydrogen-powered fuel cell vehicles) that were registered for the first time between 18/05/2011 and 31/12/2025 are exempt from vehicle tax for up to ten years from initial registration. However, the exemption applies until 31/12/2030 at the latest. [18] After expiry of the tax exemption, the motor vehicle tax to be paid will be reduced by 50 percent (§9 paragraph 2 KraftStG).[19]

[15] State Agency for Energy and Climate Protection Bavaria (LENK) (2024): Eligibility of hydrogen for the greenhouse gas quota, June 2024. Available at: https://www.lenk.bayern.de/themen/energiewende/doc/Anrechenbarkeit_von_Wasserstoff_auf_THG-Quote.pdf

[16] See https://www.now-gmbh.de/wp-content/uploads/2024/09/NOW-Factsheet_THG-Quotenhandel.pdf

[17] Federal Ministry for Economic Affairs and Climate Action (2024): Import Strategy for Hydrogen and Hydrogen Derivatives, July 2024, available at https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/importstrategie-wasserstoff.pdf?__blob=publicationFile&v=18.

[18] Federal Ministry of Finance (2020): Reform of the motor vehicle tax - clear incentives for more climate-friendly mobility, 12/06/2020, available at https://www.bundesfinanzministerium.de/Content/DE/Pressemitteilungen/Finanzpolitik/2020/06/2020-06-12-Kfz-Steuer-Reform.html.

[19] Customs (n.d.): Tax incentives for pure electric vehicles, available at: https://www.zoll.de/DE/Fachthemen/Steuern/Verkehrsteuern/Kraftfahrzeugsteuer/Steuerverguenstigungen/Elektrofahrzeuge/elektrofahrzeuge_node.html#:~:text=In%20der%20Zeit%20vom%2018.%20Mai.

5) CO_2 fleet targets

The CO_2 fleet targets will have a major impact on the commercial vehicle market, especially from 2030 onwards.

Regulation (EU) 2019/1242 setting CO_2 emission standards for new heavy-duty vehicles establishes a binding CO_2 reduction target for new heavy-duty vehicles. Thereafter, a reduction of 15% from 2025 and a reduction of 30% from 2030 compared to the reference period 2019/2020 will be prescribed.[20]

These medium to long-term targets were further tightened after a revision in 2024.

As such, the EU Commission, Council and Parliament agreed on new targets for the years from 2030 (45%), from 2035 (65%) and from 2040 (90%). These targets will then apply to heavy trucks over 7.5 tonnes and coaches.[21] [22]

These specifications increase the pressure on vehicle manufacturers to bring a significant proportion of zero-emission commercial vehicles into the market in the coming years. Examples of hydrogen vehicles available today or in the coming years include HYUNDAI Xcient, Paul PH2P (Atego), Enginius BluePower (Econic) (all available for hire purchase or for hire) and the IVECO S-eWay FCEV (planned from 2025).[23] Other vehicles available include FAUN Citipower, as well as the MAN hTGX and IVECO HD FCEV tractor units in the future (both planned for market launch in 2025).[24]

According to the current CleanRoom discussions of NOW and the Federal Ministry for Digital and Transport with leading truck manufacturers, the proportion of zero-emission new vehicles (in the heavy-duty range N3/>12t) will increase to almost 70% of annual sales figures of around 80,000 to 90,000

[20] EUR-Lex: CO2 emission performance standards for new heavy-duty vehicles, available at https://eur-lex.europa.eu/EN/legal-content/summary/co2-emission-performance-standards-for-new-heavy-duty-vehicles.html.
[21] Heavy-duty vehicles: Council and Parliament reach a deal to lower CO_2 emissions from trucks, buses and trailers, 18/01/2024, available at: https://www.consilium.europa.eu/en/press/press-releases/2024/01/18/heavy-duty-vehicles-council-and-parliament-reach-a-deal-to-lower-co2-emissions-from-trucks-buses-and-trailers/.
[22] Lohrer, M. (NOW) (2024): Current status and outlook of the ramp-up of the hydrogen economy in the transport sector. Presentation at HyWays for Future – Network Meeting on 21/08/2024, available at https://www.energiecluster.de/projekte_aktivitaeten/Hyways%20for%20Future/Netzwerktreffen_21082024/1_NOW_Lohrer.pdf.
[23] Duden, O. (GP Joule): Experiences and perspectives – project developer, presentation at the 2nd stakeholder workshop of the HyTruck project - Rostock pilot region on 11/09/2024 in Rostock.
[24] Sommer, M. (H2Mobility): Flexibility and sustainability with hydrogen, presentation at the 2nd stakeholder workshop of the HyTruck project - Rostock pilot region on 11/09/2024 in Rostock.

vehicles by 2030. Overall, the manufacturers' forecasts confirm that sales of electric vehicles with batteries and fuel cells will continue to rise rapidly over the next 5-10 years.[25]

6) Amendment of the Directive on Weights and Dimensions for Heavy Duty Vehicles

A proposal to amend EU Directive 96/53/EC on weights and dimensions of heavy-duty vehicles was also intended to adjust the permissible vehicle lengths, which would, among other things, allow additional space for hydrogen tanks behind the driver's cabin.

As things stand, however, the German Federal Government is not expected to approve these changes. The rejection is justified in particular with reference to the change in the maximum weight for vehicles (especially required for batteries): the higher axle loads of up to 12.5 tonnes and a four-tonne increase in total weight for zero-emission vehicles can therefore "not be supported for infrastructural reasons".[26] From the perspective of the Federal Government, this would ultimately massively interfere with the safety level of the bridges, with severe consequences. In addition, an increase in the vehicle height from 4.00 m to 4.30 m cannot be approved, since neither tunnels including technical equipment such as fans nor bridge passages are designed for such vehicle heights. This would affect both the federal trunk road network and, in particular, the subordinate road network.

Nevertheless, industry associations are in favour of changes to the permissible total weight. For instance, the Gesamtverband Verkehrsgewerbe Niedersachsen e.V. writes: "Still, it is important to use every opportunity to save CO_2 and to increase further eco-efficiency potential in road freight transport. In addition to the conventional articulated truck variants, this also includes the variant of the extended semi-trailer which is particularly successful in Germany."[27]

Two other essential specifications are the Clean Vehicle Directive (CVD) and the Alternative Fuel Infrastructure Regulation (AFIR). Details on both are already included in the HyTruck "Guideline: Building up Hydrogen Refuelling Stations in the Baltic Region". Consequently, both specifications are only briefly discussed below.

[25] NOW-GmbH: https://www.klimafreundliche-nutzfahrzeuge.de/marktentwicklung-klimafreundlicher-technologien-im-schweren-strassengueterverkehr-2024/, accessed on 12/11/2024

[26] Response of the Federal Government (20/12319) to a small inquiry by the CDU/CSU parliamentary group (20/12189), 02/08/2024, available at https://www.bundestag.de/presse/hib/kurzmeldungen-1014618 or https://dserver.bundestag.de/btd/20/123/2012319.pdf.

[27] Fachvereinigung Spedition und Logistik (2024): EU Transport Council postpones decision on weights and dimensions of heavy-duty vehicles, 25/06/2024, available at https://www.gvn.de/gvn-fachvereinigungen/spedition-und-logistik/aktuell/artikeldetails/eu-verkehrsministerrat-vertagt-entscheidung-ueber-masse-und-gewichte-schwerer-nutzfahrzeuge.

7) Clean Vehicle Directive

EU Regulation 2019/1161 specifies minimum quotas for clean vehicles in public procurement. The requirements differ depending on the member country. The implementation in national law had to take place by 2021. In Germany, this was implemented within the framework of the Clean Vehicle Procurement Act of 9 June 2021 (so-called SaubFahrzeugBeschG).[28] As a result, binding minimum targets for the procurement of low-emission and zero-emission cars as well as light and heavy commercial vehicles in public procurement were prescribed for the first time.[29]

The federal states are responsible for compliance with the minimum targets via regulation and assurance of public contracting authorities and sector contracting authorities for their respective territories.

For Germany, this results in quotas of 38.5% for passenger cars and light commercial vehicles (< 3.5 t TPMLM) and 10% or 15% for commercial vehicles > 3.5 t TPMLM for the procurement periods 2021-2025 and 2026-2030.[30] Thus, the quotas in this segment for Germany are higher than those in the other pilot states of the HyTruck project (Latvia, Poland, Finland and Lithuania).

8) Alternative Fuel Infrastructure Regulation (AFIR)

The AFIR (Directive (EU) 2023/1804) sets requirements for the Europe-wide development of a uniform network of electric charging and hydrogen refuelling stations. With regard to the development of a HRS infrastructure, the following essential objectives are defined, among others:

- HRS with a capacity of at least 1 tonne per day every 200 km in the TEN-T core network by the end of 2030
- HRS at each urban hub
- Design for light commercial vehicles and passenger cars as well as heavy commercial vehicles
- Provision of 700 bar hydrogen (if required, also other delivery forms such as 350 bar or liquid hydrogen (LH_2)

[28] German Bundestag, "Act on the implementation of Directive (EU) 2019/1161 of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles and amending procurement regulations".
[29] Federal Ministry for Digital and Transport (2024): FAQ on the implementation of the Clean Vehicles Directive (CVD) in Germany, 29/05/2024, available at https://bmdv.bund.de/SharedDocs/DE/Artikel/G/clean-vehicles-directive-faq.html.
[30] Federal Ministry for Digital and Transport (2024): Act on the procurement of clean road vehicles (Clean Vehicle Procurement Act), 29/05/2024, available at https://bmdv.bund.de/SharedDocs/DE/Artikel/G/clean-vehicles-directive.html.

This results in an estimated minimum number of refuelling stations of about 230 HRS along the TEN-T network and about 424 HRS at the urban hubs for Europe.[31]

According to the current status (October 2024, see Figure 2), only 2 hydrogen refuelling stations with the respective requirements in the TEN-T core network are in operation in Germany (further 6 in realization and 5 in planning). At urban hubs, 19 HRS are currently in operation, out of about 78 refuelling stations required.[32]

However, it should be emphasised that the AFIR only specifies minimum requirements with regard to the HRS network. Based on the ramp-up scenarios adopted in the context of the CleanRoom discussions from 2022 of NOW and the Federal Ministry for Digital and Transport with vehicle manufacturers, a fleet of about 38,000 hydrogen trucks (N3) and other transit traffic and N1 and N2 vehicles would require about 400,000 to 500,000 tonnes of hydrogen annually. Depending on size and capacity, this would result in a need for approximately 550 hydrogen refuelling stations in Germany.[33] This estimation was slightly revised in the context of the latest CleanRoom discussions in 2024. Accordingly, some manufacturers perceive the provisions of the AFIR as "initially sufficient".[34] Therefore, the specified number of HRS would be sufficient for the provisioning of about 10,000 to 15,000 hydrogen trucks, provided that the capacities and system design (including compressors and redundancies) of the HRS are adapted to the continuously increasing demand. As a whole, however, the precise hydrogen demand planning is still in progress.

[31] Lohrer, M. (NOW) (2024): Current status and outlook of the ramp-up of the hydrogen economy in the transport sector. Presentation at HyWays for Future – Network Meeting on 21/08/2024, available at https://www.energiecluster.de/projekte_aktivitaeten/Hyways%20for%20Future/Netzwerktreffen_21082024/1_NOW_Lohrer.pdf.

[32] Beyer, C. (NOW): Activation of hydrogen infrastructure for commercial vehicles - Federal Government view of AFIR requirements, presentation at the 1st stakeholder workshop of the HyTruck project - Rostock pilot region on 17/07/2024 in Rostock; personal communication 08/10/2024

[33] Beyer, C. (NOW): Activation of hydrogen infrastructure for commercial vehicles - Federal Government view of AFIR requirements, presentation at the 1st stakeholder workshop of the HyTruck project - Rostock pilot region on 17/07/2024 in Rostock.

[34] NOW GmbH (2024): Market development of climate-friendly technologies in heavy-duty road freight transport. Available at https://www.klimafreundliche-nutzfahrzeuge.de/wp-content/uploads/2024/11/2024_NOW-Cleanroom-Bericht_web_v2.pdf.

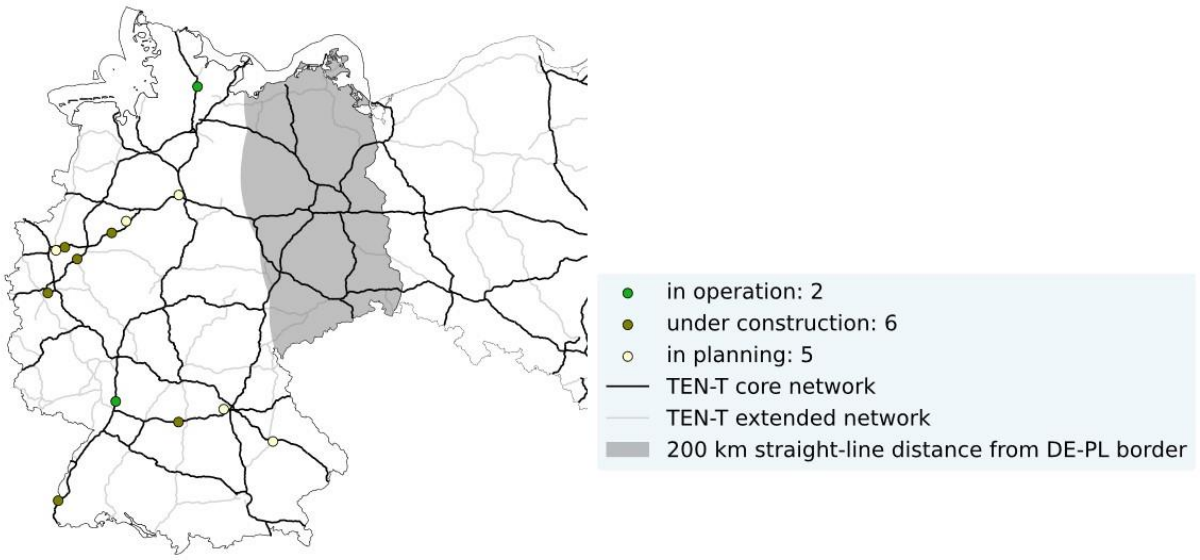


Figure 2: Locations of AFIR-compliant hydrogen refuelling stations in Germany and the border region of Poland (as of 10/2024) (source: Beyer C. (NOW)).

2.1.2. Funding/subsidies

In the context of the use of hydrogen in the transport sector, the National Innovation Programme (NIP) Hydrogen & Fuel Cell Technology should be mentioned as the relevant funding programme in Germany. As part of the 2nd programme phase (Phase II 2016 – 2026, market activation), also called NIP II, the aim was to establish the competitive creation of hydrogen and fuel cell technology in the transport sector. Projects in the field of hydrogen and fuel cell technology were funded, particularly in road, rail, water and air transport as well as in special applications.

As part of NIP II, almost 1.1 billion euros in funding was granted, including 3,444 cars and 7 light commercial vehicles, 106 buses and 146 refuse collection vehicles. 46 public HRS and 15 company HRS were also funded.[35]

Furthermore, the funding programme for climate-friendly commercial vehicles and infrastructure (KsNI) should be mentioned as an important component of German funding policy. In the first two calls for funding as well as a special call, up until now a total of over 960 million euros has been granted for commercial vehicles, refuelling and charging infrastructure and feasibility studies. These included 454

[35] Lohrer, M. (NOW) (2024): Current status and outlook of the ramp-up of the hydrogen economy in the transport sector. Presentation at HyWays for Future – Network Meeting on 21/08/2024, available at https://www.energiecluster.de/projekte_aktivitaeten/Hyways%20for%20Future/Netzwerktreffen_21082024/1_NOW_Lohrer.pdf.

hydrogen fuel cell powered vehicles and 18 HRS. In recent years, KsNI-funded vehicles even accounted for the majority of new registrations in the segment of climate-friendly commercial vehicles over 12 t permissible total mass.[36]

When describing the funding situation in Germany, particular consideration must be given to the consequences of the continuing tense budgetary situation and the strategic realignment of NOW (originally NOW – National Organisation for Hydrogen and Fuel Cell Technology) with a stronger focus on the topic of electromobility and charging infrastructure. According to a statement by NOW from September 2024, these will now be dealt with as a "priority", while "topics relating to other energy sources (in particular hydrogen and e-fuels) will be further processed in order to maintain the strategic linkage capacity."[37]

In July 2024, for instance, in response to a small inquiry in the Bundestag on the promotion of climate-neutral commercial vehicles, the Federal Government announced that, due to the necessary budgetary consolidation according to the judgment of the Federal Constitutional Court of 15 November 2023, no new funding calls under the KsNI or the Bus Directive[38] were planned.[39] However, projects that have already been approved under the guidelines will continue to be financed. The new focus is now on the development of publicly accessible charging and refuelling infrastructure and the creation of the regulatory framework conditions (see regulatory framework conditions above). Despite that announcement, funding programmes in this area are still pending.

Current funding opportunities can be checked via the "funding database"[40] or the "hydrogen pilot service"[41] of the Federal Ministry for Economic Affairs and Climate Action.

The following entries can be found in the databases, which could be relevant in the context of hydrogen-powered commercial vehicles and the required infrastructure.

[36] Lohrer, M. (NOW) (2024): Current status and outlook of the ramp-up of the hydrogen economy in the transport sector. Presentation at HyWays for Future – Network Meeting on 21/08/2024, available at https://www.energiecluster.de/projekte_aktivitaeten/Hyways%20for%20Future/Netzwerktreffen_21082024/1_NOW_Lohrer.pdf.
[37] NOW GmbH (2024): Strategic realignment at NOW GmbH, 02/09/2024, available at https://www.now-gmbh.de/aktuelles/pressemitteilungen/strategische-neuausrichtung-bei-der-now-gmbh/.
[38] Directive on the promotion of alternative drive systems for buses in passenger transport
[39] Response of the Federal Government to the small inquiry by the CDU/CSU parliamentary group – Parliamentary Paper 20/11979 – Promotion of climate-neutral commercial vehicles, available at https://dserver.bundestag.de/btd/20/123/2012389.pdf.
[40] See https://www.foerderdatenbank.de/FDB/DE/Foerderprogramme/foerderprogramme.html.
[41] See https://www.bmwk.de/Navigation/DE/Wasserstoff/Foerderung/foerderberatung.html.

Table 1: Overview of current funding programmes for hydrogen in the transport sector (vehicles and refuelling stations)

Funding programme	Comment	Link
KsNI: Funding of light and heavy commercial vehicles with alternative, climate-friendly drive systems and associated refuelling and charging infrastructure for electrically powered commercial vehicles	26/02/2024: No continuation of the KsNI funding programme	Link Link
National Innovation Programme Hydrogen and Fuel Cell Technology Phase II (NIP) – Market Activation Measures – Focus on Sustainable Mobility	Submission only until 30/06/2024. Currently no funding sketches can be submitted within the framework of the Research, Development and Innovation (R&D&I) funding guideline of NIP II.	Link Link
IKK - Sustainable Mobility	KfW loans for climate-friendly vehicles as well as infrastructure for climate-friendly public transport and for the municipal fleet	Link Link
Climate protection offensive for companies	KfW loans for climate-friendly investments by companies	Link Link

2.2. HRS network status

HRS in Germany

Figure 3 shows the current state of development of hydrogen refuelling stations for heavy-duty transport (AFIR conform and non-AFIR conform) in Germany and the border region of Poland. As of October 2024, a total of 43 HRS were in operation as well as a further 36 in realization and 40 in planning. In addition, there are 5 HRS (in realization) on the Polish side in the border region.[42]

[42] Beyer, C. (NOW): Activation of hydrogen infrastructure for commercial vehicles - Federal Government view of AFIR requirements, presentation at the 1st stakeholder workshop of the HyTruck project - Rostock pilot region on 17/07/2024 in Rostock, and personal communication on 08/10/2024

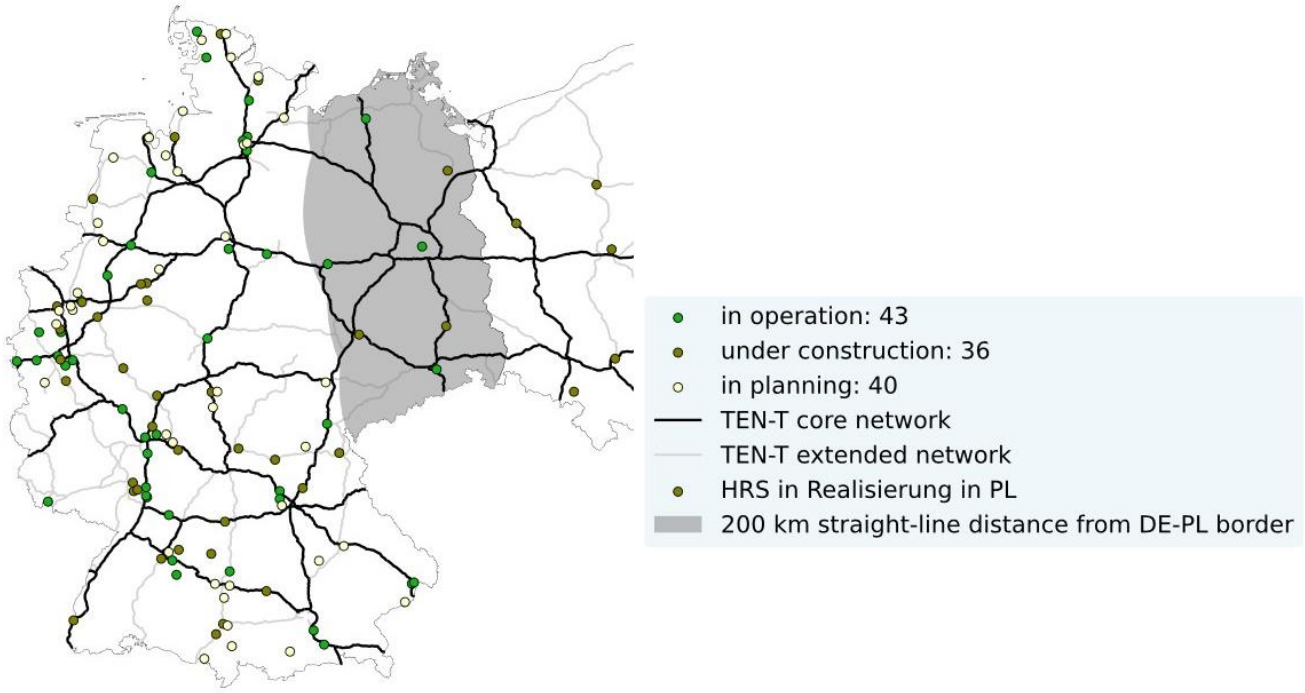


Figure 3: Locations of HRS suitable for heavy-duty traffic in Germany and the border region of Poland (as of: 10/2024) (Source: Beyer C. (NOW)).

The largest refuelling station operator in Germany is H2 Mobility (operating 350 and 700 bar refuelling stations). The company started setting up car refuelling stations throughout Germany in 2015 and now operates approximately 80 hydrogen refuelling stations throughout Germany. After the shift in focus in recent years from passenger cars increasingly to the use of hydrogen in buses and heavy commercial vehicles, the company has begun to enable truck refuelling with 350 bar by expanding existing passenger car refuelling stations. According to its own figures, the company currently has more than 3,000 refuelling procedures per week. A total of approximately 160 hydrogen trucks & buses per day are in tank operation, as well as over 70 refuse collection vehicles.[43] By the end of the year, the company plans to enable refuelling at 350 bar at 53 refuelling stations.[44]

[43] Sommer, M. (H2Mobility): Flexibility and sustainability with hydrogen, presentation at the 2nd stakeholder workshop of the HyTruck project - Rostock pilot region on 11/09/2024 in Rostock.
[44] Fuel Cells Works (2024): Over 50 New Refuelling Options for Trucks and Buses in the H2 MOBILITY Network by the End of 2024, 16/08/2024, available at https://fuelcellsworks.com/news/over-50-new-refuelling-options-for-trucks-and-buses-in-the-h2-mobility-network-by-the-end-of-2024

Existing HRS in the pilot region of Rostock and surrounding area

In order to collate the status quo of the refuelling station infrastructure in the pilot region of Rostock and the state of Mecklenburg-Vorpommern (Mecklenburg Western Pomerania) and the neighbouring states of Brandenburg/Berlin, the relevant HRS data for existing and planned HRS projects were requested from the operators in the form of a short questionnaire. The queried actors included H2APEX, GP Joule, Hypion, H2Mobility, ENERTRAG and Mint-H2.

1) Rostock-Laage (H2APEX)

Currently, there is only one HRS in the whole of Mecklenburg-Vorpommern. This is operated by H2APEX at the Rostock-Laage site.

Figure 4: HRS of H2APEX at the Rostock Laage location (Roman-Oberaigner-Allee, 18299 Laage), (Image: LBST).

Parameters	Value/comment
Location	Hans-Adam-Allee 1, 18299 Rostock-Laage (access via Roman-Oberaigner-Allee)
Operator	APEX Energy GmbH
Status	Open since October 2022
Maximum hydrogen storage capacity	252 kg (further storage tank (LP area) in the electrolysis plant)

Dispensing capacity (per day)	450 kg/d (theoretically and from 11/24 also practically 840 kg/d) (plant capacity is 1,040 kg/d - because of the low dispensing pressure of the electrolysis (max. 30 bar), the capacity is lower)
Pressure level	350 and 700 bar
H_2 properties	Green
Origin of hydrogen	Integrated in electrolysis production plant
Current price	EUR 12.85/kg
Existing anchor customers	Their own fleet, hydrogen customers from all over Mecklenburg-Vorpommern, occasional buses from the surrounding area

Since October 2024, the district of Vorpommern-Rügen has also been one of the station's anchor customers. The municipal transport company VRR has acquired three used vehicles from the Portuguese manufacturer CaetanoBus of the type "H2.City Gold", after a test operation between Greifswald and Sanitz had already been carried out in advance. According to the district of Vorpommern-Rügen, refuelling will initially take place at the H2APEX refuelling station in Rostock-Laage. However, the purchase of further fuel cell buses as part of the HyPerformer project of the District of Vorpommern-Rügen is currently under review, in which the development of a central hydrogen generation, distribution and consumer infrastructure is also being pursued.[45]

2) Rostock, Tessiner Strasse (Total/H2Mobility)

H2Mobility also operated a hydrogen refuelling station on Tessiner Strasse in Rostock from May 2017 to June 2024.

[45] District of Vorpommern-Rügen (2024): Emission-free into the future - the VVR's first hydrogen buses are picking up speed. 29/10/2024, available at: https://www.lk-vr.de/index.php?object=tx,3034.5&ModID=7&FID=3034.39625.1.

Figure 5: HRS of the company Total/H2Mobility for cars at the Rostock location (Tessiner Strasse 98) – refuelling station no longer in operation today (Image: LBST).

According to the company, the upgrade to 350 bar for use by heavy-duty transport was tested at this location, but with a negative outcome. Due to the low utilisation rate, the HRS was finally closed in the summer of 2024.

Further planned activities for hydrogen refuelling stations for heavy-duty transport in the pilot region

In addition to the existing hydrogen refuelling station in Rostock-Laage (see above), **H2APEX** is currently only planning depot refuelling stations in Mecklenburg-Vorpommern and Brandenburg that are not open to the public. Some examples are the depots of the company rebus Regionalbus Rostock GmbH (rebus) in Güstrow and Bad Doberan. The depot HRS in Güstrow was successfully completed in October 2024.[46] In total, 52 hydrogen buses are to be added to the rebus fleet by the beginning of 2025. According to rebus, the project has received funding from the Federal Government of around €18 million, with a total cost of around €42 million. However, these are not sufficient to cover the additional costs of the project compared to the use of diesel buses.

Hypion is currently planning an H_2 refuelling station in the **Stralsund region**. However, there has so far been no final investment decision (FID) – also due to the currently uncertain funding situation. A 350 bar

[46] H2APEX (2024): H2APEX successfully completes construction of a refuelling station for one of the largest hydrogen bus fleets in Europe. 2 October 2024, available at https://h2apex.com/de/h2apex-news/h2apex-schliesst-bau-von-einer-tankstelle-fuer-eine-der-groessten-wasserstoffbusflotten-in-europa-erfolgreich-ab/

refuelling capability for trucks and buses as well as an optional 700 bar refuelling for cars are planned. The hydrogen supply is provided by means of on-site electrolysis.[47]

Whether the construction of a multi-megawatt electrolysis plant at the location in the Schwerin "Göhrener Tannen" industrial area can also be used to supply mobility applications is currently being examined by the project partners **Stadtwerke Schwerin** and **GPJoule**. Other activities of GP-Joule in Mecklenburg-Vorpommern include, in particular, the planning of large-scale electrolysis in Lubmin.[48] Along the extended infrastructure corridor via Hamburg and Kiel, the ground-breaking ceremony for a 2 MW electrolyzer incl. refuelling station for buses, trucks and cars took place in November 2024 as part of the Hy-Kiel project co-initiated by GP Joule.[49]

Further activities for public hydrogen refuelling stations have not been identified.

2.3. Green hydrogen supply analysis

Due to its high potential for the generation of renewable energies, the pilot region of Rostock offers attractive conditions for the domestic production of (green) hydrogen.

Gross electricity generation in Mecklenburg-Vorpommern summed up to around 19,100 GWh in 2022, with around 15,700 GWh generated from renewable energies. This corresponds to a proportion of 82.3% and is well above the national average of 44.1%.[50] Renewable electricity from wind energy accounted for the largest share in Mecklenburg-Vorpommern at around 10,330 GWh, followed by PV (approx. 2,900 GWh) and electricity generation from biogenic sources (2,500 GWh).[51] In comparison to the rest of the country, Mecklenburg-Vorpommern is the only federal state that can already provide 100 percent of its electricity from renewable sources. According to estimates in the "Energy Concept for the Rostock

[47] Statement: Timo Hinrichs (hypion), email to Christopher Kutz, 2 October 2024.
[48] Statements: Olaf Duden (GP JOULE), email to Christopher Kutz, 2 October 2024.
[49] GP Joule (2024): Ground-breaking ceremony for the green hydrogen mobility project HY.Kiel, 14 November 2024, available at: https://www.gp-joule.com/de/newsroom/detail/feierlicher-spatenstich-fuer-das-gruene-wasserstoffmobilitaetsprojekt-hykiel/.
[50] State Office for Internal Administration - Statistical Office Mecklenburg-Vorpommern (2024): Statistical reports - electricity generation in Mecklenburg-Vorpommern, 05/09/2024, available at https://www.laiv-mv.de/static/LAIV/Statistik/Dateien/Publikationen/E%20IV%20Energie-%20und%20Wasserversorgung/E4331/E4331%202022%2000.pdf.
[51] State Office for Internal Administration - Statistical Office Mecklenburg-Vorpommern (2024): Press release, Gross electricity generation 2022, available at https://www.laiv-mv.de/Statistik/Presse-und-Service/Pressemitteilungen/?id=204391&processor=processor.sa.pressemitteilung.

Region"[52] and taking the current or foreseeable framework conditions in the Rostock region into account, up to 40 TWh of electricity can be generated from renewable energies (compared to 1,770 GWh in 2019). However, in order to exploit this potential, it would be necessary to make available areas amounting to several percent of the total area of the Rostock region. According to the Rostock Region Planning Association, new federal and state legislation requires a minimum area of land to be designated for wind energy utilisation. By 2032, 2.1% of Mecklenburg-Vorpommern's land area must be made available for wind energy (of which 1.4% by 2027). The state has broken down these requirements into equal proportions, i.e. 1.4% of the regional area by 2027 and 2.1% of the regional area by 2032, for each of the four planning regions. In addition, exclusion criteria for wind energy areas (such as protective distances from residential areas) were defined, which affect around 97% of the area of the Rostock planning region. With the update of the Regional Spatial Development Programme in 2020, around 2,700 ha of priority areas for wind energy were designated.[53] These are now to be significantly expanded through the expansion of existing priority areas (about 600 ha), the reintroduction of discarded areas from previous drafts (1,900 ha) and newly proposed priority areas (2,500 ha), in order to be able to provide the legally required minimum area of land.[54] There are currently no plans to define specific priority areas for PV installations. Recommended sites, however, include i) previously used areas, ii) marginal yield soils with up to 20 soil points and iii) "red areas" (regarding nitrate pollution).

The only existing HRS in Mecklenburg-Vorpommern is operated by H2APEX at the Rostock-Laage location and supplied with locally generated hydrogen, as described in chapter 2.2. The existing electrolysis capacity at the location is expected to grow by the year 2027 through the construction of a 100 MW electrolysis plant.[55] For this purpose, a corresponding grant notice[56] was handed over to H2APEX by the Federal Ministry for Economic Affairs and Climate Action in July 2024. The project is part of the East German hydrogen hub "doing hydrogen" (as part of the IPCEI "Hy2Infra" wave).

[52] Dr.-Ing. Grüttner EUS GmbH (2022): Energy concept for the Rostock region (2022), available at: https://www.planungsverband-rostock.de/wp-content/uploads/2022/12/Umweltfachbeitrag_Regionales_Energiekonzept_Region_Rostock_UP_April_2021_mit_Karten.pdf
[53] Rostock Region Planning Association (2020): Rostock Region Spatial Development Programme, 20/06/2020, available at https://www.planungsverband-rostock.de/wp-content/uploads/2021/03/RREP-Rostock-Fortschreibung-Energie-Juni-20.pdf.
[54] Fengler, M. & Munser, A. (2024): Hydrogen in the Rostock region – What is planned? Presentation at the 1st stakeholder workshop of the HyTruck project - Rostock pilot region on 17/07/2024 in Rostock.
[55] H2APEX (2024): Green hydrogen made in Mecklenburg-Vorpommern: H2APEX receives funding notice for the construction of a 100 MW electrolysis plant in Rostock-Laage, 15 July 2024, available at https://h2apex.com/de/h2apex-news/gruener-wasserstoff-made-in-mv-h2apex-erhaelt-foerderbescheid-zur-errichtung-einer-100-mw-elektrolyseanlage-in-rostock-laage/.
[56] The expected investment volume for the plant amounts to roughly 213 million euros, of which the federal government is supporting with 117 million euros and the state of Mecklenburg-Vorpommern with 50.2 million euros.

The refuelling station's self-supply thus represents a special case among the existing H_2 refuelling stations in Eastern Germany. For example, due to a fire at the Leuna Chemical Complex in 2024, there were several weeks of supply bottlenecks for hydrogen, whereupon the other (East) German hydrogen refuelling stations had to cease operation.[57]

Selected hydrogen projects in and around the Rostock pilot region

Significant future hydrogen projects in the pilot region are also the projects selected as IPCEI projects (Important Projects of Common European Interest). The funding notices handed over in July 2024 include the following projects:

- **HYTechHafen Rostock:** From 2027, green hydrogen from renewable energies will be produced in the port of Rostock by means of a 100 MW electrolyzer. This is to be made available to local consumers on the one hand, and fed into the nationwide hydrogen core network.[58]
- **Doing Hydrogen – a hydrogen hub for the East:** As part of this project, the pipeline operator ontras planned to build a hydrogen line between Rostock and Güstrow and to convert a line for onward transport to Berlin/Brandenburg. However, the construction of the corresponding line will not take place according to the current status (November 2024). The line was largely not considered in the final draft of the hydrogen core network, particularly for economic reasons.

  After approval by the Federal Network Agency in October 2024, only the section from Rostock to Glasewitz (newly built line) has now been included in the current core network (see Figure 6). In order to achieve planning certainty, a rapid clarification of the currently still open question of project responsibility for this subsection is crucial (as of November 2024).
- **Green hydrogen from Rostock:** H2APEX will build a 100 MW electrolysis plant for the production of green hydrogen at the Rostock-Laage site by 2027. The plant with a production capacity of more than 7,500 tonnes of hydrogen per year will also feed into the local hydrogen core network.[59] The

[57] H2Mobility (2024): Temporary supply bottlenecks for hydrogen, 06/09/2024, available at https://h2.live/news/3644/.
[58] Rostock Port (2024): Grant notice for IPCEI hydrogen project HyTechHafen Rostock, 15 July 2024, available at https://www.rostock-port.de/presse-news/aktuelle-meldungen/news/zuwendungsbescheid-fuer-ipcei-wasserstoff-projekt-hytechhafen-rostock.
[59] H2APEX (2024): Green hydrogen made in Mecklenburg-Vorpommern: H2APEX receives funding notice for the construction of a 100 MW electrolysis plant in Rostock-Laage, 15/07/2024, available at https://ir.h2apex.com/finanzinformationen/unternehmensnachrichten-uebrige-detail?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=559&cHash=23dd5c825f6c5dfc8af7eb6bdfad7693

integration of storage in combined heating/power stations, in fuel cell systems and/or at hydrogen refuelling stations (hydrogen parks) is also envisaged.

- **Electrolysis corridor East Germany:** Enertrag plans to produce hydrogen with around 185 MW of electrolysis at the sites in Rostock-Laage (Mecklenburg-Vorpommern) and Falkenhagen/Prignitz (Brandenburg). Both electrolyzers are on the "doing hydrogen" hydrogen pipeline. The announced feed-in volume is around 15,000 t/a of the hydrogen produced there.[60]

The five hydrogen projects currently announced at the **Lubmin site** (area of the former Greifswald nuclear power plant) with a total capacity of up to 4 GW of electrolysis can be mentioned as essential further planned production capacities. Participating companies include PtX Development GmbH, GP Joule, ENERTRAG, HH2E[61], Lhyfe, Deutsche ReGas and H2APEX. The projects comprise the production of hydrogen from renewable energies, its storage and feed-in into the German hydrogen core network. In addition, the landing of the import pipeline of the Baltic Sea Hydrogen Collector (BHC) project in Lubmin is planned. The further hydrogen transport to the centres of consumption in central Germany is to be made possible as part of the FLOW project.

Reference should also be made to the regional hydrogen concepts within the context of the HyLand funding programmes: HyStarter II Wismar[62], HyStarter I, HyExpert II, HyPerformer II Hydrogen Region Rügen-Stralsund.[63,64]

For assessing the current and future expected hydrogen requirements in the region, the Rostock Chamber of Commerce and Industry (IHK) together with the Rostock Hydrogen Initiative carried out a demand survey with about 600-800 companies in September/October 2024. The results will be published separately.

[60] ENERTRAG (2024): EU Commission approves funding of the ENERTRAG project "Electrolysis Corridor East Germany", 20/02/2024, available at https://enertrag.com/de/news-und-presse/pressemitteilungen/eu-kommission-genehmigt-foerderung-des-enertrag-projekts-elektrolysekorridor-ostdeutschland

[61] Despite the insolvency proceedings in self-administration initiated in November 2024 after the withdrawal of a core investor, HH2E is examining, through cooperation with new investors, how the existing projects can be continued; see, for example, HH2E (2024): HH2E AG successfully initiates self-administration and arouses market interest, 14/11/2024, available at https://www.hh2e.de/energiewende/hh2e-ag-leitet-erfolgreich-eigenverwaltung-ein-und-weckt-marktinteresse/

[62] See https://www.hy.land/hystarter-ii-region-wismar/.

[63] See https://www.hy.land/hystarter-wasserstoffregion-ruegen-stralsund/, https://www.hy.land/hyexperts-ii-region-ru%cc%88gen-stralsund/ und https://www.hy.land/hyperformer-ii-h2-projektregion-ruegen-stralsund/.

[64] Goal: development of a central hydrogen hub (generation, distribution and consumer infrastructure), project volume: approx. 25 million euros (Federal Ministry for Digital and Transport funding 15 million euros), duration: 06/2023-12/2025, actors: SWS Stadtwerke Stralsund GmbH, Energiewerk Rügen eG, Hypion GmbH, VVR mbH, FWOL GmbH, Grimmener Spezitrans & Service GmbH, Stralsund University of Applied Sciences.

Transport infrastructure (hydrogen core network)

During the stakeholder workshops (see Chapter3.2), the importance of a hydrogen transport network infrastructure as a potential source of supply for future hydrogen refuelling stations was also highlighted. The development is particularly relevant for the corridor under consideration from the pilot region of Rostock to the German-Polish border: In July 2024, the official application for a German core network was submitted to the Federal Network Agency (BNetzA) by the German pipeline network operators (FNB). [65] The Federal Network Agency largely approved the application in October 2024. The total length of the approved core network is therefore 9,040 km. The core network consists predominantly of converted natural gas pipelines (approx. 60%) and the investment costs are expected to be around €18.9 billion. The feed-in and feed-out capacities are roughly 101 GW or 87 GW. In addition to the FNB measures, infrastructures of ten VNB core network operators were also approved (468 km).

As shown in Figure 6, the approved hydrogen core network differs from the November 2023 design. At that time, a newly built line through Mecklenburg-Vorpommern and Brandenburg towards Potsdam was planned (doing hydrogen IPCEI project).

According to some stakeholders' perspectives raised during the 2nd stakeholder workshop, this surprising decision represents a great uncertainty for the region with regard to the future pipeline connection for the feed-in and supply of hydrogen. In addition, possible refuelling station sites along the pipeline route are an important argument for the future economic operation of the pipeline. For example, potential feed-in and withdrawal points are conceivable every 20 km or so along the core network.

These and other developments, such as the great importance of a hydrogen connection from Mecklenburg to Hamburg with connection of the Schwerin area and the gas storage in Kraak, were also part of the discussions around the announced hydrogen strategy of the state of Mecklenburg-Vorpommern in an event on stakeholder participation "Future Dialogue Hydrogen: Strategy for Mecklenburg-Vorpommern" on 28 October 2024 in Schwerin.

[65] The original application envisaged a pipeline network with a length of 9,666 km, which would be gradually built in Germany by 2032 and would benefit from advantages through accelerated approval procedures and financing. The total investment required was initially estimated at around €19.7 billion. Source: FNB Gas (2024): Central milestone for hydrogen ramp-up: pipeline network operators submit official application for the core network, press release dated 23/07/2024, available at https://fnb-gas.de/news/zentraler-meilenstein-fuer-den-wasserstoffhochlauf-fernleitungsnetzbetreiber-reichen-offiziellen-antrag-zum-kernnetz-ein/

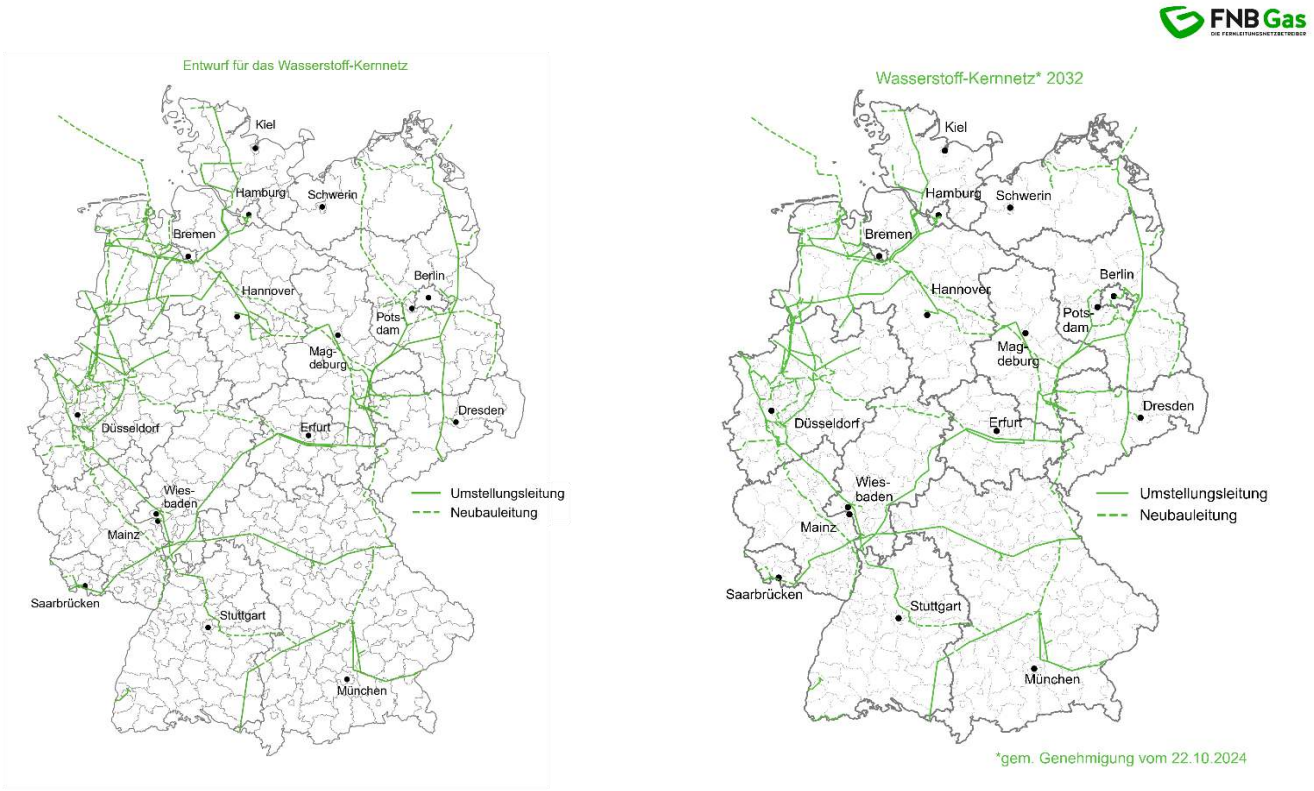


Figure 6: German hydrogen core network in the draft from 15/11/2023 (left) and the version of the core network approved by the Federal Network Agency from 20/10/2024 (right) (line = repurposed pipelines, dashed lines = new pipelines) (Source: Vereinigung der Fernleitungsnetzbetreiber Gas e.V.)[66].

2.4. HRS location suitability analysis/findings of HRS anchor customer analysis

2.4.1. Selected criteria

The identification and selection of possible HRS locations was based on predefined criteria. Digital Spatial Planning Toolkit of the University of Tartu was used as basis for analysis. Supplementary assessment of possible HRS locations were carried out by LBST and the information and recommendations of the stakeholders (see Chapter 3) were taken into account.

[66] See https://fnb-gas.de/wasserstoffnetz-wasserstoff-kernnetz/.

The following table shows the criteria used in the context of this work.

Table 2: Overview of the selected criteria for the location assessment of hydrogen refuelling stations

Category	Criteria	Relevance/weighting*	Part of the digital spatial planning tool
TEN-T (AFIR compliant)	Max. 200 km distances	HIGH	YES
	10 km from departure	HIGH	YES
	Max. 10 km distance to main corridors	HIGH	YES
	Proximity to major hubs	HIGH	YES
	Proximity to TEN-T logistics centres	MEDIUM	YES
Environmental criteria	No spatial conflict with protected areas	HIGH	YES
Existing land use	Proximity to industrial areas	MEDIUM	YES
	Proximity to commercial centres	MEDIUM	NO
	Avoidance of residential areas	MEDIUM	YES
	Avoidance of water bodies	HIGH	YES
	Proximity to agricultural land	MEDIUM	YES
Hydrogen infrastructure projects/activities	Consideration of existing hydrogen infrastructure plans (incl. transport lines and storage)	MEDIUM	YES
	Existing regional projects for hydrogen generation and import	MEDIUM	YES
Existing road infrastructure	Conventional petrol station locations	MEDIUM	YES
	Main traffic routes (heavy-duty transport)	HIGH	NO
	Strategic aspects (regional logistics hub?)	HIGH	NO
Regional aspects	Logistics companies and customers	MEDIUM	NO
	Space availability (vehicles, hydrogen equipment)	HIGH	NO
	Interest/support of refuelling station operator	HIGH	NO
	Power grid/substations	MEDIUM	NO
	Generation potential of green electricity from renewable energy plants	MEDIUM	NO

* Assumptions as part of the concept development for the pilot region of Rostock

2.4.2. Identified locations for potential hydrogen refuelling stations

Overview

For the Rostock pilot project, five potential new HRS locations for trucks were identified, two in the context of the so-called microanalysis for the Rostock region and three more along the TEN-T main lines along the A19/A20 and A24.

The following figure shows the TEN-T motorways in Mecklenburg-Vorpommern and Brandenburg. The annual traffic performance of trucks at the automatic counting stations on the motorways is also shown. The size of the cycles reflects the average daily traffic volumes (DTV) (trucks in 24h, in both directions) as determined by the Federal Highway Research Institute for the year 2022 on average per day. As can be seen on the map, the identified and potential HRS are located on busy motorways and main truck routes, including Hamburg-Berlin, but also towards Poland.

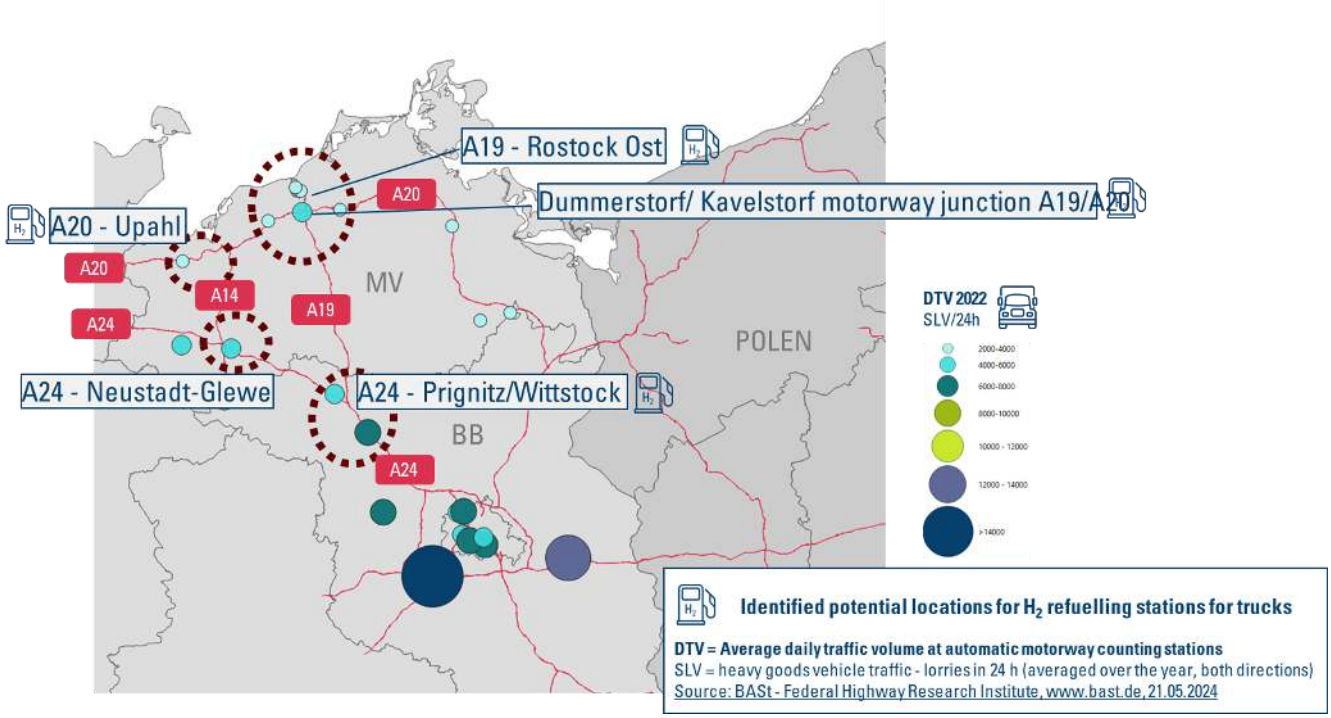


Figure 7: Overview of selected and exemplary HRS locations for trucks that were considered as part of the HyTruck project for the pilot region of Rostock (Source: LBST).

In the following, individual locations and their basic suitability regarding the criteria (see Table 2) are described in more detail. The discussion and assessment took place on the basis of GIS-supported analyses, with the help of the Digital Spatial Planning Toolkit of the University of Tartu (EE) (HyTruck D1.1),

available preparatory work and information as well as feedback from the stakeholder dialogue (see Chapter 3).

Rostock East (A19)

The Rostock East location has many commercial premises and conventional truck refuelling stations near the A19. Five motorway connections are located along the approx. 10 km route between the seaport of Rostock to motorway exit 7 – Rostock South. At the automatic counting station of the Federal Highway Research Institute (BASt), average traffic movements of 21,398 vehicles per 24 hours and heavy-duty traffic (HGV) of 3,741 vehicles per 24 hours (h) were determined (Junction 5 – Rostock North) for 2022[67].

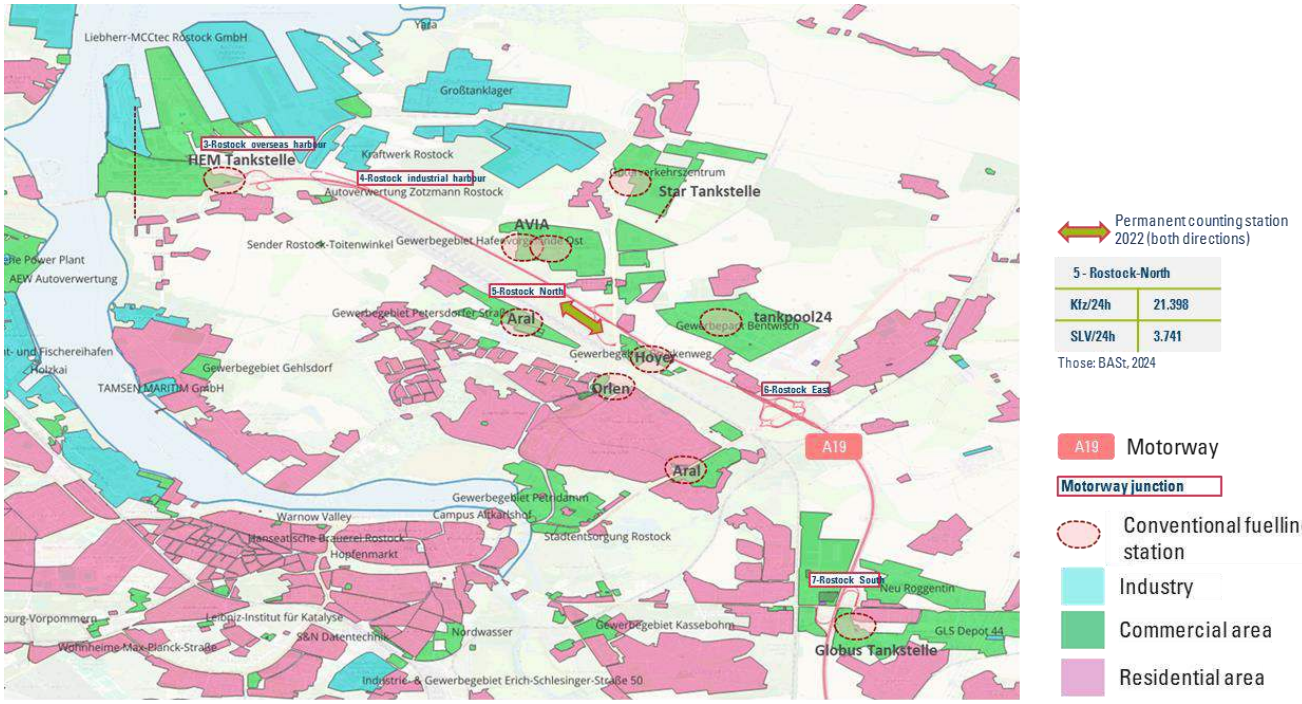


Figure 8: Location analysis Rostock East (A19), © Ludwig-Bölkow-Systemtechnik GmbH, 2024 - Data source: OpenStreetMap, BASt 2024, own research.

From 2027 onwards, green hydrogen from renewable energies will be produced in the port of Rostock by means of a 100 MW electrolyzer. This will be supplied to local consumers as well as fed into the nationwide

[67] BASt – Federal Highway Research Institute, Automatic Counting Stations 2022: https://www.bast.de/DE/Verkehrstechnik/Fachthemen/v2-verkehrszaehlung/Daten/2022_1/Jawe2022.html;jsessionid=A2A9C71DCF924AFF2788159AFFEE1043.live21322?cms_map=1&cms_filter=true&cms_jahr=Jawe2022&cms_land=13&cms_strTyp=&cms_str=&cms_dtvKfz=&cms_dtvSv=

hydrogen core network under construction.[68] This location also has terminations to the power transmission lines that also run along the A19, as well as transformer stations, including at motorway junction 5 – Rostock-North.

The availability of space in the urban area of Rostock is a major challenge. Therefore, for the planning of further land use, areas for new/additional hydrogen refuelling stations should be designated at an early stage with reservation or priority. Alternatively, rezoning of land seems particularly sensible.

Noise protection near residential areas should also be included at an early stage in further site planning.

Table 3: Assessment of the selected criteria for hydrogen refuelling station location Rostock East (A19)

Criteria	Analysis result/remark	Assessment
TEN-T	AFIR compliant; with proximity to motorway exits along the A19	☑ fulfilled
Environmental criteria	No conflicts	☑ fulfilled
Existing land use	Attractive proximity to commercial/industrial areas and logistics locations, close to the port	☑ fulfilled
	Some of the present conventional refuelling station sites are located near residential areas	To be reviewed with regard to noise protection!
Hydrogen infrastructure projects/activities	IPCEI project · HYTechHafen Rostock (see Chapter 2.3), close to core network planning, further activities in the region are in the planning stage	☑ fulfilled
Existing road infrastructure	Many conventional refuelling stations for trucks in the region, as well as main traffic route for truck traffic	☑ fulfilled
Regional aspects	Many locally based companies in the immediate vicinity/on driving routes	☑ fulfilled
	Rostock power plant at the industrial port with 110 and 380 kVA power lines available on both sides along the A19	☑ fulfilled
	However, limited availability for commercial space	High cost pressure due to limited space availability

[68] Rostock Port (2024): Grant notice for IPCEI hydrogen project HyTechHafen Rostock, 15 July 2024, available at https://www.rostock-port.de/presse-news/aktuelle-meldungen/news/zuwendungsbescheid-fuer-ipcei-wasserstoff-projekt-hytechhafen-rostock.

Dummerstorf/Kavelstorf motorway junction (A19/A20)

The motorway junction offers a strategically interesting perspective to serve the various traffic routes (north-south and east-west). The evaluation of the available data at the BASt automatic counting stations shows high traffic numbers in both directions or axes.

For example, in September 2024 Amazon opened a logistics centre at the Dummerstorf location near the A19 motorway junction (Berlin to Rostock overseas port) and A20 (west to east through Mecklenburg-Vorpommern). Utilization of hydrogen as a fuel in intralogistics is also envisaged here, which could result in fundamental synergies. The logistics centre is the twenty-third of Amazon in Germany and the third location in Mecklenburg-Vorpommern (in addition to the two distribution centres in Rostock and Neubrandenburg).[69] There are several other existing logistics centres in the region, including e.g. by Norma.

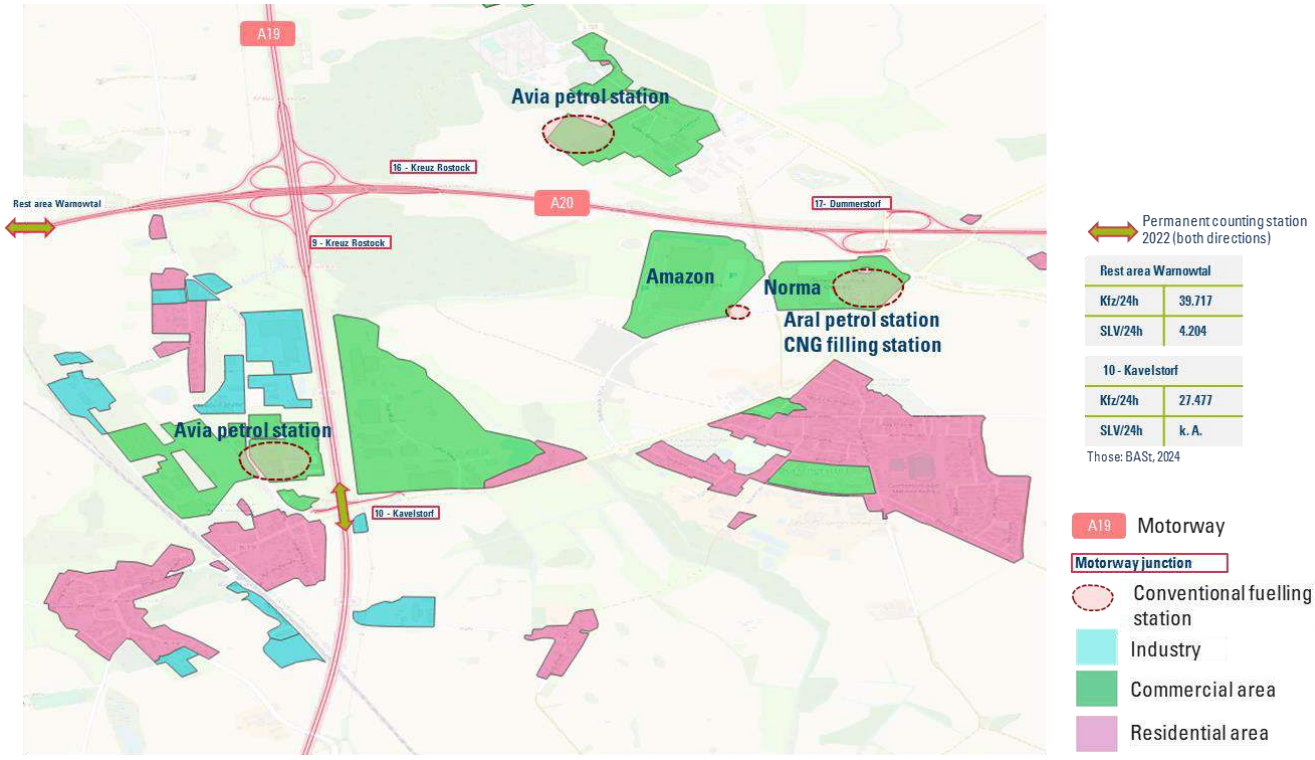


Figure 9: Location analysis Dummerstorf/ Kavelstorf motorway junction (A19/A20), © Ludwig-Bölkow-Systemtechnik GmbH, 2024 - Data source: OpenStreetMap, BASt 2024, own research.

[69] dpa (2024): Up to 1,000 jobs in the new Amazon location near Rostock, 23/09/2024.

Regarding regional hydrogen production, the company Eternal Power has announced a production project in Dummerstorf (initially 80 MW from 2028 with expansion to 400 MW). A feed-in into the planned hydrogen transport infrastructure is also foreseen.[70]

The Baltic Sea Industrial Park near Dummerstorf, which is currently being planned, also offers the possibility of connecting traffic from the A19 to the A20 or vice versa.[71]

There is only a provisional exit at the Kavelstorf junction, which would have to be upgraded in order to enable smooth truck traffic.

Table 4: Assessment of the selected criteria for hydrogen refuelling station location Dummerstorf/Kavelstorf motorway junction (A19/A20)

Criteria	Analysis result/remark	Assessment
TEN-T	AFIR compliant; close to motorway exits along the A19/A20; three motorway connections (9 – Rostock junction, 10 – Kavelstorf and 17 – Dummerstorf)	☑ fulfilled
Environmental criteria	No conflicts	☑ fulfilled
Existing land use	Attractive proximity to commercial/industrial areas and logistics locations	☑ fulfilled
	Some of the present conventional refuelling station sites are located near residential areas	To be reviewed with regard to noise protection!
Hydrogen infrastructure projects / activities	Prospect for hydrogen core network connection, further activities in the region in the planning stage	Further synergies to be clarified!
Existing road infrastructure	Conventional refuelling stations for trucks in the region on the main traffic route for truck traffic (A19 exit 10 - Kavelstorf, A20 exit 17 – Dummerstorf) High traffic utilization at the continuous counting stations for the year 2022 (rest area Warnowtal with 39,717 vehicles/24h and 4,204 HGV/24h and 10 – Kavelstorf with 27,477 vehicles/24h)	☑ fulfilled
Regional aspects	Logistics companies in the immediate vicinity/on driving routes, especially towards Dummerstorf	☑ fulfilled
	380 kVA power lines available along the A19	☑ fulfilled

[70] Eternal Power (2024): Eternal Power is planning one of the largest hydrogen plants in Europe in Mecklenburg-Vorpommern, 16 October 2024, available at: https://eternal-power.de/2024/10/17/eternal-power-plant-eine-der-grosten-wasserstoff-anlagen-europas-in-mecklenburg-vorpommern/.

[71] expose de Industrie und Gewerbepark Autobahnkreuz Rostock (Fläche 3) at Dummerstorf Landkreis Rostock.pdf (investguide-mv.de)

Neustadt-Glewe (A24)

A conversion of the existing Hoyer truck stop on the A24 would address the busy Berlin-Hamburg main route (BASt counting station Hohewisch with 5,029 HGV/24h). The truck stop has truck parking spaces and, in principle, the possibility of integrating/setting up an HRS. In addition to transit traffic, freight forwarders and logistics companies in the region can also be addressed as potential users and interested parties.

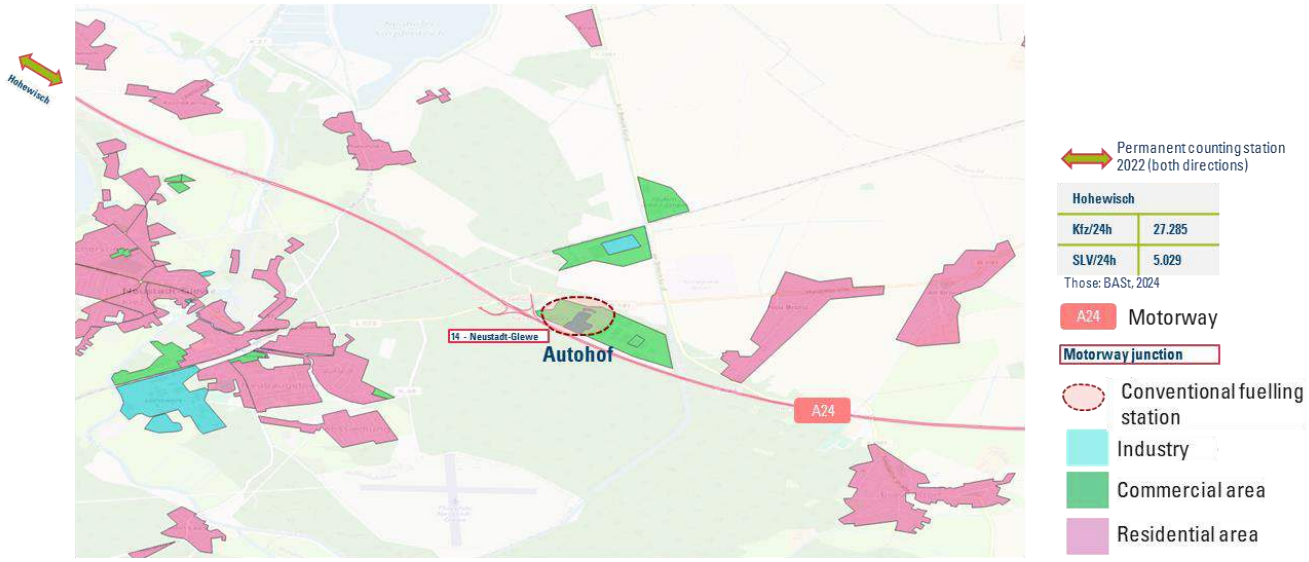


Figure 10: Location analysis Neustadt-Glewe (A24), © Ludwig-Bölkow-Systemtechnik GmbH, 2024 - Data source: OpenStreetMap, BASt 2024, own research.

Table 5: Assessment of the selected criteria for hydrogen refuelling station location Neustadt-Glewe (A24)

Criteria	Analysis result/remark	Assessment
TEN-T	AFIR compliant; close to motorway exits along the A24, motorway junction 14 – Neustadt-Glewe	☑ fulfilled
Environmental criteria	No conflicts	☑ fulfilled
Existing land use	Proximity to commercial/industrial areas and logistics sites; integration into existing truck stop	☑ fulfilled
Hydrogen infrastructure projects / activities	The construction of an electrolysis plant is being tested in the Göhrener Tannen industrial area.	Further synergies to be clarified!
Existing road infrastructure	Conversion/retrofitting of the existing truck stop of the company Hoyer. This is located on one of the main transport routes for trucks (including Berlin-Hamburg). Hohewisch automatic counting station 2022 with 27,285 vehicles/24h and 5,029 HGV/24h.	☑ fulfilled

Criteria	Analysis result/remark	Assessment
Regional aspects	Logistics companies nearby, including Volker Rumstich Transport GmbH.	☑ fulfilled
	Adjoining Brenz Solar Park	☑ fulfilled

Upahl (A20)

An HRS at the Grevesmühlen exit on the busy A20 could be integrated into the existing refuelling station or a new HRS could be built in the existing industrial area.

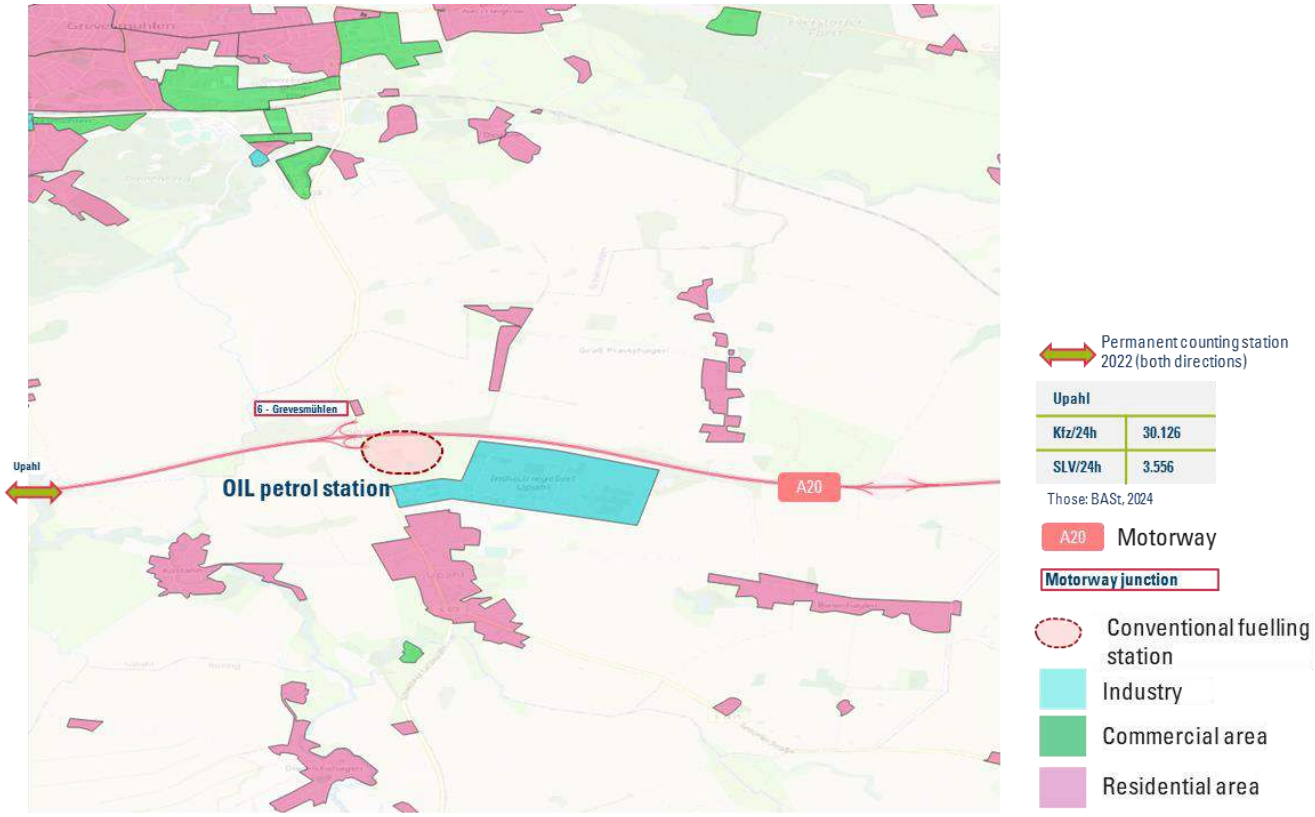


Figure 11: Location analysis Upahl (A20), © Ludwig-Bölkow-Systemtechnik GmbH, 2024 - Data source: OpenStreetMap, BASt 2024, own research.

Table 6: Assessment of the selected criteria for hydrogen refuelling station location Upahl (A20)

Criteria	Analysis result/remark	Assessment
TEN-T	AFIR compliant; at a motorway junction on the A20	☑ fulfilled
Environmental criteria	No conflicts	☑ fulfilled

Criteria	Analysis result/remark	Assessment
Existing land use	Attractive proximity to commercial/industrial areas and logistics locations, close to the port	☑ fulfilled
Hydrogen infrastructure project s/ activities	No ongoing activities identified.	
Existing road infrastructure	Existing conventional refuelling stations, motorway junction; BASt automatic counting station Upahl for 2022 with 30,126 cars/24h and 3,556 HGV/24h	☑ fulfilled
Regional aspects	Locally based companies; main driving route	☑ fulfilled

Prignitz/Wittstock triangle (A24)

South of Mecklenburg-Vorpommern on/after the A19/24 motorway triangle, a new HRS could be built on the A24 at a new location (e.g. Prignitz service station), at the Wittstock/Dosse triangle or at an existing location (e.g. motorway junction 21 – Herzsprung) and supplement the connection to Berlin. The use of regional (additional) wind turbines or solar plants for hydrogen production should be examined.

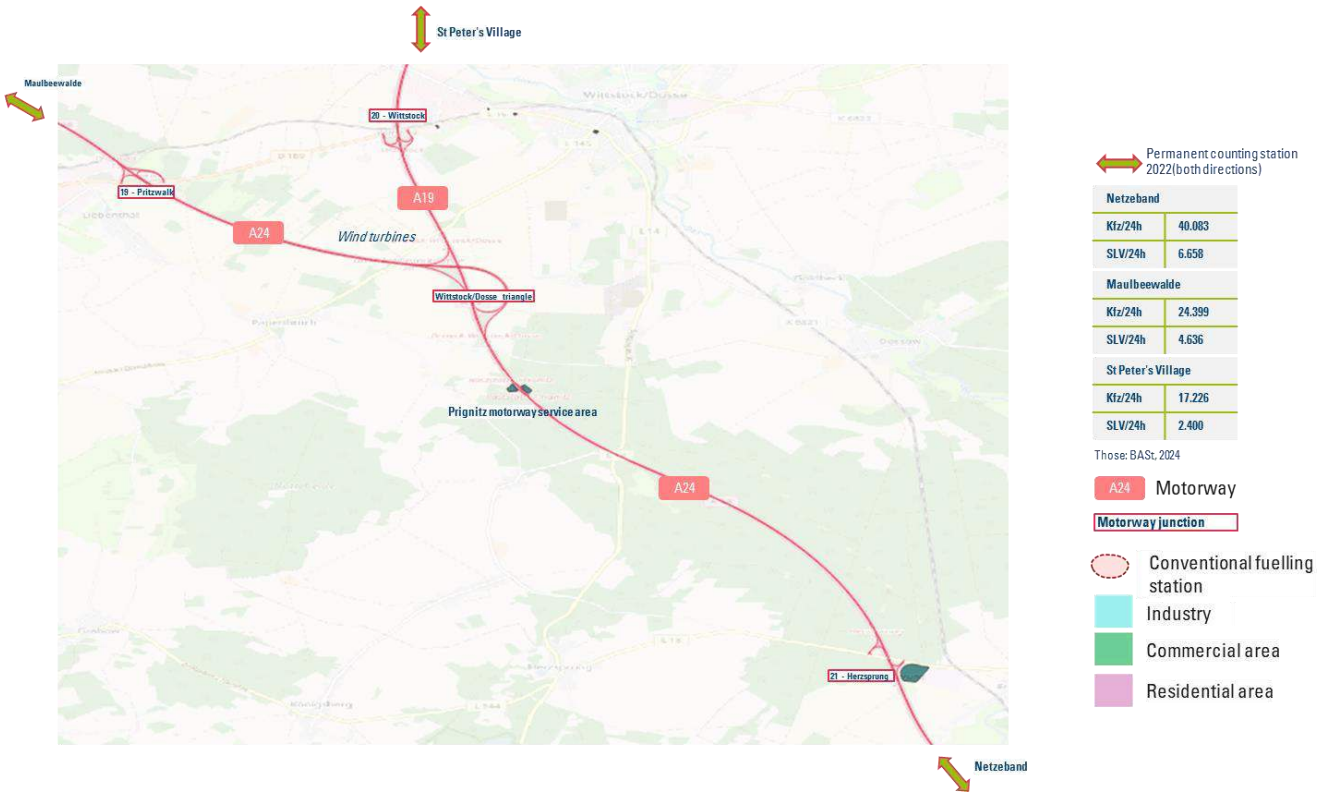


Figure 12: Location analysis Prignitz/Wittstock triangle (A24), © Ludwig-Bölkow-Systemtechnik GmbH, 2024 - Data source: OpenStreetMap, BASt 2024, own research.

Table 7: Assessment of the selected criteria for hydrogen refuelling station location Prignitz/Wittstock triangle (A24)

Criteria	Analysis result/remark	Assessment
TEN-T	AFIR compliant; with possible locations along the A24 (Prignitz service station, 21 – Herzsprung and 19 - Pritzwalk) as well as A19 (20 – Wittstock) or at the Wittstock/Dosse triangle	☑ fulfilled
Environmental criteria	No conflicts	☑ fulfilled
Existing land use	Attractive proximity to commercial/industrial areas and logistics locations, close to the port	☑ fulfilled
Hydrogen infrastructure projects / activities	No ongoing activities identified.	
Existing road infrastructure	Existing truck stop or service station, with conventional refuelling station or e-charging station and LNG refuelling stations (Herzsprung), main traffic route for truck traffic	☑ fulfilled
Regional aspects	Existing truck stops and service stations in the south Wind farm north of Wittstock/Dosse triangle	☑ fulfilled

3. HRS stakeholder dialogue

3.1. Description of the stakeholder process carried out in the pilot implementation

Regional actors

As part of the project, a total of 44 external stakeholders were identified and a total of 85 people were invited to the two workshops. Table 8 lists the companies contacted and assigns them to each stakeholder category (logistics, freight forwarders, regional player, project planner, refuelling station operator, other). The list of stakeholders has been submitted to the WMMV.

Table 8: Overview of the companies contacted within the context of the project.

	Company	Category		Company	Category
1	Arla Foods	Logistics	23	Invest in Mecklenburg-Vorpommern GmbH	Regional actor
2	Bela	Logistics	24	kp logistics	Logistics
3	BGL MV / Grimmener SpeziTrans & Service GmbH	Freight forwarders	25	Krüger Voigt	Logistics
4	Block Logistik GmbH	Logistics	26	District of Rostock	Regional actor
5	Burchardt Dassow	Logistics	27	Limes Solutions	Logistics (Association)
6	Centrum Nowej Mobilności / PSNM	HyTruck project partner	28	Logistikinitiative Mecklenburg-Vorpommern e.V.	Logistics
7	Dekra	Refuelling station (test)	29	LSK Schwerin	Logistics
8	The Rostock Hydrogen Initiative	Regional actor	30	Fachvereinigung Güterverkehr des Landes Mecklenburg-Vorpommern (Gü MV) e.V.	Freight forwarders
9	Edeka	Logistics	31	NOW	Funding agency
10	Gefahrgutservice und Beratung Neubrandenburg GmbH	Freight forwarders	32	Orlen Deutschland GmbH	Refuelling station operator
11	Joint State Planning Department Berlin-Brandenburg	Interregional planning	33	Palmberg	Logistics
12	GP Joule	Project developer	34	Rebus	Public transport

	Company	Category		Company	Category
13	Gurstke Logistik	Logistics	35	Resato Hydrogen Technology	Refuelling station components
14	H2APEX	Refuelling station operator (hydrogen), project developer	36	Rostock EnergyPort Cooperation GmbH	Regional actor
15	H2M	Refuelling station operator (hydrogen)	37	Spedition Leistikow	Freight forwarding
16	Hoyer (Wilhelm Hoyer B.V. & Co. KG)	Refuelling station operator	38	City of Rostock	Regional actor
17	Hypion	Project developer	39	Stadtwerke Schwerin GmbH (SWS)	Regional actor
18	Neubrandenburg Chamber of Commerce and Industry	Regional actor	40	Tchibo	Logistics
19	Rostock Chamber of Commerce and Industry	Regional actor	41	V. Rumstich Transport	Freight forwarding
20	Schwerin Chamber of Commerce and Industry	Regional actor	42	Wapner	Logistics
21	INFRASTRUKTUR & UMWELT Professor Böhm and Partners	Regional actor	43	WEMAG	Regional actor
22	Interreg Baltic Sea Region	HyTruck project partner	44	Wind Energy Network	Renewable energy

1st stakeholder workshop – 17 July 2024, Rostock

The first stakeholder workshop took place on 17 July 2024 from 10:00 – 13:00 at the Radisson Blu Hotel, Rostock. The agenda is shown in Figure 13. 17 people attended the meeting. The list of participants is attached to the report.

The aim of the workshop was to present the overall project to a small group of participants, to take strategic aspects into consideration and to discuss initial important findings with regard to possible principal sites. In particular, regional key players were taken into account. The contributions of the external participants (NOW, IHK Schwerin, regional planning association Rostock/Rostock Hydrogen Initiative, BGL MV) made valuable contributions to the results of the pilot project. Details can be found in the summary in Chapter 3.2 as well as the detailed workshop notes.

Agenda, 17.07.2024

Time	Title	Responsible
09:30	Arrival / Registration	All
10:00	Welcome	WMMV
	Introduction HyTruck project (motivation, background)	WMMV
10:10	Brief project presentation - pilot region Rostock / MV	LBST
10:20	"Activation of H_2 infrastructure for commercial vehicles - BUND view / AFIR requirements"	NOW
10:30	"BlueLine" MV	IHK Schwerin
10:40	H_2 activities in the Rostock region	Rostock Planning Association
10:50	Prospects for H_2 in logistics (MV)	BGL MV
11:00	Discussion	All
11:15	Kaffeepause	
11:30	Presentation of possible HRS locations	LBST
12:00	Discussion Rostock location / other locations	All
12:45	Summary, outlook	LBST
13:00	End of the event / further networking / lunch	All

Figure 13: Agenda of the 1st stakeholder workshop on 17 July 2024 in Rostock.

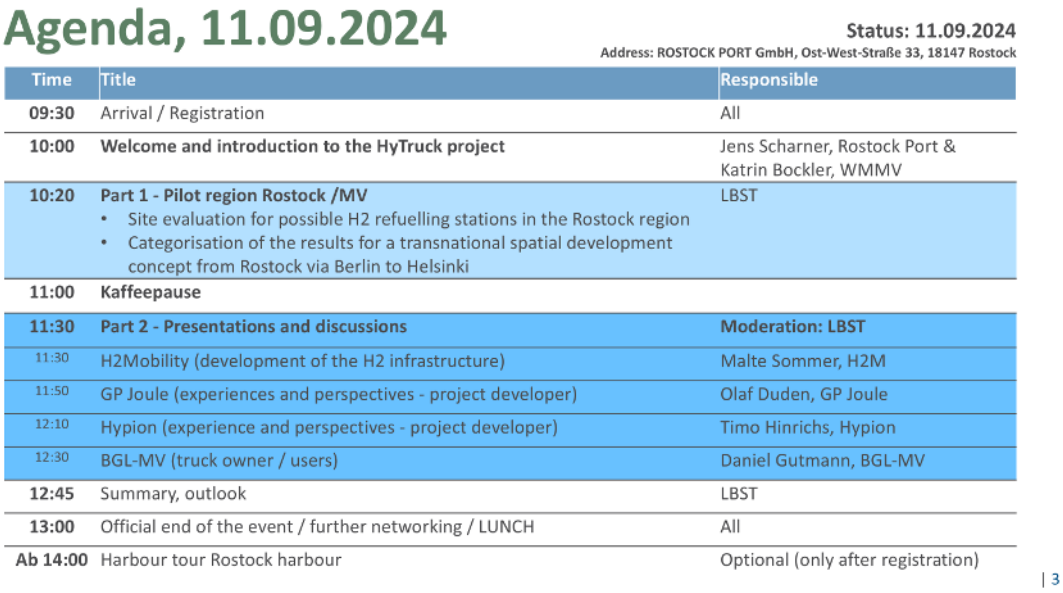
Figure 14: 1st stakeholder workshop on 17 July 2024 in Rostock.

2nd stakeholder workshop – 11 September 2024, Rostock

The second stakeholder workshop took place on 11 September 2024 from 10:00 – 13:30 at Rostock Port GmbH in Rostock. The agenda is shown in Figure 15. 26 people attended the meeting. The list of participants is attached to the report.

The aim of the workshop was to present and discuss the results of the analysis to a larger group of participants. The evaluation criteria for the suitability of the HRS locations were also discussed in detail. The contributions of the external participants (H2Mobility, GP Joule, Hypion, BGL-MV) served to provide information on the current expansion of the HRS network for commercial vehicles in Germany and to exchange experience from previous projects by refuelling station operators and project developers. Challenges with regard to the appropriate choice of location and obstacles in the regulatory environment were also discussed. The perspective of the logistics industry was also presented.

Details can be found in the summary in Chapter 3.2 as well as the detailed workshop notes.



Agenda, 11.09.2024

Status: 11.09.2024
Address: ROSTOCK PORT GmbH, Ost-West-Straße 33, 18147 Rostock

Time	Title	Responsible
09:30	Arrival / Registration	All
10:00	**Welcome and introduction to the HyTruck project**	Jens Scharner, Rostock Port & Katrin Bockler, WMMV
10:20	**Part 1 - Pilot region Rostock /MV** • Site evaluation for possible H2 refuelling stations in the Rostock region • Categorisation of the results for a transnational spatial development concept from Rostock via Berlin to Helsinki	LBST
11:00	**Kaffeepause**	
11:30	**Part 2 - Presentations and discussions**	**Moderation: LBST**
11:30	H2Mobility (development of the H2 infrastructure)	Malte Sommer, H2M
11:50	GP Joule (experiences and perspectives - project developer)	Olaf Duden, GP Joule
12:10	Hypion (experience and perspectives - project developer)	Timo Hinrichs, Hypion
12:30	BGL-MV (truck owner / users)	Daniel Gutmann, BGL-MV
12:45	Summary, outlook	LBST
13:00	Official end of the event / further networking / LUNCH	All
Ab 14:00	Harbour tour Rostock harbour	Optional (only after registration)

| 3

Figure 15: Agenda of the 2nd stakeholder workshop on 11/09/2024 in Rostock.

Figure 16: 2nd stakeholder workshop on 11 September 2024 in Rostock.

3.2. Summary of main contributions/agreements met during the stakeholder process

Summary of workshop 1, 17/07/2024 in Rostock (Radisson Blu Hotel)

The aim of this first stakeholder workshop is to present the HyTruck project (incl. pilot project for Rostock) as well as getting to know each other and strategic discussion between the project team and regional key players.

The HyTruck Rostock pilot project has two main objectives:

- **Project objective 1:** As part of the HyTruck pilot project in Rostock, possible locations for hydrogen refuelling stations (with the involvement of local actors) in the pilot region of Rostock are to be identified. These will then be incorporated into the overall concept creation in the HyTruck project.
- **Project objective 2:** The instruments developed as part of the HyTruck project should be tested and assessed in this regard.

It is apparent that there are different approaches to identifying suitable locations:

- **Top-down approach:** AFIR calls for the systematic/cross-border development of a hydrogen infrastructure in Europe and calls for an HRS every 200 km along the TEN-T corridors. This approach is also the basis of the HyTruck project.

- **Bottom-up approach:** Locally important travel routes, traffic figures, refuelling stations and industrial areas as well as logistics companies offer a good basis for deducing possible locations, such as those investigated in the BlueLine MV.

The discussion shows that a clearer delineation of the tasks of the HyTruck project is important in order to raise the right expectations of the project results: the HyTruck project's overall objective is a transnational spatial development concept for hydrogen refuelling stations. The WMMV as client emphasizes that a concrete definition of future hydrogen refuelling station locations as well as detailed planning of the locations within the context of the project are not part of the study. The aim here is to identify possible refuelling station locations (abstractly) in order to enable actors to make a selection and decision in the further course of the process and to provide approval authorities with assistance. Nevertheless, the pilot offers the opportunity to discuss a selection of potential locations.

Feedback of key (regional) actors in the form of presentations and discussion contributions are taken into account directly for project processing. Significant contributions are summarized below.

Status of HRS in Germany: A total of 39 HRS for 350 bar truck (or bus) refuelling are currently in operation in Germany, as well as another 39 each in realization and planning (as of July 2024). In addition, there are 5 HRS on the Polish side in the border region, of which 1 is in operation and 4 are in realization. Based on an estimate of the hydrogen demand of the forecasted fleet of 38,000 hydrogen trucks (N3, plus other N1 and N2 vehicles as well as transit traffic), an annual hydrogen demand of 400-500,000 t/H_2 is estimated, which would correspond to a demand of 550 HRS in Germany by 2030.

Existing preparatory work in Mecklenburg-Vorpommern and economic importance of HRS: Important preparatory work and experiences from the "BlueLine MV" project (2019) of the Schwerin Chamber of Commerce and Industry (IHK Schwerin) exist for the pilot region (and surrounding area). Potential locations (especially along the A20, A14 and A19) and the interest of specific actors (including Egger, Hoyer, Rumstich) were identified.

The development of HRS for heavy-duty transport has an important significance for regional value creation in the region, in particular through decentralised, regional projects in the mobility sector. For the successful introduction of hydrogen trucks, business and economic aspects must be taken into account with regard to the infrastructure as well as the regional needs (especially driving routes) of the freight forwarders.

Rostock Region Planning Association: ongoing regional developments

There is a fundamental conflict of objectives between "saving space" and "growing the economy" when it comes to commercial and industrial districts. The regional spatial development program is currently

being prepared (every 10 years) and project results are consequently also very relevant for this. New commercial and industrial areas are planned in and around the pilot region, including the expansion of commercial areas to include the Rostock port location. For hydrogen and commercial/industrial sites, the supply of renewable electricity and water is relevant. For the latter, a feasibility study on seawater desalination was commissioned (study results by September 2025). New legal requirements for the use of wind energy set binding area targets of 2.1% of the land area in Mecklenburg-Vorpommern (by 2032). Moreover, the expansion of solar energy use (large ground mounted PV systems) is an essential part of the planning. Important IPCEI funding decisions for hydrogen projects in the region were handed over the day before the workshop (16 July 2024) (projects: Energiehafen Rostock, H2APEX, doing hydrogen Ontras hydrogen pipeline).

Logistics industry perspective: Compliance with the requirements for emission reduction poses major challenges for the logistics industry, also due to strong competition and high cost pressure (low margins). Sufficient e-charging infrastructure (mega-chargers) and network base is not available, HRS infrastructure only under construction. In addition, there is a shortage of approximately 40,000 truck parking spaces in Germany (which would tend to be aggravated by the additional space required by e-charging infrastructure), with freight traffic on the road expected to increase significantly (by 54% by 2051). Only a fraction of the high CO_2 toll revenues of €7.6 billion (approx. €1.2 billion) are reinvested in freight transport. Flexibility is crucial for logistics companies – this includes a high number of HRS refuelling stations and short refuelling times. Hydrogen trucks are seen as an attractive alternative, especially in regional (50,000-80,000 km/year and 300 km/day) and long-distance transport (80,000-120,000 km/year and 540 km/day). However, there is currently a lack of a clear strategy and suitable framework conditions (incl. funding programmes) or binding guidelines after 2026 allowing to make further investment decisions or develop economic prospects. Additionally, the main requirements/framework conditions of the transport industry regarding CO_2 emission reduction consisting of environmental aspects, operational possibilities, local influencing factors and cost aspects were presented (see Figure 17).

Location discussion of possible HRS locations: In particular, the limited space or high demand for industrial areas in the **city of Rostock** should also be taken into account in the further evaluation. It is also pointed out that the Globus HRS station in the Rostock industrial area has already been investigated by H_2-Mobility (H2M) and classified as non-economic. A potential HRS in the **Dummerstorf industrial area** may be an interesting option from a logistics perspective. For further planning, the opinion of traditional operators (including petrol stations, Hoyer) as well as new players (H2APEX, GPJoule, ...) should be taken into account (see bilateral discussions). Further aspects on the other potential locations (Neustadt-Glewe, Upahl, Güstrow) were discussed. A criteria list/assessment matrix should support further analysis.

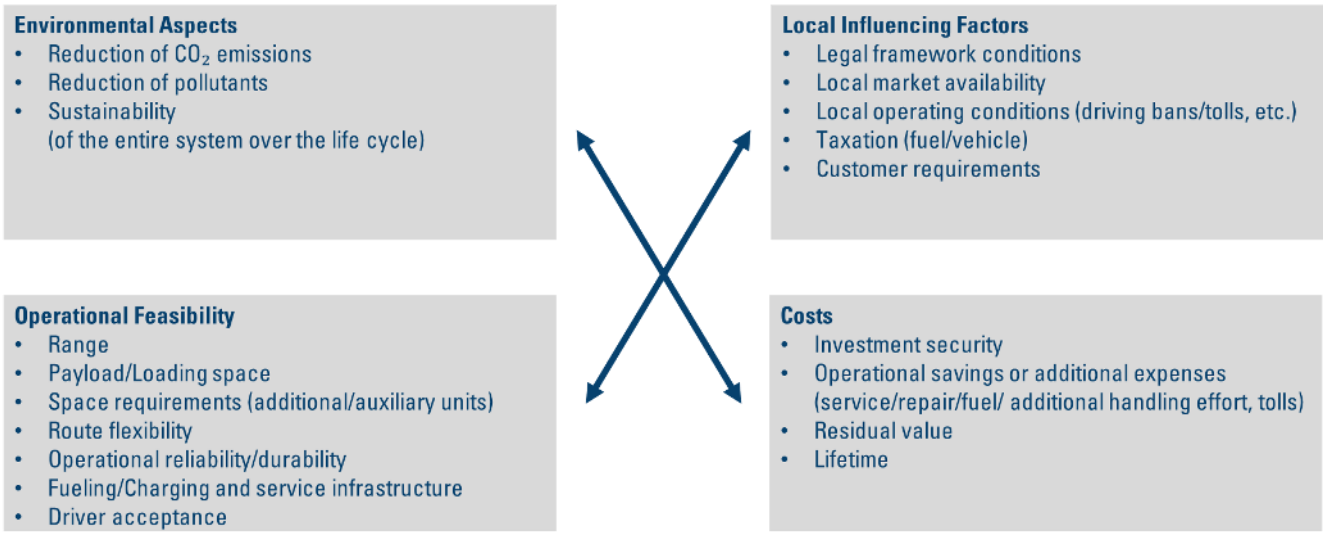


Figure 17: What does the logistics industry need – The magic square of the transport company (source: BGL-MV, Gutmann, D.).

Summary Workshop 2, 11/09/2024 in Rostock (Rostock Port GmbH)

In addition to the welcome (LBST) and presentation of the HyTruck project (WMMV), a short **introduction to the port of Rostock** as an important logistics crossroads in the Baltic Sea region was given at the beginning. Key figures are approximately 8,000 port calls per year with a throughput of 30.9 million tonnes in 2023. Furthermore, the port offers about 768 hectares of land with reserves for settlements. In 2023, 516,000 rolling loading units were also registered, of which 375,000 were trucks.

Presentation of results of HyTruck Rostock pilot: Presentation of the five identified potential HRS locations: Rostock East (A19), Dummerstorf/Kavelstorf (motorway junction A19/20), Neustadt-Glewe (A24), Upahl (A20), Prignitz/Wittstock triangle (A24). Previously, the catalogue of criteria used to assess the locations was presented and discussed. For all locations, sufficient space availability is an essential criterion.

Discussion/general feedback: The current update of the regional spatial development programme by the Rostock Region Planning Association allows to consider required areas in an early stage and to identify them with reservation/priority. Important factors to consider include the issue of emission and noise control and the resulting distances in the land-use planning. The existing experience of the planning authorities, for example for the approval of the H2APEX refuelling stations in Güstrow and Bad Doberan, should be taken into account in future planning. The current uncertainty surrounding the construction of a north-south line from Rostock to Central Germany (IPCEI project doing hydrogen) as part of the core network presents a major problem for the region. Possible refuelling station locations along the relevant route are an important argument for a potentially economical operation of the pipeline. Consequently,

the results of the HyTruck project must also be taken into account at an early stage. (Note: potential feed-in and extraction points on the core network planned approximately every 20 km).

Furthermore, it is pointed out that regional supply concepts for the supply of refuelling stations using regional renewable electricity for hydrogen production should be utilized as far as possible. Local renewable electricity supply and decentralized hydrogen projects are therefore important location criteria. Furthermore, it was pointed out that the vehicle numbers in the east-west or north-south direction should also be included in the assessment (flow traffic vs. source and destination traffic).

Further regional hydrogen requirements are currently being determined in an inquiry by the Rostock Hydrogen Initiative together with the Rostock Chamber of Commerce and Industry (IHK) (questionnaire sent to companies at the beginning of September). The results could also provide valuable information for the project.

Findings and feedback on the individual locations:

1) Rostock East (A19)

Every day roughly 40 truck transports from Tesla alone for the delivery of e-vehicles from Grünheide. In addition, BMW and VW are also customers of the car terminal.

2) Dummerstorf/Kavelstorf (A19/A20)

Eternal Power electrolysis project with hydrogen production planned in Dummerstorf. Originally, also the connection to ontras's hydrogen pipeline line (IPCEI doing hydrogen) was foreseen. Possible HRS site could also offer synergies with "doing hydrogen" new pipeline construction project. Note on other activities: Amazon is planning an HRS for internal traffic (intralogistics). It is generally recommended to seek synergies with existing public transport/bus projects (such as rebus refuelling stations in Güstrow, Bad Doberan).

3) Neustadt-Glewe location (A24)

This location, with an existing truck stop on the main route between Berlin and Hamburg, raises the question of through traffic and the point at which a refuelling station could be of interest. Hoyer could be an important regional player for source/destination traffic (=anchor customer).

4) Upahl (A20)

The site offers a motorway / refuelling station exit with an industrial area and without potential environmental or land conflicts. Integration into the existing petrol station (OIL) or a new location in the industrial area is potentially conceivable.

5) Prignitz/Wittstock

The location with existing e-charging infrastructure in particular could serve through traffic in Prignitz (near the Wittstock triangle (A24)). It would have to be examined to what extent the HRS would need to be integrated into the existing petrol station at the motorway junction or into the e-charging location.

Key findings from the contributions of the external speakers and the discussion:

H2Mobility (H2M), the largest HRS operator, currently operates 80 hydrogen refuelling stations in Europe. The existing 700 bar car refuelling stations are to be converted, where possible, for truck refuelling (350 bar + space requirements). This was not possible for the Rostock site.

The following rule of thumb can be taken into account for the establishment of a hydrogen refuelling station for heavy commercial vehicles: Area requirement of about 3,500-4,000 m^2 and a basic capacity of about 20 heavy commercial vehicles (trucks or buses) per day (corresponding to about 600 kg/day). In addition, noise requirements (noise emissions, in particular due to compression) must be considered in the approval process (distance to residential areas). So far, H2M does not operate an own refuelling station with electrolysis on site. The hydrogen is usually delivered via trailer within a radius of 200 km. New concepts include swap trailers.

Direct and indirect influencing factors in the regulatory environment currently determine the profitability of hydrogen mobility (see also Chapter 2.1). A market overview already shows a number of available hydrogen vehicles (fuel cell and hydrogen combustion). The price of hydrogen is currently around €14.50/kg at small refuelling stations. Refuelling with green hydrogen, taking into account potential additional revenues from GHG quota trading, enables cheaper prices (about €10.50/kg in Berg bei Hof). Further price reduction potentials at larger refuelling stations are expected.

Other experiences of other project developers (**GP Joule and Hypion**) include the following aspects: Hydrogen trailer delivery with 500 bar (by Resato) is expected from next year on, which allows better refuelling performance. The first ever AFIR-compliant refuelling station was built by Hypion in the Neumünster transport hub (3 pumps, namely 2x350 bar and 1x700 bar, and a capacity of up to 2 tonnes per day). The area required for this was about 3,000 m^2. Furthermore, a 40 kVA connection was required.

The final presentation by the **logistics industry** once again shows the need for action. Currently (2024), there are only 528 trucks with electric drives (including hydrogen). This corresponds to approximately a quota of 0.07 percent of the vehicle fleet. The high demands of the logistics industry in terms of flexibility (high number of refuelling stations), reliability of the refuelling stations as well as requirements for high payload and economic viability are reflected in a rather cautious attitude towards low-emission vehicles. The additional costs (seen today) for zero-emission heavy-duty vehicles with a daily mileage of about 450-

550 km can only be offset by funding. The existing regulatory environment in Germany is, therefore, considered insufficient. In this regard, the state of Mecklenburg-Vorpommern is seen as having a duty, following the cessation or uncertainties of federal funds for the promotion of hydrogen technologies (particularly vehicles). Examining the extent to which state funds could be used to cover the identified gaps is highly welcomed among stakeholders. According to some participants, the construction (and operation) of an HRS currently represents a high entrepreneurial risk, as there are not enough hydrogen vehicles or customers available. It is also not foreseeable how hydrogen sales will develop in the next few years.

The participants of the workshop see a particular **need for action in the regulatory environment** in order to ensure reliable framework conditions for electromobility (including hydrogen mobility). Otherwise, the ambitious emission reduction targets in the transport sector will hardly be achieved. Other examples of adjustments concerning the regulatory environment include the ADR Directive (which so far does not approve zero-emission vehicles for hydrogen trailers, revision probably not expected until 2027) and the (too strict) criteria for the production of green hydrogen (e.g. current regulations do not allow the use of renewable electricity after repowering plants).

The higher grid charges in the north of Germany compared to the south (driven by necessary grid interventions due to insufficient electricity grid expansion) counteract the sensible economic use of renewable energies.[72] The production of hydrogen from biogas should also be tested, as many biogas plants will probably need a new business model.

Special requirements of the transport industry

From the perspective of the truck drivers, the location of the hydrogen refuelling stations in particular is of crucial importance in order to avoid even minor detours and deviations from the planned routes (in particular transit routes, industrial areas, current refuelling station locations). The main reason for this is the high time pressure and the legal regulations regarding travel times within the logistics industry. Furthermore, there should be reasonable access and departure space at the refuelling stations, as well as the necessary manoeuvring possibilities for trucks. It should be noted that most of the existing HRS locations are not sufficiently suitable for trucks. Availability (including operating times, pressure level, reliability, capacity, i.e. no waiting times for truck drivers) and refuelling speed (incl. operation) of the HRS

[72] Note on the new regulation from 1 January 2025 regarding the distribution of additional costs in grids from the integration of installations for the generation of electricity from renewable energies: According to this, regions that bear particular cost burdens due to the expansion of electricity generation from renewable energies will be relieved from 2025. The costs arising from the relief for individual regions can be distributed nationwide. See: https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/Aktuelles/VerteilungNetzkosten/start.html.

must be guaranteed unequivocally and reliably. Ultimately, it is crucial for drivers that the hydrogen infrastructure is available across the whole country, as transport orders and routes must be made increasingly flexible and logistics must therefore also act with a high degree of freedom.

Regarding the vehicles, in addition to the economic efficiency (i.e. acquisition costs, fuel prices or transport costs per km), the range and reliability of the trucks is of great importance. In particular, the transport capacity of the trucks plays a major role, as orders and payment are billed according to tonnage (thus the payload and volume). New business models such as "pay-per-use" models could represent an opportunity here. In this case, billing is based on deployment and usage and the vehicles do not have to be purchased from the freight forwarders.

4. HRS neighbourhood analysis & HRS specific issues investigation

The present study focuses on the German pilot region of Rostock. This includes in particular the region around the city of Rostock, starting from the port of Rostock, along the A19 federal motorway into the area of the A19/A20 motorway junction near Laage in the district of Rostock.

Further discussions, however, also cover the transport corridors up to the German-Polish border. This includes, in particular, the A19 federal motorway to the border between Mecklenburg-Vorpommern and Brandenburg (Prignitz-Oberhavel district), the Wittstock/Dosse motorway junction (merging with the A24 federal motorway) as well as the transition to the A10 federal motorway (Berliner Ring) and the A12 federal motorway to the German-Polish border.

Existing and planned hydrogen refuelling stations for heavy-duty traffic

In addition to the activities described in Chapter 2.2 in and around the pilot region of Rostock, further potentially relevant developments will also be summarized below. According to Figure 3, two further HRS for heavy-duty transport are available or planned along the TEN-T corridor in the direction of Poland.

SHELL refuelling station, Berlin (Tempelhofer Weg 102, 12347 Berlin, operator H2Mobility): According to the operator, this is a refuelling station with a 350 bar and a 700 bar refuelling point. The refuelling station is currently supplied with grey hydrogen (produced from natural gas). Due to delivery difficulties because of an accident in hydrogen filling in Leuna, the HRS is currently (as of September 2024) out of operation. H2Mobility plans to switch the supply of all its own refuelling stations to green hydrogen by 2028. The price of hydrogen is currently €13.55/kg (350 bar) or €15.05/kg (700 bar).[73]

ENERTRAG Prenzlau Hydrogen Center (Brüssower Allee 100, 17291 Prenzlau): In December 2021, the operator ENERTRAG opened an HRS in Prenzlau for refuelling with 350 and 700 bar for commercial vehicles and cars. At the outset, a daily capacity of 750 kg of hydrogen is available, which makes it possible to refuel 25 buses or trucks. The HRS is supplied with green hydrogen. However, due to technical problems with surface drainage, the HRS had to close for several months. It station is currently listed as "in operation" in the portal https://h2.live/ (as of September 2024).[74]

[73] Statement: Malte Sommer (H2Mobility), email to Christopher Kutz, 27 September 2024.
[74] rbb24 (2024): Why the deployment of hydrogen buses is delayed in Uckermark and Barnim, 07/08/2024, available at: https://www.rbb24.de/wirtschaft/beitrag/2024/08/wasserstoff-busse-oepnv-nahverkehr-energie-uckermark-barnim-brandenburg.html.

Mint Hydrogen is currently not planning any hydrogen refuelling stations in the region. According to the company, any plans for refuelling stations in Brandenburg were halted due to the freeze of subsidies at the national level.[75]

Activities in the border region of Poland

Talks with the refuelling station operator Orlen also provided insights into the planned hydrogen refuelling stations on the Polish side in the German Polish border region. In general, two important freight transport corridors have to be considered in Poland: in the north-south direction from Gdansk to Kraków and in the east-west direction along the HyTruck project corridor along the Warsaw, Łódź and Poznań route.

In the border area with Germany, the following activities are to be mentioned for the development of hydrogen refuelling stations for heavy-duty transport:[76]

- **Orlen refuelling station in Gorzów Wielkopolski** (Al. 11 Listopada 148, 66-400 Gorzów Wielkopolski): in the planning phase
- **Orlen refuelling station Piła** (Al. Powstańców Wlkp. 102, 64-920 Piła): in the planning phase
- **Orlen refuelling station in Poznań** (Warszawska 231, 60-101 Poznań): In operational optimisation phase
- **Neso Wrocław (**Obornicka, 51-114 Wrocław): in the execution phase

According to plans by Orlen, a H2Hub with electrolysis and a hydrogen refuelling station is also planned in Szczecin, as well as other refuelling stations in Gorzów Wielkopolski, Zielona Gora and Łąka. It should be noted that these refuelling stations will have a refuelling capacity of 350 and 700 bar, and therefore also be suitable for heavy-duty transport (in accordance with the requirements of AFIR).

Accordingly, these considerations should also be taken into account in possible planning with regard to the transnational HRS corridor.

Finally, a support programme for hydrogen announced by the Polish government in November 2024 should be mentioned here. This has a volume of €640 million, with the aim of promoting the large-scale production of renewable and low-emission hydrogen. In addition, investments in hydrogen refuelling station infrastructure will be facilitated.[77]

[75] Statement: Elena Hof (Mint Hydrogen), email to Christopher Kutz, 4 October 2024.
[76] Data based on https://h2.live/.
[77] Fuel Cells Works (2024): Poland Boosts Green Hydrogen Industry with Substantial Subsidies, available at https://fuelcellsworks.com/2024/11/27/green-hydrogen/poland-boosts-green-hydrogen-industry-with-substantial-subsidies.

5. HRS spatial development concept

In the present study and as a part of the Interreg HyTruck project, a location analysis was carried out for the pilot region of Rostock, Germany. This analysis serves as one of five building blocks for the development of a transnational concept for an HRS infrastructure corridor from Rostock to Tallin, Estonia / Helsinki, Finland for refuelling heavy-duty trucks.

The general location assessment shows the high level of activity in Germany in the field of fuel cell mobility in recent years. With 43 locations currently in operation for the refuelling of heavy-duty trucks (as well as another 71 in realization or planning, as of October 2024), Germany can undoubtedly be regarded as an important pioneer of hydrogen mobility in the heavy-duty segment. Focussing on the aspect of compliance with AFIR requirements, two refuelling stations are already in operation, a further six are in realization and five in planning (as of October 2024).

Despite that, there is currently only one HRS in the pilot region of Rostock (and throughout Mecklenburg-Vorpommern). This is operated by H2APEX at the Rostock-Laage site. Further activities, for example in Stralsund (Hypion) or Schwerin (GP Joule) are in the planning phase, but both are currently being re-evaluated due to the significantly worsening funding situation in Germany in 2024.

In July 2024, for instance, the Federal Government announced that, due to the necessary budgetary consolidation, no new funding calls under the KsNI or the Bus Directive were planned. This funding freeze that also includes the promotion of climate-neutral commercial vehicles, poses a major challenge for the industry, as the utilization of existing refuelling stations without anchor customers with a large vehicles fleet is usually not sufficient for economical operation.

Besides that, the pilot region of Rostock has very good starting conditions for the development of a hydrogen ecosystem due to its high potential for the generation of renewable energies. Major projects in Rostock and Lubmin for the production of renewable (and also low-emission) hydrogen are important drivers of regional development. The decision of the pipeline network operators to build only one of the originally planned two north-south routes through Mecklenburg as part of the German hydrogen core network, however, poses major challenges for regional players far away from the Lubmin-Berlin route. For a secure supply situation and the connection of further regionally distributed generation sites and, if necessary, refuelling station sites south of the pilot region of Rostock, an additional connection via Schwerin to Hamburg still seems interesting. This, however, is not considered in the first stage of expansion of the German hydrogen core network.

The location analysis and assessment for suitable HRS locations in the context of the study was carried out on the basis of a previously defined criteria catalogue, which has also partly been used in the context

of the Digital Spatial Planning Toolkit within the HyTruck project. However, important regional criteria were added, thus taking local conditions into account in more detail within the analyses. On the basis of this, the following five potential HRS locations classified as suitable were identified and discussed:

(1) Rostock East (A19),

(2) Dummerstorf/Kavelstorf motorway junction (A19/A20),

(3) Neustadt-Glewe (A24),

(4) Upahl (A20) and

(5) Prignitz/Wittstock triangle (A24).

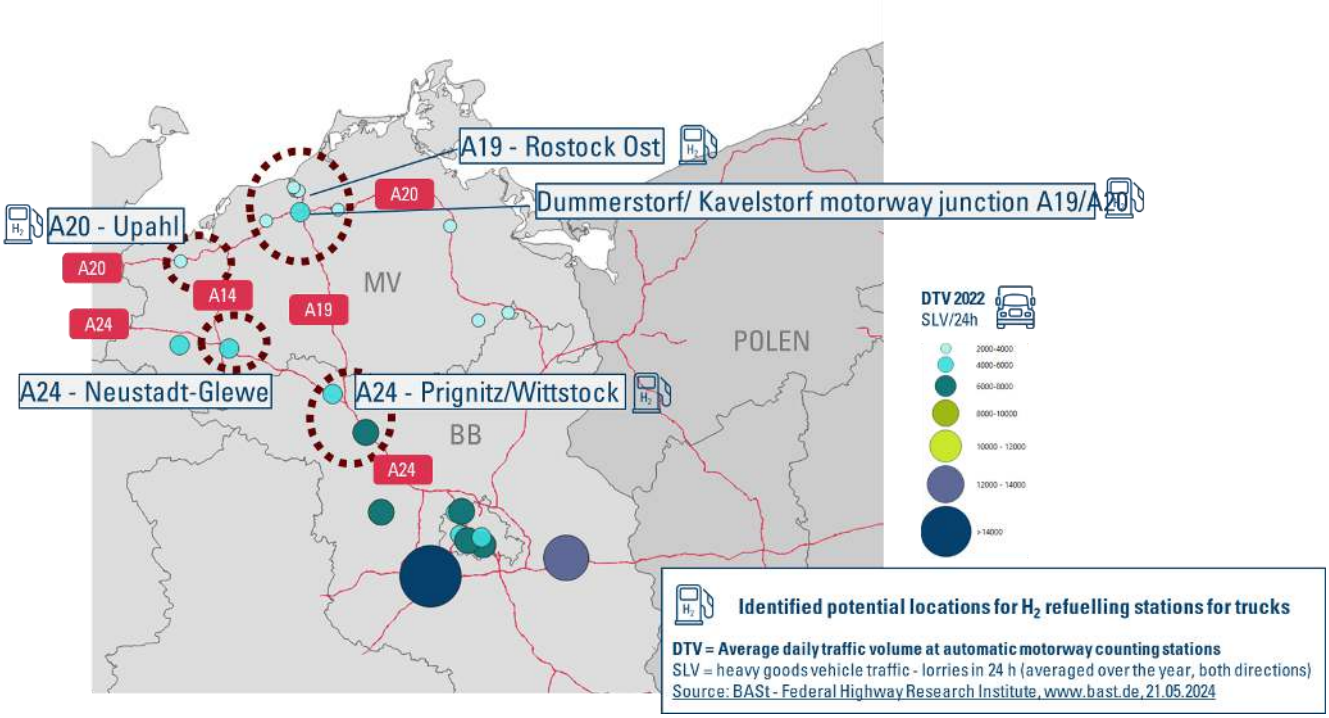


Figure 18: Overview of identified exemplary HRS locations for trucks in and around the pilot region of Rostock.

The locations were also discussed with regional actors in two stakeholder workshops during the course of the project. Further analyses and planning, but in particular complex infrastructure planning for the limited available space at the respective locations, are necessary to continue the development of the HRS network in accordance with the requirements of the AFIR.

The macroanalysis for the connection of the pilot region to the greater Berlin area and the Poland region also shows various activities on the German and Polish side with a view to the development of a HRS infrastructure.

Nonetheless, a targeted funding policy for vehicles and HRS infrastructure is considered absolutely necessary to support the use of hydrogen in heavy-duty transport and, thus, meet the high requirements for emission reduction in the heavy-duty segment. Regional examples of the use of hydrogen buses at rebus Rostock or the municipal transport company VRR in the district of Rostock can be seen as pioneers in this regard, which also fed the experiences of the regional planning and approval authorities on the subject of hydrogen. This existing experience of the planning authorities, for example for the approval of the H2APEX refuelling stations in Güstrow and Bad Doberan, should be taken into account in future planning activities.

The next steps in the HyTruck project should incorporate these experiences and assessments derived from the regional situation and – together with the other pilot regions – merge them into a supra-regional concept.

6. Evaluation of tools developed in WP 1 for HRS development

The application of the HyTruck tools as part of the Rostock pilot study is described below, as well as an evaluation of the analysis results and recommendations and hints for further improvement.

6.1. HRS Guideline: Building up Hydrogen Refuelling Stations in the Baltic Sea Region (Reiner Lemoine Institute), version as of 13/06/2024

Short description: This guide has been created to support authorities in the development of hydrogen refuelling stations (HRS). It also deals with the development of a transnational network of refuelling stations. Information and decision-making aids on the need for hydrogen, the choice of location and the hydrogen demand for trucks are given. In addition, the guide contains environmental aspects, information on the distribution of hydrogen, the development of a hydrogen refuelling station, permits and regulations, economic considerations, and materials for networking and cooperation.

Application in the pilot project: Chapters 1-7 of the guide served as an extension of the background knowledge or general information of actors involved in the planning of hydrogen refuelling stations. For the pilot region, these were of secondary importance. Chapter 8 (Site Selection), including the descriptions of the use of the Digital Spatial Planning Toolkit, was used as a starting point for the analyses in Chapter 2.4 of this report. Chapter 9 (Permits and Regulation) was the basis for the further analyses of the legal and political framework in Chapter 2.1 in this report. Chapter 10 (Networking and Collaboration) shows ways of working together in the concrete implementation of possible HRS projects and thus goes beyond the scope of the pilot study.

Suitability of the results and recommendations derived therefrom for potential further improvements: As described, the utilization was largely limited to Chapters 8 and 9 of the guideline.

For the proposed adjustments in Chapter 8 (Site Selection), reference is made to the following explanations on the Digital Spatial Planning Toolkit in Chapter 6.3.

In particular, the information compiled in Chapter 2.1.1 should be considered for regulatory requirements and funding opportunities. For Germany, this concerns the compilation of various direct and indirect regulatory influencing factors that influence the utilization of hydrogen in the transport sector both on the fuel side and on the vehicles and refuelling stations. These go beyond the European aspects of the

Clean Vehicle Directive (CVD) and the Alternative Fuel Infrastructure Regulation (AFIR) mentioned in the guide and include, for example:

- CO_2 pricing in accordance with the Fuel Emissions Trading Act (BEHG)
- CO_2-differentiated truck toll
- Revenues from GHG quota trading
- Vehicle tax exemption for zero-emission vehicles
- CO_2 fleet targets
- EU regulation on weights and dimensions

In the context of funding programmes, it is important to incorporate the changes at national level (see 2.1.2). This applies in particular to the discontinuation of funding from NIP II and the associated plans not to extend the KsNI funding programme beyond 2024. The de facto abolition of the funding of zero-emission commercial vehicles and the announced focus on infrastructure presents vehicle operators with major challenges (see also discussions during the stakeholder workshops, Chapter 3.2).

Finally, it should be noted that the status of the current number of refuelling stations should be updated (page 45 of the guide). On the one hand, it must be taken into account here that the refuelling station in Rostock has ceased operations in the meantime (see also Chapter 2.2). On the other hand, it is recommended to focus in particular on refuelling stations suitable for heavy-duty traffic (i.e. 350 and possibly 700 bar refuelling, sufficient capacity and sufficient manoeuvring space).

After statements during the 2nd stakeholder workshop, the following rule of thumb for the requirements for new (public) locations should also be included in the guide:

- Land area: approx. 3,500 – 4,000 m^2
- Development plan: with as little noise restriction as possible
- Minimum required capacity for economic operation: approx. 20 heavy commercial vehicles per day (around 600 kg)

As a contribution to the 1st stakeholder workshop, NOW also mentioned the following recommendations for the planning of hydrogen refuelling stations, which should also be included in the HyTruck project[78]:

- View AFIR compliance as the basic prerequisites for the locations
- AFIR targets should be understood as minimum targets. Indeed, the actual requirement is determined by potential customers.
- Other tools and instruments that can support the planning of hydrogen refuelling stations:
  - Hydrogen network of the refuelling station of the future
    (see https://www.tankstelle-der-zukunft.de/wasserstoffnetz/)
    The map is used to **identify locations and determine the size, capacity and cost of hydrogen distribution stations** along the European Hydrogen Backbone (EHB), the TEN-T corridors under the provisions of the Alternative Fuels Infrastructure Regulation (AFIR).

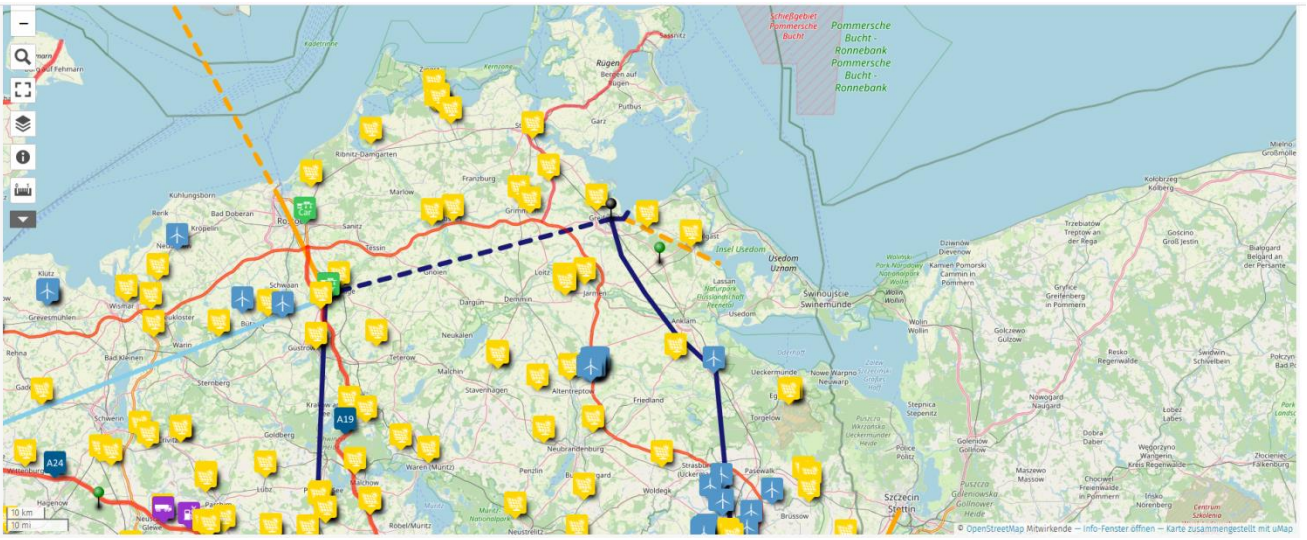


Figure 19: Screenshot of the "Hydrogen Network" tool from the Refuelling Station of the Future project (source: HRS of the Future).

  - NOW's StandortTOOL (presented in June 2024)
    (link: https://standorttool.de/)
    The StandortTOOL is the planning tool of the National Centre for Charging Infrastructure for a

[78] Beyer, C. (NOW): Activation of hydrogen infrastructure for commercial vehicles - Federal Government view of AFIR requirements, presentation at the 1st stakeholder workshop of the HyTruck project - Rostock pilot region on 17/07/2024 in Rostock.

Germany-wide charging infrastructure. It supports federal states, municipalities and network operators in local expansion planning and provides the general public with information on demand, current status and expansion activities. The integration of hydrogen is planned from the end of 2024.

6.2. A catalogue of technical standards and norms for hydrogen refuelling stations dedicated for heavy duty transportation in the BSR (PSPA, subcontractor: AVL), as of January 2024

Brief description: The catalogue provides an overview of the relevant technical norms, standards and specifications for the operation of hydrogen refuelling stations.

Application in the pilot project: The focus of the pilot project was on identifying potentially suitable locations. The technical standards and norms described in the catalogue are used in particular in the detailed planning, construction and operation of refuelling stations. Consequently, no detailed analysis of the HyTruck tool could be carried out as part of this pilot project.

Suitability of the results and recommendations derived therefrom for potential further improvements:

-

6.3. Digital spatial planning toolkit (University of Tartu).

Brief description: see https://hytruck.landscape-geoinformatics.eu/docs/.

Application in the pilot project: As explained in chapter 2.4, the Digital Spatial Planning Toolkit of the University of Tartu was used for the identification of possible HRS locations and further regional aspects were examined with the help of GIS-based analysis and discussed with stakeholders in workshops and interviews.

As part of the project, an exchange took place with the developers of the Digital Spatial Planning Toolkit.

Suitability of the results and recommendations derived therefrom for potential further improvements:

It is recommended that regional information and specifics on existing industrial areas, locations of logistics companies and customers of freight forwarders, (main) transport routes as well as information on electricity grids, substations and renewable energy generation are also included. For this purpose, a specifically higher regional resolution and consideration of individual locations and the immediate environment, as shown in Chapter 2.4.2, must also be carried out.

As part of this work, there was also an intensive exchange with local stakeholders in order to obtain additional information, to validate existing information and to include specific recommendations for the further selection and discussion of the suitability of potential HRS sites. In particular, the exchange of information on current plans and developments is relevant (e.g. planning association, economic development agency, municipalities), while the involvement of regional actors (e.g. freight forwarders, refuelling station operators, companies) is beneficial.

6.4. Comprehensive evaluation model for HRS planning

The tool for analyzing economic and ecological factors of HRS planning (including the supply of hydrogen) was not available at the time of this analysis. Moreover, the application appears to be particularly relevant with regard to the detailed planning of the refuelling station and thus goes beyond the focus of the present short study.

Ludwig-Bölkow-Systemtechnik GmbH (LBST)
Daimlerstrasse 15 | 85521 Ottobrunn |
Germany www.LBST.de