

HYDROGEN ROADMAP Brochure

rhein
kreis
neuss



Colour Theory

If we are to achieve our climate protection targets in North Rhine-Westphalia, then hydrogen will be of crucial importance.

Hydrogen...

... is the most abundant element in the universe, virtually inexhaustible and can be produced locally.

... can, by virtue of its high energy density, reduce energy consumption across various sectors in a climate-neutral and cost-efficient manner.

... can be stored and transported exceptionally well.

... is molecular, gaseous, colourless, odourless and non-toxic under normal conditions.

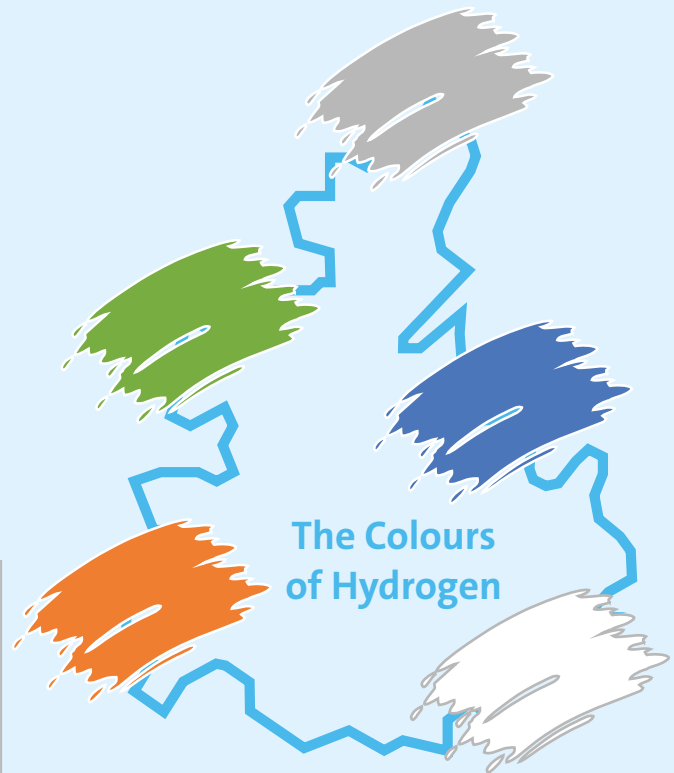
... is combustible and forms a flammable mixture with air at concentrations of between 4 and 77 per cent.

... is 14 times lighter than air and thus highly volatile.

... forms the basis, for instance, of ammonia, methanol and e-fuels.

The energy balance of hydrogen can differ considerably depending on the production process employed. These differences are symbolically represented by colours, as the resulting energy balance of hydrogen varies greatly depending on the production process. This is illustrated by the different colours.

However, hydrogen itself is colourless. This symbolises the raw materials and production methods used.



The most important colours and production methods for hydrogen in our region are:

- **Grey hydrogen** which is produced by the steam reforming of coal or natural gas. In this process, 10 kg of climate-damaging CO₂ are generated for every 1 kg of H₂. Grey hydrogen is currently often the only option for material applications.
- **Blue hydrogen** is essentially grey hydrogen whose CO₂ is directly captured during production and either stored by means of CCS (Carbon Capture and Storage) or utilised through CCU (Carbon Capture and Utilisation).
- **White hydrogen**, often referred to as natural hydrogen, is molecular hydrogen found in natural deposits (as opposed to hydrogen that is produced artificially) and is thus a primary energy source.
- **Orange hydrogen** is produced using biogenic or non-biogenic waste. This typically involves the thermochemical conversion of waste materials, for instance through gasification or pyrolysis.
- **Green hydrogen** is produced by electrolysis, splitting the water molecule using electricity derived solely from renewable sources.

In the long term, green hydrogen is the only sustainable variant of hydrogen production.

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Foreword by Hans-Jürgen Petrauschke

Dear ladies and gentlemen,

I am delighted to be able to present to you the Hydrogen Roadmap for Rhine District of Neuss, developed with the support of the Wasserstoff-Hub Rhein-Kreis Neuss/Rheinland e.V.

The Rhine District of Neuss forms a strong community, and we take pride in uniting tradition with change. These two aspects—the preservation of what is worth keeping and the drive for innovation—ultimately provide the foundation for the versatility of our location, as well as the high quality of life and economic success we enjoy. It is not a coincidence that the Rhine District of Neuss is an internationally competitive location that is highly attractive for industry, commerce and trade. This is further enhanced by our excellent connections via road, rail, and the Rhine, which underscore our outstanding infrastructural position.

The Hydrogen Roadmap is powered by our innovativeness and marks the beginning of a structural transformation into a hydrogen competence region as investments in hydrogen are investments in the future. The future hydrogen backbone network will form the backbone of a high-performance hydrogen infrastructure and energy supply. The route through Rhine district of Neuss reinforces the development into a hydrogen competence region and strengthens the existing infrastructure.

Our clear objective is to generate sustainable economic growth and value creation, and to establish hydrogen as the basis for secure and climate-neutral electricity and heat production in industry, commerce, and trade, and also ensure sustainable mobility. For this reason, the

roadmap considers the entire hydrogen value chain—from production to application—and actively involves key stakeholders from the robust economic structure of the Rhine district of Neuss in order to achieve positive regional and supra-regional impacts. The roadmap identifies key projects to make hydrogen available to industry and business in the Rhine District of Neuss in a demand-oriented and reliable manner and thus creating a blueprint for the transformation of companies in our region.

At the same time, we make an important contribution towards the security of supply and to climate protection policy of the NRW state government, while consistently advancing the climate change prevention measures of the Rhine District of Neuss as set out in the integrated climate protection concept. As a living document, the hydrogen roadmap shows ways of tackling climate change in a long-term and targeted manner while at the same time creating sustainable growth for the region.

I would like to thank all those involved in the creation of this work and warmly invite you to read this brochure to find out more about the potential and opportunities of hydrogen and to join us in shaping the future of the Rhine District of Neuss.

Hans-Jürgen Petrauschke

Administrator of the Rhine District of Neuss



Foreword by Dr. Dieter Ostermann und Dirk Brügge

Dear ladies and gentlemen,

As the board members of the Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V., we are delighted to be able to present the Hydrogen Roadmap for Rhine district of Neuss. This document is the result of an intensive, future-oriented process that was only made possible through close cooperation between the administration of the Rhine district of Neuss, the contracted companies DMT ENERGY ENGINEERS GmbH and Implement Consulting Group, as well as the Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V., and the numerous committed partners from business, science, and society.

Hydrogen is more than just an energy source: Hydrogen forms the key to sustainable and climate-neutral economic growth. The Rhine District of Neuss has great potential to play a pioneering role in our country's hydrogen economy. There are only a few districts in Germany that can obtain hydrogen in three different ways. 1. through on-site production via electrolysis using renewable energies, 2. via imports of green ammonia through inland ports, and 3. through a connection to the hydrogen core network.

By means of the Hydrogen Roadmap that has now been presented, we gain clear guidance and can outline the perspectives on how the unique conditions of the Rhine district of Neuss can be harnessed to ensure new economic stability for our region and industry even after brown coal power generation has been phased out—while at the same achieving the European and national climate targets.

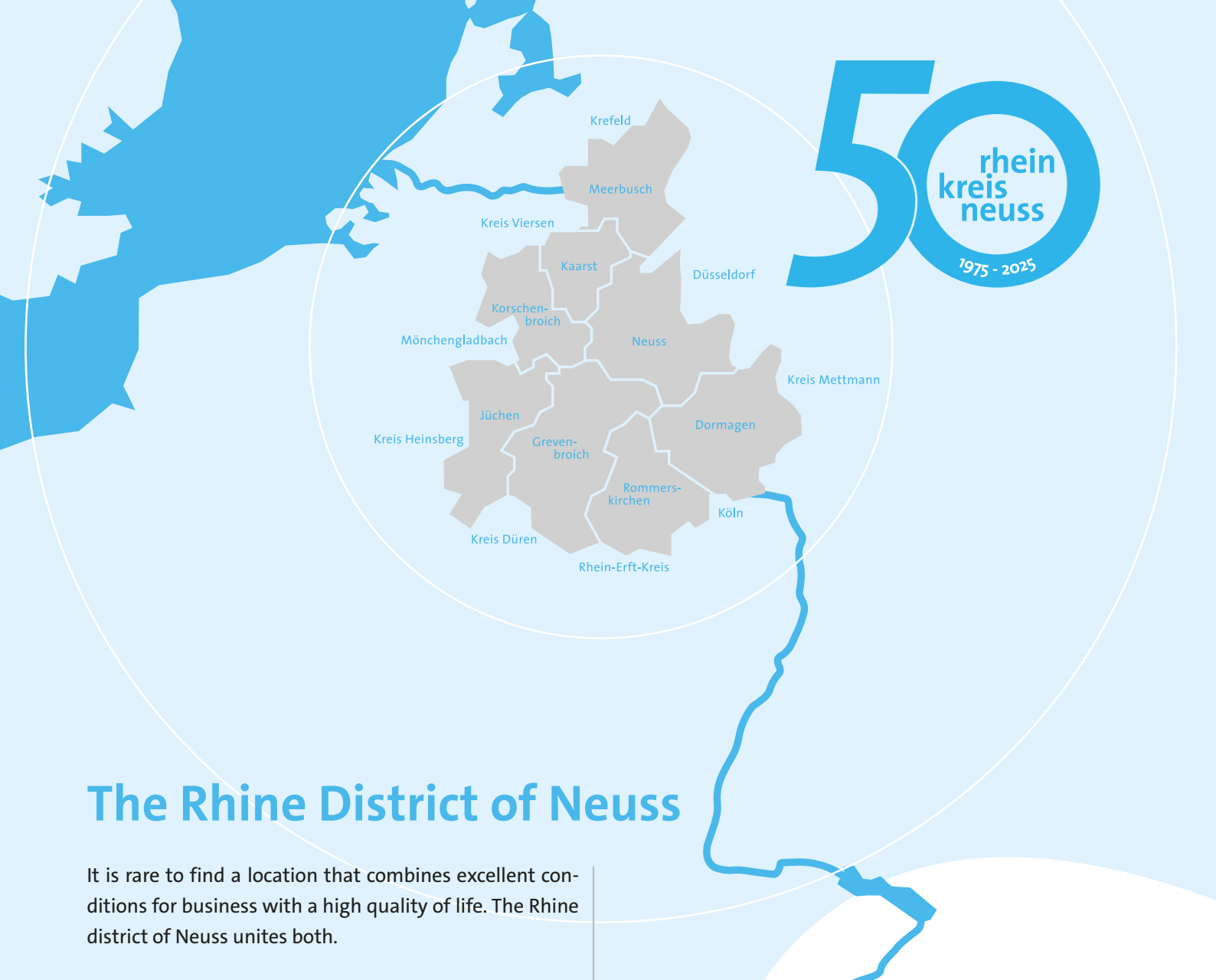
The hydrogen roadmap of the Rhine district of Neuss reveals how the hydrogen value chains in the Rhine district of Neuss can be established in order to seamlessly secure the district's strong economic position in the future. From hydrogen production, through component and plant construction, transport, and finally to the application of hydrogen, it demonstrates how strategic projects and partnerships here in the Rhine District of Neuss can enable sustainable change and transform the district into a driver of innovation and a model for transformation for many other regions. Our goal is to strengthen the economy, create new jobs, and drive forward climate protection – not only at a regional level but also with effects that extend beyond that.

Our association views itself as a central platform and network facilitator for the development of a future-proof hydrogen infrastructure. We invite all stakeholders to become part of this movement and, together with us, transform the Rhine district of Neuss into a model region for hydrogen. It is our shared commitment to boldly seize the opportunities offered by hydrogen, and setting the course for a sustainable future.

We thank all those who have contributed their expertise and commitment to the development of this Hydrogen Roadmap. We want the Rhine District of Neuss to become a role model for a powerful structural change towards a strong, climate-neutral economy in a sustainable world. Together with you, we are determined to follow this path – for the people in our region, for our planet, and for future generations.


Dr. Dieter Ostermann
Chairman of the Board


Dirk Brügge
Deputy Chairman of the Board



The Rhine District of Neuss

It is rare to find a location that combines excellent conditions for business with a high quality of life. The Rhine district of Neuss unites both.

Even the Romans settled here 2,000 years ago, laying the foundations for a rich cultural and economic development. Today, the economic strength of the Rhine District of Neuss puts it at the top of the most populous federal state of North Rhine-Westphalia. In nationwide rankings and comparative studies, the special quality of the location is repeatedly reflected in top positions. Through its innovativeness, excellent location, strong economy, and acknowledged high quality of life, the Rhine District of Neuss offers ideal conditions for companies and investors. As a location, it is in international demand.

Our modern and future-oriented district administration is a committed point of contact for companies and investors alike, helping to contribute towards our high locational attractiveness. Added to this is our central location at the heart of Europe and our excellent infrastructure. This includes the Neuss harbour, as well as superb connections by road and rail, and our proximity to the two international airports in Düsseldorf and Cologne-Bonn.

The European and German headquarters of numerous world-renowned companies have found their ideal location in the Rhine District of Neuss. A highly qualified workforce, a healthy mix of industries including numerous medium-sized companies, the favourable transport links and a huge sales market – more than eight million people live within a radius of 50 kilometres alone – provide the best prerequisites for economic success.

Seven cities and one municipality form a strong community under the umbrella of one of Germany's most populous districts (460,000 inhabitants). They are the towns of Neuss, Grevenbroich, Dormagen, Meerbusch, Kaarst, Jüchen, Korschenbroich, and the municipality of Rommerskirchen. The Rhine District of Neuss is boldly shaping the future.

H₂ Roadmap in a nutshell

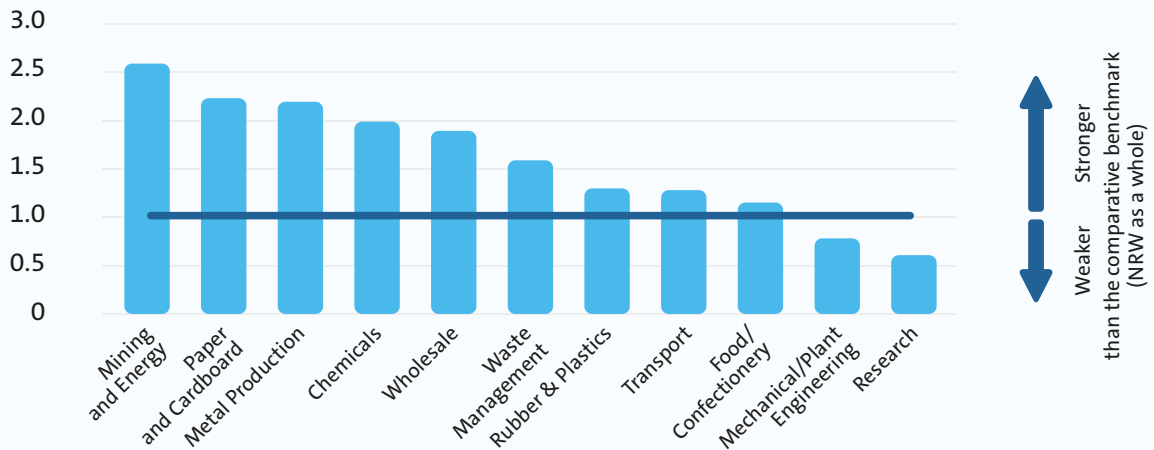
The goal of the H₂ Roadmap is to ensure sustainable growth for our region and, based on green hydrogen and its derivatives, to create secure, climate-neutral, and competitive value chains.

This will secure jobs in our energy-intensive industry for the future and create additional incentives for new companies to set up in future technologies.

To this end, the H₂ Roadmap focuses on the entire hydrogen value chain ranging from the production to application and actively involves key players in the high-performance economic structure from industry, SMEs and the skilled trades as well as all the relevant stakeholders.

Key projects are identified and value creation effects are developed for suppliers from the plant engineering and component development sector.

Localisation quotient of different sectors in the Rhine district of Neuss



Source: Chamber of Industry and Commerce of the Central Lower Rhine district (2022)

Based on the localisation factor (the strength of an industry sector compared to NRW), it is evident that the Rhine District of Neuss has a strong focus on energy-intensive value chains. Thus, hydrogen, as an energy source and storage medium, can play a central role in the decarbonisation of the economy.

The entire value chain is mapped in the Rhine District of Neuss and supported jointly by large-scale industry and SMEs.

Reliable supply routes and supply chains are established by virtue of the diverse production capacities via renewable energy and electrolyzers, extensive import oppor-

tunities by ship and rail, the development of ammonia import facilities, and the connection to the core network. The Rhine District of Neuss is a strong hydrogen sink and thus represents an ideal model region in accordance with the National Hydrogen Strategy and the H₂ Roadmap for NRW.

This results in three central fields of action concerning the hydrogen strategy for the Rhine District of Neuss:

- Field of action 1: Supply
- Field of action 2: Stakeholder support
- Field of action 3: Communication and control

Approach

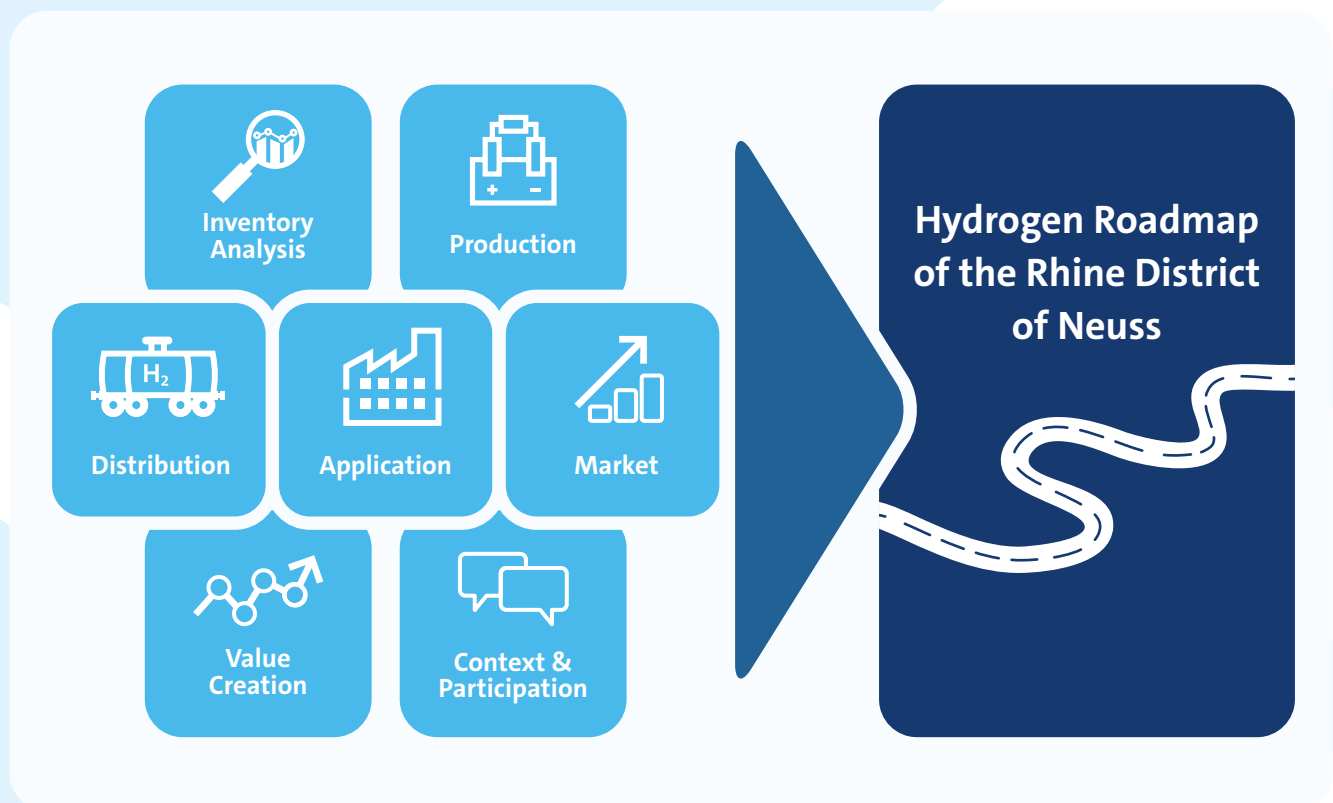
Under the joint leadership of Rhein-Kreis Neuss and Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V., the consultancy firms DMT ENERGY ENGINEERS GmbH and Implement Consulting Group were commissioned to draw up the hydrogen roadmap.

The goal was to develop a roadmap that builds on the region's strengths: its innovativeness, strong community spirit, and the diversity of the regional industry and stakeholders. The roadmap in this case is designed to cover the next 10 years until 2035 and to describe the steps and measures required to transform the Rhine district of Neuss into a hydrogen competence region.

The development process methodically followed the entire hydrogen value chain in Rhine District of Neuss, starting with an inventory analysis, then production

and distribution, and extending to the application of hydrogen. The regulatory framework conditions of the national market and the value creation potential to be realised were explicitly included to ensure a sustainable economic effect.

Through participation and the intensive, active involvement of regional stakeholders from industry, business, politics, and administration in regular exchange and engagement formats, the concerns of all relevant groups were comprehensively addressed. In addition, needs, challenges, and plans collected through online surveys and in-depth interviews have been incorporated into the roadmap. Together, potential pilot projects were developed and outlined, which can subsequently serve as a blueprint for future developments in the region.



Inventory analysis

The Rhine District of Neuss is a particularly economical-ly strong industrial region with excellent infrastructural connections. Following the decision in 2022 to phase out brown coal power generation in the Rhineland mining area – brought forward from 2038 to 2030 – the Rhine District of Neuss is particularly affected by the structural transformation and the necessary climate-neutral transformation of the district’s energy-intensive industry.

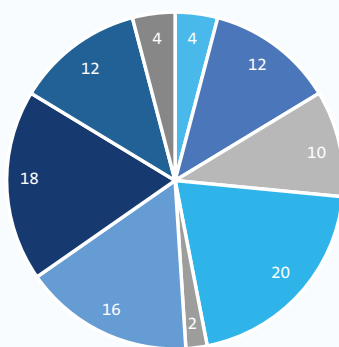
The National Hydrogen Strategy and the Hydrogen Roadmap for NRW identify the safeguarding of the energy-intensive industry as one of the most important target groups, which will be particularly dependent on the development of the hydrogen economy and the rapid expansion of hydrogen infrastructure. Thus, hydrogen and its rapid, secure, and competitive availability will be essential for the transformation and indispensable for

strengthening the region’s energy-intensive industry and preserving the affected jobs.

Where the Rhine District of Neuss is concerned, the conditions are especially favourable. Here, the entire hydrogen value chain – ranging from the production, distribution to the application – can be covered. In addition, a connection to the hydrogen core network has already been planned and envisaged.

The focus in this case is on industrial H₂ users, particularly for the generation of process heat as well as for material applications, including green derivatives such as ammonia (NH₃). Component manufacturers are also well represented, although to date there are fewer local stakeholders in the production sector.

H₂ value chain stakeholders Represented in the Rhine District of Neuss



- Generation
- distribution and infrastructure
- application – mobility
- application – energy
- application – material
- components
- administration and networking
- services
- research

A total of 98 stakeholders from the H₂ value chain were recorded.

Applications in energy-intensive industry in particular still compete with natural gas-based processes. Consequently, the implementation of them is highly dependent on the pricing and availability of (green) hydrogen, making their realisation challenging even today.

These factors have resulted in only a few projects being implemented in the district so far. However, the region stands to benefit greatly from the exchanges of experience and networking both internally and extending beyond the region.

Conclusions

- Strong companies with a focus on industrial users.
- Mobility represents an application with a low technical entry barrier.
- Diverse supply structures are required.
- Strong support sectors.

Action recommendations

- Identification of industrial drivers.
- Example applications in the fields of industry and mobility.
- Pursuit of all supply approaches.
- Close networking of the stakeholders.

Hydrogen production

Concepts for hydrogen production – such as local and decentralised electrolysis for regional hydrogen generation – have been analysed, and potential scenarios for the necessary expansion of renewable electricity capacities have been considered.

Initial pilot structures were examined and possible alternative supply pathways, for instance via an ammonia infrastructure, were identified.

Potential locations for the various resulting requirements were evaluated.

The production of green hydrogen via electrolysis correlates directly with the availability of electricity from renewable sources. For an assessment of the potential and demand for hydrogen generation, the requirements of industrial users as well as the potential for wind and photovoltaic electricity generation are of key importance.

Conclusions

- A maximum renewable energy generation potential of up to 4,500 GWh per annum is feasible, though realistically 1,100 GWh per annum can be assumed.
- The municipalities of Grevenbroich and Jüchen currently (and in the future) possess the highest potential in the district where electricity from wind and solar is concerned.
- From the realistic expansion scenario, a theoretical hydrogen generation potential of 0.3 TWh per annum results, rising to 0.5 TWh per annum (15,000 tonnes H₂ per year) by 2030.
- Several industrially relevant sites are suitable in providing local electrolysis.
- Ammonia inland ships have a loading capacity of between 500 t and 2,000 t (equivalent to 85 t to 350 t H₂).

- An additional very potent supply option is ammonia cracking, with possible locations near the local chemical industry or at the Port of Neuss.

Action recommendations

- Long-term promotion of renewable energies.
- Implementation of an electrolyser to support an initial user.
- Development of an NH₃ infrastructure as a second supply option.






Hydrogen distribution

A key component in successful ramping up of the hydrogen economy in the Rhine District of Neuss is a stable and future-oriented supply infrastructure. The roadmap considers various distribution scenarios, with the focus primarily on the planned and approved hydrogen backbone network. This demonstrates the strong coverage of the Rhine District of Neuss.

A connecting pipeline via the important infrastructure node at the Neuss-Düsseldorf port can close a gap in the local distribution network.

Furthermore, possible distribution network connections, trailer deliveries, and inland shipping have been examined, and preliminary concepts for storage and refuelling stations have been drafted.

		Distribution			Transmission		USD/kg	<0.1	0.1 - 1.0	1 - 2	>2
		0 - 50 km	51 - 100 km	101 - 500 km	>1,000 km	>5,000 km					
	Repurposed	Urban Network	Regional Pipeline	Onshore Pipeline	Onshore/Subsea Pipeline	Not specified					
	New construction	Urban Network	Regional Pipeline	Onshore Pipeline	Onshore/Subsea Pipeline	Not specified					
	LH ₂	Not specified	Not specified	Not specified	LH ₂ Schiff	LH ₂ Schiff					
	NH ₃	Not specified	Not specified	Not specified	NH ₃ Schiff	NH ₃ Schiff					
	LOHC	Not specified	Not specified	Not specified	LOHC Schiff	LOHC Schiff					
	LH ₂	LH ₂ Lorry	LH ₂ Lorry	LH ₂ Lorry	Not specified	Not specified					
	Gaseous	Lorry	Lorry	Lorry	Not specified	Not specified					

Estimation of the transport costs per kilogramme of hydrogen for each transport option, depending on the transport distance and based on the assumption of high utilisation of the transport options (Hydrogen Council, 2021).

Conclusions

- The Rhine District of Neuss offers very good conditions for future-oriented hydrogen delivery as well as for a robust distribution infrastructure.
- Users can be supplied via the 50-km-long hydrogen backbone network (conversion planned by 2030, new pipelines by 2032), which already covers half the area of the Rhine District of Neuss within a 3-km corridor, or through well-developed distribution networks (to be converted from natural gas to hydrogen).
- The preliminary H₂ refuelling station concept proposes three locations. A public H₂ refuelling station must be established in Neuss as an urban hub by 2030 due to the EU regulation on the build-up of infrastructure for alternative fuels (AFIR).
- Lower hydrogen requirements of up to 10 t/day (100 GWh/a) can, as elsewhere, be met by trailer deliveries. Proximity to a hydrogen production/ filling facility is advantageous here. The expansion of the infrastructure is essential.

Action recommendations

- Intensive support for the feasibility study on converting the supply line at the Port of Neuss from natural gas to hydrogen (including customer acquisition, permitting, and public information).
- In addition to the port the support of other clusters from industry, power plants and industrial estates is required for the H₂ connection.
- A working group “Refuelling Station” should focus on site selection and demand forecasting. Interchanges with NOW for site modelling should be sought.
- Support through concrete coordination with potential buyers and the conclusion of letters of intent for an H₂ uptake that is as binding as possible in terms of time and quantity is required.
- Consideration of H₂ in municipal heat planning.

Hydrogen applications

The Rhine District of Neuss, with its energy-intensive industry and strong logistics sector, offers diverse areas of potential for the feeding in, utilisation and application of hydrogen. It has been possible to identify and present these areas of potential as part of the roadmap. The use of hydrogen offers significant long-term potential for decarbonising both the industry and logistics sectors.

Industrial and business areas have also been examined, as they can benefit from hydrogen-based energy or heat supply concepts.

Conclusions

- High levels of H₂ application potential in the Rhine District of Neuss: up to 800,000 t/a (equivalent to 5.4 GW of electrolysis).
- Industrial areas and mobility represent important anchor customers as drivers of the transformation.
- In the case of industrial areas and industrial buyers with demands of over 10 t/d, a network-connected supply is the only viable solution.

Action recommendations

- Identify anchor customers.
- Create synergies, ensure spatial proximity and develop alternative supply concepts between producers, energy suppliers and buyers.
- Motivate comprehensive networking among the various stakeholders, establish regular exchange formats, concretise joint projects and jointly close any gaps.
- Determine the need for funding and communicate it at an early stage; identify funding opportunities and support funding applications.
- Maintain constant communication with political bodies and regulatory authorities, eliminate grievances and jointly manage processes that could jeopardise projects.





Hydrogen market

The ramp-up of the regional hydrogen economy in the Rhine District of Neuss – and the corresponding investment decisions – are highly dependent on the national and international hydrogen market conditions, and therefore directly on the future price development of green hydrogen.

Within the roadmap, the national market dynamics, the current and future price developments and their influence on market trends were analysed. The development of a regional hydrogen market in terms of the corre-

lation between supply and demand as well as the potential for use in the different sectors was also considered in this process.

Due to RDN's excellent connection with both the existing and emerging infrastructures, a diverse hydrogen supply offer across all delivery methods can be anticipated in the long term. This, in turn, should lead to potentially competitive hydrogen prices – even if the forecasts still remain quite divergent during the ramp-up phase.

Conclusions

- The simultaneity of the supply options leads, in the medium term, to globally traded market prices.
- Applications focus on processes that have no alternatives, especially in the energy-intensive industry → By 2045, a “minimum demand” can be expected; additional demands will depend on the availability of alternatives.
- Price parity with natural gas is crucial for the switch in industrial applications.

Action recommendations

- Regional measures for reducing H₂ costs:
 - Ensure infrastructure connections
 - Accelerate permitting procedures
 - Promote collaborations and initiatives
- Regional measures to influence pricing policy:
 - Collaborations with regional authorities involving fixed purchase volumes
 - Communication of local activities

Value creation

The development of a local hydrogen economy offers great potential to meet the requirements of the structural transformation for decarbonisation and the conversion of industrial energy systems. On the one hand, it can successfully transform the affected industries and secure jobs. On the other, new companies may be drawn to the Rhine District of Neuss by its outstanding energy availability in a competitive regional market – thereby creating new, future-proof jobs.

The roadmap assesses the conditions in the Rhine District of Neuss as very positive in this regard. The prospect of high H₂ demands from the local industries in question, the comprehensive opportunities for establishing a robust and redundant H₂ distribution structure,

and the prospect of significant H₂ availability through local production all facilitate a promising ramp-up of the hydrogen economy in the Rhine District of Neuss.

Due to the broad market access, relatively low hydrogen prices can be expected and, in the long term, it is also conceivable that demand from consumers with a low willingness to pay will be met. In the short term, supply will primarily be limited to regional producers.

This situation will be further improved in the medium term by the core network connection and the possibility of extensive ammonia imports, thus turning the region into a model area for a modern hydrogen economy on an industrial scale.



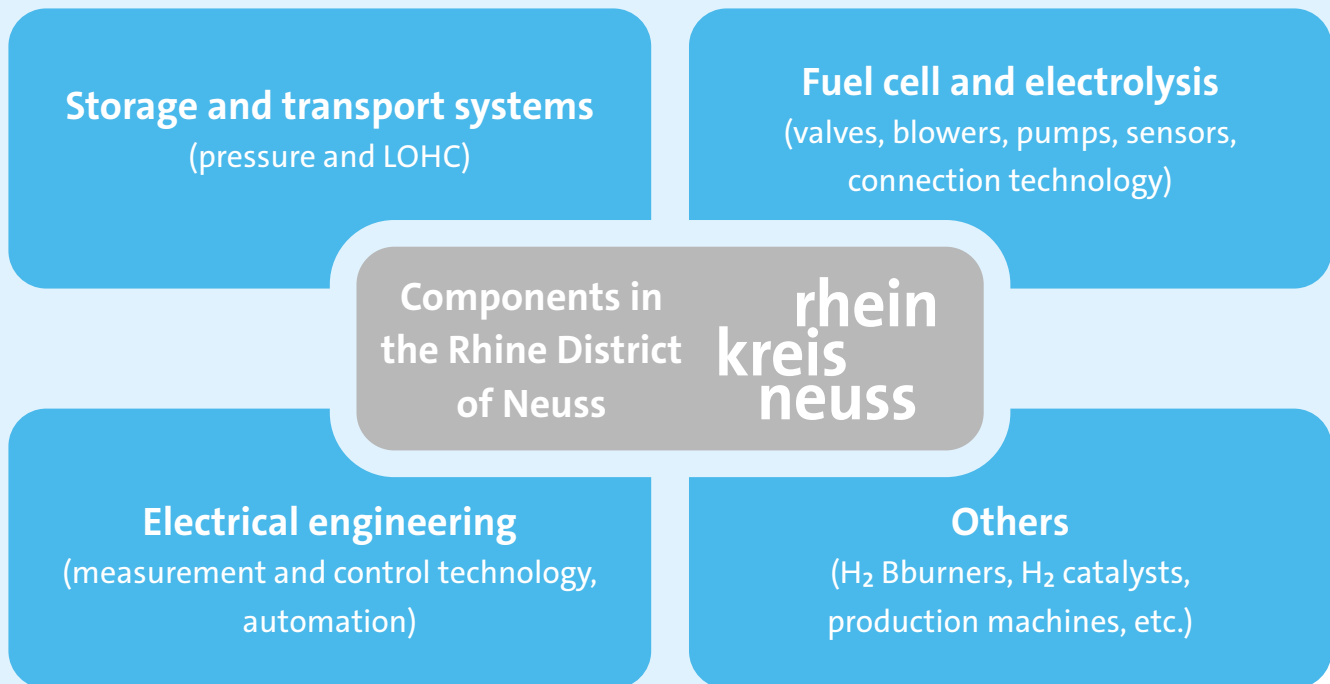
Hydrogen economy in the Rhine district of Neuss – SWOT

Value creation	Industry/ Sector	Strengths	Weaknesses	Potential	Recommendation
H ₂ generation	Energy suppliers, investors etc.	Many potential stakeholders; long-term demand exists	Renewable potential is limited	Medium/high	Implement projects to initiate H ₂ value creation independently of the core network
Distribution and Infrastructure – H ₂ via pipeline	Grid operators, energy traders etc.	RDN is part of the core network; further pipelines planned	Demand for connection to the network is still limited	Very high	Infrastructure expansion forms the basis for the H ₂ economy and should therefore be broadly supported
Distribution and Infrastructure – NH ₃ as a derivative	Port, energy traders, chemical industry, industrial gases	Berthing at Rhine ports possible; chemical industry, NH ₃ -utilisation (in substance), available areas for crackers	Availability of space (for larger crackers at Neuss port)	Very high	Flagship cracker project; support regarding space and permitting
Application – Industry	Aluminium, chemicals, food, mechanical engineering, paper etc.	Energy-intensive industry as a potential major customer for H ₂	Price and security of supply not assured	Very high	Industrial demand is essential for the H ₂ economy and vice versa. Support measures for H ₂ introduction
Application – Mobility	Logistics, harbour, freight forwarders etc.	RDN is a logistics and mobility centre	Municipal fleets rely on battery-powered mobility	High	Establishment of mobility clusters of logistics companies and support H ₂ refuelling stations
Application – Conversion	Energy supplier/ power plant operator	Power plant location is available	No gas connection available so far	Very high	Support the Neurath site for an H ₂ gas power plant
Application – Heat	Energy suppliers, housing	Dense distribution network	Restricted availability	Medium	Await municipal heat planning. Support sensible individual projects
Components	Mechanical engineering/ Supplier industry	Existing products and competencies	High levels of development effort and costs	High	Support for developments through specialist services (innovation platform, Production Launch Centre Hydrogen, PLCH)
Service	Consultancy, Planning and Engineering	Strong in RDN based on lignite, industry	Need to adapt to new topics such as hydrogen	High	Support developments through specialised offers
Research	Universities, colleges, research centres	RDN is surrounded by strong research centres	Hardly any relevant research takes place in the RDN itself	Medium	Networking Research centres with local companies drive the development of PLCH (H ₂ application and -competence centre)
Management/ Networking	Management/ Hydrogen Hub RDN Rheinland	RDN has been active in the H ₂ sector for many years, H ₂ -Hub very successful	Dependence on external cooperation	Very high	Building the regional H ₂ economy requires continued and intensified activities

Existing strengths and competences of companies in the Rhine District of Neuss

Companies are now already active in the manufacturing of components and the provision of services in the hydrogen economy sector. However, establishing the hydrogen economy offers an additional, significantly

higher potential for job creation in Rhine District of Neuss. The roadmap with the defined starter projects serves as a basis for this.



Existing products/expertise of the companies in the RDN in the field of hydrogen.

Conclusions

- Results of the interviews conducted indicate that: The H₂ economy is considered “important” by stakeholders in the Rhine District of Neuss.
- Companies from RDN are well-positioned across the value creation chain.
- Starter projects and a competence centre will support the strategy’s implementation and unlock additional value creation potential.
- Projects worth up to €1 billion are feasible.
- More than 20,000 jobs could be secured or created through hydrogen.

Action recommendations

- Further in-depth discussions with companies and stakeholders through regular exchange formats (Rhine District of Neuss, Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V.).
- Offer initial consultancy for stakeholders in collaboration with the Chamber of Industry and Commerce.
- Further develop the pilot projects and develop additional, new project approaches.
- Detail the concept of the Production Launch Center Hydrogen (PLCH) as the link between research, start-ups and industry.

Results and Strategy – Fields of Action

Field of action 1: Supply



- Accelerate the expansion of renewable energies (RE).
- Regional H₂ production by means of electrolysis; utilisation concept in the detailed planning.
- Concept development of an ammonia infrastructure (cracker, transshipment infrastructure).



- Stringent pursuit of RE expansion targets.
- Realisation of at least one regional electrolysis plant; testing of further sites.
- Commissioning of the cracking project; supply industry and chemical production with NH₃ and H₂.



- Continued operation of the electrolysis plant with a local anchor customer.
- Commissioning of additional sites.
- Evaluate possible scaling of the cracker/cracking sites.



Ensure supply

2028

- Planning of the (expansion) construction of the gas transmission networks to the core network, concretisation of the implementation periods.
- Conduct a study on the supply pipeline for Neuss Port/Lausward Power Plant (D).
- Plan further core network connections for energy-intensive companies.

2030

- (De-)construct the gas transmission networks to the network.
- Plan the supply pipeline for the Neuss Port/Lausward Power Plant.
- Preparation of the connections for energy-intensive companies.

2035

- Core network in operation / on the brink of completion
- Realisation of the supply pipeline for the Neuss Port/Lausward Power Plant.
- Connect the first implementation projects via pipeline.



Expand infrastructure

Field of action 2: Stakeholder Support



- Clarify needs, particularly within a working group.
- Commission 1st 1 refuelling station.
- Establishment of the working group (see Field of Action 3) to coordinate needs.



- Further development of the field of use, for instance by a 2nd refuelling station.
- Integration of supra-regional initiatives.



- Expand the HRS infrastructure to up to three refuelling stations.



Support Logistics

2028

- Introduction of a working group to network component manufacturers, users, producers, researchers and other service providers.
- Support of project consortia.
- Identification of first demonstration users.
- Supply concept for demonstration plants.

2030

- Implementation of the first demonstration and application projects in the area of process heat.
- Cooperation with the PLCH competence centre (see field of action 3).
- Ensure supply through projects in Field of Action 1.
- Exchanges of experiences within the working group.

2035

- Conversion of initial process strands.
- Establish a multi-pillar supply concept (see Field of Action 1).
- Working group focuses on the establishment of the core network.



Create Opportunities for Industry

Field of Action 3: Communication and Control



- Provide initial consultancy for companies.
- Offer support with feasibility studies and conceptualisation.
- Establishment of specialist working groups.
- Close cooperation with surrounding networks/stakeholders.
- Establishment of a common voice at state and federal levels.
- Establishment of a public information centre.



- Realise/conceptualise projects on a cross-regional basis.
- Establish and structure a supra-regional exchange of experiences.
- Communicate needs and make use of funding opportunities at a state and federal level.



- The working group supports the establishment of the core network.
- Conversion of individual process lines in consortia (see Field of Action 2).
- Utilisation of funding and expansion of infrastructure at state and federal levels.



Ensure Support

2028

- Definition of the partners and users of the PLCH competence centre.
- Evaluation of the planned company locations/development areas and their H₂ demand (e.g. energy-intensive industry, data centres).

2030

- Jointly implement pilot and demonstration projects (see Field of Action 2).
- Commission the PLCH competence centre.
- Development of industrial areas with hydrogen supply (see Field of Action 1).

2035

- Establish the PLCH competence centre as a central hub for piloting and testing H₂ technology and the exchange of experiences.
- Planning and expansion of core network connections.



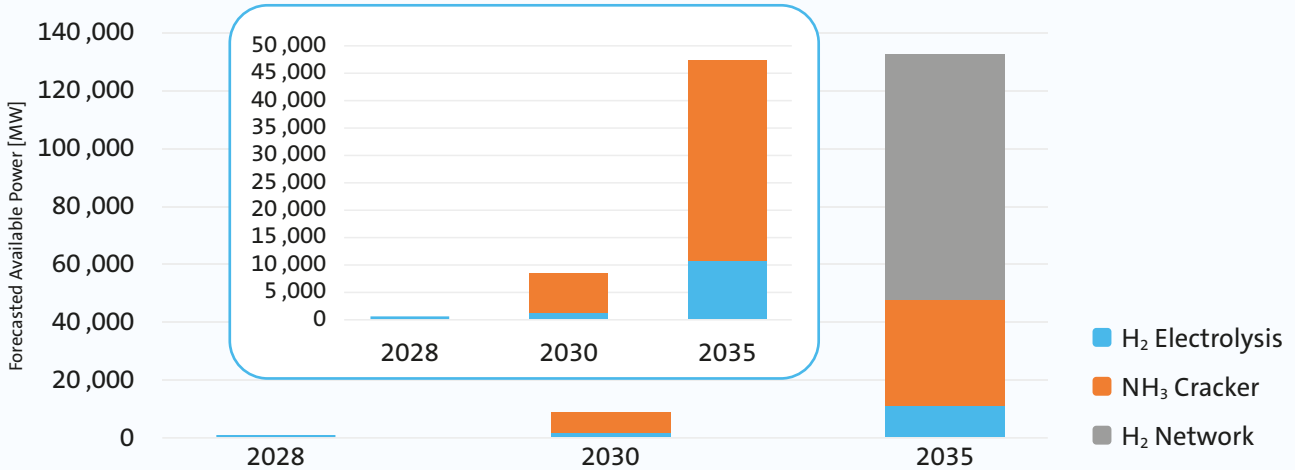
Utilise Synergies

MILESTONES

Goal 1: Availability

The realisation of the three supply options of electrolysis, ammonia cracking and network connection determines the availability of hydrogen in Rhine District of Neuss. The speeds at which these are realised vary, resulting in the forecasted hydrogen availability (measured in power in MW) shown in the diagram.

Capacity Development of Supply Routes



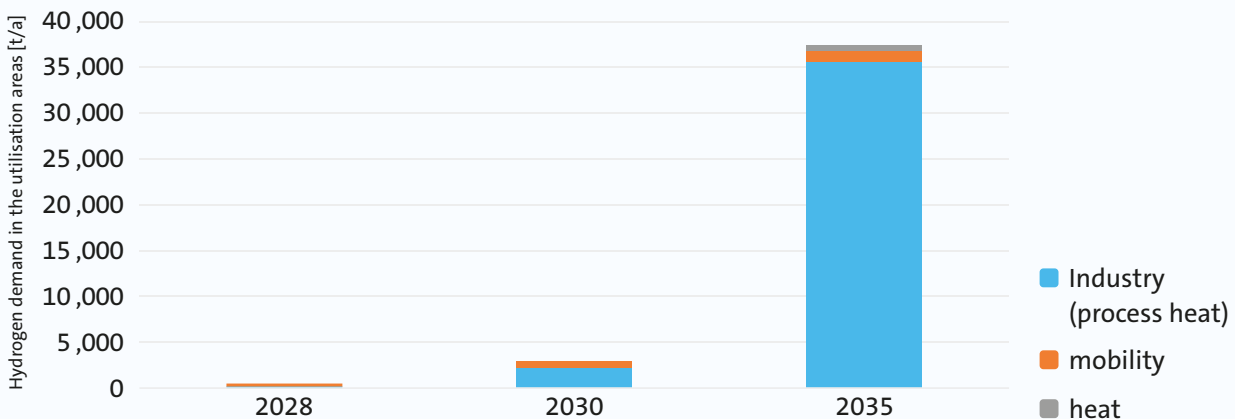
Milestones in the field of availability:

- 2028** At least one electrolysis plant in the Rhine district of Neuss or surrounding area.
- 2030** Further electrolysis plants, at least one ammonia cracker in operation.
- 2035** Core network connection achieved; significantly increased available power.

Goal 2: Use

In the Rhine District of Neuss, application is primarily focussed on the energy-intensive industry sector. The equally important energy generation using gas-fired power plants has not been taken into account due to the lack of a power plant strategy to date. Mobility and, to a lesser extent, building heating are taken into account.

Hydrogen demand in the utilisation areas



Assuming that availability and prices develop as favourably as predicted, approximately 30% of processes could be decarbonised using H₂ by 2035.

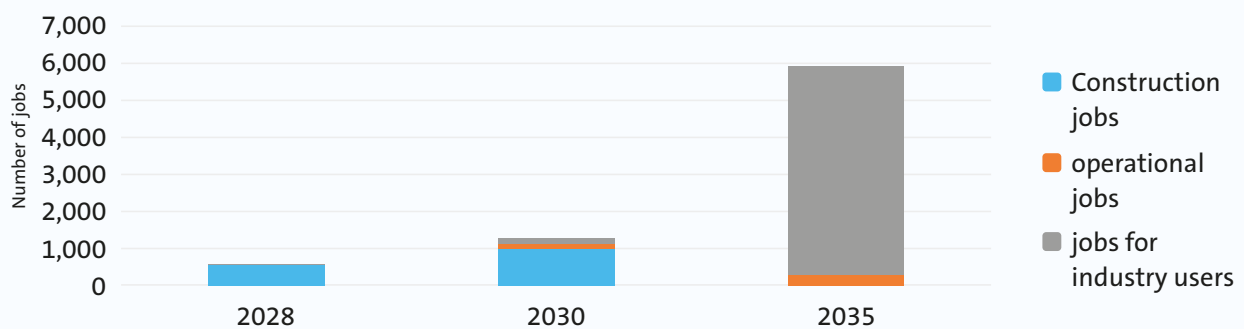
Milestones in the field of use:

- 2028** First use in the field of mobility.
- 2030** First pilot projects in industry.
- 2035** Implementation of the first complete industrial strands.

Goal 3: Employment

Job growth in the Rhine District of Neuss is highly dependent on the development of hydrogen technology and can be divided up into two phases: a preparatory phase and a utilisation phase (following connection to the core network). In the first phase, jobs are created through investment projects – particularly in the construction of infrastructure and facilities. Through an increasing conversion of the energy-intensive industry from 2030 onwards, preserving and creating jobs through the transformation to a hydrogen economy will become the key concern.

Number of affected and newly created jobs



Milestones in the field of employment:

- 2028** First jobs in the field of generation.
- 2030** Additional jobs in the field of generation, preservation of industrial jobs with H₂.
- 2035** Significant increase in the number of jobs in and through the hydrogen economy.



Pilot projects

In collaboration with local stakeholders, companies and Rhine District of Neuss—and with the support of the Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V. – three project sketches have been developed in various participatory formats for the areas of mobility, production and infrastructure. These initiatives are now to be

jointly pursued by the partners involved as concrete projects, serving as both a launch pad and a blueprint for further hydrogen projects in the Rhine District of Neuss. Detailed project briefs have been included in the comprehensive roadmap.

“Electrolysis” pilot project

Goal

Support for first-mover users by means of an early realisable supply option involving a cost structure that can be planned in the medium-term.

Stakeholders

Anchor customers/buyers, BOO (Build-Own-Operate), permitting authorities, funding bodies.

Outlook

- Potential users exist → the decision on the supply option will depend on the price difference between locally produced H₂ and that supplied via the core network.
- Continuation of initial discussions with the involved project stakeholders.
- Define power sources and secure price commitments.
- Identify anchor customers with minimum purchase volumes.
- Combination with an H₂ refuelling station is possible.
- The duration of the permitting process, construction and commissioning will depend on the framework conditions of the project/feasibility study.



Pilot project “H₂ refuelling station”

Goal

Decarbonisation of regional and supra-regional logistics at the port as well as transit traffic. Initial motivation for local companies to switch to fuel cell vehicles.

Stakeholders

Buyers, investors, municipality/district, funding bodies.

Outlook

- Determine the needs of anchor customers/buyers and forecast demand for transit traffic.
- Assess area availability and select an appropriate site.
- Continuation of initial discussions with the project stakeholders involved.
- Define the framework conditions with regard to the technical requirements.
- Develop a business case/financing model.
- Commence the permitting and implementation phase.

“Extension Pipeline” pilot project

Goal

Conduct an economic and technical assessment of the conversion of an extension pipeline – with an estimated route length of 12.2 km – to the core network (using the existing NETG pipeline) for the supply of Neuss Port and the combined cycle power plant of Lausward (Düsseldorf).

Stakeholders

Operators (of the long-distance pipeline network), buyers/users, municipal utilities.

Ausblick

- Assessment and development of the framework conditions for a feasibility study on converting an extension pipeline to the core network for the supply of different hydrogen consumers.
- Continuation of initial discussions with the project stakeholders involved.
- Upon the confirmation of demand from the Network Development Plan and subsequent evaluation of the economic and technical feasibility of the supply, the following steps can occur:
 - Planning Phase (risk analysis, system design, possibly planning and construction, etc.).
 - Preparation: (authorities management, material certification, permitting, etc.).
 - Implementation: (conversion, possibly new construction, etc.).
 - Commissioning: (acceptance, testing, certification, etc.).

Production Launch Center Hydrogen (PLCH) – The Regional H₂ Competence Centre

The 'Production Launch Center Hydrogen' (PLCH), which acts as a regional competence centre and should be located in the immediate vicinity of the Rhine, is of key importance in the development of a comprehensive hydrogen economy and en route to becoming a hydrogen model region.

Such hydrogen competence or user centres generally serve as key institutions in building trust in the technology and supporting the hydrogen strategies of the region as well as of state and federal governments in their implementation. Furthermore, these centres are intended to accelerate and test the pathway to market readiness for application-oriented research and to pave the way for the widest range of practical applications.

Within the roadmap, an initial concept and potential thematic focal points for a future H₂ competence centre were outlined. In this case it should be situated on a site with excellent infrastructural connectivity and relevance

to structural change. The research findings indicate that such an H₂ competence centre will have a relevant influence on the projects developed as part of the hydrogen roadmap and can generate additional value creation effects in the long term.

In order to overcome the necessary technological challenges, it will be of key importance that the knowledge and know-how present in the research as well as in the numerous companies and start-ups are quickly and purposefully transferred into safe and stable products, which will then form the basis for the ramp-up of the hydrogen economy. The faster, better and more purposefully the gap between research and development—and between development and market readiness—is closed, the more successfully the components can be deployed in the transformation, sustainable climate targets can be achieved and new value chains in plant and mechanical engineering can be created.



The Production Launch Center Hydrogen in the Rhine District of Neuss

- It bridges the development gap between research and application in the manufacturing of efficient components for the hydrogen economy.
- The focus is on the development and industrialisation of automated, scalable and cost-optimised products and production processes to solve the current challenges faced.
- It offers attractive site conditions and space for innovation.
- Serves as a nexus by networking research, industry and start-ups.
- Encourages the establishment of companies and thus creates new jobs.
- Secures the preservation of existing jobs through cross-sectoral support for structural change.
- As a technology centre, it can act as a driving force and partner for the existing and established H₂ research landscape.
- Promotes the regional economy by bringing together hydrogen companies throughout the value chain and transferring their experience and industry knowledge.
- Serves as a networking platform in Rhine district of Neuss for both regional and supra-regional stakeholders of the hydrogen economy and has an impact extending beyond the region.

The PLCH has clear goals, here are a few examples of this:

Development and Demonstration:

Develop technologies for the industrial use of hydrogen (H₂) and demonstrate them in pilot projects (e.g. paper drying, aluminium smelting, food processing).

Knowledge transfer:

Offering of training courses and workshops for companies, professionals and the public; include technician training courses, business consultancy, public relations and measures to promote acceptance.

Network building:

Establish and promote collaborations between industry, universities and research institutions as well as political bodies.

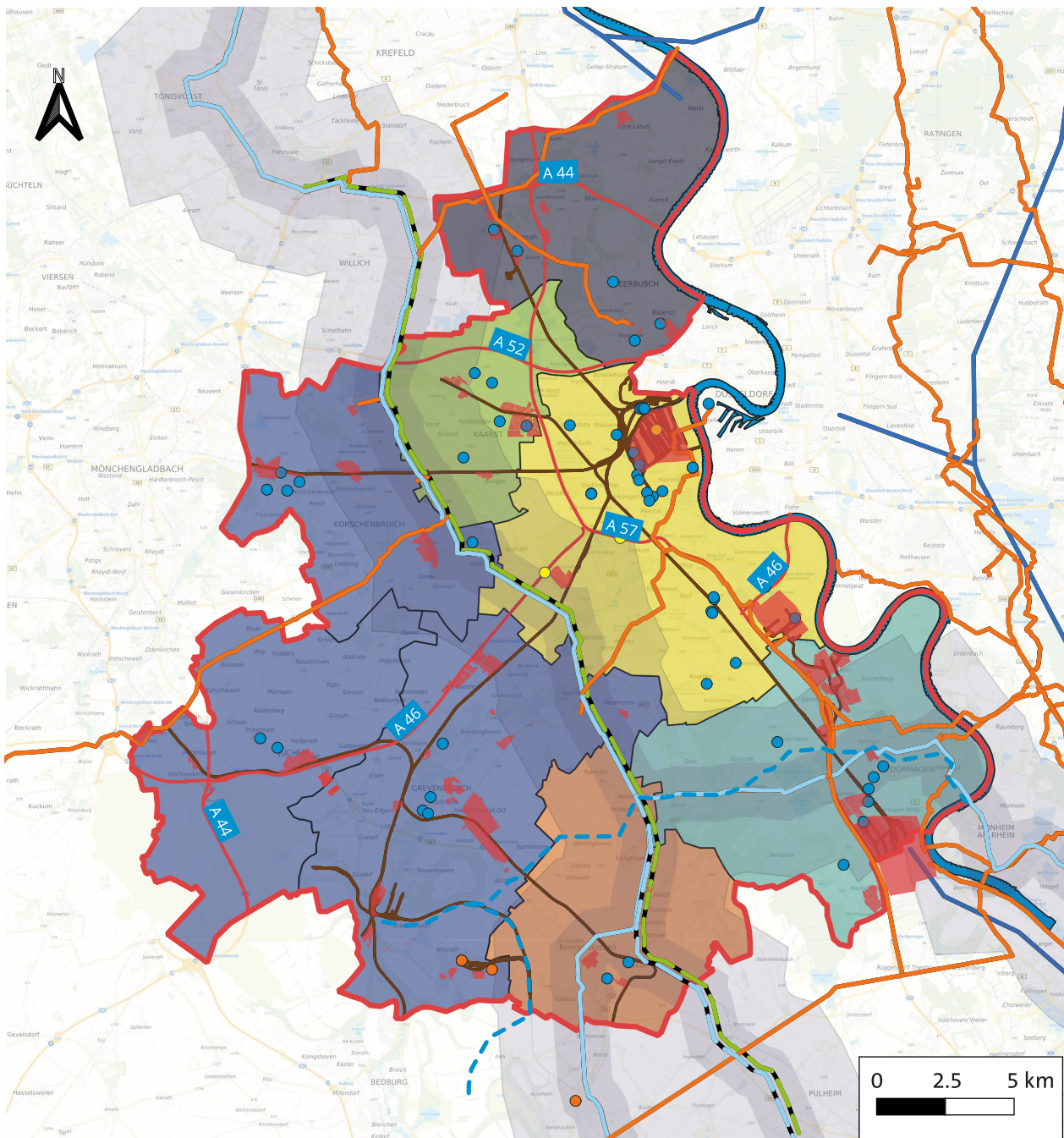
Innovation:

Support of start-ups and new business models in the hydrogen economy.

Technological focus:

e.g. H₂-based heat sources, energy management, carbon-free process heat

Potential and planned H₂ infrastructures in the Rhine District of Neuss



Key

- Industrial and commercial areas
- Motorways
- Rail network
- Gas-fired power stations
- Coal-fired power stations
- H₂ Refuelling Stations (Rough Concept)

Lines

- Natural gas
- Existing Hydrogen Pipeline
- Hydrogen Core Network Conversion
- - - Construction of new hydrogen core network
- Core network 1 km buffer
- Core network 3 km buffer
- CO₂ New Construction (Possible Route DRC)
- - - Rhine transport line

Distribution Network Operators

- evd energieverorgung dormagen GmbH
- NEW Netz GmbH
- Rhein-Sieg Netz GmbH
- Stadtwerke Kaarst GmbH
- Stadtwerke Meerbusch GmbH
- Stadtwerke Neuss GmbH

Summary

The Hydrogen Roadmap has analysed areas of potential, identified opportunities and risks and developed action recommendations across the hydrogen value chain.

For the industries located in the Rhine District of Neuss, solution approaches and scenarios for entering the area of hydrogen applications as well as the various supply options for hydrogen have been outlined.

Now it is up to all the stakeholders in the Rhine District of Neuss, collaborating with all the means at their disposal, to boldly embrace the inevitable transformation into a climate-neutral industrial region. In doing so, they should capitalise on the excellent existing infrastructural conditions and opportunities ensuring the Rhine District of Neuss becomes an outstanding hydrogen model region and is, and continues in the future, to be internationally recognised as a model example of value creation, stability and attractiveness.



The complete Hydrogen Roadmap for the Rhine District of Neuss as well as this brochure in digital format can be accessed via the QR code below.



Hydrogen Roadmap of the Rhine District of Neuss
(<https://www.h2-hub-rheinland.de/wasserstoff-roadmap>)

The Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V.

Hydrogen is becoming a mainstay of the energy sector, including in the Rhine District of Neuss. The Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V., as a central platform and competent contact point for industry, commerce, trade, science and research, political bodies and administration, is a key organisation for the ramp-up of the hydrogen economy in the region as well as in the Rhineland mining district.

By means of knowledge transfer, networking and initiatives, the entrepreneurially managed Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V. promotes structural change, secures sustainable value creation and employment in the region, and brings hydrogen into practical use for the sectors of mobility, energy and heat supply.

What does the association stand for?



Would you like to find out more about the work of the Wasserstoff Hub Rhein-Kreis Neuss/Rheinland e.V. and become part of the successful hydrogen economy in the Rhine District of Neuss?

Then get in touch with us and become a member:
www.wasserstoff-hub-rheinland.de

oder



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