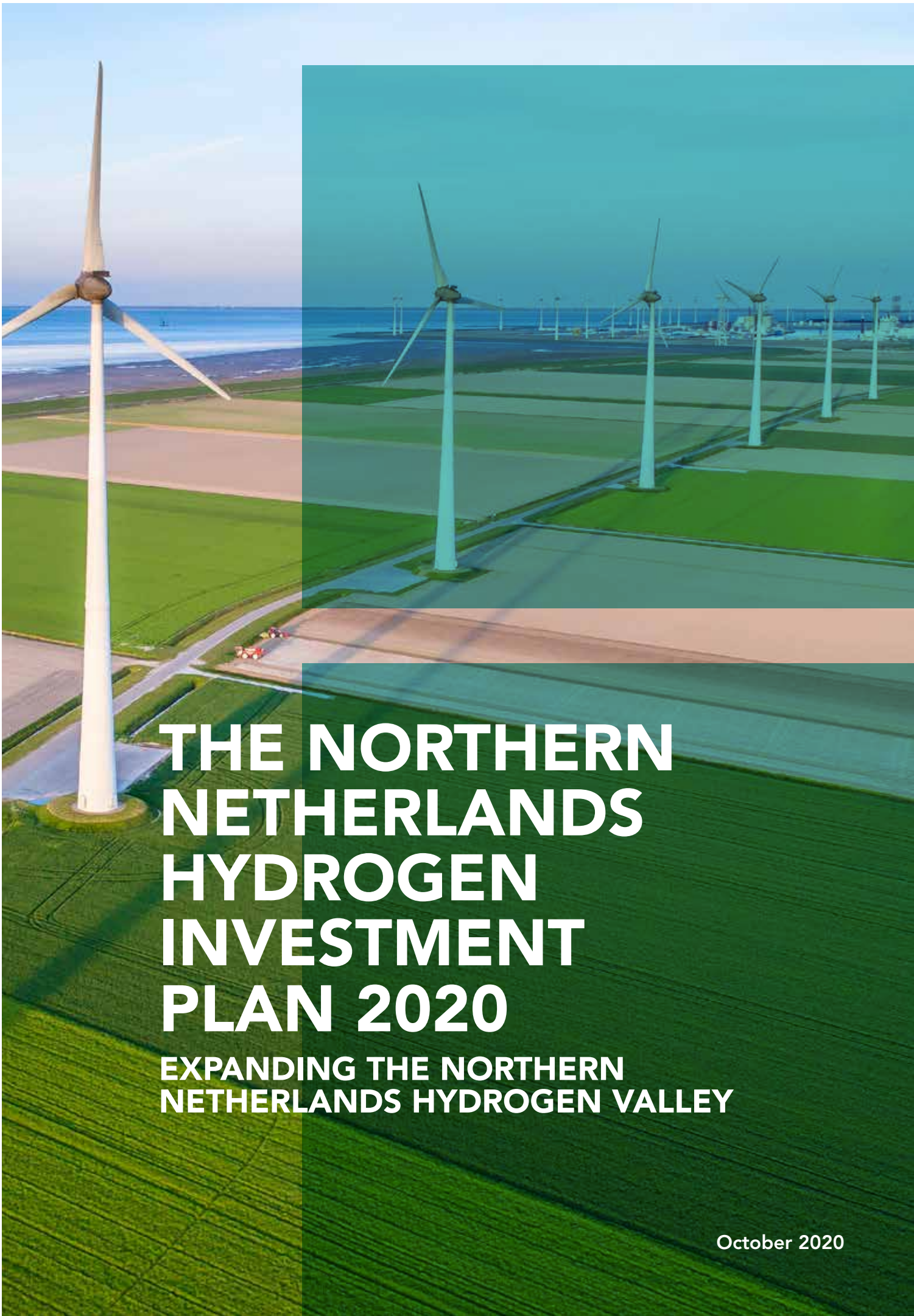

THE NORTHERN NETHERLANDS HYDROGEN INVESTMENT PLAN 2020

EXPANDING THE NORTHERN NETHERLANDS HYDROGEN VALLEY

October 2020

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PREFACE

Over the past several years, the Northern Netherlands has accelerated its hydrogen project pipeline together with its ambitions of becoming the leading European hydrogen ecosystem. The Northern Netherlands has received recognition from the Fuel Cells and Hydrogen Joint Undertaking (FCH JU)[1] Hydrogen Valley grant as the leading European Hydrogen Valley developing a full-fledged green hydrogen value chain, and is highlighted as a target region for the European Just Transition Fund. Furthermore, global businesses (e.g., Engie, Equinor, RWE, Shell, and Vattenfall) have increasingly committed to the Northern Netherlands as their hydrogen ecosystem of choice, and regional governments have increased their commitments to realize the Northern Netherlands hydrogen ecosystem. Close collaboration with surrounding countries will add to the region's development. This increased momentum has brought about the next phase in the realization of the Dutch hydrogen opportunity, moving from pilots and demos to maturing and scaling up the Northern Netherlands hydrogen ecosystem. To highlight the ambitious nature of the Northern Netherlands, one goal of the region is to have offshore hydrogen production by 2030. Whereas the project pipeline in the 2019 Investment Agenda was worth EUR 2.8 billion in total, all investments in this 2020 Investment Plan amount to over EUR 9 billion.

In the buildup of a hydrogen ecosystem like this, the region faces technical and economic challenges, and also needs to address societal acceptance. The Northern Netherlands Hydrogen Investment Plan supports this next phase with the provision of a concrete road map, a set of requirements, and an implementation plan to realize Dutch hydrogen potential.

Hydrogen is an attractive emerging industry: green and blue hydrogen are needed to meet Dutch and global climate targets as feedstock and fuel, especially in hard-to-abate sectors (e.g., industry, heavy-duty transportation), while bringing about improved air quality and the abatement of other pollutants like nitrogen oxides and particulate matter. As the leader in the European gas industry, the Netherlands is favourably positioned to build on its heritage of natural gas excellence to accelerate hydrogen development and lead this emerging industry. A leading Dutch hydrogen industry has the potential to attract global businesses, investments, and talent – it would provide the Netherlands with the opportunity of securing 66,000 existing recurring FTEs (e.g., in gas infrastructure, mobility), attracting 41,000 new recurring FTEs (e.g., in maintenance, operations), and up to 104,000 new one-off FTEs by 2050.The benefits will be shared by the whole of the Netherlands and northwestern Europe. This is not something the Northern Netherlands could (or should) pull off by itself. Such efforts can only lead to results if coupled with those of other regions, like Germany, Belgium and the EU as a whole. In that regard, we look upon the tremendous attention to and push for green hydrogen by many of the relevant actors with whom the Northern Netherlands gladly continues to cooperate.

"The Northern Netherlands is on its way to making the Hydrogen Valley a reality. The activities in the region will bring the cost of renewable hydrogen down. This will pave the way for large-scale deployment in the EU and thus contribute to achieving the climate targets. It really is a showcase of cooperation between parties from various sectors in the Northern Netherlands and a role model for a future hydrogen economy."

—Bart Biebuyck,
FCH JU

"The plans in the Northern Netherlands are unique and promote 'a massive increase' of electrolyzer production. In this way, the Investment Plan highly contributes to the European 2x40GW green hydrogen initiative and should be the starting point for the creation of a European Hydrogen Investment Agenda."

—Jorgo Chatzimarkakis,
Hydrogen Europe

"The Northern Netherlands has a unique starting position for developing a hydrogen economy, but it needs to expand its assets fast, in part by realizing import and large-scale export facilities. If you ask me, the region is actually quite modest with this plan."

—Ad van Wijk,
Professor of Future Energy Systems

"ENGIE is fully committed to green hydrogen and supports the Northern Netherlands as a core European region for developing the hydrogen value chain including large-scale electrolysis."

—Michele Azalbert,
Engie

"RWE supports the ambitions of the Northern Netherlands, which we consider a sweet spot for kickstarting the European green hydrogen market."

—Roger Miesen,
RWE

1 A European public–private partnership to support the deployment of fuel cell and hydrogen technologies

EXECUTIVE SUMMARY

The Northern Netherlands has a unique opportunity to cost-effectively develop an integrated hydrogen ecosystem, to become a game-changer in global hydrogen development, and to accelerate Dutch hydrogen momentum. In addition to this strong regional triple helix, the Northern Netherlands has unique access to the critical assets required for a cost-competitive hydrogen ecosystem. It has:

i. Access to European hydrogen offtake markets, with over 400 PJ per annum of addressable northwestern European (Benelux, western Germany, northern France) demand (30 GW hydrogen equivalent) being expected by 2030 when considering the 2016 Paris Agreement's 1.5 degree C. scenario.

ii. Large offshore wind potential north of the Northern Netherlands, with available space for over 20 GW, of which 4 to 6 GW of hydrogen-dedicated wind is required by 2030.

iii. Strategic locations for hydrogen production at industrial hubs (Delfzijl, Eemshaven, Emmen) to develop 100 PJ per annum of hydrogen production capacity by 2030.

iv. Available and dense gas infrastructure, with high-quality parallel gas pipelines, salt caverns for hydrogen storage, and strategically located ports.

v. Knowledge on gas and hydrogen trading, transport, and innovation, which builds on the Dutch position as the European leader in natural gas excellence and ongoing hydrogen projects.

The Northern Netherlands also has a systemic approach in place to create integrated self-sustaining value chains for end uses that can form the blueprint for the rest of Europe. Furthermore, the existing project pipeline provides the momentum needed to mature and scale up the Northern Netherlands hydrogen ecosystem in the coming decade, underpinned by more than 50 projects in the value chain in (production, transport, and storage) and end uses (in industry, transportation, power, and buildings), with over EUR 9 billion in planned direct hydrogen-related investments (excluding offshore wind and grid expansions, which require large investments by themselves and are essential for the hydrogen ecosystem to be developed).

The Northern Netherlands has been recognized as the leading Hydrogen Valley in Europe. Building on this current momentum, recognition, and ambition level, the region aspires to remain the leading European hydrogen ecosystem beyond 2030, covering the entire hydrogen value chain, including offshore wind (at least 4 to 6 GW), hydrogen production (50 to 75 PJ per annum of green hydrogen production), transport (1,150 km of connected northwestern European hydrogen pipelines), storage (150 PJ potential), and demand in northwestern Europe (400 PJ per annum from Benelux, western Germany, and northern France). By 2030, the Northern Netherlands will produce approximately 100 PJ of hydrogen per annum to supply over 25 percent of the hydrogen demand in northwestern Europe. Beyond 2030, when the European hydrogen ecosystem is fully developed, the Northern Netherlands will be the global center of hydrogen infrastructure and expertise, renewing its role as a leading "gas roundabout" and market hub for green fuels, manufacturing excellence, knowledge, and innovation.

To realize the Northern Netherlands' ambition in a systemic way, a road map has been implemented with two phases:

Phase 1: Maturing and scaling (2020 to 2025). From now until 2025, the Northern Netherlands will mature and scale up to between 5 to 10 PJ of hydrogen capacity per annum, with various projects in place across the value chain, from production (Eemshydrogen, DJEWELS 1 and 2, HyNetherlands Phase 1, GZI Next Emmen) and infrastructure (Northern Netherlands hydrogen backbone

and HyStock storage) to use cases (BioMCN, Holthausen, Magnum Power Station, SkyNRG, Hydrogen Hoogeveen, HEAVENN). Over EUR 850 million in investments will be required to realize these projects. Apart from these private investments, additional regulatory and financial commitments are needed to ensure timely execution.

Phase 2: Expanding to northwestern Europe (2025 to 2030). From 2025 onwards, the Northern Netherlands hydrogen ecosystem will grow to 100 PJ per annum of Northern Netherlands hydrogen capacity by 2030, of which 75 percent will be green hydrogen (6 GW equivalent) and 25 percent will be blue hydrogen production. The region will expand its reach to serve the northwestern European hydrogen markets with 400 PJ per annum of addressable hydrogen demand by 2030. Large projects will drive integrated hydrogen ecosystems (NorthH_2, HyNetherlands Phases 2 and 3, H2M) while domestic and cross-border connections will connect the Northern Netherlands to northwestern European offtake markets (Benelux, western Germany, northern France). To realize these projects, over EUR 9 billion will be invested, and short-term governmental actions are needed to mandate hydrogen usage, expand offshore wind capacity, and synchronize cross-border investments and regulatory frameworks, in a complex environment of globally interconnected businesses and public bodies.

While private and public stakeholders are committed to realizing the Northern Netherlands hydrogen ecosystem, additional offshore wind, supporting regulatory frameworks, and short-term funding are needed to bridge investment gaps. Pre-2025 projects require short-term regulatory incentives and additional funding to meet short-term financial investment decisions. The larger projects towards 2030, most with financial investment decisions before 2025, require the implementation of clear regulatory frameworks in the next two to three years to ensure a timely rollout of hydrogen-related assets. Overall, four key areas of required mechanisms were identified, with ten specific actions that need to be carried out by the Dutch government in addition to the actions of the Northern Netherlands. They focus on the power, means, and people that are necessary for this transition. The key areas are (A) hydrogen production, infrastructure, and demand (Actions 1 to 4), (B) offshore wind capacity (Action 5), (C) the larger hydrogen ecosystem (Actions 6 and 7), and (D) overall program management (Actions 8 to 10). The ten actions are as follows:

1. **Ensuring a supporting regulatory framework** by being exempted from the Energy Directive II (RED II) additionality and correlation requirements during the maturing and scaling phase. Power purchase agreements in combination with the Guarantees of Origin will enable hydrogen from renewable sources to be labeled and priced as such, creating a larger market. After 2025, additional offshore wind for hydrogen will ensure additionality requirements are met.

2. **Introducing hydrogen scale-up funds and support instrumentation** (e.g., expression of interest programs) with sufficient size to bridge investment gaps for critical hydrogen ecosystem assets.

3. **Compensating for the initial investment gap for critical infrastructure** to ensure future-proof infrastructure investments are made that facilitate the rollout of the hydrogen ecosystem. A decision on the infrastructure for transport and storage is needed in 2021.

4. **Incentivizing hydrogen demand uptake** via supporting regulatory frameworks (e.g., volume mandates or targets, carbon contracts for difference, feed-in tariffs, premiums, expression of interest tenders,or trading programs) and a hydrogen trading market and by boosting demand with support policies for specific end-use sectors (such as measures and policy initiatives to stimulate the use of hydrogen or its derivatives in the transportation sector).

5. **Accelerating offshore wind development** by advancing the allocation and spatial planning of at least 4 to 6 GW of offshore wind capacity dedicated to hydrogen production north of the Northern Netherlands. A decision on the expansion of the Dutch offshore wind target for hydrogen is needed in 2021.

6. **Investing in the needs of the greater hydrogen ecosystem** via educational programs and supporting innovation centers in the region.

7. **Transitioning intangible assets** (talent, knowledge, innovation) from other industries, such as natural-gas-related assets.

Assigning the majority of the allocated Just Transition Fund budget to the Northern Netherlands to support with the relevant investments needed to expand the Northern Netherlands Hydrogen Valley.

8. **Steering hydrogen ecosystem development** by setting up a Northern Netherlands Transformation and Coordination Office, focused on strategy, projects, and collaborations.

9. **Orchestrating a systemic national approach** to the end-to-end development of the hydrogen ecosystem and ensuring development is in line with the scale-up of the larger ecosystem.

The build-out of the Northern Netherlands hydrogen ecosystem to 2030 – based on the current project pipeline – builds on EUR 9 billion of planned investments, of which most are private investments, and is expected to attract over 25,000 hydrogen-related jobs. Hydrogen will increasingly help realize CO_2 emission reduction targets, with 5.5 to 11 Mt of annual greenhouse gas emissions reduced by 2030 – this is 2.5 to 5.0 percent of 1990 Dutch emission levels.

To realize the hydrogen opportunity in the Northern Netherlands, the regional triple helix of government, industry, and knowledge institutions has developed an 18-month implementation plan. The Northern Netherlands will set up a Transformation and Coordination Office to orchestrate the scale-up of the hydrogen ecosystem. Regional work groups will detail the requirements for realizing and expediting the project pipeline (demand, infrastructure, production, offshore wind), especially considering a number of critical financial investment decisions to be made in the years to come. The larger hydrogen ecosystem and job potential will be assessed to ensure an effective hydrogen transition. As part of the implementation plan, the Dutch and European governments will play a vital role in orchestrating nationwide and Europe-wide hydrogen development. Dutch governmental support is needed to support setting up the necessary short-term regulatory mechanisms, accelerating the offshore wind spatial planning process, and ensuring national programs are in place to effectively transfer labor across industries. European support is needed to ensure pragmatic and swift handling of hydrogen funding initiatives, which in turn ensure timely realization of financial investment decisions.

01 AN ATTRACTIVE OPPORTUNITY FOR THE NETHERLANDS

Hydrogen presents an attractive opportunity for the Netherlands to lead an emerging industry. The European decarbonization strategy increasingly stresses the relevance of hydrogen and the need to accelerate innovation. The Netherlands can build on its position as a leader in the European gas industry and its heritage of natural gas excellence to accelerate hydrogen development and lead this emerging industry, positioning the country as the center of the European hydrogen backbone. To capture this opportunity, it is critical that the Netherlands acts now.

The Dutch hydrogen opportunity

In 2019, the Dutch government introduced the Climate Agreement, with an ambitious climate target: to reduce greenhouse gas emissions by 49 to 55 percent by 2030, compared to 1990 levels. The Agreement states that a combination of renewable power and carbon-neutral energy carriers, such as hydrogen and biomass, are necessary to meet this target. This Agreement is widely supported by the public, and has garnered over 50 signatures from leading organizations in the Netherlands. It has been followed up by the Kabinetsvisie Waterstof, the Dutch government's vision document on hydrogen, which highlights in more detail how hydrogen can play large role in decarbonizing hard-to-abate economic sectors.

In the Dutch energy transition, green and blue hydrogen play a pivotal role in meeting the climate targets. Hydrogen enables the decarbonization of hard-to-abate sectors (e.g., industry feedstock, high-grade industrial heating, and heavy-duty or long-range transportation, including shipping; applications where electricity or batteries do not suffice). It also enables the power sector to operate a fully decarbonized, reliable, and secure power system, providing flexibility to integrate solar and wind at scale, long-duration energy storage capabilities, and zero-carbon dispatchable capacity for periods of peak demand. In addition, the Dutch economy will be able to gain a competitive edge by transitioning early, and benefit from improved air quality and the abatement of other pollutants like nitrogen oxides and particulate matter.

In addition, hydrogen provides an opportunity for the Netherlands to transition away from the natural gas economy while benefitting from existing knowledge and infrastructure. Triggered by the Groningen earthquakes, the Netherlands pledged to transition away from its role as the leading European natural gas economy – with the consequence of possibly losing 20,000 jobs by 2022. However, given the comparable characteristics of hydrogen and natural gas, the Netherlands sees hydrogen as a natural industry extension, allowing it to build on existing gas knowledge, infrastructure, and trading experience, while targeting the economic benefits of the projected growth in hydrogen demand.

A European call to action

In recognition of the growing global consensus on the pivotal role hydrogen plays in supporting decarbonization, the EU and individual member states have implemented numerous decarbonization strategies. One such example is the EU's recently published "Hydrogen strategy for a climate-neutral Europe," which

intends to help implement the ambitious European Green Deal and build on the European Commission's New Industrial Strategy for Europe and recovery plan. The Strategy sets out a vision for how to turn clean hydrogen into a viable solution for decarbonizing different sectors over time, installing at least 6 GW of renewable hydrogen electrolyzers by 2024 and 40 GW of renewable hydrogen electrolyzers by 2030. In line with this, the Dutch target for green hydrogen is to develop 3 to 4 GW of renewable hydrogen electrolyzers by 2030 (around 10 percent of the EU's target). This fits well into the European industry vision to secure 80 GW of green hydrogen production capacity by 2030, half in Europe and half in other regions, with the hydrogen then imported to Europe.

The European commitment to hydrogen comes with an economic rationale, driven by a 35 percent cost reduction in green hydrogen production over the past five years, with an additional 55 percent cost reduction in green hydrogen production expected towards 2030. For the Netherlands, scaling up clean hydrogen production is also a cost-effective decarbonization solution, as green hydrogen will become cost-competitive with grey hydrogen towards 2030 to 2035, remain cost-competitive with shipping imports of green hydrogen, and secure hydrogen supply in the region. The potential for more cost-competitive green hydrogen supply from southern Europe via integrated European hydrogen pipelines or tankers is not to be expected before 2035, with security of supply remaining a rationale for long-term green hydrogen production in the Netherlands. In addition, the expected cost reduction of green hydrogen production will result in select applications achieving commercial viability before 2030 at forecast carbon prices (e.g., EUR 60 to 100 per ton of CO_2 equivalent for steel). This combination of cost reductions and clear regulatory commitments would result in hydrogen demand in Europe increasing to the equivalent of 2,400 PJ by 2030 and the equivalent of 8,100 PJ by 2050, addressing 6 percent of final energy consumption in 2030 and 24 percent in 2050.

The EU further emphasizes the importance of acting now, given that investments made over the next decade will only impact emissions in 2050 (investment cycles are often 25 years), and these therefore need to support the zero-emission targets.

A unique opportunity for the Netherlands

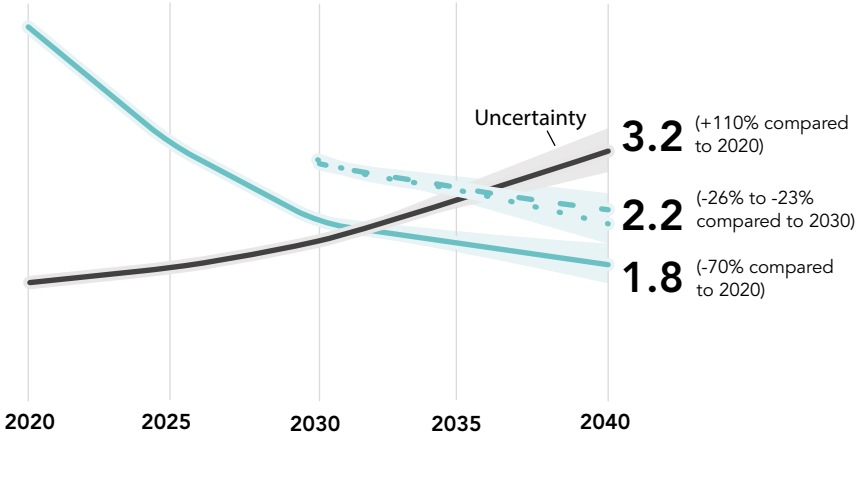
In the development of a Dutch and European hydrogen ecosystem, the Netherlands has the unique opportunity of building on its existing knowledge and infrastructure, developing a cost-effective decarbonization solution, and attracting socioeconomic benefits.

Existing knowledge and infrastructure. The Netherlands has access to the assets needed to develop a robust hydrogen ecosystem: potential for at-scale offshore wind, hydrogen infrastructure (dense high-quality gas infrastructure, hydrogen storage in salt caverns, port availability), talent and knowledge institutions, chemicals trading, and hydrogen offtake markets. Planned projects in the North Sea will provide 11 GW of offshore wind capacity by 2030, after which a further scale-up of between 20 to 40 GW will be realized. Thanks to the country's natural gas heritage, it boasts dense, at-scale pipeline infrastructure which can be cost-effectively retrofitted to transport hydrogen. The combination of the pipeline quality and parallel infrastructure supports the cost-effective transition to hydrogen, while the availability of natural salt caverns enables at-scale hydrogen storage, amounting to the equivalent of over 150 PJ in storage capacity (around 5 percent of 2018's Dutch energy demand). Given the country's natural gas heritage and global thought leadership, the Netherlands also has the expertise and knowledge institutions necessary

Exhibit 1

Scaling up local green hydrogen becomes cost-competitive with grey hydrogen by 2030–35, and remains cost-competitive with shipping imports of green hydrogen while securing energy supply

EUR per kg

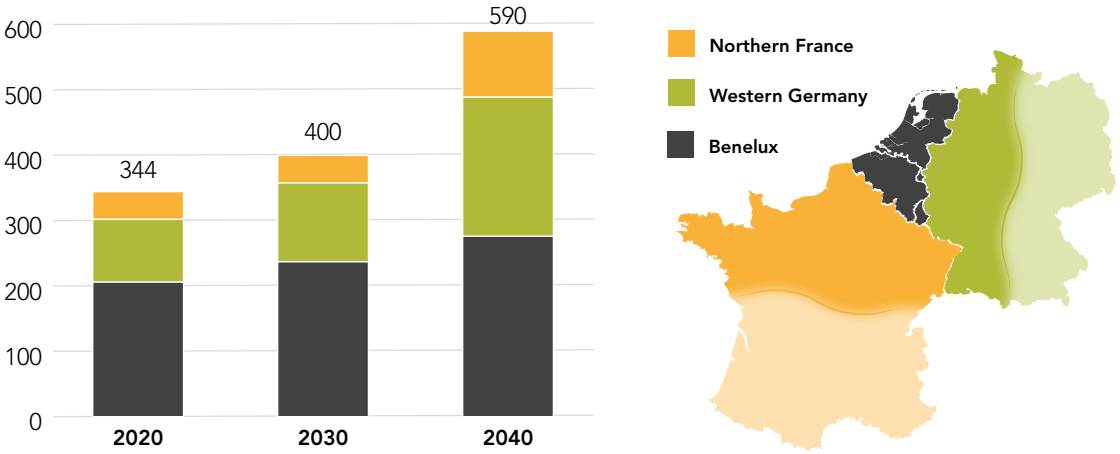


Source: Hydrogen council: Path to hydrogen competitiveness, 2020. Additional projections from: Northern Netherlands Hydrogen Coalition and Planbureau voor de Leefomgeving: Klimaat- en Energieverkenning, 2019

Exhibit 2

The addressable regional demand, with a northwestern European hydrogen infrastructure in place, increases to 400 PJ in 2030 in a 1.5 degree C. scenario (Paris Agreement, 2016)

PJ p.a.

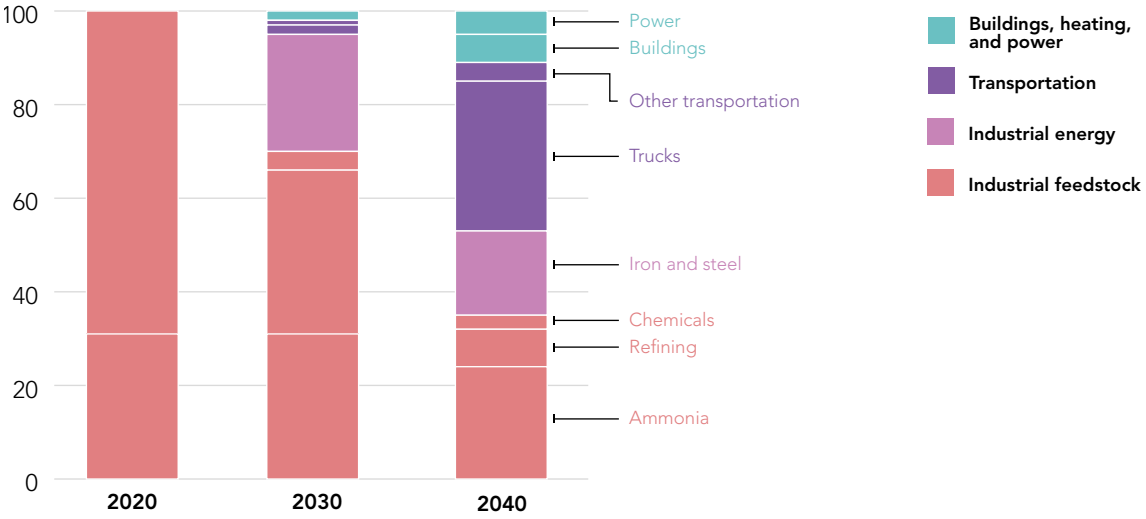


Source: Northern Netherlands Hydrogen Coalition

Exhibit 3

Hydrogen demand use cases will shift from industry feedstock today to transportation and industrial energy towards 2030 and beyond

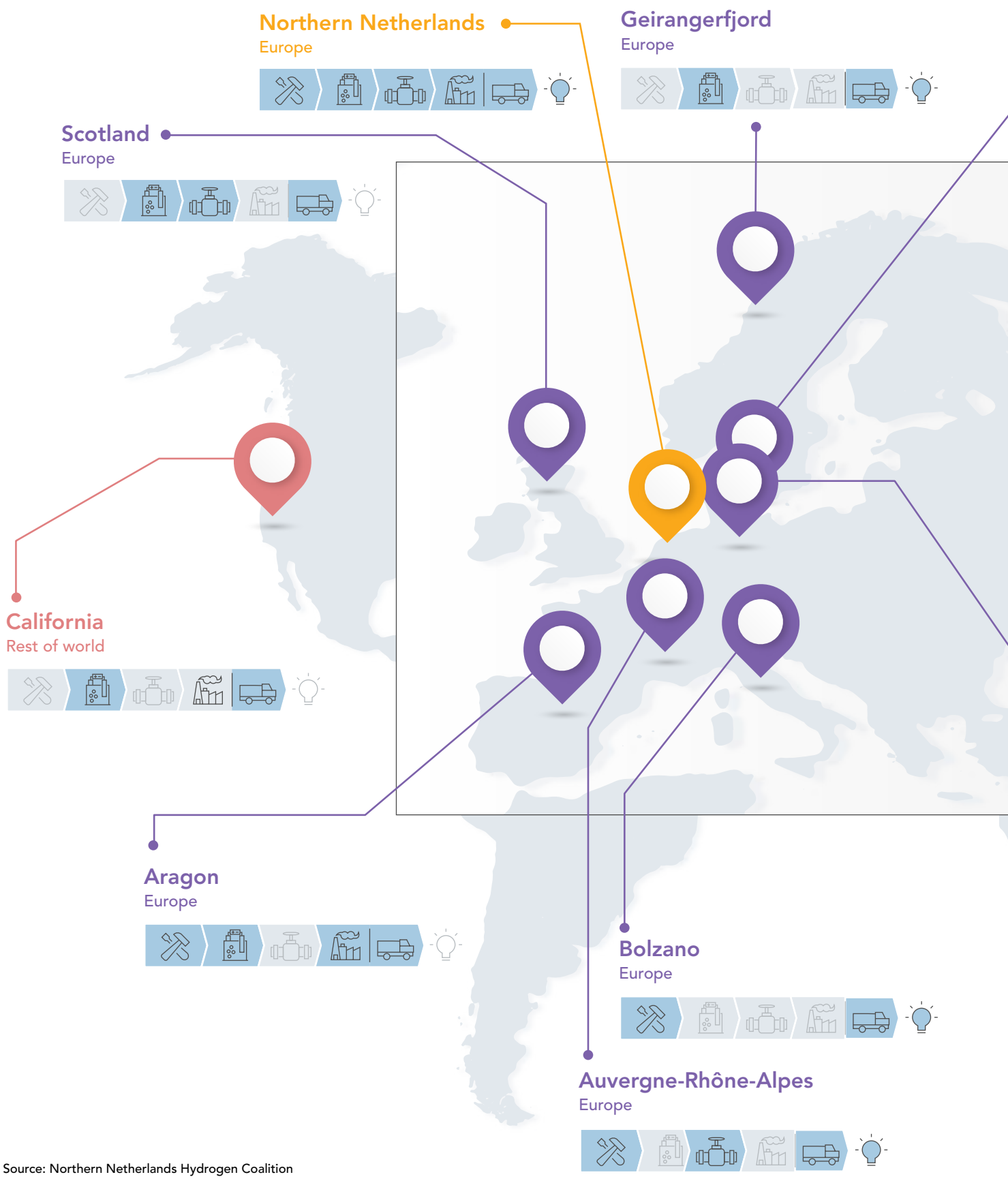
Percent



Source: Northern Netherlands Hydrogen Coalition

Exhibit 4

The Northern Netherlands hydrogen ecosystem is unique, compared to other global hydrogen hubs, in developing an integrated hydrogen value chain



Source: Northern Netherlands Hydrogen Coalition

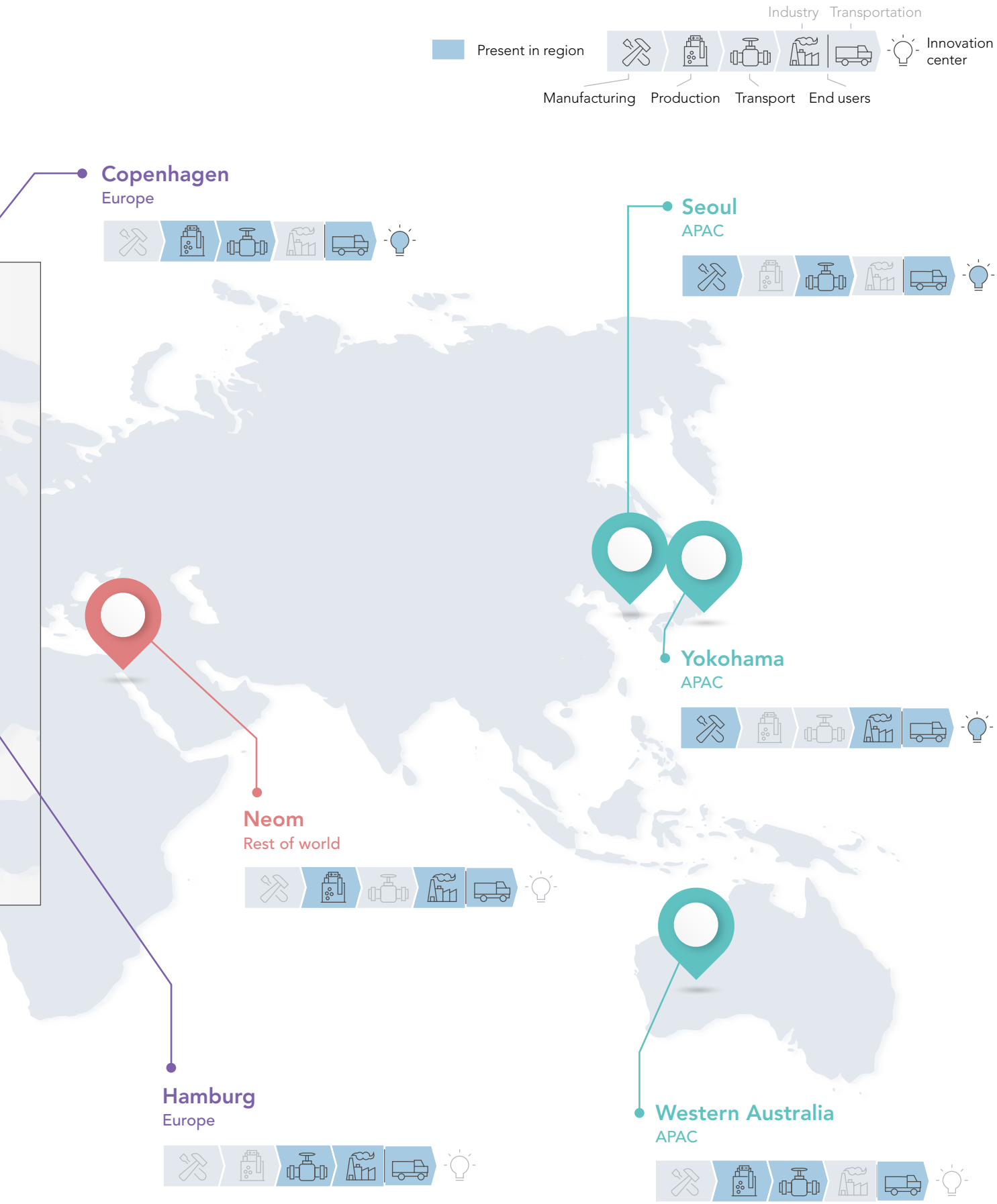
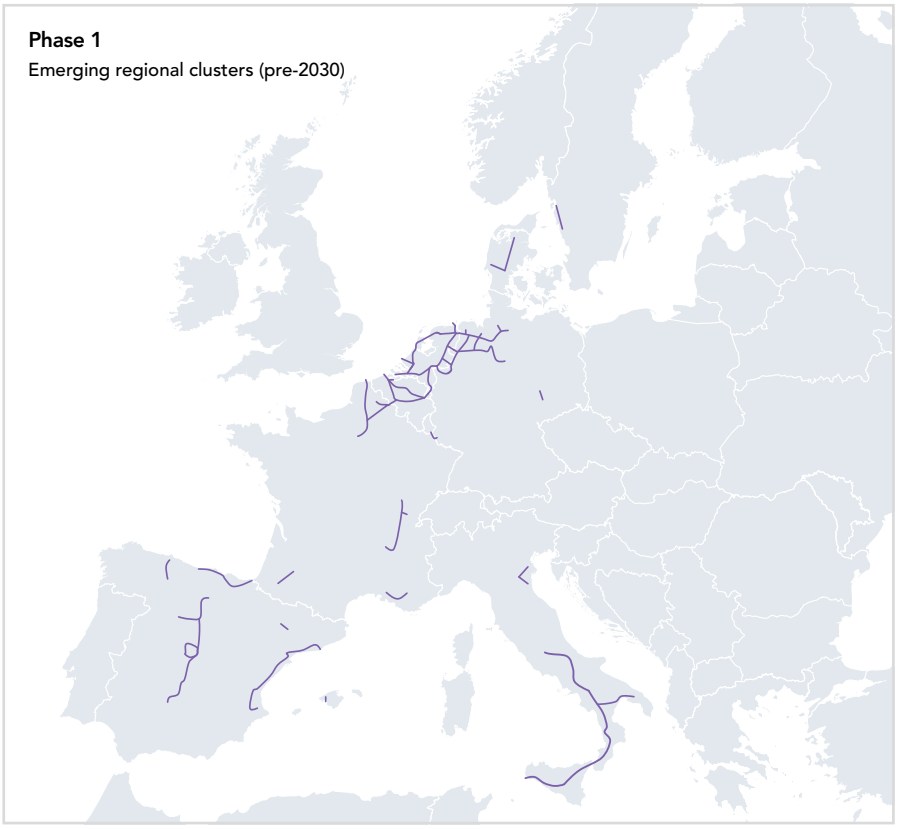

Present in region
Industry
Transportation
Manufacturing
Production
Transport
End users
Innovation center
Copenhagen
Europe
Seoul
APAC
Yokohama
APAC
Neom
Rest of world
Hamburg
Europe
Western Australia
APAC

Exhibit 5

The Northern Netherlands has a central role in developing the European hydrogen backbone, by connecting northwestern Europe pre-2030 and all of western Europe by 2040



Source: Gasunie: European Hydrogen Backbone, 2020

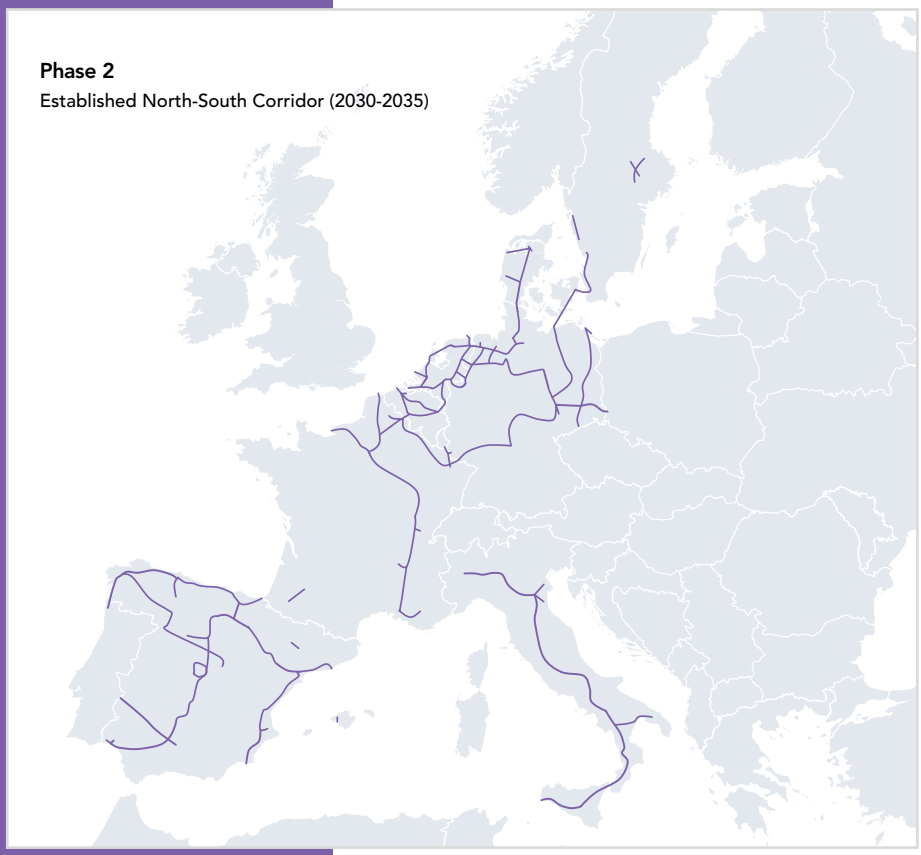
to accelerate hydrogen innovation. In addition, the Netherlands has an outstanding trading position, with leading positions in the European Transport Scoreboard and World Economic Forum Port Infrastructure Ranking. Finally, the Netherlands is strategcally positioned with large domestic (e.g., Delfzijl, Chemelot, Rotterdam) and nearby cross-border (e.g., North Rhein-Westphalia) hydrogen offtake markets. Taking these factors into consideration, it can be concluded that hydrogen is a "strategic fit" for the Netherlands.

Cost-effective decarbonization. The Netherlands would benefit from developing a leading European hydrogen ecosystem by accelerating more cost-effective decarbonization of the energy system, ensuring a decarbonized energy system that is reliable and secure, and attracting new businesses and job opportunities from an emerging industry. An early transition to hydrogen also creates a competitive advantage for the Netherlands in achieving its decarbonization targets, as hydrogen is more competitive than other carbon-neutral alternatives in some hard-to-abate industries (e.g., steel) and sometimes even the only carbon option (e.g., feedstock for fertilizers).

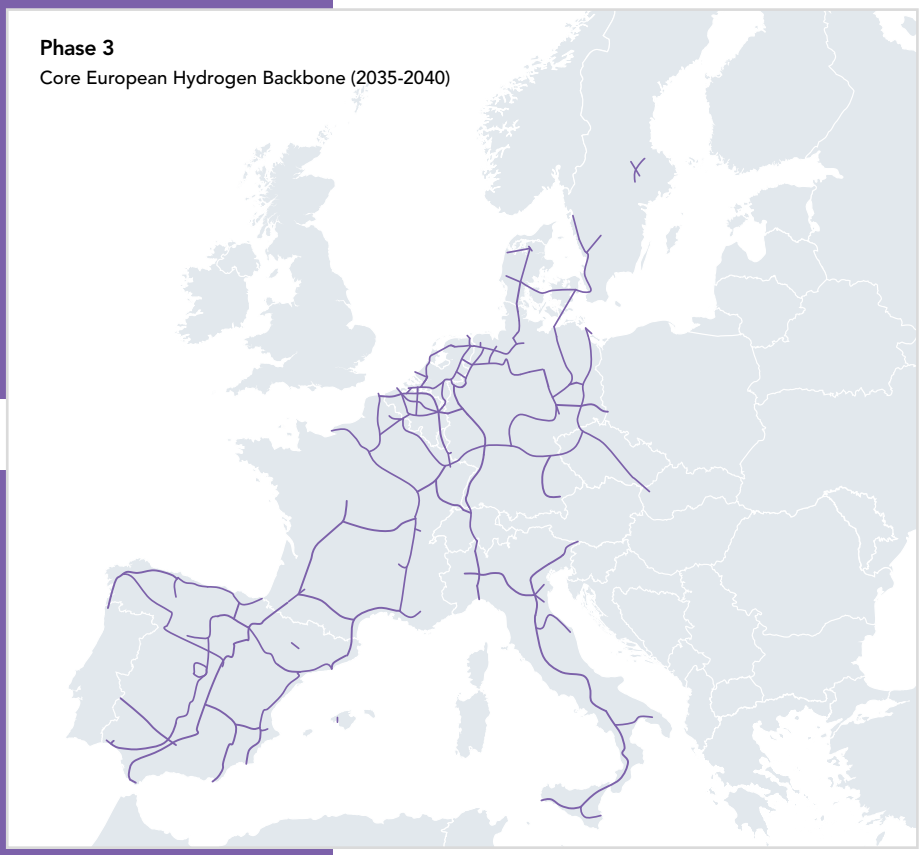
Socioeconomic benefits. Another early-mover advantage of developing a leading European hydrogen ecosystem is securing and attracting businesses and job opportunities. A Dutch hydrogen ecosystem can secure up to 66,000 existing FTEs (e.g., in gas infrastructure, mobility) and attract up to 41,000 new FTEs (e.g., in vehicle maintenance, electrolyzer operations) for recurring jobs by 2050. In addition, the build-out of the hydrogen ecosystem can create up to 104,000 FTEs in one-off jobs between 2020 and 2050 (e.g., in engineering, construction). By 2030, the estimated hydrogen-related job potential is 25,000 FTEs in the Netherlands, of which 90 percent are recurring and 10 percent are one-off jobs, in both large companies and SMEs. And these jobs are not just in the industries active in hydrogen production, transport, or end use; a manufacturing industry could emerge, specializing in various types of high-tech equipment.

The Netherlands needs to act now to capture this unique hydrogen ecosystem opportunity, including the early-mover advantage. Initial Dutch Climate Agreement targets show a willingness to act, with the objective of installing at least 500 MW of green hydrogen production capacity by 2025 and 3 to 4 GW by 2030. Beyond targets, the private and public sectors must work together to execute on broad set of initiatives to realize the Dutch hydrogen opportunity.

Phase 2
Established North-South Corridor (2030-2035)



Phase 3
Core European Hydrogen Backbone (2035-2040)



02
A UNIQUE POSITION FOR THE NORTHERN NETHERLANDS

Focusing on a prioritized set of regions in the Netherlands will help accelerate Dutch hydrogen momentum by increasing spend effectiveness, ensuring collaborative ecosystems, focusing businesses, and orchestrating investments. Given the access to critical assets, the integrated value-chain approach, and the committed project pipeline, the Northern Netherlands is uniquely positioned to accelerate the Dutch and European hydrogen ecosystem.

Access to critical assets

The Northern Netherlands has access to the following critical assets required for a competitive hydrogen ecosystem: hydrogen offtake markets, offshore wind potential, strategic locations for hydrogen production, available and dense infrastructure (pipelines, storage, ports), and gas and hydrogen knowledge.

Hydrogen offtake markets. The Northern Netherlands is surrounded by developing hydrogen demand hubs (e.g., Chemelot, North Rhine-Westphalia). Additionally, the demand for hydrogen in the Benelux states is projected to reach 240 PJ per annum by 2030 (2.0 Mt equivalent) with centers in the Northern Netherlands, Rotterdam, and Antwerp. The Northern Netherlands hydrogen infrastructure backbone holds the potential to supply northwestern Europe by 2030, and a larger area of Europe towards 2040. By 2030, the cumulative addressable demand from the Northern Netherlands will reach 400 PJ per annum (3.3 Mt equivalent) when considering the 2016 Paris Agreement's 1.5 degree C. scenario with 60 percent coming from Benelux, 30 percent from western Germany, and 10 percent from northern France.

Given the proximity of the Northern Netherlands to the projected hydrogen offtake markets in northwestern Europe, green hydrogen can already be supplied via hydrogen trucks while the pipeline infrastructure is being developed. Once the hydrogen pipeline system is fully operational, the transport costs of green hydrogen will further decline and unlock the full demand potential. In this regard, collaboration with nearby industrial clusters like the port of Rotterdam is crucial. The Northern Netherlands should continue to foster its connections with Amsterdam, Rotterdam, Zeeland, and Limburg, and continue to build up the relationship with Germany.

Offshore wind potential. The North Sea (up to Dogger Bank) north of the Northern Netherlands is a great resource for offshore wind, with shallow near-shore locations with significant potential (22 GW). Solar power, onshore wind, and imports of surplus renewable power from Denmark (Cobra, as a project of common interest), Norway (NorNed), and Germany offer additional renewable capacity for hydrogen production. Domestic green hydrogen production is expected to remain cost-competitive with imports until at least 2035, and additionally ensures security of

supply beyond 2035. Renewable energy developers are also expected to strongly promote the acceleration of green hydrogen production, as – coupled with offshore wind – it reduces merchant-price risk. In addition to offshore wind providing an opportunity for hydrogen production, hydrogen production and storage also supports the build-out of offshore wind by balancing an intermittent power supply and reducing the need for grid expansions.

Strategic hydrogen production locations. The Northern Netherlands has sufficient physical space available for offshore wind generation, transmission, production, and transport near ports and industrial hubs. The strategic and available locations in Eemshaven, Delfzijl, and Emmen are able to meet the 100 PJ per annum hydrogen production ambitions of the Northern Netherlands towards 2030.

Available and dense infrastructure. The Northern Netherlands has access to dense gas infrastructure, with high-quality parallel gas pipelines, salt caverns for hydrogen storage, and ports in Delfzijl and Eemshaven.

The existing gas pipeline infrastructure in the Northern Netherlands is well suited to being cost-effectively retrofitted for hydrogen, with the potential to connect northwestern Europe (if an investment decision in 2021 is facilitated by Benelux, western Germany, and northern France). By 2025, the hydrogen backbone of the Northern Netherlands will be developed, with around 169 km of pipelines. Next, the Dutch and northwestern European interconnections will be developed to realize the European hydrogen backbone by 2027.

The Northern Netherlands also has access to natural hydrogen storage locations in salt caverns to help balance the grid and increase grid resilience. The total Dutch hydrogen storage potential is 150 PJ of hydrogen capacity in salt caverns, which is the second largest in Europe after Germany's. 72 percent of this storage capacity is located in the Northern Netherlands.

Looking beyond 2030, as global hydrogen production and transport takes off, the Northern Netherlands, with its ports in Eemshaven and Delfzijl, is set to become the European roundabout for European-produced and imported green hydrogen. The shipping of green hydrogen is also expected to increase from locations with cheap and ample renewable energy supply (e.g., southern Europe, Africa, and the Middle East).

Gas and hydrogen knowledge. The Northern Netherlands has an established ecosystem with gas expertise in place and is a proven energy research and innovation hub that builds on long-standing innovation (e.g., Gasunie, CEER, University of Groningen, applied science and vocational training). The region's expertise in gas trading, transport, and innovation plays a vital role in determining the competitiveness and position of a hydrogen ecosystem in the emerging European economy in the long run. Both the region and government actively support hydrogen as the next frontier in energy technology by supporting pilot projects and bringing together global hydrogen expertise (e.g., New Energy Coalition, recognition as a Hydrogen Valley). Regional knowledge institutions are also ramping up innovation centers (e.g., DNV GL, Entrance, TNO) to spearhead next-generation hydrogen initiatives and scale up industrial-size hydrogen production capacity (e.g., Magnum). Hence, the Northern Netherlands provides a unique environment in which to concentrate hydrogen talent, with proven global thought leadership on green hydrogen.

The integrated value-chain approach

The Northern Netherlands has adopted a systemic approach to creating integrated hydrogen value chains. This approach involves building on integrated ecosystems (project HEAVENN) and a strong triple helix of government, industry, and knowledge institutions.

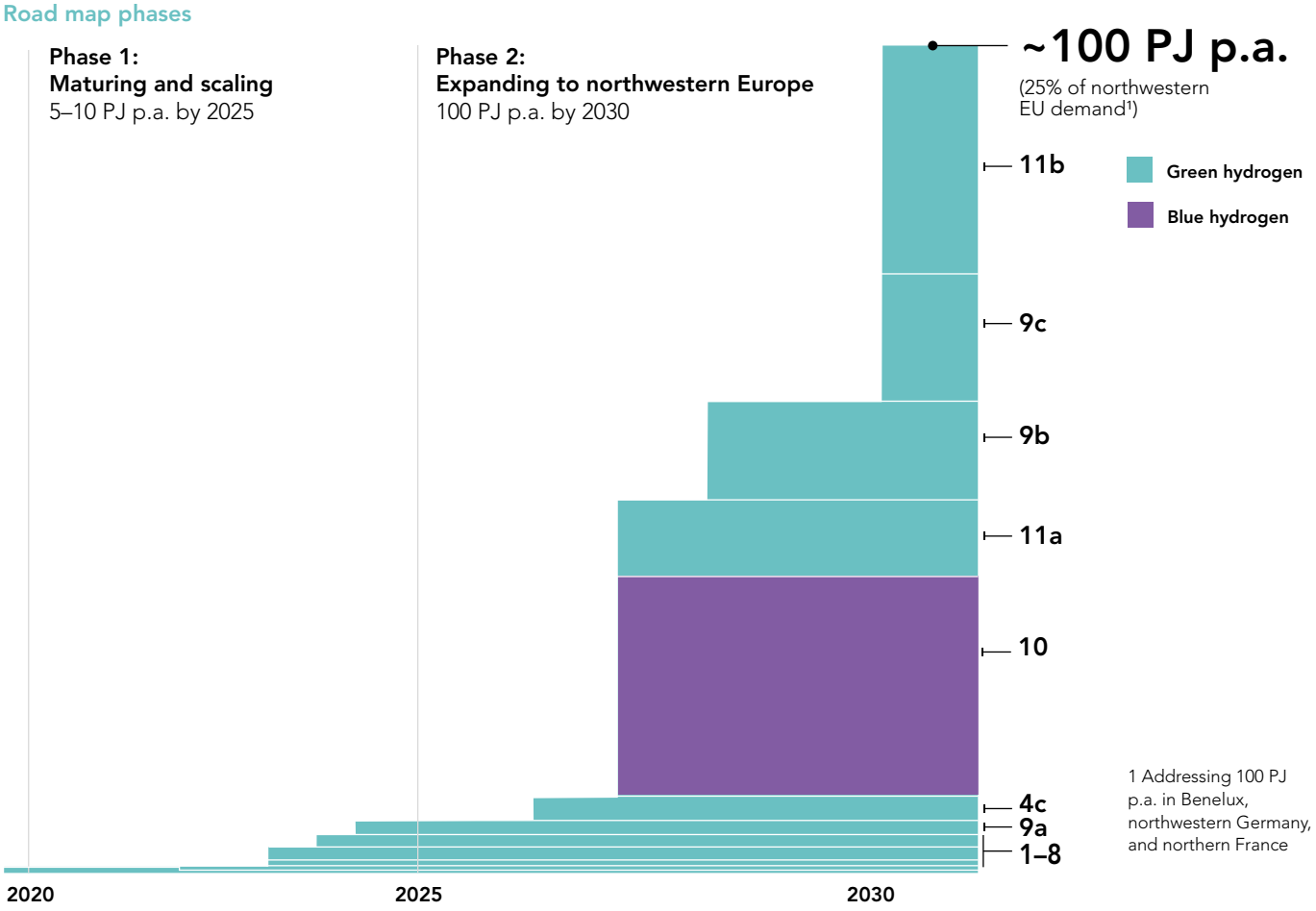
Integrated ecosystems. The Northern Netherlands is focused on creating self-sustaining hydrogen businesses, including SMEs, across the value chain, supported by the private and public orchestration of projects and investments. Many projects across the value chain (production, transport, storage) and use cases (transportation, industry, buildings) are already in place. Recently, the FCH JU awarded the Northern Netherlands' flagship project HEAVENN with a grant and Hydrogen Valley status. Additionally, the EU nominated the province of Groningen as a potential recipient of the Just Transition Fund, which is very important for expanding the Northern Netherlands Hydrogen Valley.

The triple helix. The Northern Netherlands has a strong coalition of government, industry, and knowledge institutions. This triple helix has proven to be key success factor in the

Exhibit 6

The Northern Netherlands' hydrogen production capacity will increase to 5–10 PJ p.a. by 2025 towards 100 PJ p.a. by 2030

Road map phases



	Projects	Players	Capacity addition PJ p.a.	GW	Date ready	Type
1	Battolyser pilot	Industry coalition	0.001	0.00002	2019	
2	Hydrogen wind turbine	Lagerwey	0.02	0.003	2020	
3	4 hydrogen wind turbines	Lagerwey	0.1	0.01	2020–22	
4	GZI Next	Shell, NAM Enexis Gasunie	a. 0.1 b. 0.8 c. 3.2	a. 0.01 b. 0.04 c. 0.2	2022 2023 2026	
5	DJEWELS 1	Nouryon, Gasunie, BioMCN	0.4	0.02	2022	
6	DJEWELS 2	Nouryon, Gasunie	1.7	0.08	2023	
7	Electrolyzer incl. storage	Stichting WadDuurzaam	0.03	0.001	2023	
8	Eemshydrogen	RWE	1.6	0.1	2023–2024	
9	HyNetherlands	ENGIE, Gasunie (infrastructure partner)	a. 1.6 b. 12 c. 16	a. 0.1 b. 0.75 c. 1	2024 2028 2030	
10	H2M	Equinor, Gasunie	28	1.0	2027	
11	NorthH_2	Shell Groningen Seaports Gasunie	a. 10 b. 29 c. 58	a. 1.0 b. 3.0 c. 6.0	2027 2030 2040	

acceleration of hydrogen momentum. Regional and local governments are actively supporting and developing hydrogen projects (e.g., orchestrating them or providing subsidies); cross-industry collaborations and global businesses are investing in and developing the ecosystem (e.g., Engie, Equinor, RWE, Shell, and Vattenfall); and knowledge institutions are setting up the facilities to test and scale up innovation in the region (e.g., HydroHub). Stakeholders in the triple helix are committed to the hydrogen value chain and invested in helping to successfully develop the Northern Netherlands ecosystem.

Committed regional and local governments. The Northern Netherlands' regional and local governments are committed to creating a leading hydrogen ecosystem by taking a supporting and orchestrating role to ensure an effective rollout of integrated value chains. This is reflected in the regional smart specialization strategy (RIS3), in which hydrogen is widely embedded. Resources are made widely available, with, for example, the Province of Groningen dedicating half its energy and economic affairs staff and budget to hydrogen-related developments. Co-funding of projects (e.g., HEAVENN, DJEWELS) is supported via subsidy programs that are largely dedicated to hydrogen investments (e.g., Nationaal Programma Groningen). The Northern Netherlands' dedication to kick-starting the hydrogen ecosystem is no empty gesture, with regional governments having already committed significant sums to hydrogen research, infrastructure, and end use, including over EUR 15 million to the HydroHub test center, the DJEWELS 1 electrolyzer, and the HEAVENN project. In addition, regional governments have allocated millions to hydrogen mobility in their own fleets and public transit. Moving forward, the financial commitments will only increase over the coming years. Aside from budgets, regulatory support is provided on hydrogen-related spatial planning (e.g., electrolyzers), environmental policies, and mobility initiatives (e.g. buses, trains, ships). European support is required for orchestrating hydrogen support mechanisms at a European level, with a pivotal role for the Northern Netherlands as a leader in the S3 Platform European Hydrogen Valleys Partnership, facilitated by the European Commission.

Committed project pipeline

The Northern Netherlands has a strong project pipeline for accelerating hydrogen development. There are currently over 50 projects dedicated to developing a hydrogen ecosystem in place across the value chain (e.g., electrolyzer capacity, gas infrastructure) with planned private and public investments amounting to over EUR 9 billion by 2030. The maturing and scaling phase, running until 2025, is focused on developing the first blueprints of the hydrogen ecosystem, with initial production capacity, hydrogen infrastructure (pipelines, storage), and offshore wind in place. The expanding to northwestern Europe phase, running until 2030, is focused on developing the full hydrogen ecosystem with a full-fledged infrastructure backbone at scale to connect stakeholders across the value chain, both in the Netherlands and beyond.

In the maturing and scaling phase, hydrogen production capacity is expected to increase to 5 to 10 PJ per annum (250 to 500 MW equivalent), with large projects including DJEWELS 1 and 2 and Eemshydrogen. The hydrogen infrastructure in the Northern Netherlands will be developed to connect production, storage, and demand centers in the area. Moreover, multiple use-case projects will be launched (e.g., energy transition hub around Veendam, Magnum Power Plant in Eemshaven, hydrogen homes in Hoogeveen, SkyNRG in Delfzijl, and GZI Next in Emmen).

In the expanding to northwestern Europe phase, hydrogen production capacity is expected to increase to 100 PJ per annum (of which the green hydrogen share is 6 GW equivalent). This is comparable to 15 percent of the 2030 European hydrogen production capacity target, with large projects including NortH2 and HyNetherlands. NortH2 is Europe's largest green hydrogen project, with plans to directly connect 4 GW of offshore wind to green hydrogen production in Eemshaven by 2030. The infrastructure expansion to the rest of the Benelux, western Germany, and northern France will extend the reach of hydrogen offtake markets and be the initial effort to create a European hydrogen backbone. The first announced large industrial use cases in the region include projects from Nedmag, Kisuma Chemicals, and Vattenfall.

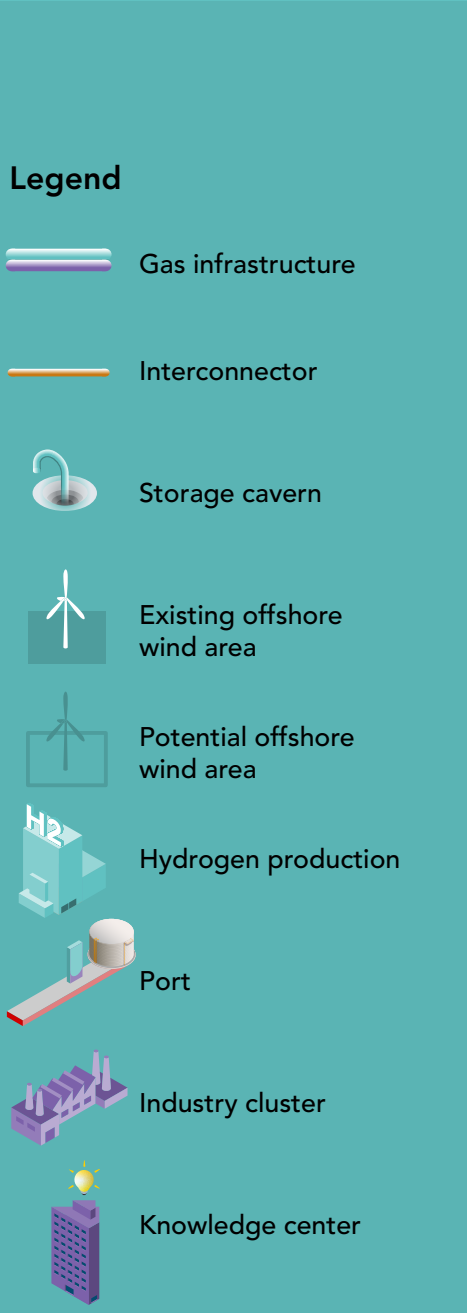


Exhibit 7

Indicative view of the planned hydrogen ecosystem towards 2030

03
A BLUEPRINT FOR THE REST OF EUROPE

The Northern Netherlands is uniquely positioned to become Europe's leading hydrogen ecosystem and serve as the continent's hydrogen blueprint. To realize this leading position, the Northern Netherlands has ambitious goals for 2030 and beyond. Pre-2030, the Northern Netherlands will mature and scale its hydrogen ecosystem and expand to full northwestern European coverage. Post-2030, once the European hydrogen ecosystem is fully developed, the Northern Netherlands will be an established hydrogen ecosystem, renewing its role as a leading "gas roundabout" of Europe.

Pre-2030: The first holistic hydrogen ecosystem as a blueprint for the rest of Europe

Over the coming decade, the Northern Netherlands will retain its leading position within the growing European hydrogen ecosystem, becoming the first region with a holistic regional ecosystem covering the entire hydrogen value chain. In a two-step approach, the Northern Netherlands will mature and scale up its hydrogen ecosystem by 2025, and expand its hydrogen ecosystem coverage to all of northwestern European by 2030.

The Northern Netherlands produces hydrogen cost-competitively from offshore wind through an accelerated project pipeline of electrolysis, which will generate 5 to 10 PJ of hydrogen per annum by 2025 (250 to 500 MW equivalent) and over 6 GW by 2030. Early uptake by industry, mobility, and power sector applications in the region is driven by well-designed incentive structures (e.g., subsidies, RED II) and the hydrogen trading market, resulting in cost-competitive green hydrogen applications. Certainty in the offtake market stimulates further build-out of green hydrogen production capacity and innovation in hydrogen applications. In addition, the carbon-neutral hydrogen ecosystem, with its cost-competitive greenfield industrial hydrogen use cases (e.g., chemicals production), attracts globally leading industrial businesses and investment to the region. Retrofitting existing natural gas infrastructure (e.g., parallel gas pipelines, salt caverns) via domestic and cross-border projects (e.g., Northern H_2 infra, coupling with

German H_2 Startnetz) will enable the Northern Netherlands to become the leading hydrogen infrastructure backbone of the Netherlands and Europe. The opportunities in production, infrastructure, and hydrogen end use create jobs (up to 25,000 FTEs), attract talent to the region, and stimulate cross-functional R&D from industry and knowledge institutions. The triple helix of government, industry, and knowledge institutions in the Northern Netherlands further accelerates hydrogen developments via a common vision and project collaborations across the value chain.

As the first region in Europe with a fully developed hydrogen ecosystem featuring renewable power production, hydrogen production, hydrogen transport and storage, and hydrogen offtake markets, the Northern Netherlands provides a blueprint for the rest of Europe to develop its own hydrogen ecosystems. This strategy is specifically supported by existing cooperations with the Clean Hydrogen Alliance, the S3 platform, and Germany (i.e., the state of Lower Saxony). In addition, the Northern Netherlands will have the infrastructure backbone in place to supply northwestern Europe with over 25 percent of its hydrogen demand.

Post-2030: A leading "hydrogen roundabout" and magnet for talent and innovation

By 2030, the Northern Netherlands will have an established hydrogen market structure, with a liquid hydrogen trading market and a fully developed infrastructure backbone. This, combined with the region's large shipping capacity in the Eemshaven and Delfzijl ports, will enable the Northern Netherlands to become the "roundabout" for European-produced and imported green hydrogen.

Compared to the pre-2030 hydrogen ecosystem, the focus in the Northern Netherlands will shift from being an early mover across the hydrogen value chain to specializing in cross-cutting hydrogen innovation and technology with rapidly growing and globally leading hydrogen businesses. The accumulation of talent and knowledge institutions, combined with strong industry cooperation, will transform the region into a center of excellence for manufacturing and hydrogen innovation.

Exhibit 8

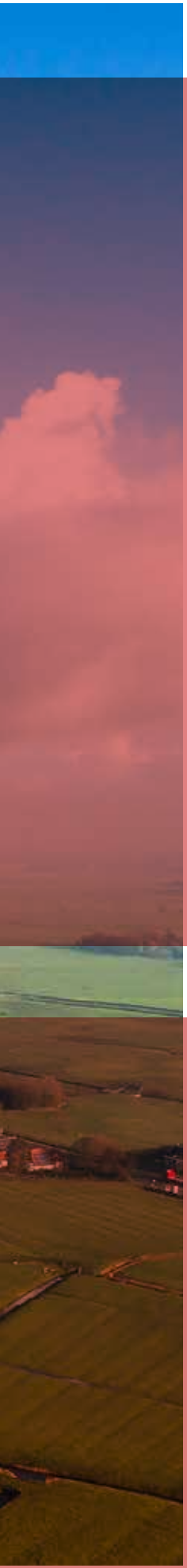
The Northern Netherlands is uniquely positioned to develop a strong green hydrogen ecosystem, attract talent and innovation, and serve as a blueprint for other European regions

2030 milestones

6 GW	100 PJ	400 PJ	>EUR 9 bn	25,000 FTEs
Dedicated offshore wind	Hydrogen production	Addressable hydrogen market	Investments	Job creation

Source: Northern Netherlands Hydrogen Coalition

04
A ROAD MAP TO 2030



The Northern Netherlands has a strong road map in place to build up the Dutch and northwestern European hydrogen backbone. The plan is to mature and scale up its integrated hydrogen ecosystem to a clean hydrogen capacity of 5 to 10 PJ by 2025, and to a capacity of 100 PJ by 2030. A large project pipeline is in place to drive the Northern Netherlands hydrogen road map forward, with projects dedicated to short-term production (DJEWELS 1 and 2), infrastructure (connecting the Northern Netherlands' industrial clusters and storage caverns), and demand (Groningen and Drenthe energy transition hubs), plus larger ecosystem-wide projects (HEAVENN, NorthH_2).

Phase 1: Maturing and scaling up the Northern Netherlands hydrogen ecosystem (2020 to 2025)

Over the past two years, the region successfully established innovation hubs, hydrogen pilots, and demo projects, like the HydroHub, HyStock, and Ecolution, which kick-started the development of the Northern Netherlands hydrogen ecosystem. In the maturing and scaling phase, running from now until 2025, over 35 projects covering the entire hydrogen value chain are planned, including demand investments in hydrogen end-use applications, infrastructure and logistics investments in hydrogen transport and storage, production investments in offshore wind and hydrogen production capacity, and knowedge and innovation investments across the full hydrogen value chain. This broad systemic range of projects ensures the coordinated progression of the Northern Netherlands hydrogen ecosystem and will form the blueprint to roll out hydrogen infrastructure across northwestern Europe (Benelux, western Germany, northern France).

Demand. With over 20 hydrogen demand projects already in place, hydrogen end-use applications in different sectors (mobility, industry, power, buildings) will be piloted or scaled up over the coming years. Hydrogen demand in the mobility sector will be kick-started by introducing various hydrogen vehicles, such as long-distance buses, trucks, trains, ships, and drones, plus putting the required hydrogen refueling stations in place. BioMCN announced at-scale consumption of hydrogen as a feedstock for producing renewable e-methanol, which can replace grey methanol in industrial applications and be used as renewable synthetic fuel in transportation. Several industries in central and eastern Groningen envision a transition from natural gas to green gas (9 PJ per annum), which could make hydrogen a viable option for them because of their strategic locations next to foreseen hydrogen production facilities. Other hydrogen end-use initiatives include the energy transition hub in Veendam, a residential heating pilot in Hoogeveen, and a renewable e-methanol production facility in Delfzijl.

Infrastructure and logistics. The Northern Netherlands hydrogen infrastructure is planned to be complete by 2025, with 169 km of hydrogen pipelines and an initial storage capacity of 0.5 PJ in salt caverns, connecting Eemshaven, Delfzijl, Emmen, and other hydrogen storage locations. The hydrogen transport pipeline will be made up of 29 km of newly built pipelines plus around 140 km of existing pipelines from the parallel gas infrastructure. In addition, 5,000 tons of hydrogen storage capacity (0.5 PJ equivalent) will be made available at Zuidwending to balance hydrogen supply and demand.

Production. 0.7 GW of offshore wind and 1.25 GW of onshore renewable capacity are planned to be installed by 2025. This is in addition to the 1.8 GW of renewable capacity that is already available. To unlock the 2030 Northern Netherlands ambition level of 6 GW of electrolyzer capacity (around 75 PJ per annum equivalent), the initial projects need to be fully secured with offshore wind supply, and the larger projects for 2030 need initial,

at-scale offshore wind commitments. In the short term, hydrogen production will require 4 to 6 GW of dedicated offshore wind capacity, which must be spatially planned to ensure successful investment decisions for the Northern Netherlands hydrogen ecosystem. In terms of hydrogen production capacity, around 5 to 10 PJ of electrolyzer capacity (250 to 500 MW equivalent) is planned to be installed by 2025, with projects including DJEWELS 1 and 2, Eemshydrogen, and HyNetherlands. However, to realize these projects, further clarity and the support of regulatory frameworks are required to mandate production asset build-out and long-term hydrogen demand.

Knowledge and innovation. Strong commitment to talent and knowledge institutions provides a human-resource basis for the developments to come. Therefore, investments in education and R&D are necessary to build hydrogen expertise in the Northern Netherlands, such as professional training programs or job certificates. The regional governments support vocational training to develop technical capabilities (installation, engineering, etc.). Knowledge institutions have incorporated programs focused on technical and business-related hydrogen topics (e.g., CEER, the Hanze University of Applied Sciences). The HydroHub provides a testing bed to scale up hydrogen use cases. Lastly, the New Energy Coalition and DNV GL offer hydrogen courses for energy professionals.

The maturing and scaling up of the Northern Netherlands hydrogen ecosystem – based on the current project pipeline – builds on EUR 850 million of planned investments, of which most are private investments, and is expected to attract over 5,000 hydrogen-related jobs. Hydrogen will increasingly realize CO_2 emission reduction targets by 2030, with 0.5 Mt of annual greenhouse gas emissions reduced by 2025.

Phase 2: Expanding of the Dutch hydrogen ecosystem to northwestern Europe (2025 to 2030)

Ten large projects are already in place to realize northwestern European expansion of the hydrogen ecosystem by 2030. This will create a stepping stone for the Northern Netherlands to become the European backbone of hydrogen infrastructure and ensure a cost-competitive hydrogen production hub beyond 2030.

Demand. The addressable 2030 hydrogen demand in northwestern Europe (Benelux, western Germany, northern France) is expected to increase from 340 PJ today to over 400 PJ by 2030, when considering the 2016 Paris Agreement's 1.5 degree C. scenario. The largest offtake markets are refining (36 percent of 2030 demand), ammonia (31 percent of 2030 demand), and iron and steel (25 percent of 2030 demand). In addition, the uptake of green hydrogen will create demand for new hydrogen applications such as chemicals and biofuels (4.5 percent of 2030 demand), trucks (2.5 percent of 2030 demand), and trains, ships, and planes (1 percent of 2030 demand). Initial forecasts for hydrogen end use are already being made, with Vattenfall, Kisuma Chemicals, and SkyNRG announcing large quantities of hydrogen demand (11 PJ) for power generation (demonstration project: CO_2-free flexible power generation) and industry feedstock by 2030.

Infrastructure and logistics. The Northern Netherlands will be connected to the main regional hydrogen offtake markets in the Netherlands and northwestern Europe, with the main infrastructure backbone planned to be ready by 2027. The emerging backbone is largely based on retrofitted natural gas infrastructure, achieved through the conversion of existing pipelines where parallel ("looped") routes are available. By 2030, this will translate into a dedicated Dutch hydrogen backbone of around 1,150 km and a European hydrogen backbone of approximately 6,800 km, connecting the Netherlands, Germany, Belgium, and parts of France. Furthermore, four hydrogen storage locations in salt caverns will also be connected. Additional, unconnected regional networks are likely to emerge in Italy, Spain, Denmark, Sweden, France, and Germany, which are likely to be connected after 2030.

Production. Annual production capacity will significantly increase to around 100 PJ, of which 75 percent will be green hydrogen (6 GW equivalent) and 25 percent will be blue hydrogen. Large green hydrogen projects include HyNetherlands and NorthH_2. Given the addressable hydrogen demand of around 400 PJ per annum in northwestern Europe, when considering the 2016 Paris Agreement's 1.5 degree C. scenario, the Northern Netherlands will be able to supply around 25 percent of northwestern European demand by 2030. To realize 6 GW of green hydrogen production capacity by 2030, significant additional offshore wind capacity and electricity transmission infrastructure needs to be made available. The required spatial planning for additional capacity needs to be done in the next two to three years to ensure the timely build-out of sufficient offshore wind. In addition, power grid and water management infrastructure have to be in place to support the increased power and fresh-water demands of electrolyzers.

The expansion of the Northern Netherlands hydrogen ecosystem – based on the current project pipeline – builds on EUR 9 billion of planned investments, of which EUR 63 million are in hydrogen demand applications, EUR 1.8 billion in infrastructure and logistics, and EUR 7.8 billion in production projects. In addition, the Northern Netherlands 2030 project pipeline is expected to create 25,000 FTEs in hydrogen-related jobs. Moreover, given the potential for green and blue hydrogen to replace natural gas combustion, the usage of hydrogen has the potential to contribute to lowering CO_2 emissions by 5 to 10 Mt,

Hydrogen chemicals cluster

The DJEWELS 1 and DJEWELS 2 projects are key examples of the Northern Netherlands' integrated hydrogen ecosystem approach, with the chemicals industry as the main offtake market. The projects are an international consortium between Nouryon and Gasunie, receiving initial funding from the EU and the Waddenfonds. Two electrolyzer facilities will be developed over the coming years: DJEWELS 1 with 20 MW of capacity and DJEWELS 2 with 80 MW of capacity. On the demand side, BioMCN has announced its intention to use green hydrogen – in combination with CO_2 from other processes – to produce renewable methanol, which can be used as chemical feedstock to phase out fossil feedstock and as e-fuel for hard-to-decarbonize transportation applications such as shipping. Compared to fossil-based methanol, this will reduce emissions by up to 27,000 tons of CO_2 per annum. To ensure short-term realization of the chemicals cluster, an integrated ecosystem was set up, with DJEWELS and BioMCN being co-located to minimize short-term infrastructure needs as the Northern Netherlands hydrogen pipeline infrastructure is under construction. These initial commitments and the integrated ecosystem approach have accelerated hydrogen development and attracted other hydrogen chemicals businesses to join the region, such as SkyNRG, with its plans to use green hydrogen to produce clean aviation fuel.

which is 3 to 6 percent of 1990 Dutch emission levels. And since there are also other, more carbon-intensive, end-use applications that hydrogen has the potential to replace (e.g., heavy-duty vehicles, shipping, steel manufacturing), the expected CO_2 reduction because of hydrogen is expected to go beyond 5 to 10 Mt of CO_2 per annum.

Prerequisites for realizing the hydrogen road map of the Northern Netherlands

To realize the hydrogen road map of the Northern Netherlands, a set of prerequisites must be fulfilled. Businesses and governments in the region have already committed to the Northern Netherlands becoming the hydrogen backbone of Europe, with significant investments, resources, and planned projects in place. However, Dutch (and European) governmental support is needed to ensure sound hydrogen business cases, which are required to realize the planned project pipeline.

The maturing and scaling phase, which will run until 2025, requires a set of short-term and long-term regulatory mechanisms (e.g., exemption from the RED II additionality and correlation requirements), and financial commitments (e.g., bridging the investment gap for infrastructure by 2021; expression of interest programs for scale-up projects) that mandate the timely execution of hydrogen projects. Prerequisites for realizing the 2030 expansion to northwestern Europe include a sustainable hydrogen demand market, supported by regulatory frameworks mandating hydrogen usage, a trading market matching supply and demand, and the build-out of offshore wind capacity, hydrogen production facilities, and pipeline and storage infrastructure. These prerequisites can only be achieved through a synchronized investment and regulatory plan that secures integrated value chains in the Northern Netherlands, which have to be orchestrated throughout a complex environment of globally interconnected businesses and public bodies, with presence and strategic focus beyond the Netherlands.

Financial support is needed in the coming decade to bridge the price gap between green hydrogen end uses and fossil fuel alternatives that are based on grey hydrogen or other fossil fuels (coal, natural gas). The expected cost reduction of green hydrogen by 2030 reduces the price gap between green and grey hydrogen from EUR 1.6 per kg in 2025 to EUR 0.25 per kg by 2030. Given the green hydrogen production capacity increase of 5 to 10 PJ per annum in 2025 to around 75 PJ per annum by 2030, the total value gap to be bridged will be EUR 80 million to 160 million in 2025 and around EUR 180 million by 2030. As this assumes only a direct transition from grey to green hydrogen, the realistic price gap will likely be larger, due to potential hydrogen end-use applications in hard-to-abate sectors (e.g., heavy-duty trucks, steel manufacturing).

Exhibit 9

The Northern Netherlands hydrogen road map for 2030 focuses on scaling up the hydrogen ecosystem and expanding the network to northwestern Europe

Roadmap phases	Phase 1: Maturing and scaling (2020–25)	Phase 2: Expanding to northwestern Europe (2025–30)
Hydrogen production capacity	5–10 PJ p.a.	100 PJ p.a.[1]
Green hydrogen production costs	EUR 3.3/kg	EUR 2.3/kg
Investment needed	~EUR 850 mn	~EUR 9 bn
Jobs created[2]	~5,000 FTEs	~25,000 FTEs
CO_2 abated	0.28–0.56 Mt of CO_2	5.6–11.2 Mt of CO_2
Description	• **Mature and scale up an integrated Northern Netherlands hydrogen ecosystem** by synchronizing investments along the value chain (production, infrastructure, demand) • **Develop a blueprint** to roll out hydrogen infrastructure at scale	• **Expand the Northern Netherlands hydrogen ecosystem to serve northwestern Europe** by increasing production capacity and connecting the greater region

1. GW of green hydrogen production next to 28 PJ p.a. of blue hydrogen production towards scale-up of the hydrogen ecosystem by 2030
2. Including both recurring and one-off jobs

Source: Northern Netherlands Hydrogen Coalition

Hydrogen mobility cluster

With over 15 mobility projects ongoing or close to being started, the Northern Netherlands has created mobility opportunities across the entire value chain, with a committed triple helix of government, industry, and knowledge institutions developing the hydrogen ecosystem. Innovative pilots have been launched to showcase the potential (H_2Grow, High V.LO-City, hydrogen fuel cell train). Demand is mandated by regional governments committing to hydrogen in public transit use cases (e.g., buses, boats, trains). Hydrogen refueling station infrastructure and the supporting hydrogen delivery trucks are being rolled out by private (Shell, Holthausen, Green Planet, Pitpoint) and public investments. Furthermore, new mobility opportunities are entering the Northern Netherlands,because global businesses are attracted to the unique combination of the region's hydrogen ecosystem, its systemic approach to developing hydrogen use cases, and its ongoing hydrogen mobility project pipeline. For example, Hyzon Motors just recently announced the opening of its European headquarters and hydrogen truck manufacturing division in the Northern Netherlands.

05 SUPPORT NEEDED – TEN ACTIONS

The Northern Netherlands needs support to realize the Dutch hydrogen opportunity. Private and public stakeholders are committed to the Northern Netherlands, but additional governmental commitments to offshore wind, regulatory frameworks, and short-term funding are needed to bridge investment gaps. Pre-2025 projects require short-term regulatory incentives and additional funding, such as an exemption from the RED II additionality and correlation requirements, additional funding (e.g., expression of interest programs), and compensation programs for initial investment gaps for future-proof infrastructure. Clear regulatory frameworks must be implemented in the next two to three years to enable the next phases of these projects, most of which require a financial investment decision before 2025. Only this will ensure the timely rollout of the Northern Netherlands and broader Dutch hydrogen ecosystem.

To realize the short- and long-term project pipeline, a set of actions must be implemented in four key areas: (A) Hydrogen production, infrastructure, and demand, (B) Offshore wind capacity, (C) Larger hydrogen ecosystem, and (D) Overall program management. Ten necessary actions were identified for unlocking the Dutch hydrogen opportunity.

A. Hydrogen production, infrastructure, and demand

1. **Ensuring a supporting regulatory framework by being exempted from the RED II additionality and correlation requirements** during the maturing and scaling phase. To ensure the scale-up of green hydrogen with sufficient renewable power in the short term, hydrogen scale-up projects must be exempted from the RED II additionality and correlation requirements. RED II states that green hydrogen production can only be supplied through (new) additionally developed renewable energy capacity, and not through power from current renewable plans or renewable assets. It is recommended that until significant further renewable energy build-out is realized, a capacity of up to 1 GW of renewable power be made available for green hydrogen production, in line with the build-out of electrolyzer capacity.

2. **Introducing hydrogen scale-up funds and support instrumentation** (e.g., expression of interest programs) of sufficient size to bridge investment gaps of critical hydrogen ecosystem assets. To ensure timely financial investment decisions for the Northern Netherlands project pipeline in both the short and long term, investments need to be derisked significantly. This requires adding funds and instrumentation to support investment gaps during the mature and scale phase. Expression of interest programs are – if done well – an effective way to do so and can provide governmental funding for a set of key projects (e.g., via tendering), which can be allocated to interested developers. Another mechanism for facilitating timely financial investment decisions on projects is to grant

Exhibit 10

Critical hydrogen support mechanisms are needed over the next 1–3 years to realize near-term ecosystem development and unlock the long-term 2030 ambition level

	Short-term actions are required ...	
Area	**... to realize the Phase 1 ambition level (2020–25)**	**... to unlock the Phase 2 ambition level (2025–30)**
Hydrogen production, infrastructure and demand	1 **Ensuring a supporting regulatory framework** for production and demand by being exempted from the RED II additionality and correlation requirements, and implementing measures to stimulate the use of hydrogen or its derivatives in end-use markets 2 **Introducing hydrogen scale-up funds and support instrumentation** to bridge investment gaps for critical hydrogen ecosystem assets 3 **Compensating for the initial investment gap for critical infrastructure** to ensure future-proof infrastructure investments that facilitate the rollout of the hydrogen ecosystem	4 **Incentivizing hydrogen demand uptake** via supporting regulatory frameworks and a hydrogen trading market
Offshore wind capacity		5 **Accelerating offshore wind development for hydrogen** by advancing the spatial planning of at least 4 to 6 GW of dedicated offshore wind capacity north of the Northern Netherlands
Larger hydrogen ecosystem	6 **Investing in the needs of the larger hydrogen ecosystem buildup** via educational programs and supporting innovation centers in the region	7 **Transitioning intangible assets** (talent, knowledge, innovation) from other industries
Overall program management	8 **Assigning the majority of the allocated Just Transition Fund budget to the Northern Netherlands** 9 **Steering hydrogen ecosystem development** by setting up a transformation and Coordination Office	10 **Orchestrating a systemic national approach** to the end-to-end development of the hydrogen ecosystem and ensuring developments are aligned
	Actions needed in next 1–2 years	**Actions needed in next 2–3 years**

Source: Northern Netherlands Hydrogen Coalition

certain permitting exemptions for relevant subsidies, such as accelerating right-of-way approvals for new pipeline infrastructure or environmental permits for new hydrogen production facilities.

3. **Compensating for the initial investment gap for critical infrastructure** to ensure future-proof infrastructure investments that facilitate the rollout of the hydrogen ecosystem. Essential to the development of a hydrogen ecosystem is hydrogen infrastructure, including pipelines and storage. The Northern Netherlands has a systemic approach to building the regional infrastructure, which will comprise around 169 km of pipelines and 5,000 tons of storage capacity in salt caverns (0.5 PJ equivalent) by 2025. The pipelines are mostly existing parallel gas pipelines, of which the redundant parts are retrofitted to enable hydrogen transport. The investment decision for the transport and storage infrastructure is needed in 2021 and will therefore precede the development of the market. To ensure a future-proof investment, the capacity of the infrastructure for transport and storage needs to be scaled to future demand. At the time of the final investment decision, this will cause an investment gap which needs to be derisked. To achieve competitive pipeline throughput fees, a compensation method would be required during these ramp-up years.

4. **Incentivizing hydrogen demand uptake via supporting regulatory frameworks and a hydrogen trading market.** Currently, green hydrogen is often not competitive with existing technologies or grey hydrogen. To bridge the price gap and incentivize green hydrogen consumption, favourable regulatory frameworks need to be developed. There are multiple ways to mandate and target hydrogen end-use applications, such as volume mandate, feed-in tariffs, guarantees of origin, trading programs, or blending mandates targets for the use of hydrogen or its derivatives. Volume mandates can incentivize hydrogen consumption for final end-use applications. Such mandates can be industry specific and designed according to the ease of exchanging the incumbent technology with green or blue hydrogen. Feed-in tariffs can be used to compensate for price gaps between the investment required for hydrogen and the next-best low-carbon technology. Hydrogen trading programs, in line with the EU Emissions Trading System or the Australian Renewable Energy Target, are other potentially effective methods to mandate hydrogen consumption.

B. Offshore wind capacity

5. **Accelerating offshore wind development for hydrogen.** Significant additional offshore wind capacity is required to realize green hydrogen production of around 75 PJ per annum (6 GW equivalent) by 2030. Current plans for 1.2 GW of offshore wind capacity near the Northern Netherlands are not sufficient, and at least 4 GW of additional capacity is required by 2030. Given the long lead times in offshore wind development, the government needs to decide next year whether to expand the spatial planning for at least 4 to 6 GW of offshore wind park capacity dedicated to green hydrogen production near the Northern Netherlands.

C. Larger hydrogen ecosystem

6. **Investing in initial hydrogen ecosystem buildup.** When developing the hydrogen ecosystem, intangible essentials need to be addressed as well. Due to the ongoing gas phaseout, existing gas-related employees are to be reskilled for hydrogen-related jobs. Educational courses relevant to the hydrogen industry should be developed. The regional population also needs to be supported in the transition to a hydrogen ecosystem. Information sessions and transparent communication can contribute to building the larger hydrogen ecosystem.

7. **Transitioning intangible assets.** To expand the hydrogen ecosystem by 2030, several long-term mechanisms for transitioning intangible assets need to be enacted in the short term. It is critical to attract highly specialized talent to the region and to commit R&D funding to develop world-leading hydrogen innovation and expertise.

D. Overall program management

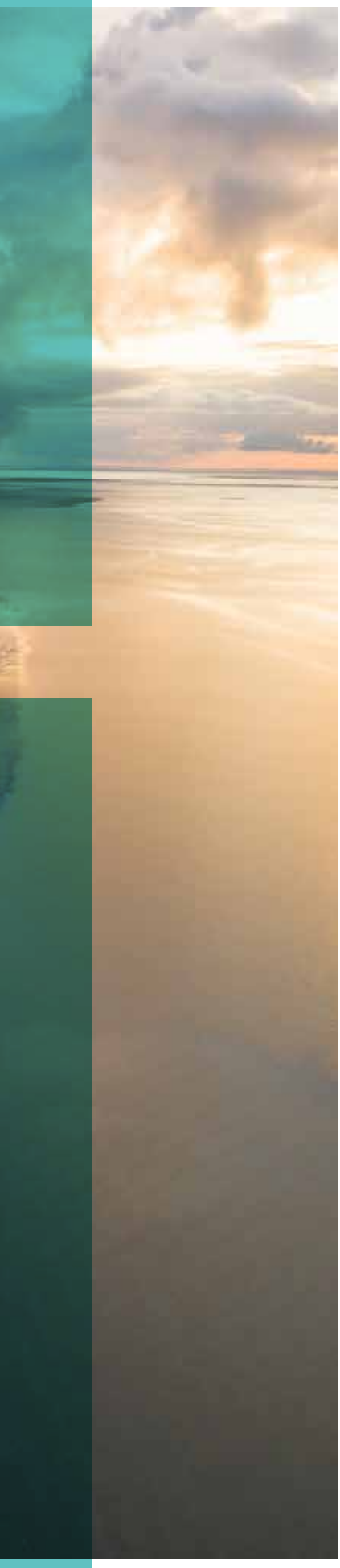
8. **Assigning the majority of the allocated Just Transition Fund budget to the Northern Netherlands.** The EU has created the Just Transition Fund to support regions in addressing the social, economic, and environmental impacts of the transition to a low-carbon economy. The EU nominated the province of Groningen as a potential recipient of the Just Transition Fund, which is very important for expanding the Northern Netherlands Hydrogen Valley. A majority of the nationally allocated Just Transition Fund budget should therefore be assigned to the Northern Netherlands.

9. **Steering hydrogen ecosystem development by setting up a transformation and Coordination Office.** The Northern Netherlands Transformation and Coordination Office requires national support to collaborate on critical topics. A Transformation and Coordination Office office will ensure coordination, collaboration, and alignment of stakeholders across the entire value chain, which will go beyond the Northern Netherlands. Led by Northern Netherlands businesses, the Transformation and Coordination Office will facilitate these conversations, keep track of the project pipeline, manage external stakeholder communication, and ensure the accountability of all stakeholders to their commitments.

10. **Orchestrating a systemic national approach** to the end-to-end development of the hydrogen ecosystem. To ensure a systemic approach to developing a Dutch hydrogen ecosystem, end-to-end governmental orchestration is needed. Elements of the hydrogen ecosystem are highly intertwined along the value chain (e.g., green hydrogen capacity is mostly dependent on the available renewable energy capacity from offshore wind). Regional and national governments need to work together to ensure system-wide orchestration to account for the interdependencies in the value chain.

    A way to ensure successful governmental orchestration is to develop an end-to-end Dutch hydrogen strategy with integrated targets throughout the hydrogen ecosystem. This ensures an effective build-out, where, for example, offshore wind capacity is expanded in line with the planned electrolyzer capacity build-out and hydrogen demand mandates.

06 IMPLEMENTATION PLAN FOR THE NEXT 18 MONTHS



To realize the hydrogen opportunity in the Northern Netherlands, the triple helix of government, industry, and knowledge institutions has developed an 18-month implementation plan (see detailed plan in the Appendix). The Northern Netherlands has acknowledged the need for a systemic approach to developing a full-fledged hydrogen ecosystem with initiatives across the value chain. With regional collaborations, the Northern Netherlands plans to expedite hydrogen development and innovation to position the region as the backbone of and blueprint for the northwestern European hydrogen ecosystem. The implementation plan addresses the efforts that the Northern Netherlands will take, in line with the four key areas introduced in Chapter 5. In addition, the plan highlights which short-term government actions are required to unlock the Dutch hydrogen opportunity.

A. Hydrogen production, infrastructure, and demand

The Northern Netherlands is committed to developing the hydrogen ecosystem, covering production, infrastructure, and demand. In 2020, the region will set up a hydrogen use case work group to develop a detailed timeline for rolling out hydrogen use cases until 2025 and matching demand and supply to derisk investments, with actions including:

1. Identifying priority hydrogen use cases to develop by 2025 – based on decarbonization potential, project feasibility, and economic impact – and developing implementation timelines

2. Identifying quick-win hydrogen use cases which can be implemented cost-effectively in the short term

3. Forecasting aggregated hydrogen demand for expected use cases to match hydrogen production and supply, and developing hydrogen purchase agreements to derisk production and demand investments.

In 2020 (until early 2021), a Northern Netherlands project work group will examine the challenges and opportunities faced by the short- and long-term project pipeline. The work group will identify potential for cross–value chain initiatives (e.g., centralization of supply and demand, purchase agreements, hydrogen trading market), and outline key a reas of interest for realizing the planned projects, such as the potential of supporting regulatory frameworks (e.g., RED II, trading credits, feed-in tariffs, trading programs).

In 2020 and 2021, as budgets are made and

potential funds are granted (e.g., the Just Transition Fund), regional governments will allocate significant amounts of their budgets to critical hydrogen ecosystem projects to ensure the systemic development of the Northern Netherlands hydrogen ecosystem.

External need: To ensure constructive national collaboration on hydrogen development and the required regulatory support mechanisms, the Northern Netherlands invites national government representatives to join work groups. To realize positive financial investment decisions in the coming one to two years, immediate regulatory mechanisms are needed (e.g., RED II additionality exemption, expression of interest programs). Furthermore, initial regulatory frameworks (e.g., volume mandates, feed-in tariffs, trading programs) need to be developed to ensure a sustainable hydrogen market in 2030. These frameworks will mandate the expansion of the Northern Netherlands hydrogen ecosystem to northwestern Europe by 2030.

B. Offshore wind capacity

The Northern Netherlands' green hydrogen plans rely largely on scaling up offshore wind. A systemic approach is required to ensure the offshore wind scale-up supports the scale-up of the entire Northern Netherlands hydrogen ecosystem.

In 2020 (until early 2021), a Northern Netherlands project work group will develop a minimum viable timeline of phased offshore wind expansion required to realize the region's 2030 hydrogen ambitions. In addition, the regional grid requirements will be assessed to identify any necessary grid expansions for facilitating offshore wind expansions.

External need: With the Dutch government leading the spatial planning process of offshore wind, the Northern Netherlands seeks to collaborate with the government over the next 6 to 12 months to develop an offshore wind expansion road map that provides systemic benefits to the Netherlands while realizing the Northern Netherlands hydrogen project pipeline.

C. Larger hydrogen ecosystem

To create a larger ecosystem supportive of developments in hydrogen, various actions will be carried out. Over the period from 2020 to 2021, the transition potential of jobs will be identified and supported through knowledge institutions and regional governmental regulations and financing. To systematically address the job transitions, three actions will be taken:

1. A detailed map will be made of gas-related jobs that are likely to be phased out in the region, building on existing analysis.

2. Jobs related to the hydrogen ecosystem will be identified, including their required skill sets.

3. Support mechanisms (e.g., professional training, reskilling programs, job certificates) will be put in place to boost the transformation of existing jobs, attract and develop new talent, and create an attractive investment proposition for global hydrogen businesses.

External need: To ensure socioeconomic benefits for the Netherlands, Dutch governmental support is needed over the next one to two years to orchestrate national job programs to educate new talent or reskill existing talent. In addition, potential regulatory incentives are needed to support neighboring industries (e.g., natural gas, water management) in transitioning to hydrogen use cases.

D. Overall program management

To ensure a well-orchestrated, systemic approach to hydrogen in the Northern Netherlands, a Transformation and Coordination Office will be set up in the fall of 2020, led by the private sector. This office will orchestrate and facilitate work teams that will develop the region's short- and long-term strategies, identify white spaces in the value chain, and connect interdependencies in the project pipeline. In addition, the Transformation and Coordination Office will ensure that the project is well orchestrated by putting in place project performance indicators, frequent communication forums (and other communication methods), and key responsible stakeholders throughout the ecosystem.

External need: To ensure the Netherlands effectively develops its hydrogen ecosystem, cross-regional orchestration of hydrogen ecosystem development is needed. A Dutch hydrogen road map with clear focus areas, combined with cross-regional work groups, will enable an effective rollout of the Dutch hydrogen ecosystem.

APPENDIX

Exhibit 11

List of Northern Netherlands hydrogen projects

Maturing and scaling

Expanding to northwestern Europe

	Company name	Project	Location	Capacity[1]		Date ready
				PJ p.a.	MW	
Hydrogen production	Industry coalition	Battolyser pilot plant	Eemshaven	0.001	0.015	2019
	Lagerwey	H_2 wind turbine	Eemshaven, Delfzijl	0.02	2–3	2020
	Lagerwey	4 H_2 wind turbines	Eemshaven, Delfzijl	0.1	10	2020–22
	Shell, EBN, Gasunie	GZI Next Phase 1[2]	Emmen	0.1	10	2022
	Nouryon, Gasunie	DJEWELS 1	Delfzijl	0.4	20	2022
	Nouryon, Gasunie	DJEWELS 2	Delfzijl	1.7	80	2022
	Shell, EBN, Gasunie	GZI Next Phase 2[2]	Emmen	0.8	40	2023
	Stichting WadDuurzaam, Stichting Humsterland	Electrolyzer including storage	Lauwersoog	0.025	1.5	2023–24
	RWE	Eemshydrogen	Eemshaven	0	100	2023–24
	Engie, Gasunie (infrastructure partner)	HyNetherlands Phase 1	Eemshaven	0.03	100	2024
	D4	Biomass and electrolysis hydrogen production	Leeuwarden	0.1	10	2024
	Shell, EBN, Gasunie	GZI Next Emmen scale-up[2]	Emmen	3.2	200	2026
	Equinor, Gasunie	H2M, blue hydrogen via ATR	Eemshaven	28	1,000	2027
	Nouryon	200 MW electrolyzer	Delfzijl	3.2	200	2027
	Gasunie, Shell, Groningen Seaports	NorthH_2 Phase 1	Eemshaven	10	1,000	2027
	Engie, Gasunie (infrastructure partner)	HyNetherlands Phase 2	Eemshaven	12.3	750	2028
	Engie, Gasunie (infrastructure partner)	HyNetherlands Phase 3	Eemshaven	16.4	1,000	2030
	Gasunie, Shell, Groningen Seaports	NorthH_2 Phase 2	Eemshaven	29	3,000	2030
	Gasunie, Shell, Groningen Seaports	NorthH_2 Phase 3	Eemshaven	58	>6,000	2040
Hydrogen infrastructure	Gemeente Groningen	Distribution of hydrogen to refuelling stations	Northern Netherlands	-		2018
	Groningen Seaports, Teijin Aramid	H_2 distribution to Chemiepark Delfzijl	Delfzijl	-		2019
	Gasunie	Northern Netherlands hydrogen backbone	Northern Netherlands	-		2025
	Gasunie/EnergyStock	Hystock Phase 1: small hydrogen cavern	Zuidwending	0.5		2025
	Gasunie	Netherlands hydrogen backbone	Netherlands and western Germany	-		2027–30
	Gasunie/EnergyStock	Hystock Phase 2: multiple large hydrogen caverns	Zuidwending	-		2030
	NAM and partners	Small chain: infrastructure refurbishment	Northern Netherlands	-		-
Hydrogen demand	Nouryon, QBuzz, Pitpoint, and others	High V.LO-City	Delfzijl	0.002		2017
	Kisuma Chemicals	High Temperature Pressure Swing Absorption	Veendam	0.05		2027
	Holthausen, Green Planet en Pitpoint	8 refueling stations	Northern Netherlands	-		2019–22
	Emmtec and customers	High-temperature heat and electricity	Emmen	0.1–3.5		2020
	Stichting WadDuurzaam	H_2 Ecolution: boost hydrogen ships in the Wadden	Lauwersoog	-		2020–21
	Municipality of Groningen	>5 mobility initiatives (e.g., fuel facilities, municipal vehicles)[2]	Groningen	-		2020–22
	Municipality of Hoogeveen	Residential heating[2]	Hoogeveen	-		2020–23

	Company name	Project	Location	Capacity[1]		Date ready
				PJ p.a.	MW	
Hydrogen demand	Holthausen	Fuel cell and electric vehicle refurbishment factory	Hoogezand	-	-	2020–25
	Hyzon	Hydrogen truck factory producing 2,000 trucks p.a.	Groningen	-	-	2021
	ISPT and partners	HydroHub: Hydrogen R&D hub on EnTranCe	Groningen	-	-	2021
	Orange Gas, Resato	5 hydrogen refueling stations	Drenthe	-	-	2021
	OV-bureau Groningen Drenthe	20 buses in Groningen and 10 in Emmen		-	-	2021
	Theo Pouw Secundaire Bouwstoffen BV	Hydrogen trucks	Groningen	tbd	-	2021
	Lauwersoog Water Ev.s, Stichting WadDuurzaam	2 shipping and fishing initiatives	Lauwersoog	-	-	2021–23
	Nedmag	Regional energy transition hub for Groningen	Veendam	1.2	-	2023
	BioMCN	Production of renewable e-methanol from low-carbon hydrogen	Delfzijl	-	-	2023
	Theo Pouw BV	Hydrogen vessel	Groningen, Eemshaven	50	-	2022
	NPRC, Nouryon, HyEnergy Transstore, Lenten Scheepvaart	Weva 1, 2, and 3 (shipping)	Delfzijl	-	-	2023–25
	Province of Groningen	Hydrogen trains	Province of Groningen	-	-	2024
	Avebe	Hydrogen potato trucks	Gasselternijveen, Ter Apelkanaal	1 mn kg p.a.	-	2025–30
	Vattenfall	Magnum power plant with 30% hydrogen co-blending	Eemshaven	0.6	-	2025
	Vattenfall	Magnum power plant on 100% hydrogen	Eemshaven	10.8	-	2027
	Kisuma Chemicals	Phaseout of natural gas	Veendam	0.3	-	2030
	Shell and partners	Hydrogen refueling stations	Northern Netherlands	-	-	-
	SkyNRG	Supply line (DSL-01) for aviation fuel production	Delfzijl	-	-	-
	NES	Blending of 20% hydrogen in gas grid	Ameland		-	-
	Kisuma Chemicals	Scale-up of HT-PSA	Veendam	0.006	-	-
	Avebe	Steam production with hydrogen	3 sites in the Northern Netherlands	2.4	-	2030
	Corre Energy, Nouryon	Hydrogen for compressed air energy storage	Zuidwending	-	-	-
	Municipality of Groningen	Greening of 100 municipal vehicles and machines	Groningen	-	-	2030
Hydrogen research and innovation	Hanze University of Applied Sciences and partners	Green Hydrogen Booster Entrance	Groningen	-	-	Ready
	VNO NCW MKB Noord and partners	Hydrogreenn	Northern Netherlands	-	-	Ready
	Energy College	Gas 2.0 vocational training program	Northern Netherlands	-	-	Ready
	University of Groningen	Various energy majors, minors, and research programs	Groningen	-	-	Ready
	Hanze University of Applied Sciences	3 master's programs in energy	Groningen	-	-	Ready
	Fryslan Wetsus	Center of excellence for sustainable water technology	Friesland	-	-	Ready
	Energy Campus, Leeuwarden	Sustainable energy production	Friesland	-	-	Ready
	New Energy Coalition and partners	HyDelta research program	Groningen and other regions	-	-	2020–21
	New Energy Coalition and partners	HEAVENN[2]	Northern Netherlands	-	-	2020–26
	ISPT and partners	Hydrohub MW test center	Groningen	-	-	2021
	DNV GL	Hydrogen Innovation Center	Groningen	-	-	2021
	Liander, Groenleven and partners	Pilot for hydrogen storage at solar park	Oosterwolde	0.01	1.4	2021
	FME	Green Shipping Waddenzee	Northern Netherlands	-	-	-
	Municipality of Emmen and partners	EmmTrance vocational training facility for hydrogen	Drenthe	-	-	-

1 Conversion of hydrogen capacity is done by power throughput (100 MW is the equivalent of 1.6 PJ p.a.) and hydrogen weight (1,000 tons of hydrogen is the equivalent of 0.1 PJ p.a.)
2 (Some of which are) part of HEAVENN

Exhibit 12

The Northern Netherlands road map

	Phase 1 2020–25: Maturing and scaling	Phase 2 2025–30: Expanding to northwestern Europe
Overall project details	>35 projects in place (e.g., HEAVENN) >EUR 850 mn of planned investments	>10 long-term projects in place (e.g., NorthH_2) >EUR 9 bn of planned investments
Production (power and hydrogen production)	Install 2 GW of renewable power capacity and plan additional capacity Realize 5–10 PJ p.a. of hydrogen production capacity (250–500 MW equivalent) (e.g., DJEWELS)	Realize at least 10 GW of additional offshore wind in the Northern Netherlands Realize 100 PJ p.a. of hydrogen production capacity, of which ~75 PJ will be green hydrogen (6 GW equivalent)
Infrastructure and logistics (pipelines, storage, ports)	Develop the initial Northern Netherlands hydrogen pipeline network of 169 km (Eemshaven – Delfzijl – Emmen) Connect initial storage capacity of 0.5 PJ in salt caverns	Expand the hydrogen backbone to all of the Netherlands and regional hubs in Belgium, western Germany, and northern France Connect 3–4 large-scale hydrogen storage caverns
Demand (end uses across mobility, industry, power, and buildings)	>20 projects in place across all sectors (mobility, industry, power, buildings) Most mature hydrogen initiatives are in mobility (hydrogen busses and communal vehicles) and industry (green methanol production for use as industry feedstock in industry or transportation e-fuel)	400 PJ of addressable demand in the region (2016 Paris Agreement's 1.5 degree C. scenario) First large local demand announcements include decarbonization initiatives of Vattenfall, Kisuma, and SkyNRG
Key mechanisms needed	**Needed in the next 1–2 years** Exemption from RED II additionally and correlation requirements Introduction of hydrogen scale-up funds and support instrumentation (e.g., electrolyzer tenders) Compensation for the initial investment gap for critical infrastructure	**Needed in the next 2–3 years** Market program for end users (e.g., volume mandates, feed-in tariffs) Acceleration of offshore wind development via early-on spatial planning and tendering End-to-end contracts and subsidies with government as orchestrator

Source: Work team analysis

Exhibit 13

The Northern Netherlands implementation plan

Implementation areas	Key actions	Timing 2020	2021	2022
A **Hydrogen production, infrastructure, and demand**	Setting up a work group by the Northern Netherlands Hydrogen Coalition to develop a timeline for rolling out hydrogen use cases, and matching supply and demand to derisk investments, with actions including: • Identifying priority hydrogen use cases to develop by 2025 • Identifying cost-effective quick-win use cases to be implemented in the short term • Forecasting aggregated hydrogen demand for expected use cases to match with supply, and orchestrating hydrogen purchase agreements to derisk investments			
	Realizing a short- and long-term project pipeline for the Northern Netherlands: • Examining challenges and opportunities faced by the short- and long term project pipeline • Identifying value chain initiatives, such as centralization of supply and demand and purchase agreements • Outlining key areas to realize planned projects, such as the potential to support regulatory frameworks (e.g., RED II, trading credits, feed-in tariffs)			
	Inviting national government representatives to join work groups, in order to realize financial investment decisions and immediate regulatory frameworks			
B **Offshore wind capacity**	Ensuring offshore wind scale-up to support the scale-up of the entire Northern Netherlands hydrogen ecosystem, with actions including: • Developing a minimum viable timeline of phased offshore wind expansion required to realize the region's 2030 hydrogen ambitions • Assessing regional grid requirements to identify any necesarry grid expansions for facilitating offshore wind expansion			
	Developing an offshore wind expansion road map in collaboration with the government over the next 6 to 12 months,that provides systemic benefits to the Netherlands while realizing the Northern Netherlands hydrogen project pipeline			
C **Larger hydrogen ecosystem**	Creating a larger ecosystem supportive of developments in hydrogen: • Mapping gas-related jobs that are likely to be phased out in the region • Identifying jobs related to the hydrogen ecosystem, including their required skill sets • Developing support mechanisms to boost the transformation of existing jobs, attract and develop new talent, and create an attractive investment proposition for global hydrogen businesses			
	Orchestrating national job programs with Dutch governmental support to educate new talent or reskill existing talent			
D **Overall program management**	Setting up a Transformation and Coordination Office in the fall of 2020, led by the private sector, with responsibilities including: • Developing the short- and long-term strategy of the region • Identifying white spaces in the value chain • Connecting interdependencies in the pipeline			
	Orchestrating project management, with actions including: • Putting project performance indicators in place • Organizing frequent communication forums • Assigning key responsible stakeholders throughout the system			
	Creating cross-regional orchestration of ecoystem development by establishing a Dutch hydrogen road map with clear focus areas and a cross-regional work group			

Source: Northern Netherlands Hydrogen Coalition

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