EXECUTIVE SUMMARY

This report shows how the Netherlands is advancing its journey towards becoming the foremost hydrogen hub in North-Western Europe (NWE). It contains two types of information: strategic information on the Dutch hydrogen vision and policy, and detailed information on what is going on in the field. Information is updated to July 2022 when Shell took final investment decision (FID) on Holland Hydrogen I with an initial capacity of 200 MW (picture of the cover page). This is an important milestone. Holland Hydrogen I is the first large-scale electrolyzer investment in the Netherlands. It will be Europe's largest renewable hydrogen plant when it starts operation in 2024.

The report is divided into five chapters, starting with recent policy developments (Chapter 1), and then analyzing the hydrogen full-value chain (demand, Chapter 2; infrastructure, Chapter 3, production, Chapter 4; and imports, Chapter 5). Annexes contain detailed information on Dutch regional clusters (Annex 1), blue hydrogen projects (Annex 2), green hydrogen projects (Annex 3) and hydrogen projects based on biomass (Annex 4).

The main findings are summarized hereunder.

Policy agenda: 2022 a busy and crucial year for hydrogen

The Netherlands presented its national hydrogen vision and policy agenda in March 2020. It entails policies, regulation, funding, and an international strategy to develop a hydrogen-based economy in the country to align with national decarbonization targets. The vision focuses on **deploying hydrogen infrastructure** in the country and targets to install **0.5 GW of electrolyzer capacity by 2025, and 3-4 GW by 2030.** The Netherlands wants to become a European leader in the deployment of clean hydrogen[1]. Building on its strategic location in global oil and gas logistics, the Netherlands is aiming to become **a European hub** for the production, import and transport/transit of green hydrogen.

The new government, which took office in January 2022, has tightened up and accelerated the national decarbonization goals to make the Netherlands a climate-neutral, fossil-free and circular economy by 2050 at the latest. The government has set **ambitious emission reductions of at least 60% by 2030** compared to 1990. Among several measures, **production and import of renewable hydrogen will play a key role** in achieving the more stringent targets. The Dutch policy is fully intertwined with the negotiations on the European Commission (EC) Fit for 55 package, notably its mandates for renewable fuels of non-biological origin (RFNBOs). The EC REPowerEU plan, announced in response to Russia's invasion of Ukraine, accelerates EU and Dutch efforts to scale up renewable hydrogen production and imports to move away from Russian fossil fuel imports**. The Dutch government is now assessing the feasibility and desirability of targeting at least 8 GW of electrolyzer capacity by 2030**.

To provide a clear investment framework, the government wants to have **major hydrogen policies and financial support in place in 2022**. Two key policy documents were issued at the end of June 2022. The first one deals with the **organization and development of the hydrogen market** and shows how the government intends to regulate the various segments of the hydrogen value chain. The other one, focused on the **hydrogen transmission network**, confirms government support to the realization of the Dutch hydrogen backbone and details its development up to 2030. A national hydrogen program (NWP) officially started in January 2022 to stimulate the contribution of hydrogen to the realization of the new broaden and deepened energy transition. Its work plan to 2025 will be transformed into a **hydrogen roadmap to be reviewed by the government by the end of 2022**.

[1] The Dutch government refers to clean or sustainable hydrogen. This includes renewable (or green) hydrogen, and low-carbon (or blue) hydrogen, as well as hydrogen produced from sustainable biomass.

Since the beginning of 2022, the government has significantly **increased its support to hydrogen**. This includes a reservation of €15 billion over the next 10 years from the Climate and Transition Fund for advanced renewable energy carriers, including green hydrogen and e-fuels. The annual budget for the 2022 SDE++, the major instrument to support the energy transition, has been raised to €13 billion (from €5 billion previously). A new upscaling instrument has been devised to implement hydrogen demonstration projects and achieve cost reduction (€250 million in the first round to support approximately 100 MW of electrolysis projects). A green fund dedicated to green hydrogen and green chemistry has been launched (€838 billion). The Netherlands participates in the process of establishing Important Projects of Common European Interest (IPCEI) in the field of hydrogen. In total, €1.385 billion is available in the Netherlands within the IPCEI Hydrogen.

Creating the certainty of demand

The Netherlands is already **a major user of (grey) hydrogen**. It is the EU second largest market, behind Germany. The country uses 1.5 MtH_2/y, mainly in refineries and chemical plants located **in five regional industrial clusters**. The decarbonization of these industrial clusters is a priority of the Dutch policy. **Creating a market for green hydrogen** is one of the key objectives of the Dutch policy as initial developments showed a strong willingness to develop green hydrogen production, but little demand for this hydrogen. This is changing quite rapidly with the proposed Fit for 55 mandates for RFNBOs use in industry and transport. **In the coming years, hard-to-abate sectors**, such as industrial processes, including for the production of synthetic fuels and ammonia for marine transportation and aviation, and heavy-duty mobility, **will drive sustainable hydrogen demand** in the Netherlands. In the long term, hydrogen demand varies greatly according to climate-neutral energy system scenarios, from 2 MtH_2 to 7 MtH_2 by 2050. In addition, the production of sustainable fuels for aviation and shipping will require large volumes of hydrogen. The hydrogen demand for this varies from around 4 MtH_2 to about 8 MtH_2 in 2050.

The Dutch refining, petrochemical and chemical sectors are already starting to move away from fossil fuel feedstocks and the production of carbon products towards sustainable feedstocks and products. This includes using offshore wind power to produce green hydrogen, to help decarbonize processes and produce sustainable fuels. The **transformation of Shell's Pernis refinery in Rotterdam into an integrated energy and chemical park** is an illustration of this transformation involving biofuels, green hydrogen, and carbon capture and storage (CCS). In the chemical sector, **chemical company OCI** has announced its intention to develop the first integrated green ammonia and methanol value chains through large-scale green hydrogen supply from North Holland, while **Yara Sluiskil** is following the green hydrogen and the CCS routes to accelerate emission reductions. The government is signing tailor-made agreements with the largest industrial emitters, one of which was signed with **Tata Steel Netherlands** (TSN) in July 2022. It envisions a switch to direct reduction ironmaking (DRI) using green hydrogen, instead of natural gas as initially envisaged.

The fuel cell electric vehicle (FCEV) market is nascent in the Netherlands. The government has introduced a **heavy transport subsidy program** for supporting the purchase and operation of hydrogen FC trucks. In the medium/long term, **synthetic fuels** will enable the decarbonization of aviation and marine transport. The Netherlands is very active in this field with several demonstration programs for hydrogen-powered ships and first demonstrators for the production of sustainable aviation fuels (SAF).

In addition, the government foresees a role for the use of hydrogen for **dispatchable carbon-free power** at times when there is little generation from wind and solar. Renewable hydrogen has the potential for wider application in the long run, including in the built environment, passenger transport and agriculture.

Infrastructure: all starts with the backbone

The Netherlands will be **the first country in the world to make its existing natural gas transmission network suitable for hydrogen**. The Dutch government has tasked Gasunie to develop a national infrastructure for hydrogen transport in the Netherlands. Gasunie's subsidiary **HyNetwork Services**

will be appointed as the regulated transmission system operator (TSO) of the onshore network. **The government will invest €750 million** through to 2031 for the development of the transport network. The €1.5 billion Dutch hydrogen backbone, which is **part of the future European Hydrogen Backbone**, will consist of 85% repurposed natural gas pipes, supplemented by new pipes. Industrial clusters and regions, seaports, landing points for offshore wind, import terminals, storage facilities and neighboring countries will have access to the hydrogen transmission grid between 2025 and 2030. Gasunie is also developing the first large-scale hydrogen storage site at Zuidwending (Groningen). **Having the infrastructure in place in time, and sooner than any other countries, will give the Netherlands a clear competitive advantage.**

Production: A European leader in the deployment of hydrogen

The government aims **at scaling up green hydrogen as quickly as possible** and gradually makes the existing grey hydrogen production more sustainable. **Blue hydrogen is a transitional technology** to ease and accelerate this process.

The former government relied on CCS to a large extent to decarbonize industrial activities rapidly, at scale and efficiently. As such, **SDE++ funding has been made available for all industrial applications of CCS**. The invasion of Ukraine has changed market conditions for blue hydrogen. However, CCS remains a key policy in the Netherlands as **most blue hydrogen projects are in fact decarbonization projects based on unavoidable residual gases.** CCS is also highly recognized as a necessary technology to achieve net-zero emission (NZE) and create negative emissions. The Netherlands is well positioned to play a leading role in Europe in this area with its offshore depleted fields ready to store CO_2 and the existing offshore oil and gas infrastructure that can reduce CCS costs. The new government has **raised the ceiling for industrial CCS projects eligible to the SDE++ to 8.7 MtCO2/y by 2030** (of which 2.5 Mt/y has already been awarded to the industrial parties that supply their captured CO_2 to the Porthos CCS project). **New infrastructure projects are being developed (Aramis, CO2next)** to ensure the industry meets its decarbonization goals by 2030. But future blue hydrogen production (around 1-1.2 MtH_2 by 2030) is **lower than expected one year ago and still depends on FID being taken rapidly** to ensure the infrastructure is in place. Also, rapid changes in technology and regulation can significantly impact the role of blue hydrogen as seen with the cancellation of the Athos CCS project when TSN opted for the DRI route.

The momentum for green hydrogen is accelerating. The **project pipeline is huge** and, if fully realized, the electrolysis capacity deployment would be much larger than the current 2030 national target. At the end of 2021, the Netherlands took the lead in announced renewable hydrogen projects in Europe. **As of July 2022, there were 51 announced electrolyzer projects with a combined capacity of 18.6 GW at full development** (including potential scale up to 2040), **of which 11.6 GW by 2030**. Depending on key parameters (full load hours, efficiency of electrolyzers), the associated green hydrogen production reaches around 1 MtH_2 in 2030. A significant fraction of the potential comes from the **NortH2 project** (up to 4 GW by 2030 and 10 GW by 2040). Most projects are at feasibility stage. Their realization depends on policy development and financial support. **2022 and 2023 are decisive years** as several projects' proponents intend to take FID in the short term and start production by 2026. An important milestone was **Shell's FID for the development of Holland Hydrogen I**.

A key trend is the **move to large projects** (hundreds of MW to GW scale), **associated with offshore wind production**. The government has doubled its offshore wind target to around 21 GW by 2030. **Energy system integration** is becoming a decisive factor in offshore wind tenders. Offshore renewable hydrogen production will provide an innovative solution to bring large amount of renewable energy to the shore. **Regional cooperation** is vital to integrate larger offshore wind production. Belgium, Denmark, Germany, and the Netherlands are cooperating to become the "**Green Power Plant of Europe**". They have set a target of developing at least 65 GW of offshore wind capacity by 2030, and at least 150 GW by 2050 (the Esbjerg Declaration). The four countries have also intensified cooperation in the production of renewable hydrogen, with plans to expand related infrastructure in the region.

Imports: The Netherlands as NWE green hydrogen hub

The Dutch government is **committed to importing clean hydrogen** and **making the Netherlands the European gateway for global green hydrogen** (and hydrogen-based products). The government is developing an import strategy that includes 1) the creation of corridors for the import and export of low carbon hydrogen, 2) diversification of low carbon hydrogen supplies and routes, as a pillar of security of supply, and 3) sustainability criteria to ensure that large-scale production of hydrogen leads to sustainable development of future export countries. The government is working on **establishing the pre-conditions** for international hydrogen chains, such as building large-scale infrastructure, expanding cooperation with neighboring countries (notably with Germany) and trade relationships with overseas countries, addressing safety issues, accelerating certification of hydrogen, stimulating research and innovation (R&I) on hydrogen carriers.

Dutch ports are accelerating their plans to create the required import infrastructure and grasp a first-mover advantage. The ports of Rotterdam, Amsterdam, Northern Netherlands, and Zeeland envisage playing a key role in the trade of green hydrogen and hydrogen-based products. They expect to be able to import hydrogen carriers (green ammonia) from 2025 onwards. More specifically, **the Port of Rotterdam, which has ambitions to be the Gateway to Europe,** is cooperating with more than ten potential hydrogen supplying countries to initiate international hydrogen supply chains. In anticipation of the rapid growth in European hydrogen imports, **the number of proposed hydrogen import terminals in Rotterdam has surged:** Rotterdam has now 6 proposed import terminals, of which 5 were announced between April and June 2022. **The port could import as much as 4 MtH_2/y in 2030.** Altogether, based on recent ports' announcements, the Netherlands could import more than 5 MtH_2/y in 2030 for its own and neighboring countries' needs. This would account for **half of the REPowerEU 10-MtH_2 import target**.