

EXECUTIVE SUMMARY

Policy context and National Hydrogen Strategy

The German federal government adopted its National Hydrogen Strategy (NWS) on 10 June 2020. With this strategic document, the government has committed itself to the pivotal importance of hydrogen for a successful energy transition, effective climate action and the future of German industry. The NWS puts an **emphasis on green hydrogen, promotes its rapid market rollout and the establishment of the necessary value chains**. The NWS provides **a comprehensive and detailed package of measures** to support the market launch of hydrogen technologies in Germany and abroad.

Germany aims to be climate-neutral by 2050. Hydrogen is seen as a pivotal element in achieving the climate change goals and was presented as the **second Energiewende** by German economic and energy minister. The NWS focuses on the **production of green hydrogen only** as the government considers that only hydrogen produced on the basis of renewable energies is sustainable in the long term. **Coupling sectors via green hydrogen and its derived products (Power-to-X)** is set to be a backbone for an energy future based on renewables. The focus on green hydrogen will make necessary to import substantial amounts of hydrogen. The government expresses the belief that “a global and European hydrogen market will emerge in the coming next ten years and carbon-free hydrogen (e.g. blue hydrogen) will therefore also play a role in Germany on a transitional basis”.

The government aims to **establish hydrogen technologies as a new pillar of the German export-oriented economy**. The intention is to make Germany **a global leader in hydrogen technologies**. Hydrogen is also set to play an important long-term role in safeguarding the **attractiveness of Germany’s industrial sector**. Hydrogen is a central part of the German economic stimulus package, which provides for **€9 billion in additional funds** to promote the generation, transport and use of green hydrogen. Of this amount, €7 billion will be made available for the market ramp-up of hydrogen technologies in Germany and a further €2 billion put towards forming international partnerships.

The implementation of the NWS is an ongoing process. The action plan focuses on the first phase of a market ramp-up (2020-2023). In a second phase (2024-2030), the domestic market will be consolidated, and European and international dimensions established.

Hydrogen demand

The NWS estimates **future hydrogen demand at 90 to 110 TWh by 2030**, compared with around 55 TWh used today (mainly grey hydrogen). The NWS focuses on sectors that **cannot be decarbonized in any other way**. Two lead sectors will contribute to the increase in hydrogen demand initially: **the industrial sector**, starting with the steel and chemical industries and the **transport sector**, with a focus on heavy goods transport and long-distance transportation, as well as on aviation. These large off-takers will help the market ramp-up and drive cost reductions and further technological progress in hydrogen and fuel cell (FC) technologies. Hydrogen use as an energy source for **heating will be added in the longer term**.

In view of long term GHG neutrality, **new and low-CO₂ production routes are actively being tested by the German steel and chemical industries**, such as using green hydrogen in the iron-reducing process in working blast furnaces, as feedstock in the chemical industry and to produce carbon neutral fuels for the transportation sector. To raise the uptake of green hydrogen in these industries, the government already provides financial support schemes and will implement new measures, among which a new pilot program for **Carbon Contracts for Difference** and the possible establishment of **a demand quota** for climate-friendly products. Due to intensive international competition in these industries, beyond national and European actions, the German government considers further actions at international level to create equal opportunities on the global market and avoid carbon leakage.

Hydrogen applications in the mobility sector are still in early stages in Germany. The German government will use the opportunity presented by the transposition of the EU Renewable Energy Directive (RED II) to push hydrogen use in the sector. The government will also support making renewable kerosene and will assess a renewable fuel quota in aviation of at least 2% in 2030. The government wants to build up an infrastructure for hydrogen refuelling suited to heavy duty transport, public transport and rail services for local passengers. As of January 2020, there were 82 hydrogen refuelling stations (HRS) in Germany. Germany has the **most ambitious targets for hydrogen infrastructure within Europe** with a target of 100 HRS by the end of 2020, 400 by 2025 and 1,000 by 2030. While FC vehicles are still a niche market in Germany, the NWS supports the establishment of a **competitive supply industry for FC systems** including an industrial basis for large-scale FC stack production for vehicle applications. The use of hydrogen in the mobility sector will help German FC manufacturers to raise their role on the global market.

In the heat sector, the government focusses on support to high-efficient FC heating systems and to **"hydrogen-ready"** combined heat and power (CHP) plants.

In the power sector, the NWS does not consider the use of hydrogen to supply large-scale power plants, as is the case in Japan for instance. The focus is on the key role of **green hydrogen and PtX** to support the integration of a higher share of renewables into the energy system and to provide the required **grid balancing and long-term energy storage services needed by a renewables-heavy grid**. Nevertheless, German manufacturer Siemens is making progress towards its commitment to increase the hydrogen capability in all its turbine models to at least 20% by 2020, and 100% by 2030 and energy providers (e.g. Uniper) **are considering hydrogen to decarbonize their fossil-fired power generation**.

Hydrogen production

Going forward, Germany wants to make green hydrogen competitive by pushing cost reductions with a fast domestic and international market ramp-up enabling technological progress and scaling effects. **A total of 5 GW of hydrogen electrolysis capacity is to be installed in Germany by 2030**, corresponding to 14 TWh of green hydrogen generation, and requiring 20 TWh of additional renewable power. Another 5 GW of electrolyser capacity is planned for 2035 (2040 at the latest).

Germany is a front-runner in the electrolysis market and has played a pioneering role in the testing and further development of PtX technologies. As of July 2020, **67 PtX plants were in operation, construction and planning in the country with a combined electrical capacity close to 1,000 MW**, of which 31 demonstration plants, with a combined capacity of 35 MW, were operational. The **market is on an exponential growth path**. Since the beginning of 2019, a dozen of projects with a combined capacity of almost 700 MW have been announced in Germany. The change occurred in June 2019 when the government short-listed 20 projects under the idea competition "real laboratories of the energy transition". **These projects will result in significant upscaling, with several 100-MW projects to be built**, and diverse sector coupling experience tested at an industrial scale and in a real environment.

The measures included in the NWS will give a further boost to the sector. They include the improvement of framework conditions for the operation of PtX projects and for the efficient use of renewable power, the exemption of the production of green hydrogen from the EEG (Renewable Energy Sources Act) surcharge, new business and cooperation models for operators of electrolysers and for electricity and gas network operators, funding support for investments in electrolysers in the industrial sector and new measures to make investments in hydrogen production based on offshore wind economically viable. The German government has made the **large-scale use of offshore wind power** to produce green hydrogen a cornerstone of the NWS.

Hydrogen infrastructure

Germany's vast natural gas infrastructure is part of the NWS from the outset as existing assets can be converted to hydrogen requiring the construction of fewer new projects. In the future,

infrastructure for the exclusive transport of hydrogen will emerge. The German gas transmission system operators (TSOs) have presented a possible future vision for a trans-regional hydrogen network and a first step towards a future hydrogen economy. **The visionary H2 network covers 5,900 km and is 90% based on the existing pipeline network for natural gas.** In addition, in the draft of the **Gas Network Development Plan (NDP) 2020-2030**, the German TSOs have dedicated a separate chapter to the topic of green gases and modelled a hydrogen network for the year 2030 for the first time.

Since 2013, hydrogen blending (up to 10%) at the distribution level has been assessed in Germany. Ongoing projects will test 20% blending. At the transmission level, the TSOs have taken the basic approach of developing a separate infrastructure for hydrogen transmission in pipeline networks, mostly based on converted existing gas pipelines.

European and international dimensions

As potential hydrogen demand far exceeds the potential domestic production, **Germany is set to become a large importing country of sustainably produced hydrogen or derived products.** This will require relevant large-scale plants abroad and investment-intensive infrastructure. To this end, the German government will conclude **energy partnerships with potential exporting countries**, promote the establishment of sustainable production capacity and new supply chains and provide partner countries with the relevant technology and targeted solutions. International cooperation on hydrogen will be intensified at all levels and will extend to other key hydrogen importing countries, as well as to current producers and exporters of fossil fuels in view of a global transition to hydrogen. International trade in hydrogen and its derived products will not only create new trade relations for Germany and the EU, but also improve security of supply.

A German hydrogen strategy cannot be drawn up independently from what is happening at the EU level and in other countries. Hydrogen is seen as a **European joint project** from the outset, given that many preconditions and challenges regarding the market ramp-up can only be resolved in the **EU internal market and legal framework**. Facilitating the development of a hydrogen market on EU level is a key aspect of Germany's Presidency of the EU Council that the country holds until the end of 2020. Germany wants to introduce **reliable sustainability standards** and **certification** for green hydrogen, its downstream products and the various application fields of hydrogen, as well as for a high-quality infrastructure. The government will promote joint investment in hydrogen projects and cross-border cooperation. To foster EU leadership in hydrogen technologies, Germany will promote the implementation of a new **"Important Project of Common European Interest (IPCEI)" for hydrogen technologies** and systems as a joint project with other member states.

In the short term, European countries (in particular, northwest and southern Europe) appear the most likely sources for imported clean hydrogen. The use of offshore wind energy in countries bordering the North and Baltic Sea will play an important role. At international level, there are many potential exporters (Africa, Russia, Ukraine, the Middle East, Australia, Chile). It can be expected that **(North) African countries will play a prominent role** during the transformation process towards the use of hydrogen. In this context, the German government has signed a cooperation agreement with Morocco for the development of green hydrogen projects and Germany is now developing the first industrial plant for green hydrogen in Africa.

Green hydrogen and PtX technologies are essential for Germany, not only for the production of the hydrogen required in the country to decarbonize its energy system and safeguard the long-term attractiveness of its industry, but also as a flexibility option in the German power grid and as a core technology for the international export market. With its Energiewende, Germany has driven the world towards green electricity. With the adoption of the NWS, **the German government is taking bold steps to drive and accelerate the deployment of green hydrogen globally.**