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Power plant strategy defines the role of hydrogen in the future climate-neutral electricity system

The power plant sector is an important field of application for hydrogen. This concerns the balancing of an electricity system increasingly fed by wind and solar energy on the one hand and, on the other hand, a centralised heat supply via combined heat and power plants. In view of the very tight time frame for conversion of the electricity system (80 per cent of electricity generation from renewable sources, last issue of emission allowances under the EU Emissions Trading Scheme in the second half of the 2030s), there is considerable pressure to take action and ramp up the use of hydrogen in the electricity system quickly. Taking lead times for the planning, approval and construction of power plants into account, completing the initial round of tenders in the first half of 2024 is therefore imperative. There are also five key challenges specific to the electricity system:

- Sufficient gas-fired power plant capacities must be built, taking regional requirements into account, which are also suitable for the increasing use of hydrogen.
- On the part of plant manufacturers, the supply of power plant capacities suitable for full hydrogen utilisation must be significantly expanded.
- The infrastructure connection of the power plant sites intended for the use of hydrogen has to be secured in good time with regard to the hydrogen core network and the corresponding connection lines.
- Hydrogen-based electricity generation places specific demands on storage infrastructures, especially since fuel demand is highly variable over time.
- In the highly competitive electricity market, solutions to compensate for the additional costs of using hydrogen must be developed for the hydrogen ramp-up phase. This will occur in coexistence with natural gas-fired power generation in Germany and abroad.

Against this background, the German National Hydrogen Council welcomes the German government's plan to present a power plant strategy for a climate-neutral electricity supply in Germany in the near future. The power plant strategy is intended to ensure the expansion of power plants by 2030/2035. This should guarantee the stability of the power grid in accordance with the BMWK's System Stability Roadmap as well as security of supply with regard to the target of 100 per cent renewable energy (RE) in the electricity system, with a simultaneous expected increase in electricity demand and retiring power plant capacities in the course of the coal phase-out. Fuel-based, flexible power plants will make an important contribution to system and supply security in a future, decarbonised energy system.

According to initial publications, the power plant strategy envisages a total of three segments: hydrogen sprinter power plants, hydrogen hybrid power plants and H_2-ready power plants. The first tenders are to be issued in 2024. For the smaller segment of sprinter and hybrid power plants, the key challenges are the large-scale availability of electricity generation plants suitable for the full use of hydrogen (funding for the development and testing of large hydrogen turbines has to be provided in the 8th Energy Research Framework Programme) as well as avoiding funding conditions that pose electricity market design challenges, such as direct or indirect restrictions on plant operating times and the like.

The largest tendering volume is planned for H_2-ready power plants and modernisations (fuel switch) of existing plants. Up to 10 GW is contemplated initially, which may increase to a total of up to 15 GW after evaluation. Transitional operation with natural gas/synthetic gas (SNG) is planned here before a mandatory switch to hydrogen by 2035 at the latest. However, promoting power plant capacities is not sufficient for this transition phase. Instead, hydrogen readiness has to be specified more precisely as a pre-qualification condition. A specific set of instruments to compensate for the additional costs of hydrogen is useful and necessary. Overall, the subsidies should be distributed across the different power plant types in an economically efficient manner, maximising the effect on the electricity supply gap.

A HOLISTIC VIEW OF GAS-BASED GENERATION PLANTS

There are currently over 65,000 gas-based electricity generation plants operating in Germany. More than 90 per cent of these plants not only feed into the power grid but also serve as an important source of energy in local and district heating networks. A similar picture emerges for some 400 plants that are in operation with a net nominal output of ≥ 10 MW_{el}. Almost 80 per cent of these power plants also feed into local and district heating networks. These CHP plants form an integral part of the heat supply for municipalities and individual neighbourhoods in many cases. The transition from existing natural gas-based electricity generators to hydrogen-based operation should therefore be considered in the context of municipal heat planning in particular.

The current portfolio of gas-based electricity generators shows that the requirements and framework conditions of all energy systems – electricity, heat and gas – must be taken into account in the planned tenders for the power plant strategy. Steps must be taken to ensure that future and existing power plant sites can be supplied with sufficient quantities of hydrogen by 2035 at the latest. In addition, transporting the generated electricity also has to be possible. For H_2-ready power plants and existing plants, the continued supply of natural gas/synthetic gases has to be secured until the switch to hydrogen is made. Also note that there will be mixed and methane regions at the distribution network level in the medium term.

SECURING THE SUPPLY OF POWER PLANTS WITH AN EFFICIENT HYDROGEN INFRASTRUCTURE

When planning future hydrogen power plants, the proximity to the hydrogen core network must be taken into account as a key criterion in addition to the ability to connect to the power grid. A cost-efficient connection to the core network must be planned by 2035 at the latest for new construction, existing power plants to be converted to hydrogen and also future decentralised power plant sites. For the connection to the core network, priority should be given to existing gas pipelines in both the transmission and distribution networks and their conversion to hydrogen without affecting the existing supply of natural gas.

The requirements resulting from the power plant strategy therefore have to be taken into account in the future development of the hydrogen network, at the transmission and distribution grid level. The feed-in capacity to (CHP) power plants is a key driver both for the sizing of the core network and as a basis for future investments and the scope of fees. In addition, measures are required as part of the system development strategy to ensure that all energy infrastructures necessary for the implementation of the power plant strategy can cover the resulting future needs. This applies to the further development of the H_2 network beyond the core network as well as the power grid and natural gas network.

DEVELOPMENT OF HYDROGEN STORAGE AS A NECESSARY INFRASTRUCTURE ELEMENT

The electricity sector's demand for hydrogen places increased demands on the hydrogen infrastructure, including potential hydrogen storage. In addition to the time required for the conversion to hydrogen, the actually usable storage volumes and feed-in capacities should also be considered. Based on existing cavern storage in Germany, the German National Hydrogen Council envisages a hydrogen storage volume of around 33 TWh[1]. Hydrogen storage is an essential element of the hydrogen infrastructure, making it possible to balance the differences between feed-in and feed-out profiles. Incentive instruments should therefore be established promptly for hydrogen storage as well, to avoid a time lag between storage and the H_2 core network. Thus the power plant strategy needs to be consistently supported by the announced hydrogen storage strategy.

SECURING HYDROGEN AVAILABILITY

The supply of sufficient quantities of hydrogen for the operation of hydrogen-based power plants must be guaranteed, both via domestic production sites and via import routes. Especially during the market ramp-up, hydrogen will only be available to a limited extent. Accordingly, it needs to be provided for the climate-neutral electricity supply and for use in flexible power plants. The supply of the transforming industry, its CO_2 reduction contributions and value creation potential also have to be taken into account. A clear understanding of future hydrogen demand for electricity generation is essential to support domestic production and a targeted implementation of the import strategy.

ANCHORING THE TRANSITION TO HYDROGEN-BASED GENERATION IN THE LONGER-TERM ELECTRICITY MARKET DESIGN

Finally, the German National Hydrogen Council points out that the power plant strategy can only be a first step in the transition to an electricity market design that is suitable for a climate-neutral electricity and energy system. The provisions in the power plant strategy to secure the hydrogen ramp-up in the electricity system need to be compatible with the future electricity market design. Supporting hydrogen-based electricity generation must be an important element of the future electricity market design.

[1] German National Hydrogen Council whitepaper 'Die Rolle der Untergrund-Gasspeicher zur Entwicklung eines Wasserstoffmarktes in Deutschland' (The role of underground gas storage units in the development of a hydrogen market in Germany), 29 October 2021.

THE GERMAN NATIONAL HYDROGEN COUNCIL

On 10 June 2020, the German Federal Government adopted the National Hydrogen Strategy and appointed the German National Hydrogen Council. The Council consists of 26 high-ranking experts in the fields of economy, science and civil society. These experts are not part of public administration. The members of the National Hydrogen Council are experts in the fields of production, research and innovation, industrial decarbonisation, transportation and buildings/heating, infrastructure, international partnerships as well as climate and sustainability. The National Hydrogen Council is chaired by former Parliamentary State Secretary Katherina Reiche.

The task of the National Hydrogen Council is to advise and support the State Secretary's Committee for Hydrogen with proposals and recommendations for action in the implementation and further development of Germany's National Hydrogen Strategy.

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APPENDIX

Figure 1: The H_2 core network and gas-fired power plants in Germany