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Green hydrogen – a key building block for a successful energy transition

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Everyone is talking about green hydrogen. It is seen as a bright beacon of hope in Germany's quest to become greenhouse gas neutral by 2050. There is also a high level of interest in the underlying technologies from the industrial sector. Green hydrogen is produced by the electrolysis of water using electricity generated exclusively from renewable energy (RE). In further steps, the hydrogen generated in this way (H_2) can be further processed into methane, fuels or base chemicals through the addition of carbon dioxide (CO_2). The conversion of electricity from RE into gaseous or liquid energy carriers is also referred to as power-to-X (P2X) (Figure).

Climate neutrality requires P2X

Climate action scenarios for Germany show that the goal of reducing greenhouse gas emissions by 95% and more will require the use of P2X technologies. The technologies fulfil two important functions: First, the synthetically generated energy carriers enable the decarbonisation of applications that are difficult or impossible to supply directly with renewable energy or directly with electricity generated from renewables. These mainly include aviation, shipping and heavy goods transport, high temperature generation in industry and the use of carbon in industrial production processes such as the steel and chemicals industry. Second, the growing proportion of renewable energy in electricity generation makes the long-term storage of surplus electricity from RE systems increasingly important. Hydrogen or methane generated using P2X technology can be stored and reconverted into electricity in power plants to bridge prolonged phases of low wind and solar output.

The challenges are considerable

In the current early stage of the P2X market, the technologies still face major hurdles. The following main challenges need to be tackled:

– Many P2X technologies are still in the trial phase and industrial-scale implementation of production chains has not yet started. The production costs of electricity-based combustibles, fuels and base materials are currently much higher than those of their fossil alternatives.[1] The collapse in the price of fossil energy carriers as a result of the coronavirus crisis further exacerbates this problem.

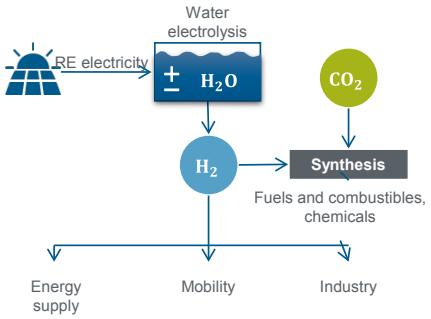
– Considerable additional renewable electricity generation capacity is required to produce the necessary quantities of electricity-based energy carriers. Given the limited available space for RE expansion in Germany and more favourable location conditions and, hence, cost advantages in other countries, it must be expected that a high share of necessary green gases and fuels will have to be imported in the long term (e.g. from northern and southern Europe or North Africa).[2] Relevant investment-intensive infrastructure still has to be put in place.

– The electricity-based generation of methane, fuels and base chemicals requires a carbon dioxide source in addition to green hydrogen. The production process can only be made nearly greenhouse gas neutral in the long term if the required CO_2 is directly captured from the air. This technology must first reach market readiness as well.

National hydrogen strategy adopted

In the face of these challenges, a regulatory framework and state incentives are needed in order for P2X technologies to penetrate the market on a broad scale. The German Federal Government has set the course for this with its National Hydrogen Strategy of June 2020. A comprehensive package of measures is to support the market launch of hydrogen technologies in Germany and abroad. The federal government's recently adopted economic stimulus package provides for EUR 9 billion in additional funds to promote the generation, transport and use of green hydrogen and its derivatives. A total of 5 GW of hydrogen electrolysis capacity is to be installed in Germany by 2030 (current capacity: less than 100 MW). The federal support is to mobilise private investment, tap into cost reduction potential and open up new export opportunities for German plant manufacturers.

Figure: Generation of electricity-based fuels and base materials



Source: KfW

[1] Cf. Prognos AG (2020): Kosten und Transformationspfade für strombasierte Energieträger (*Cost and transformation pathways for electricity-based energy carriers* – our title translation, in German only).

[2] Cf. Öko-Institut e.V. (2019): Die Bedeutung strombasierter Stoffe für den Klimaschutz in Deutschland (*The importance of electricity-based substances for climate action in Germany* – our title translation, in German only).