Policy Brief - Iron to hydrogen

Background

Germany is making great progress in decarbonizing the electricity system; in the first half of 2024, the share of renewable energy in gross electricity consumption was 57%. The share of renewable energy is set to rise to at least 80% by 2030 and to 100% by 2035. A climate-neutral electricity system, which is predominantly based on low-cost but weather-dependent energy sources such as wind and solar power, requires **flexible backup capacities** that can generate electricity using storable CO2-free energy sources. This is addressed in the planned **Power Plant Safety Act**, which provides for the construction or conversion of 7 GW of H2-ready gas-fired power plants that are to be operated with green hydrogen in the long term, as well as 500 MW of so-called sprinter power plants that use only green hydrogen.

There are several technological options for the supply of hydrogen. The most discussed option is the local production of hydrogen in Germany using electricity from offshore wind energy. However, this option will not be sufficient to cover Germany's entire hydrogen demand (especially for industry and backup power plants). The German government's hydrogen strategy therefore envisages an **import share of 50-70% in 2030**. Another option is to import green ammonia from other regions of the world, which is broken down in a cracker in Germany. In both cases, the hydrogen would then be transported to the power plant via the H2 core network. A third option for supplying H2 is to import reduced iron (DRI) directly and deliver it to power plants by ship/train. **DRI can store large amounts of energy and requires very little additional energy to release the stored energy**. When combined with water, heat and a catalyst in a chemical process, the DRI reacts to form iron oxide (rust) and releases hydrogen. This can then be used to generate electricity in a power plant. The Climate Neutrality Foundation has commissioned the renowned consulting and certification company DNV to examine the three paths described for hydrogen production for use in German power plants in terms of costs and technological maturity.

Core results

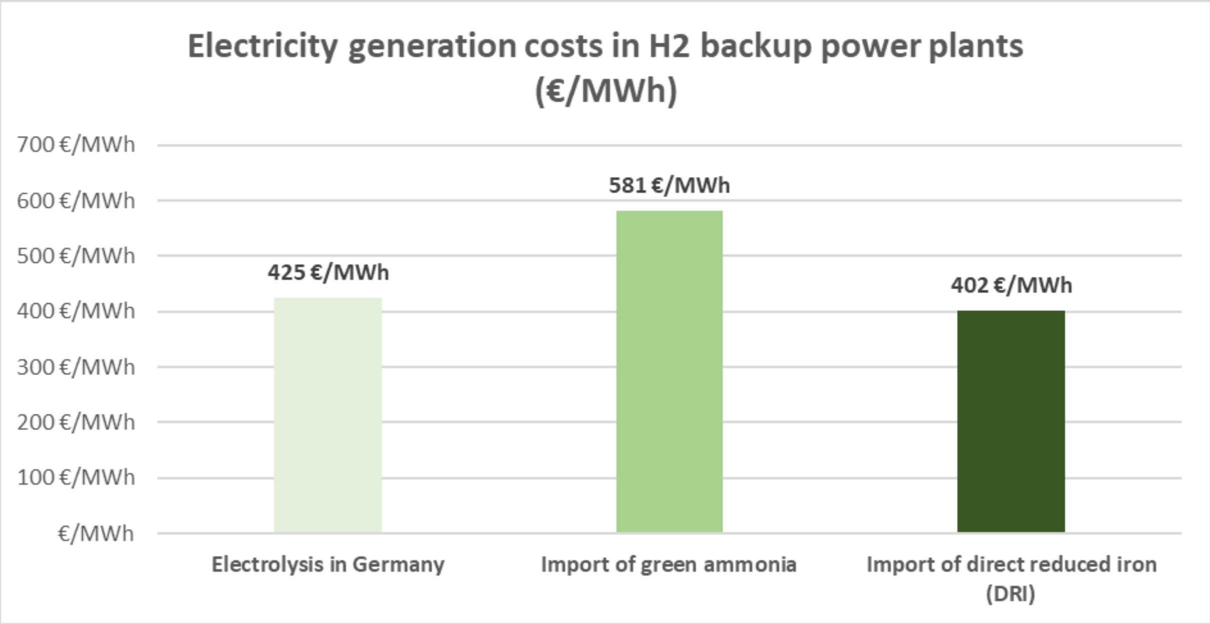
1. **A climate-neutral electricity system, which is predominantly based on cost-effective but weather-dependent energy sources such as wind and solar power, requires flexible backup capacities for a few hours a year that can generate electricity using storable CO2-free energy sources.** These must be able to bridge so-called dark doldrums with little solar radiation and no wind. There are more technological solutions for this than is generally known. The Power Plant Safety Act should take this into account in its design.

2. **Green iron is an energy storage medium that can be stored relatively easily and inexpensively and can be used to produce large quantities of climate-neutral hydrogen at the power plant site as required.** A first plant for the direct reduction of iron ore using hydrogen produced with very cheap electricity from photovoltaic systems is currently being built in Namibia and will start production at the end of 2024. Imported green iron can be used not only for steel production, but also for electricity generation.

3. **A detailed comparison by the Norwegian firm DNV on behalf of the Climate Neutrality Foundation shows that backup power plants that produce electricity with hydrogen based on imported green iron (I2H - Iron to Hydrogen) can probably do this more cost-effectively than power plants that use green hydrogen from a German or European pipeline network.** Generating electricity from hydrogen from cracked green ammonia would be much more expensive than the first two options.

4. **In terms of expansion speed and security of supply, it also seems advisable to consider the iron-to-power process for supplying backup power plants with green hydrogen.** The processes currently envisaged as part of the power plant strategy for the storage and supply of hydrogen are likely to have physical expansion limits, for example in the availability of natural caverns for intermediate storage. In the provision via the ammonia cracking process, for example, the number of crackers required, and secure transport infrastructure represent a growth limit.

5. **The key components "generation, transportation and storage" of the three variants examined for the provision of backup capacities each have different degrees of technological maturity.** Only actual operation will show which technologies will prevail and to what extent. In addition to costs, the actual availability of pipeline hydrogen and green iron will also play a role here; criteria such as resilience must also be considered.



Conclusion

Iron-to-hydrogen technology is a promising method for supplying green hydrogen in Germany in line with demand. It is the cheapest of the methods compared and is also the easiest to store in the long term. **Iron-to-hydrogen should therefore be considered in the Power Plant Safety Act.** In addition, iron-to-hydrogen can be a suitable supplement to the hydrogen backbone, as it enables decentralized H2 supply in places that will not be connected. In comparison, ammonia is most likely limited to centralized cracking at ports of entry, as ammonia crackers are less flexible to use and as ammonia handling requires a more stringent safety protocol for transport and storage.