Hydrogen Insight

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Hydrogen in Europe's energy economy

A plausible road map

Key implications

Deep decarbonization of Europe's economies is likely to involve the widespread deployment of hydrogen in the supply of energy to consumers. The conditions in which consumer demand for hydrogen will be able to develop will be different in each main sector of demand: heating, transport, industrial energy use, and, where necessary as thermal power to back up wind and solar, power generation. The government and industry will both have a role to play.

- **Centralized and decentralized decision making.** As sectoral needs for hydrogen develop differently, so do the decision-making processes that will lead to growth in demand. These decisions can broadly be categorized as centralized and decentralized.
- **Technology choice.** In the next few years, the choice of hydrogen manufacturing technology will also be primarily, not exclusively, guided by the scale of demand appropriate to each sector.
- **Convergence and mutual reinforcement.** Over time, as hydrogen grids develop and the scale of electrolyzers increases, the two approaches will begin to overlap and then converge. A process of mutual reinforcement will begin, improving the economic attractiveness of hydrogen for users and suppliers.

The IHS Markit Hydrogen Forum describes how these developments play out. It proposes for Europe a plausible pathway for both the demand side and supply technologies. It traces out the potential contribution of hydrogen across the European energy economy.

Centralized and decentralized drivers of growth in hydrogen demand

Some sectors are likely to have significant demand for hydrogen only if the central government drives major projects, in cooperation with leading, well-resourced industrial companies. For example, the conversion of regional gas grids to deliver hydrogen for the **heating** of homes, offices, schools, and hospitals (the residential, commercial, and public sectors) will require strong, **centralized** decision making.

Demand for hydrogen as a fuel in other sectors—notably the **transport** sector—is likely to develop in a more **decentralized** fashion. Vehicle fleet operators such as municipal bus companies, long-distance truck companies, and port drayage or warehouse operators will compare the economic advantages of hydrogen fuel-

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cell electric vehicles (FCEVs) with other means of aligning their operations with low-carbon and low local pollution requirements. The decision-making process that will drive the early stages of hydrogen demand in transport will be highly decentralized.

Industrial demand for hydrogen as energy benefits from **both centralized and decentralized** approaches. Where centralized decisions drive grid development, there will clearly be location-based opportunities for fuel switching—if a persuasive economic or environmental case can be made for the industry concerned. At the same time, local opportunities for the introduction of hydrogen as an energy source in certain specific sites are likely—for example, by extension from current process uses in the refining and chemical industries.

Timing and technology choice

The choice of technology for manufacturing hydrogen will, in the early years of hydrogen demand growth, be strongly influenced by various sector-specific characteristics.

- **Methane reforming—steam methane reforming (SMR) and autothermal reforming (ATR).** Where scale and centralization are required—notably in grid conversion—the appropriate technology in the 2020s and probably into the 2030s will be methane-based reforming: either conventional SMR or, more likely, the newer ATR technology. Carbon capture and sequestration will be required so that the hydrogen made from these processes is low carbon. Accordingly, the location of such plants is likely to be in coastal areas where offshore storage of the captured carbon dioxide is more readily accessible—by pipe or ship.

- **Electrolysis.** Where investment for hydrogen use is localized, and on a smaller scale, electrolysis becomes a more interesting option.[1] As this technology moves from the pilot stage to the first commercial operations, the costs of electrolysis will come down, and scale will increase. The rate at which this event occurs—the "learning rate"—will be crucial in determining how fast this technology supplements and then eventually replaces methane-reforming technologies.

Convergence and mutual reinforcement: The track to a hydrogen energy economy

Over time, hydrogen grids will develop, both to supply the heating sector in regions with high winter peak heat demand and in areas where industrial clusters make the economics locally attractive.[2] Clearly, industry in areas where the residential heat load favors the construction of grids will benefit from the availability of reliable, at scale, hydrogen supply. Filling stations for FCEVs will also develop more rapidly in these areas. Equally, the economics of developing grids for residential customers' peak needs will be improved by the existence of nearby high base-load industrial and transport demand.

As electrolyzers increase in size and costs decline to levels that are competitive with methane reforming, electrolysis-based hydrogen manufacturing will become increasingly attractive to supply an ever-wider range of demands. It will be more extensively used to feed the grids as well as at dedicated local sites.

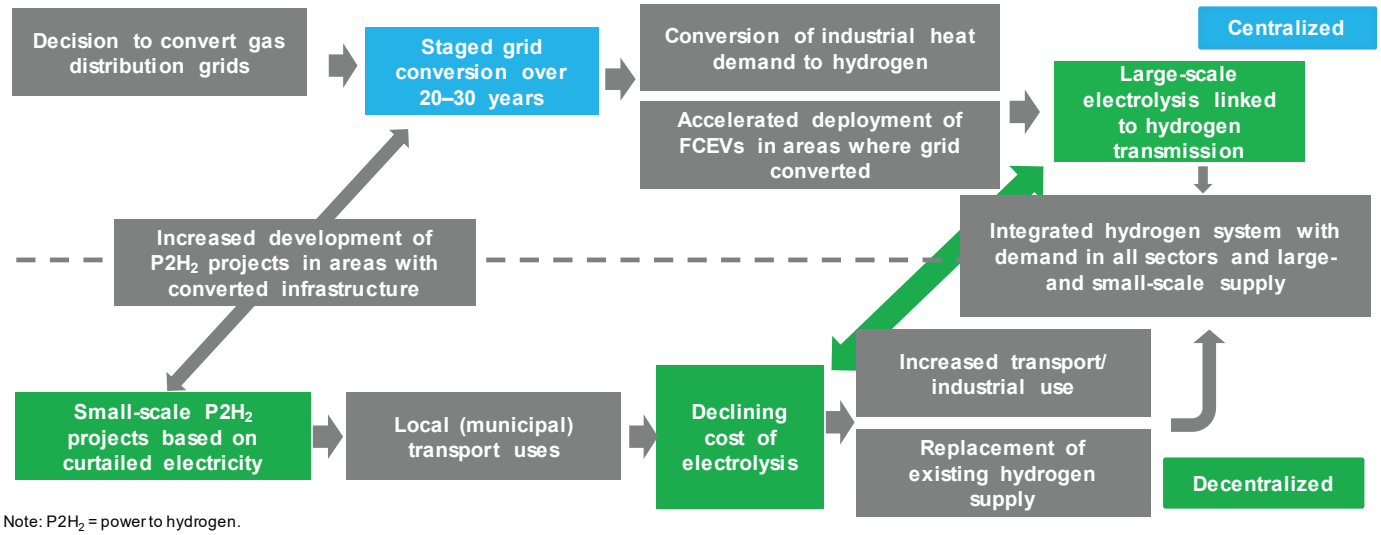
In summary, the two approaches in technology will begin to overlap, compete, and operate in parallel. Additionally, the two forms of decision making—centralized and decentralized—will begin to converge. A process of mutual reinforcement will begin, improving the economic attractiveness of hydrogen for users and suppliers. Figure 1 illustrates the above narrative.

1. Delivery by conventional tube and truck from large SMR/ATR sites will remain an important alternative, notably for very small sites such as some vehicle-fueling stations.

2. Hydrogen pipelines to supply industrial process uses are already in operation in industrial heartlands in northern Europe.

Figure 1

Integration of hydrogen into the energy system



Note: $P2H_2$ = power to hydrogen.
Source: IHS Markit

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