

Strategic insights on governance of hydrogen innovation and the chicken and egg problem

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If acceleration of hydrogen innovation is adopted as a political goal, policy strategies need to take account of technology-specific challenges.

Hydrogen has recently emerged as an important policy topic. The former Norwegian Government's Hydrogen Strategy (OED/KMD, 2020) outlined that hydrogen can be an important zero-carbon solution for application areas in which there are few alternatives. Hydrogen could also contribute to value creation from Norwegian energy resources. This is also acknowledged by the current Government, which aims to contribute to the development of a full hydrogen value chain (Regjeringen, 2021). Meanwhile, the European Commission's Hydrogen Strategy (also 2020) argued that hydrogen is "essential to support the EU's commitment to reach carbon neutrality by 2050".

However, hydrogen faces different kinds of challenges than some other zero-carbon solutions, such as electrification and the use of batteries for energy storage. A key challenge is the "chicken and egg" problem, referring to the pervasive uncertainty in the emergence of a full hydrogen value chain. While the implementation of battery-electric technologies in transport has benefited

from an existing supply of electricity and availability of grids, comparable parts of hydrogen value chain are lacking. This lack of hydrogen production and distribution infrastructure discourages potential users (for instance transport companies) to invest in hydrogen-using technologies. Simultaneously, lack of demand discourages investments in hydrogen production and distribution.

It has been argued that science, technology and innovation (STI) policies aiming to meet the Paris Agreement goals need to go beyond the typical approaches of R&D funding and support for formation of innovation systems (Schot and Steinmueller, 2018, Weber and Rohracher, 2012). This is because the decarbonization challenge is systemic in nature, embedded in the path dependent societal, behavioural and technological patterns of sectors. Current unsustainable technologies (fossil fuels) benefit from already existing socio-technical systems (comprised of infrastructure, production patterns, knowledge bases, regulations, established user routines), making them more accessible than novel fuels, and also cheaper insofar as negative externalities are not internalised. By contrast, novel sustainable solutions often face multiple systemic barriers. The chicken and egg problem in hydrogen is a case in point of such challenges.

If hydrogen is considered as a key solution in reaching climate mitigation targets, the governance strategy to foster hydrogen innovation needs to take account of the specific challenges that hydrogen is facing. In this policy brief we discuss strategic insights for innovation policy that may help to tackle challenges such as the chicken and egg problem in hydrogen innovation, given that the acceleration of hydrogen innovation is adopted as a political goal.

These insights are based on a research sprint carried out in User Case 3 in FME NTRANS (Mäkitie et al., 2021). Concrete policy instruments have been explored in an earlier FME NTRANS policy brief (FME NTRANS, 2021), while this policy brief focuses on the strategy level. We propose four insights on the governance of hydrogen innovation and especially the chicken and egg problem.

Reduction of uncertainty through state leadership

Because of uncertainty regarding both the supply of and demand for carbon-free hydrogen, few private actors have yet been willing to commit to the early-mover risks related to investments in hydrogen solutions, causing delays in hydrogen innovation. Clear commitment and direction towards the deployment of hydrogen solutions is needed. In the absence of – or preferably in combination with – risk-willing private actors, strong and explicit state leadership may contribute to breaking this deadlock and help to accelerate the hydrogen innovation by reducing uncertainty. This may constitute concrete goals and milestones for deployment of hydrogen technologies, a credible budget to realize such goals and horizontal (cross-ministerial) and multi-level (regional and national) coordination of governance.

Technology-specific policies

Compared with biofuels and battery-electric technologies, hydrogen is challenged by a more immature value chain. Moreover, hydrogen can be used in several forms (gaseous, liquefied, as ammonia), creating a demand for further experimentation and learning with various types of hydrogen solutions. The challenge for hydrogen innovation is thus qualitatively different from

some of the other zero-carbon solutions in transport. Innovation policy should acknowledge such differences by addressing the specific needs of hydrogen innovation. This may include earmarked support for value chain development, public procurement to ensure market formation, support for hydrogen hubs, and continued support for experimentation in different application domains.

Policy mixes for transformation

As already alluded to above, radical environmental innovations such as hydrogen requires a coherent, comprehensive and credible mix of policies (Rogge and Reichardt, 2016). Both supply (e.g. investment support and goals for infrastructure build-up) and demand (e.g. increased use of public procurement) instruments need to be combined to address the challenges in hydrogen innovation. Different instruments may be needed for different phases of innovation (early formative phase and later growth phase). Moreover, the competitiveness of hydrogen and also other zero-carbon solutions can be improved with an increasing carbon fee for fossil fuels.

Adequate financing for regional activities

Due to the extra costs related to hydrogen technologies and the need to build infrastructure, acceleration of hydrogen innovation is likely to require substantial public investments. In the early phase, networks of hydrogen providers and users are likely to materialize in particular regions or localities rather than being widespread. Regional public actors facilitating such processes for example via public procurement may however not have adequate financial means to alone manage the additional costs and other challenges. Thus, the extra costs related to financing of regional hydrogen infrastructure may have to be considered when seeking to implement the innovation policy for hydrogen.

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