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The promise of hydrogen is a distraction from rapid decarbonisation, discuss.

Recently, countries have increased their efforts to limit CO2 emissions and decarbonise a variety of sectors, realizing the catastrophic effects of climate change [1]. The use of Low Carbon Hydrogen (H2) as an alternative to fossil fuels has been steadily gaining support. Theoretically, hydrogen can be produced using energy from renewable energy sources and be used as a fuel cell, combusted in boilers, turbines, engines, as an input to chemical processes, stored at large scales and transported similarly to natural gas [2]. Due to the sector being at its infancy, though, the opportunity cost of hydrogen adoption is very high. The UK, for example, is investing £1 billion by 2025 to low carbon hydrogen production despite the uncertainty of the sector regarding H2 production, storage, adoption and of the timeframe in which hydrogen could make a significant impact to decarbonization [2].

At the point of combustion, hydrogen produces zero carbon emissions, but no abundant sources of pure hydrogen can be found on Earth. Currently, hydrogen production is split into three categories, each resulting from a different production method. Grey hydrogen is produced by methane reforming, and it results in significant amounts of CO2 emissions during the production process. Globally, 97% of hydrogen production follows this method, proving that the use of hydrogen is not aiding decarbonization yet [3]. Blue hydrogen is produced similarly, though CO2 is captured and stored at the point of production. This method is still at its infancy and results in high production costs. Green hydrogen (currently accounting for the rest 3% of H2 production) can be a carbon neutral procedure, as H2 is produced from electrolysis powered by renewable energy sources.

Recently, the production of green hydrogen could aid in further decarbonization of the electricity sector, due to the increased penetration of renewable energy sources. The uncertainty in wind and solar farm electricity production due to its direct correlation with weather conditions has facilitated the need for electricity storage. In the UK, on a cold, non-windy winter day, the surge in electricity demand from increased demand for residential heating is currently met with the use of fossil fuel generators. On a windy autumn day, the electricity supply surpasses demand, and that results in the system operator artificially limiting (curtailing) wind power generation. In 2022, over 4 TWh of wind electricity production was curtailed [4]. EU research [5] showed that if all wind farm electricity generation curtailed in the EU were to be used for hydrogen production, it could fuel between 230.000 and 606.000 cars for a year. Research from MIT showed that green hydrogen production and its later use for electricity generation during peak hours could be more cost effective in California than the construction of lithium-ion battery farms for the same purpose [6].

Another benefit of hydrogen comes from its ability to decarbonize “hard-to-abate” sectors due to the need for chemical reactions requiring combustion and to the decreased energy density of battery storage compared to fossil fuels. For example, iron and steel production account for approximately 9 % of global CO2 emissions annually. The iron production process includes the reaction of iron oxide with carbon for the formation of iron and carbon dioxide, requiring fuel combustion [7]. Moreover, heavy-duty transportation such as trucking, shipping and air travel could be decarbonized with the use of hydrogen as a fuel, since the battery weight for those applications would be enormous and the charge times would decrease profit margins significantly [8]. It has to be noted, though, that massive investments are needed for the wide adoption of hydrogen in these sectors, since most of these applications are still on experimental stages.

All in all, hydrogen use appears to have the potential to aid the decarbonization of various sectors. The use of curtailed wind and solar energy for the production of green hydrogen could help further decarbonize the electricity and transportation sectors. Moreover, hydrogen’s ability to decarbonize hard-to-abate sectors such as manufacturing, and air travel also seems promising. Its investment opportunity cost is very high, though. The capital and engineering effort needed for wide hydrogen adoption could be channelled elsewhere in existing technologies that will result in short-term rapid decarbonisation.