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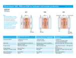
Renewable hydrogen value chains

The 10 largest proposed renewable hydrogen electrolys worldwide





Giga-scale green hydrogen projects

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It was not so long ago that 10MW and 20MW electrolyser projects were regarded as large-scale, cutting edge innovations. However, things have moved on! 2020 was the year that the world became familiar with the concept of Giga-Watt green hydrogen projects. A Gigawatt is 2 orders of magnitude more than the scale at which hydrogen electrolysers currently operate.

According to several studies, it is anticipated that green hydrogen could contribute 20% of global energy in 2050. Renewable power to produce the green hydrogen on electrolysers is most likely to come from hydroelectric, wind, and solar sources – all of them will need to ramp up to accommodate the huge growth in green hydrogen demand.

From the top ten proposed renewable hydrogen electrolyser schemes, 8 are planned to be supplied with a mix of wind and solar power. Two projects in northern Europe where the wind blows strong, but the sun does not always shine, are exclusively wind powered.

Six out of the top 10 projects are in the Asia Pacific: five in Australia, and one in China. These projects will be in regions where the wind and solar intensity combine to yield the optimum conditions for renewable power generation. This one of the keys to an economically attractive green hydrogen project. The benefit of minimising the input costs of power to the electrolyser far outweigh the hydrogen distribution costs.

There are several reasons that the cost of renewable power has fallen in recent years: PV and wind turbine technologies are becoming more efficient; larger projects are being executed to leverage economies of scale; higher production volumes for PV panels and wind turbines are driving down unit costs. However, the main reason that the average unit cost of renewable power is falling globally is that large projects are being installed in parts of the world where the weather is ideal.

Access to water is another requirement for green hydrogen production on electrolysers. Fresh water is convenient and requires only demineralisation. Sea water can be desalinated and then demineralised. This consumes some additional power within the process, but only a few percent – it is not the main power requirement.

Direct coupling of a solar farm to a hydrogen electrolyser avoids transmission power losses and minimises congestion on the electricity grid. Solar power produces direct current (DC) power, and hydrogen electrolysers consume DC power. Direct coupling of the electrolyser to the solar farm also means that losses otherwise associated with the DC to AC conversion on an inverter to prepare the electricity for the grid, and then additional losses associated with the AC to DC electricity conversion on a rectifier to prepare the electricity for the electrolyser can be avoided.

Capital expenditure on the inverter and rectifier can also eliminated with direct coupling of PV to electrolysers. The reduced energy losses combine to give directly coupled PV powered hydrogen electrolysers approximately 10% percent better performance than electrolysers fed from the electricity transmission grid, which carries AC power such as that produced by wind farms or hydroelectric schemes.

When producing hydrogen directly on the solar farm, there is no need for electricity transmission. However, it will be necessary to distribute the hydrogen to the application centres or for export. This can be achieved using a diverse range of mechanisms ranging from high pressure compressed gas to liquefied hydrogen and pure hydrogen pipelines or with admixing into natural gas network pipelines.

Conversion of the hydrogen to ammonia is also possible. Shipping of liquid ammonia takes place at scale today and there are 120 ports around the world with ammonia storage to enable international trade in this clean energy vector. Most of the ammonia production that exists today is aligned to the urea fertilizer value chain. In the future 'green-ammonia' is also likely to become an energy vector, like hydrogen.

Ammonia can be used as a fuel for shipping. It can also be used on gas-turbines in electrical power plants. Or it can be burned with coal on coal-fired power plants. In Japan, plans were recently announced to add 20% of ammonia to all existing coal fired power plants. Each plant would consume approximately 500,000 Tonnes per year of ammonia.

That would increase the global ammonia demand by about 20 million Tonnes per year, adding 10% to global demand. Of course, the ammonia must be produced in a low-carbon pathway, such as from green hydrogen, to support the international intent for decarbonisation.

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