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Blogs

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Mega-scale renewable hydrogen tied to mega-scale wind and solar farms

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Renewable hydrogen will contribute a significant percentage of global energy in 2050 as the world transitions to carbon-neutrality. The pace of scale-up for green hydrogen projects will be rapid and the sector is in an exponential growth phase. The largest hydrogen electrolysers operating today are in the 10 and 20MW order of magnitude. The mega-scale renewable hydrogen scheme proposals for this decade will see hydrogen electrolysers ramp up into the GW scale... two orders of magnitude higher than the largest units that are likely to be operating in 2021.

Of the top ten proposed renewable hydrogen electrolyser schemes that are in planning or in execution at the end of 2020, eight will be few with a mix of wind and solar power. The other two projects form that top ten list are wind powered and located in northern Europe.

Project	Power
Asian Renewable Energy Hub	14GW
NortH2	10GW
AquaVentus	10GW
Murchison Renewable Hydrogen	5GW
Beijing Jingneng Inner Mongolia	5GW
Helios Green Fuels Project	4GW
Pacific Solar Hydrogen	3.6GW
H2-Hub Gladstone	3GW
HyEx	1.6GW
Geraldton	1.5GW

Mega-scale renewable hydrogen projects

Five out of the top ten renewable hydrogen projects that are under discussion globally at the time of writing are in Australia. In much of the country, wind and solar intensity combine to yield ideal conditions for renewable power generation. Optimal weather resources are key to economically attractive renewable power generation and are the key to mega-scale renewable hydrogen projects.

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 has been falling globally in recent years is that large projects are being installed in parts of the world where the weather is ideal.

Solar ramp up leads to solar panel production growth

The ramp up in solar projects is pulling for mass production of solar panels. These factories consume huge quantities of high purity industrial and specialty

gases. As with many manufacturing processes, the largest factories have migrated from high-cost western countries to China. Since the biggest solar projects are in the APAC region, there is a good fit between production and demand locations.

Nine out of the world's top 10 solar panel producers have production in China. The top four solar panel producers in 2019 were all Chinese companies. Their combined output in that year created solar panels with the potential to produce more than 40GW of electricity. On average, they ramped up their output in 2019 by around 20% vs 2018.

JinkoSolar, the world's largest solar panel producer started out in 2006 making wafers. Within 14 years, their annual turnover has grown close to USD4 billion. They produce the most efficient P-type Poly PERC and Mono PERC solar cells with efficiencies better than 22%. Energy conversion efficiency is another critical success factor for good returns on a renewable hydrogen project.

Electrolyser energy efficiency from solar power to renewable hydrogen

Direct coupling of a solar farm to a hydrogen electrolyser avoids grid transmission power losses and avoids adding to 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 (Alternating Current) 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. With direct coupling, the capex for the inverter and rectifier are also eliminated from the project budget – thereby improving the scope for good return on investment.

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 it is necessary to distribute the hydrogen to applications for transportation, heating, or industrial uses. This can be done with high pressure compressed gas cylinders, liquefied hydrogen tankers, pure hydrogen pipelines or by admixing hydrogen into existing natural gas pipelines.

Electrolysis is also used to produce fluorine for solar panel production

During solar panel manufacturing, fluorine is used as a cleaning gas for plasma-enhanced and thermal CVD tool dry-chamber cleaning. Fluorine is the ideal replacement for fluorine-bearing gases such as chlorotrifluoromethane, nitrogen trifluoride and sulphur hexafluoride and in these applications. Each of these chemicals has an extremely high global warming potential.

Safety concerns related to the storage and transportation of this very toxic and corrosive gas mean that fluorine is generally produced and consumed on-site as required. This limits the inventory of fluorine and avoids the need for high pressure storage.

Fluorine is produced by electrolysis of anhydrous hydrogen fluoride to yield hydrogen gas at the cathode and fluorine gas at the anode. The process is like electrolysis of water to produce hydrogen. However, it requires the salt potassium bifluoride as a charge carrier and hydrogen fluoride gas must be added continuously during electrolysis.

For the electrolysis of water to hydrogen, the electrolysis of hydrogen fluoride to fluorine and a host of other applications, electrochemistry will play an increasingly important role in a decarbonised future. Electrification of the energy and chemicals sectors will be a progressive transition that will require massive investment to manage the technology and infrastructure transformation.

Nexant Training, market insights and services

Find out more about emerging hydrogen applications and electrolyser technologies at the new Nexant Training course: Hydrogen – Clean and powerful energy, helping you to understand hydrogen's role in the energy transition.

Nexant Energy and Chemicals Advisory is at the forefront of petrochemical and energy business modelling. Our understanding of market developments and emerging technologies ensures that our forecasts are based on the most up to date scenarios. We also have the insight to evaluate the technologies that are most likely to succeed in the future. That is essential when de-risking a major new plant investment or evaluating an M&A target.

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