Maximising hydrogen production from PV solar parks

By Stephen B. Harrison on May 11, 2021 | Translate NEWS

Green hydrogen could contribute about 20% of global energy in 2050. Renewable electricity to feed the electrolysers for green hydrogen production will predominantly be generated from hydroelectric, wind, and solar sources. Maximising hydrogen production from the available natural resources means improving electrolyser efficiency and the output of the renewable power infrastructure. For a solar park, that means focusing on the basics, such as appropriate cleaning of the solar panels, and consideration of more sophisticated options such as adjusting the angle of the panels to track the sun's movement through the day.

There are massive R&D efforts under way to enhance hydrogen electrolysers. They will most certainly result in capex and maintenance cost reductions resulting from cheaper materials of construction and enabling the selection metals that are easier to process. However, breaking through the ceiling of about 80% energy conversion efficiency is proving to be a real challenge.

Coming back to the other link in the chain, the solar array may be the answer to improve hydrogen output. Power management improvements could play an increasing role and could lead to a step change in operating economics. CQSola, located in Queensland, Australia is innovating in this area. The company has recently filed several patent applications related to electronical engineering innovations for PV power management – all of which have been integrated into smart electronic devices are ready to produce at scale for major solar schemes in Australia and around the world.

Reaching full power output potential

One of the breakthrough benefits of the CQSola power management system is that it allows each solar panel in array to generate electricity to its full potential. It thereby solves an age-old problem in PV farm management: if one single panel is operating below peak performance, it limits the power output of many other panels around it.

The problem that is being solved is a bit like this: when trucks travel in convoy on a single-lane highway or mountain road, they must travel at the speed of the slowest vehicle. Put them in a wide field next to each other and the fastest trucks can go fast, and the slower ones can do their best to catch up. Just like horses at the race-course – the fittest and fastest are not held back.

The power loss from the problem of 'trucks in convoy travelling as the speed of the slowest truck' can mean significantly less power generation versus the maximum potential output of the PV solar scheme. CQSola believes that for many schemes the additional power output will be between 10 and 25%. They are also confident that up to 40% is possible, as has been demonstrated on a pilot installation in Eastern Australia.

The CQSola equipment is of particular interest for reviving older installations or for use on solar schemes that have a sub-optimal geographical location. In older systems it is often the case that some panels have aged prematurely and are holding others back. Replacement of a panel or whole array is possible, but with aged systems finding precisely matched spare parts is tough. This can lead to the situation where panels are of different power output and some are being held back.

The implications for new solar farms be a significant uplift in power generation. The alternative might be a much larger PV array with associated space and cost implications. Solar parks where trees or overhead power lines create share are similarly impacted. The CQSola power management devices are designed to avoid these isolated issues pulling the whole solar park down.

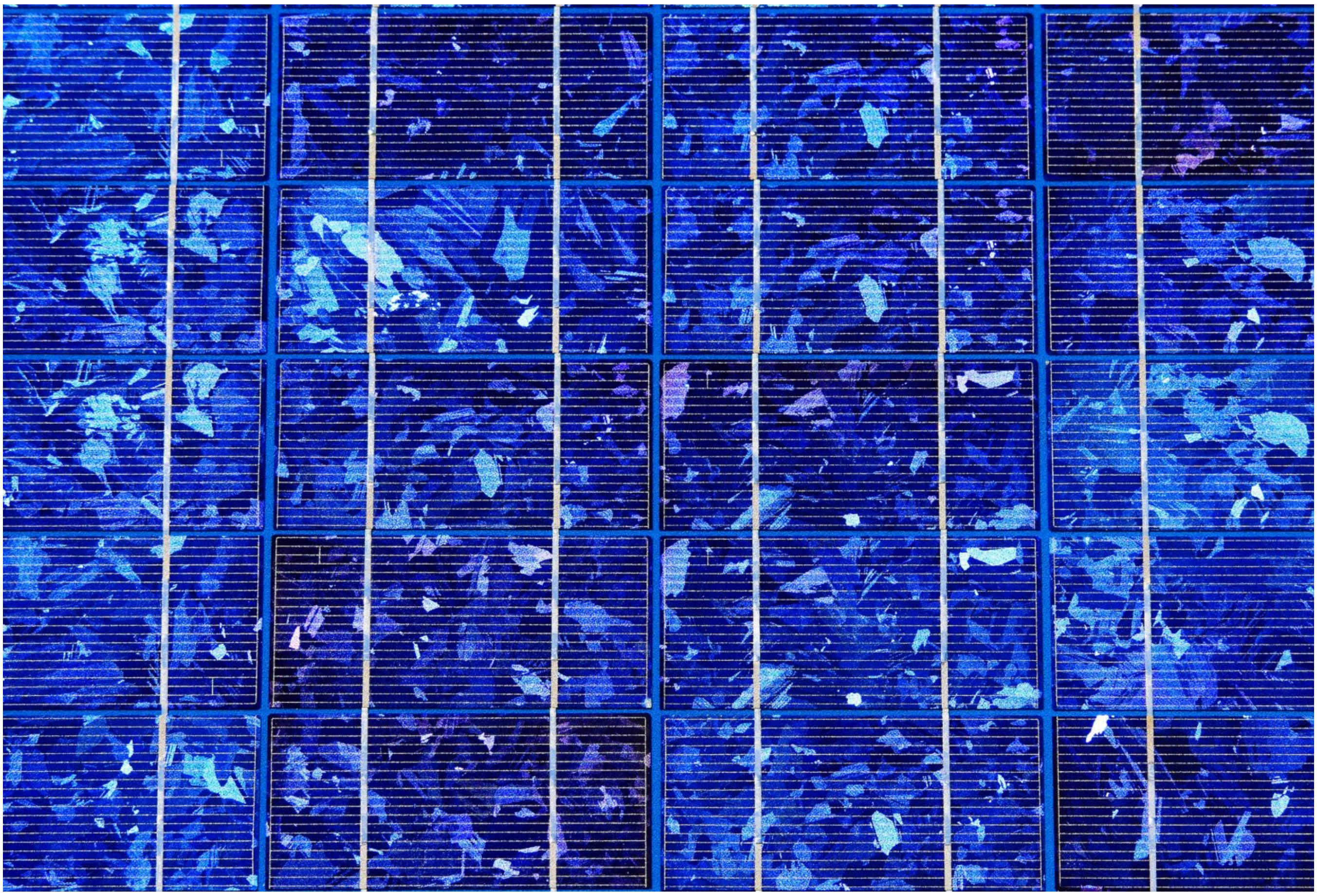
On rooftop solar systems space is limited. If the operator wants more power, they need to work with the array of panels they have space for and retrofitting power management devices could be highly cost effective to upgrade the system power output.

Fresh water and saltwater floating solar schemes are also within scope for the CQSola power management electronics. Careful attention has been paid to water-proofing the equipment and 'utility' grade engineering has been applied to ensure that the electronic devices can tolerate harsh salt-water or sea-spray environments.

Trimming back the total cost of ownership

The CQSola equipment has several features beyond the increase in power output. Their devices can be used to isolate individual panels within the array for maintenance. The safety of the maintenance team can be secured without shutting down large areas of the solar farm which would result in overall generation yield reduction.

The isolation feature can also be automated to react to environmental emergencies. Bushfires are common in the Australian outback. The ash can conduct electricity and damage the solar panels. The CQSola PV panel solar power management electronics can shut the system down before problems escalate. After cleaning, the system can be restarted with minimal risk.



Polycrystaline silicon in a solar panel

Hurricanes and tropical storms can also be problematic in some parts of the world where large solar parks for hydrogen production are planned. The force of the wind can scatter the solar panels around. Pro-actively shutting them down when a hurricane is approaching can minimise the damage caused be the severe weather event.

The power management features of the CQSola equipment also mean that the solar panels can be operated for an extended period and still achieve high electrical output. The typical life of a panel can be stretched from 20 to perhaps 25 years. That means replacement costs are reduced and the solar panel disposal and recycling burden is also minimised.

Breaking through the plateau of PV panel performance

JinkoSolar operates one of the industry's largest R&D centres and certified solar panel testing facilities. It produces the world's most efficient P-type Poly PERC and Mono PERC solar cells with conversion efficiencies of UV light to power of better than 22%. But across the industry, the pace of this development is slowing: a plateau is being reached. Different areas of focus will be required to solve other problems that have received less attention up to now. Only by addressing every link in the chain can the overall costs of green hydrogen be minimized.

To achieve the next wave of green hydrogen cost reductions there must be innovations across the full extent of the green hydrogen production and distribution value chain – from the first rays of sun to the point of utilisation. PV park power management technology can help to make a step change in the way operators are able to optimise their solar parks to maximise green hydrogen production.

On proposed large-scale renewables schemes aligned with Giga-Watt hydrogen electrolysers the positive implications of the CQSola equipment are profound. If a few panels on a rooftop scheme are being held back by 10% the result may be a loss of a few kW. But, if the panels in a GW solar park are not allowed to operate at their full potential the implication could be a loss of several tonnes per day of hydrogen generation.

Green hydrogen favours giga-scale renewables parks in optimal geographic locations

Five out of the 10 largest proposed green hydrogen electrolyser schemes are Australia. In many parts of that country the wind and solar intensity combine to yield the optimum conditions for renewable power generation. This is the key to an economically attractive green hydrogen project.

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 the past decade is that large projects are being installed in parts of the world where the weather is ideal.

When producing hydrogen directly on the solar farm, there is no need for electricity transmission infrastructure and the use of inverters and rectifiers to switch from AC to DC can be avoided. This saves capex. The reduced energy losses of co-location also combine to give direct-coupled solar powered hydrogen electrolysers approximately 10% percent better performance than electrolysers fed from the AC electricity transmission grid.

Even for a co-located electrolyser, DC to DC conversion equipment is generally required to balance the impedance of the PV panels with subsequent parts of the system. The CQSola power management system improves further on this direct coupling because the DC to DC power management is built into their devices and the capex of large impedance management devices can be avoided. Stripping this equipment out of the scheme also reduces energy losses.

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