Technoeconomic Advantage of N-type TOPCon Photovoltaic Systems for Green Hydrogen Production

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The necessary shift of today's global markets toward a sustainable future, H2 can play a key role when it comes to decarbonizing the energy, industrial, and transportation sectors. However, the conventional grey H2 will not be an option to reduce carbon emissions due to an estimated CO2 emission of 90 grams per Mega Joule, which is higher than traditional fuels used. Hence, large-scale production of H2 from cleaner sources is essential to meet the rising demand for H2.

At a lower cost of renewable energy particularly solar, its integration is key to realizing an economic and sustainable (low emission) process for "green" H2 production. The levelized cost of energy (LCOE) of a solar PV system plays a critical role in determining the cost of energy production for a competitive hydrogen electrolysis system powered. The global weighted-average (LCOE) of utility-scale solar PV declined by 87% between 2010 and 2022, from USD 0.371 to USD 0.048/kWh. The record low solar power price of USD 0.0132/kWh was achieved by Jinkosolar with its N-type TOPCon panels in Abu Dhabi in 2022.

The loss of power supply probability as a system reliability criterion, the life cycle cost (LCC), and the levelized cost of energy (LCOE) as economic indicators are incorporated a multiobjective optimization functions to maximize the PV system economically.

Several existing studies have concluded that the energy yield and the performance ratio is higher in the case of the N-type PV system. N-type TOPCon solar-powered electrolysis hydrogen production approach has the highest exergy and energy efficiency compared to P-type PV technology and other methods of creating hydrogen, according to the evaluation.

The certain advantages of N-type PV rely on

Higher Efficiency of N-type

The higher the efficiency and performance reliability of a solar PV system, the lower the LCOE. Compared to PERC cell which have reached its efficiency limit of 23%, N-type TOPCon cell shows rapid improvement in efficiency, for example, so far the record high efficiency of TOPCon cell is 26.4% made by Jinkosolar in 2022. It is the case of this technology, to compensate and ensure continued profitability. Recent PV technology shifts towards N-type TOPCon, indicate that up to a 30% reduction in green hydrogen production costs can be expected within the next decade.

By utilizing a methodology for evaluating the lifecycle energy generation and LCOE of PV systems with P-type and N-type panels, and studying the PV system's connection in a utility-scale solar-electrolyzer combination to produce green hydrogen, the better suitable configuration was identified to be the configuration with N-type TOPCon biracial panels, a single-axis tracking structure based on their technical and economic performance.

The Levelized cost of electricity (LCOE) and levelized cost of hydrogen production (LCOH) are calculated, and results show that such N-type TOPCon PV systems can generate electricity and produce hydrogen at competitive costs. In the UAE, the LCOE and LCOH can reach as low as 2.1 cents/kWh and $2.51/kg-H2, respectively. In northern west China, these costs can reach as low as 2.9 cents/kWh and $2.86 /kg-H2. Such competitive costs make N-type TOPCon PV systems attractive for new investments in green hydrogen technology in these regions.

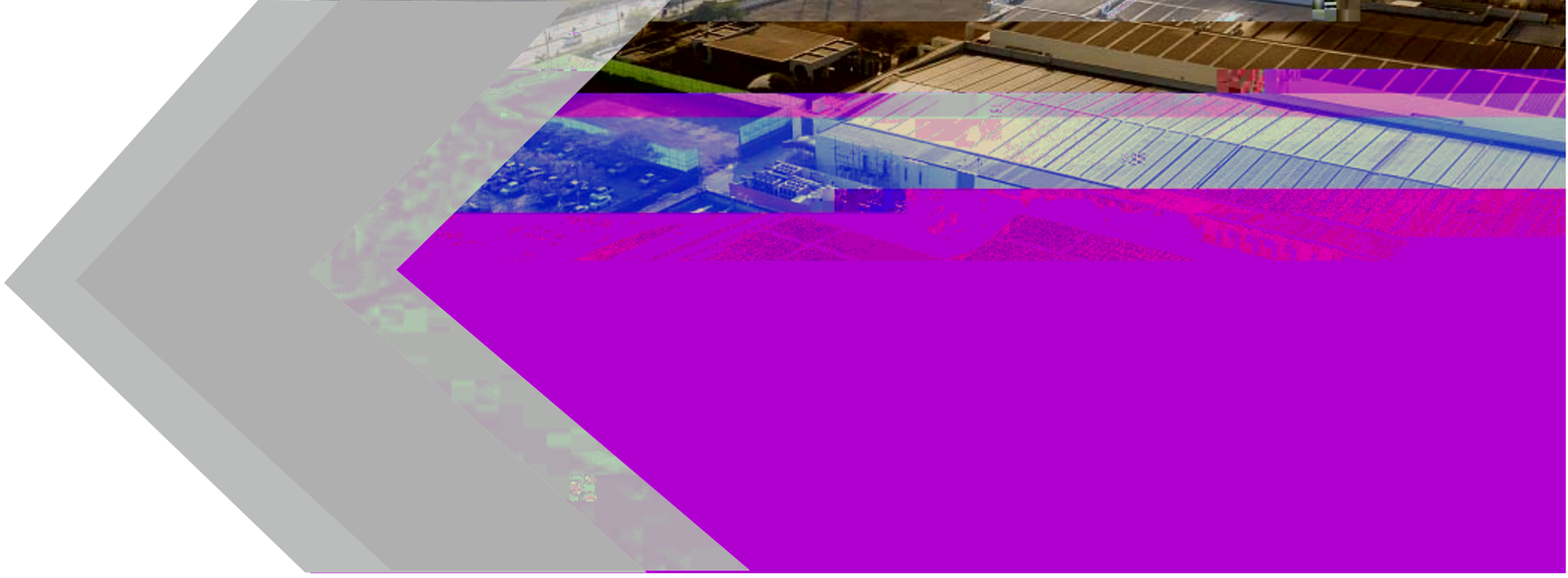
Lower Temperature Coefficient of N-type

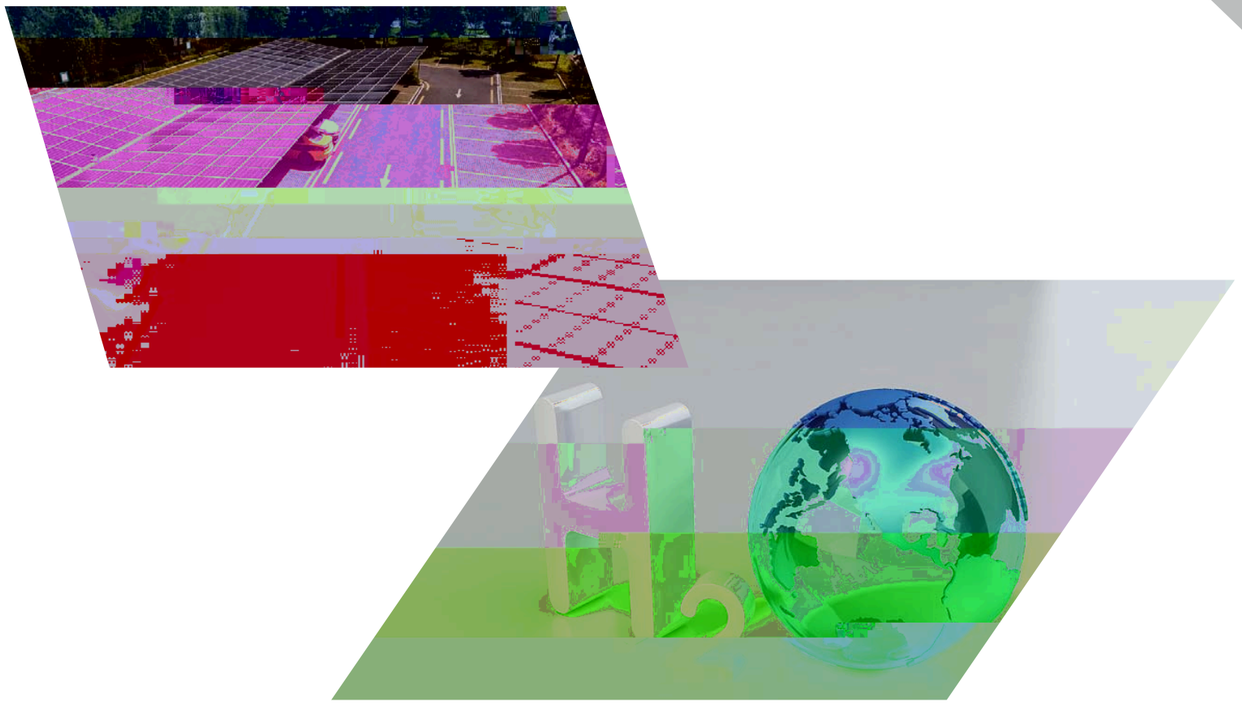
No matter electrolysis or thermochemical reactions, hydrogen production process generates excessive heat dissipation released into the environment. The lower temperature coefficient of N-type solar cells, which is as low as 0.29%/ Celsius degrees, minimizes the impact of on-site high ambient temperatures, thereby resulting in higher energy yield.

Better Low-Light Performance

The better low light performance of N-type indicates a prolonged daily working time of PV system, which boasts half to one hour longer than P-type system.

In the last few years, the hydrogen economy has gained wider adoption by many countries in the Middle East, including Saudi Arabia and the United Arab Emirates. Saudi Arabia, for example, is planning to be one of the world's biggest exporters of green hydrogen by 2030.





Air products and chemicals, U.S.-based hydrogen production, and hydrogen infrastructure developer, recently signed an agreement in July 2020 with Saudi Arabia' s utilities developer Acwa Power and Neom to develop a $5-billion hydrogen-based ammonia production facility powered by renewable energy in NEOM (the newly developed futuristic megacity in the north of Saudi Arabia where N-type solar-driven electrolysis hydrogen innovation go together).

N-type solar-powered hydrogen has become an exciting and dynamic industry in the UAE, and China, with the construction of n-type solar-driven hydrogen facilities already planned and underway.