Energy Conversion & Hydrogen

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To achieve the energy transition, future energy supply systems will require an even greater expansion of renewable energies, such as photovoltaics (PV) or wind power. Still, these technologies have to further increase their performance, reliability and flexibility. In addition, clean, field-proven solutions for sector coupling are needed. Here, hydrogen can act as a central bridge between the intermittent power from PV or wind and the still dominant hydrocarbon-based energy system. Unlike today's predominant production routes via fossil fuels, "green hydrogen" is produced entirely without CO2 emissions through the electrolysis of water with renewable electricity, and it can even be combined with captured CO2 to produce carbon-neutral fuels or chemical feedstocks.

The prevailing credo, therefore, is that global decarbonization cannot occur in the long term without green hydrogen, wherein terawatts of renewable energy will be needed to achieve it. Thus, significant research and development efforts are needed to further improve the efficiency, cost, durability, and manufacturability of both clean hydrogen and renewable energy technologies and systems.

In the hydrogen conversion value chain, cost-effective water electrolysis is the missing link. For example, the costs of proton/anion exchange membrane electrolysis (PEM/AEM) systems need to be reduced by scaling up and switching to sustainable materials with a low content of noble metals. On the other hand, high-temperature solid oxide electrolysis cells (SOECs) or direct photo-electrochemical conversion routes need to be developed towards commercial demonstration.

With regards to renewable electricity from PV systems, performance and reliability are key for building and sustaining a reliable and affordable power sector. Therefore, novel degradation mechanisms of PV components in interaction with new applications, uses, and weather conditions need to be understood and addressed, while the design, operation, and maintenance (O&M) of PV power plants need to be fully digitized to further reduce the related levelized cost of electricity (LCOE).