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Integrated solar hydrogen production: Impact of the local climate

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Hydrogen as a versatile, greenhouse gas-free energy carrier will play an important role in our future economy. Yet sustainable, competitive production and distribution of hydrogen remains a challenge. Highly integrated solar water splitting systems aim to combine solar energy harvesting and electrolysis in a single device, similar to a photovoltaic module.[1] Such a system can produce hydrogen locally without the requirement to be connected to the electricity grid. Unlike large electrolysis that draws power from the grid, the power density of such a device is reduced so far that it does not require active cooling, but its operating temperature will closely follow outdoor conditions.

Here, we present our work on high-efficiency integrated solar water splitting devices based on multi-junction solar absorbers. The light-absorbing component is sensitive to the shape of the solar spectrum and generally becomes more efficient at lower temperatures. Catalysis, on the other hand, benefits from higher temperatures. These conflicting trends wih respect to the temperature impact the design of the solar hydrogen production system. We analyse how the local climate affects production efficiency[2] and show in a lab study that adequate system design allows efficient operation at temperatures as low as -20°C.[3] These insights can help to design small-scale distributed solar hydrogen production for both temperate regions, but also more extreme climatic conditions.

[1] M.M. May et al., Nature Communications **6** (2015), 8286.
[2] M. Kölbach et al, Sustainable Energy & Fuels **6** (2022), 4062.
[3] M. Kölbach, K. Rehfeld, M.M. May, Energy & Environmental Sciences **14** (2021), 4410-4417.