FlowPhotoChem lay summary

Title	Kilowatt-scale solar hydrogen production system using a concentrated integrated photoelectrochemical device
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Aims	This study aims to demonstrate the potential of a thermally-integrated photoelectrochemical device at scale which utilizes solar concentration to produce hydrogen, oxygen and heat. Notably, this work demonstrates this technology at the kilowatt scale whilst achieving a high device-level solar-to-hydrogen efficiency.
Why is this important?	Hydrogen is an important industrial chemical feedstock and energy vector. Current production of hydrogen is dominated by carbon-intensive methane reforming (often referred to as "grey hydrogen") and it is essential that we to move towards CO_2-free hydrogen production ("green hydrogen"). Solar energy is a large and sustainable resource and therefore solar energy-derived fuels and chemicals are particularly attractive. In order to develop solar fuel technologies, it is important to move from lab-scale research to pilot-scale demonstrators, such as described in this study.
What methods were used?	A pilot-scale system was developed and constructed on EPFL campus and comprised of a 7 m-diameter solar parabolic dish, an integrated photo-electrochemical reactor placed in the focal point of the dish and various auxiliary components such as pumps and heat exchangers. An experimental campaign was conducted over a number of days under a variety of meteorological conditions.
What was learned?	The pilot plant achieved performed well in a number of metrics over the experimental campaign - 20.3% device-level solar-to-fuel efficiency, 5.5% system-level solar-to-fuel efficiency and 35.3% system-level thermal efficiency where the Gibbs free energy is used to calculate solar-to-fuel efficiencies. We investigated various control strategies for operation of the solar dish and discovered that water flowrate control was a promising method for stabilising water temperatures under varying solar irradiance. We also overcame a number of design challenges in the integration and construction of the reactor unit.
How could this research benefit citizens, society and other researchers?	This pilot-scale demonstrator presents a scalable approach to high performance thermally integrated photovoltaic-electrolysis system as a pathway to a more sustainable future.
Link to full paper/abstract	https://www.nature.com/articles/s41560-023-01247-2