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Assessing the potential of photoelectrochemical carbon removal as negative emission technology

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Current greenhouse-gas emission rates appear to be incompatible with the goals of the Paris Agreement without large-scale employment of negative emission technologies (NET). Though a timely cut in emissions is preferable to the large-scale roll-out of NET, which would require significant resources, it might be unavoidable [1].

We assess the potential contribution of photoelectrochemical CO_2 reduction to negative emissions. This approach is at the moment mainly developed for the production of renewable fuels that store solar energy in the chemical bonds of hydrocarbons. Yet, photoelectrochemistry can also deliver other products, that maximise carbon conversion efficiency and storability rather than the energy conversion efficiency. The anticipated conversion efficiencies are significantly higher than the processes in natural photosynthesis. This translates to potentially much smaller land and water footprints than bioenergy-based carbon capture and storage [2]. Furthermore, the technology could be employed in low-latitude deserts, reducing the competition for arable land with food production. We also outline the remaining, significant technological challenges associated with photoelectrochemical carbon sinks.

[1] Anderson and Peters, Science 354 (2016), 182-183.
[2] May and Rehfeld, Earth Syst. Dynam. 10 (2019), 1-7.