Electronic Supplementary Material (ESI) for Energy & Environmental Science.

Energy & Environmental Science

COMMUNICATION

A new approach for sustained and efficient H_2 photoproduction by *Chlamydomonas reinhardtii*

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Electronic supplementary information (ESI)

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Figure S1. Photochemical activity in the wild-type *Chlamydomonas reinhardtii* culture exposed to a train of 1 s light pulses interrupted by 9 s dark periods. Before measurements, cell suspensions at around 14 µg mL^{-1} Chl (*a* + *b*) were dark adapted for 10 min in the gas tight cuvette under either Ar or air atmosphere. A train of saturating white light pulses (~500 µmol photons m^{-2} s^{-1}) was provided with the pulse amplitude modulated fluorometer (Dual-PAM-100, Walz). Arrows indicate the points for switching on / off the measuring light. Algal suspension was stirred throughout the experiment. In the case of anaerobic incubation, the presence of H_2 gas in the headspace of the cuvette was confirmed with a GC.

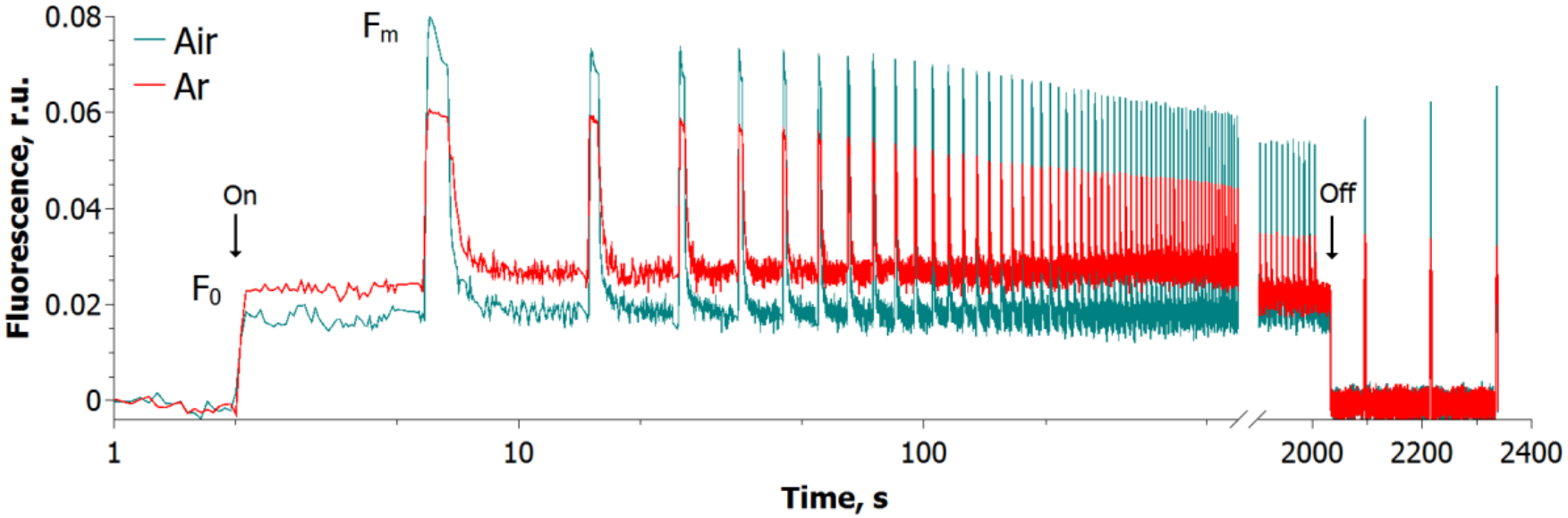


Figure S2. H_2 photoproduction and O_2 evolution in algal cultures exposed to continuous light. The cultures were treated with different amounts of 1 s light pulses (420 µmol photons m^{-2} s^{-1}) interrupted by 9 s dark periods (shown as a number of cycles), dark-adapted for 2 minutes, and then continuous light of the same intensity was applied. The arrows indicate the points of continuous light application.

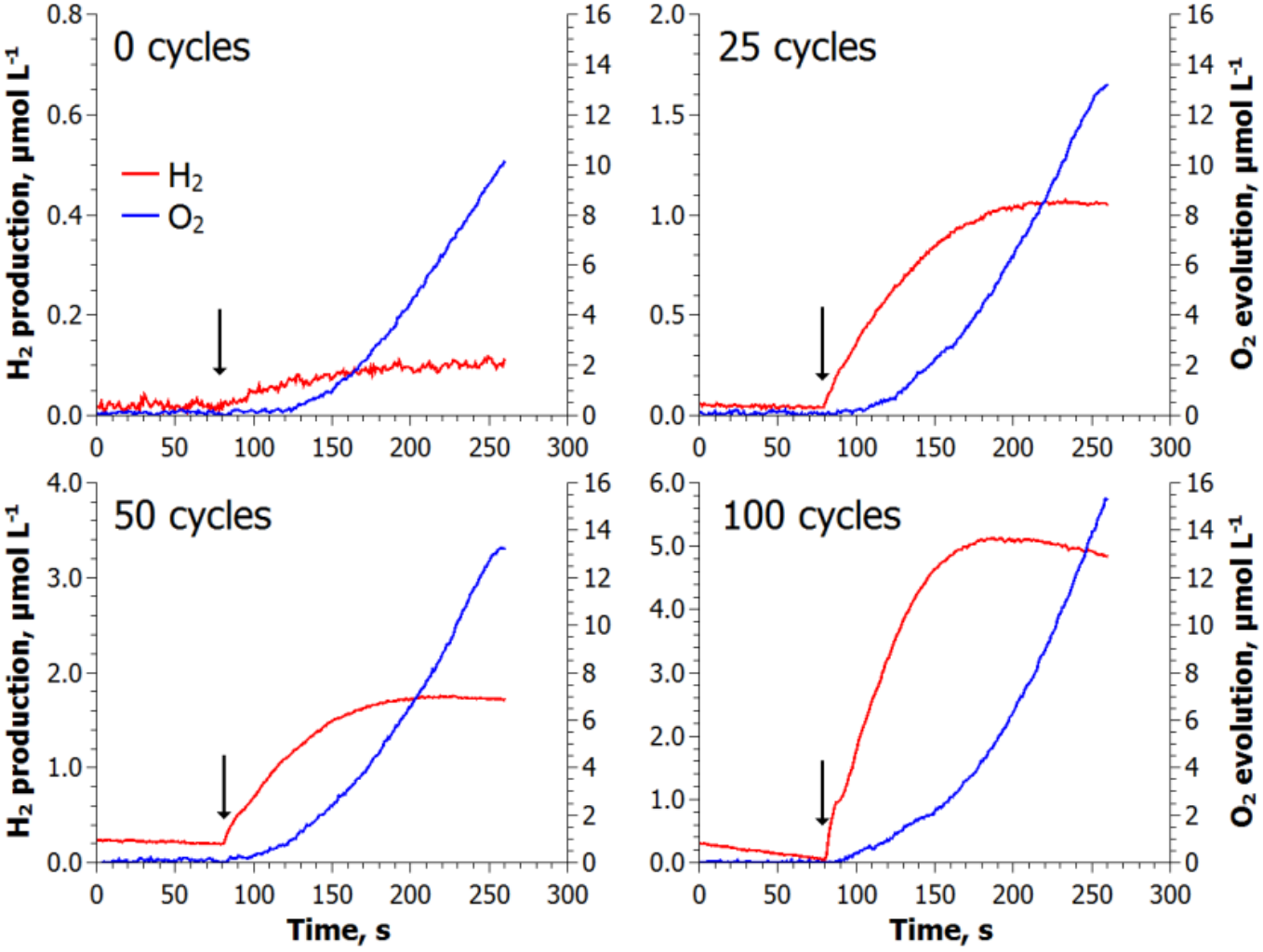


Figure S3. Mass spectrometric simultaneous monitoring of H_2, O_2 and CO_2 exchange in algal cultures exposed to a train of 1 s light pulses (420 μmol photons m^{-2} s^{-1}) interrupted by 3 s dark periods.

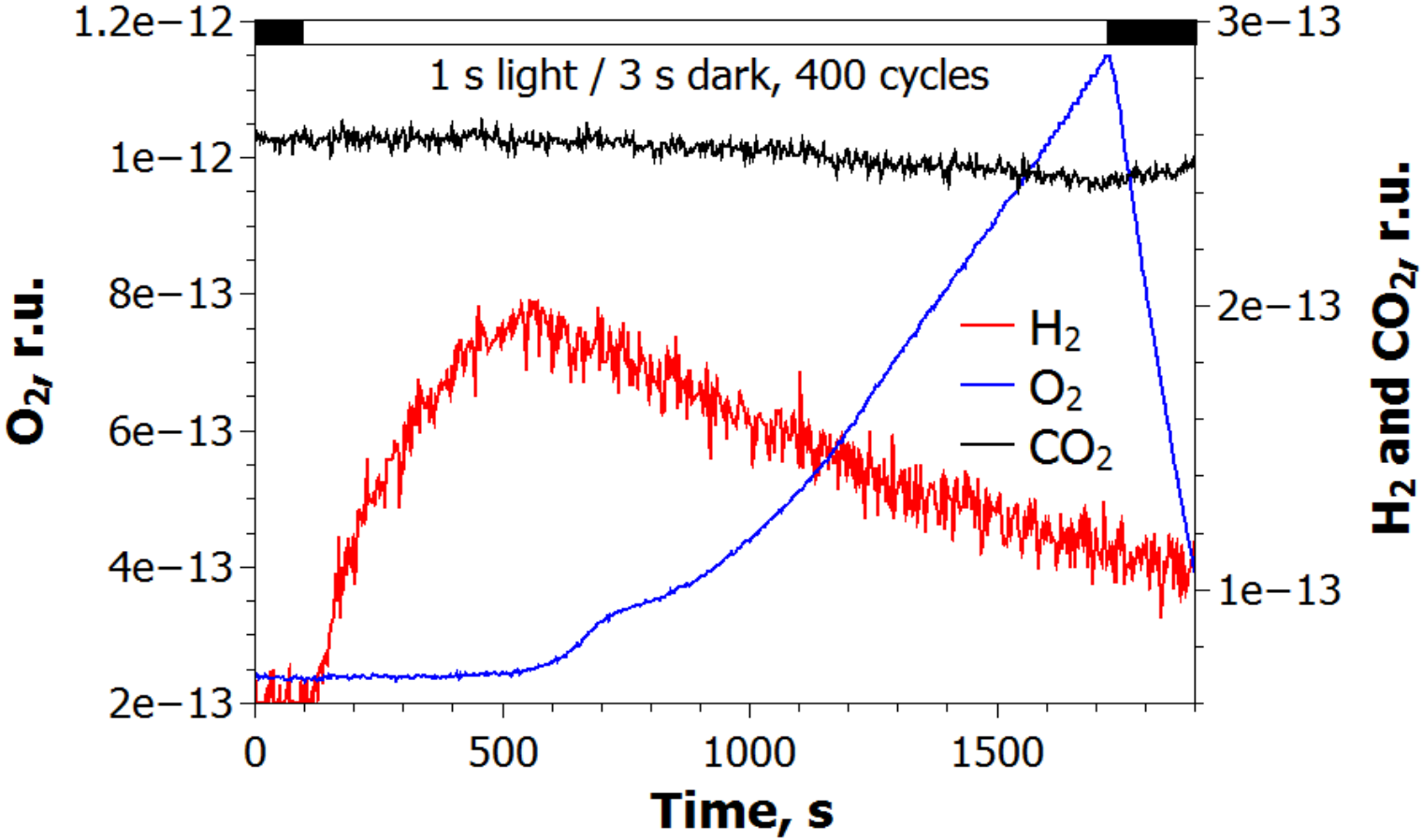
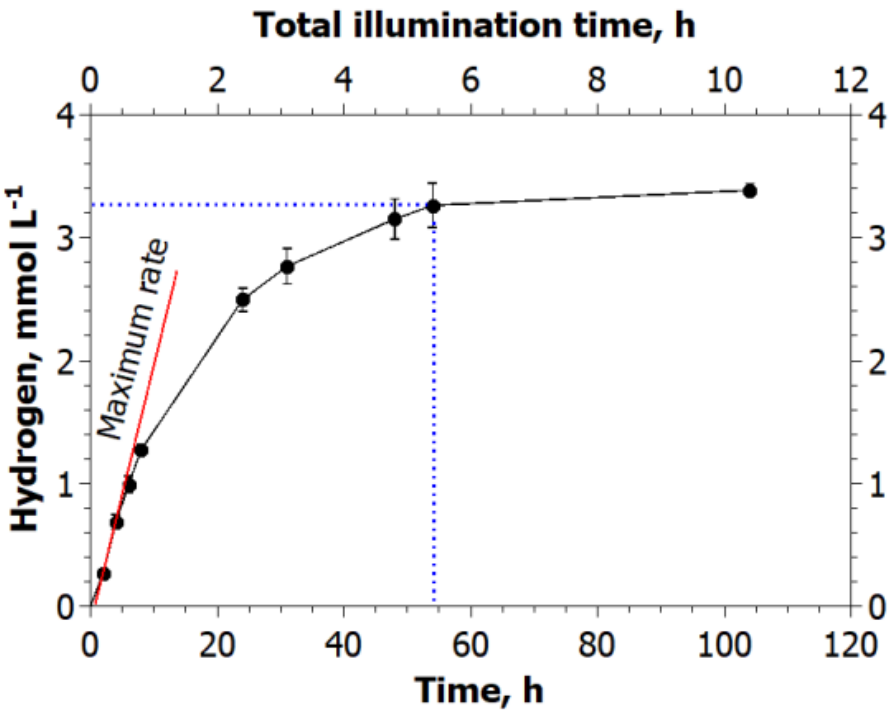


Figure S4. Evaluation of light energy to H_2 energy conversion efficiency (LHCE) of the pulse-illuminated *C. reinhardtii* cultures. 10 ml algal suspensions with the total Chl content of about 18 mg L^{-1} were exposed to a train of 1 s light pulses (35.11 W m^{-2} PAR) interrupted by 9 s dark periods under Ar atmosphere. The LHCEs were calculated for the maximum rate of H_2 photoproduction (red line) and for the 54 h production period using eqn (1). 35.11 W m^{-2} corresponds to 180 µmol photons m^{-2} s^{-1} white light at the surface of the suspension culture.

$$\eta\ (\%) = 100\ \frac{\left(\Delta G^o - RT\ln\left(\frac{P^o}{P}\right)\right) V_H}{E_S\ t\ A} \qquad (1)$$

where ΔG^o is the change of the standard Gibb's free energy for the water-splitting reaction (237,200 J mol^{-1} at 25°C and 1 atm), R is the universal gas constant, T is the absolute temperature, P^o and P are the standard and observed H_2 pressures (atm), V_H is the amount of H_2 photoproduced (mol), E_S is the energy of the incident light radiation (J m^{-2} s^{-1}), A is the illuminated surface area (m^2) and t is a sum of illumination periods (s).

(A) Original H_2 photoproduction data



(B) Parameters and final efficiencies

	Max. rate	H_2 yield (54 h)
V_H (mol):	4.20134E-6	3.26347E-5
P (atm):	0.0028	0.0133
A (m^{-2}):	0.002178	0.002178
E_S (J m^{-2} s^{-1}):	35.11	35.11
t (s):	720	19440
	1.7	0.5
η (%) *:	2.2	0.63

* η is calculated for the upper H_2 gas combustion energy (ΔHc) of 285.8 kJ mol^{-1}.