# Supplementary Information

## Light manipulation using organic semiconducting materials for enhanced photosynthesis

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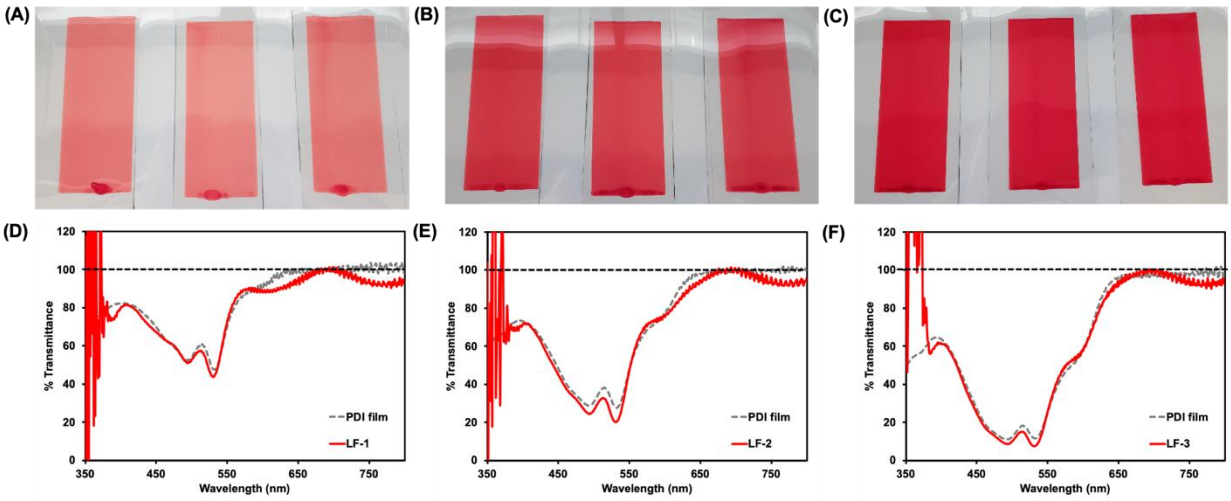
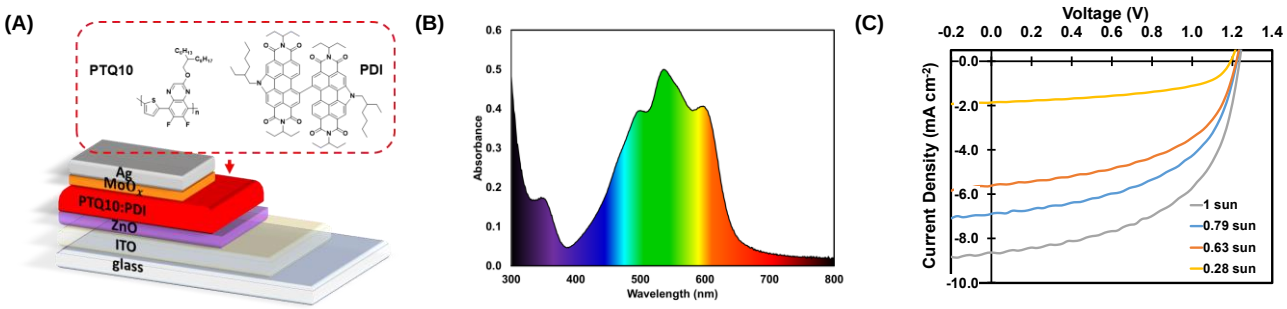
**Supplementary Table 1.** Average and standard deviation of OPV devices metrics.

| **Light intensity** | **$V_{oc}$ (V)** | **$J_{sc}$ (mA/cm$^2$)** | **FF (%)** | **PCE (%)** | **$P_{in}$ (mW/cm$^2$)** | **$P_{out}$ (mW/cm$^2$)** |
|---|---|---|---|---|---|---|
| 1 sun | 1.25 ±0.01 | 8.8 ±0.2 | 52 ±1 | 5.6 ±0.2 | 100 | 5.6 ±0.1 |
| 0.79 sun | 1.23 ±0.01 | 7.0 ±0.2 | 52 ±1 | 5.7 ±0.2 | 79 | 4.5 ±0.1 |
| 0.63 sun | 1.23 ±0.01 | 5.7 ±0.1 | 52 ±1 | 5.7 ±0.2 | 63 | 3.65 ±0.04 |
| 0.28 sun | 1.20 ±0.01 | 1.90 ±0.04 | 52 ±1 | 4.2 ±0.2 | 28 | 1.17 ±0.02 |

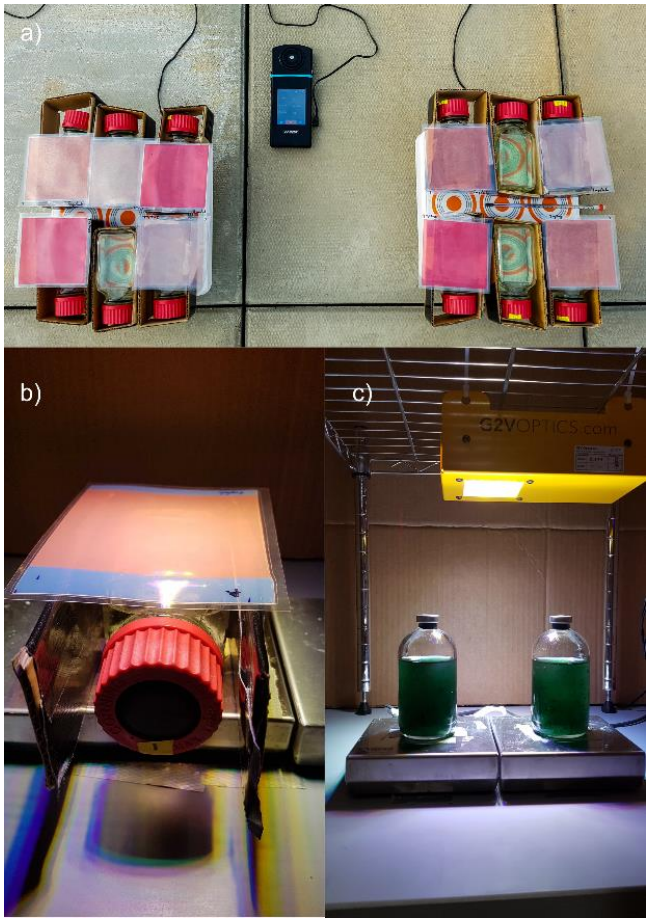
OPV device architecture: glass/ITO/ZnO/PTQ10:PDI/MoOx/Ag. PTQ10:PDI photoactive layer processed from 1:1 weight ratio solutions (20 mg/mL in *o*-xylene with 1% v/v diphenyl ether solvent additive) in air. OPV devices measured in air.



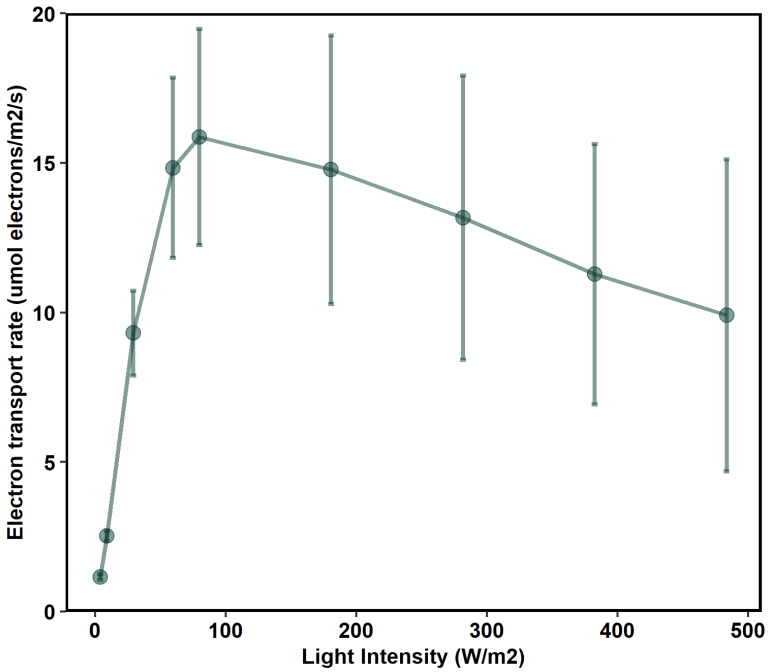

**Supplementary Figure 1.** Photographs of PET/PDI films coated in triplicate with PDI coating concentrations of (A) 2 mg/mL, (B) 5 mg/mL and (C) 10 mg/mL in *o*-xylene. Red films are 10 x 30 cm. Optical transmission spectra (D-F) of the PDI films (PET/PDI) and the final light filters (Lamination sheet/PET/PDI/UV-barrier film/Lamination sheet). The spectra show that plastic films have no significant impact on the transmission above 400 nm. LF1-1, LF-2, and LF-3 were fabricated with the PDI films coated from 2 mg/mL, 5 mg/mL, and 10 mg/mL PDI in *o*-xylene solutions, respectively.




**Supplementary Figure 2.** A) OPV device architecture and photoactive layer materials. B) Optical absorption spectrum of the OPV photoactive layer blend (glass/ITO/ZnO/PTQ10-PDI). C) Current density-voltage curves of the OPV devices tested under different light intensities.

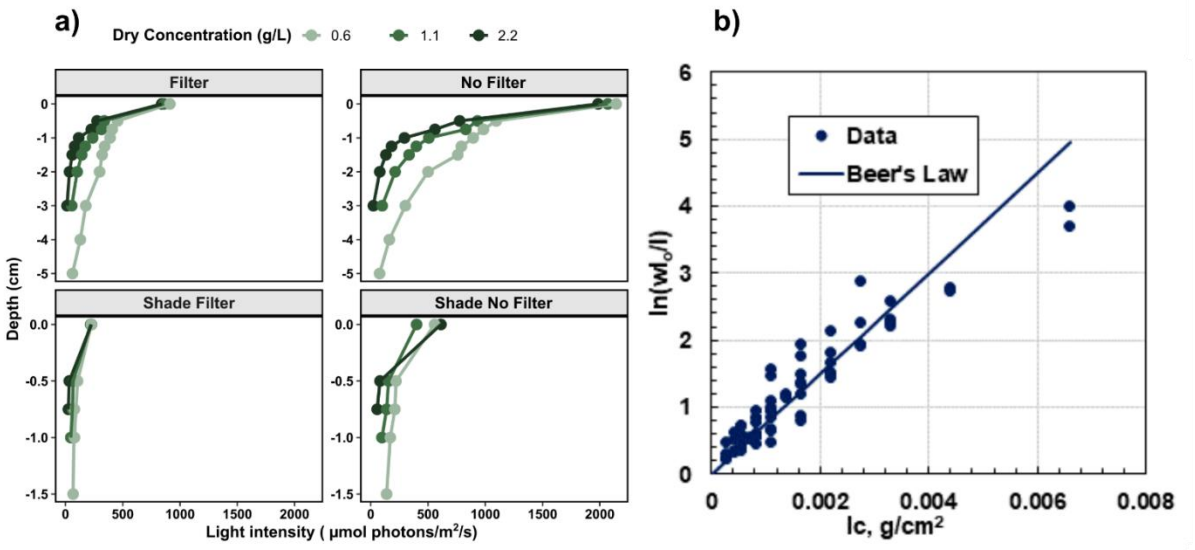



**Supplementary Figure 3**. Photographs of bottle experiments. a) Experimental setup for experiments 6-10 using 12 rectangular bottles and sunlight. Experiments 6 and 7 were performed in a greenhouse, experiments 8-10 were performed on the roof in direct sunlight. b) Experimental setup for experiments 4 and 5 using singular rectangular bottles with a solar spectrum mimicking light from G2V optics. c) Experimental setup for experiments 1-3 using 2 cylindrical bottles with a solar spectrum mimicking light from G2V-optics.

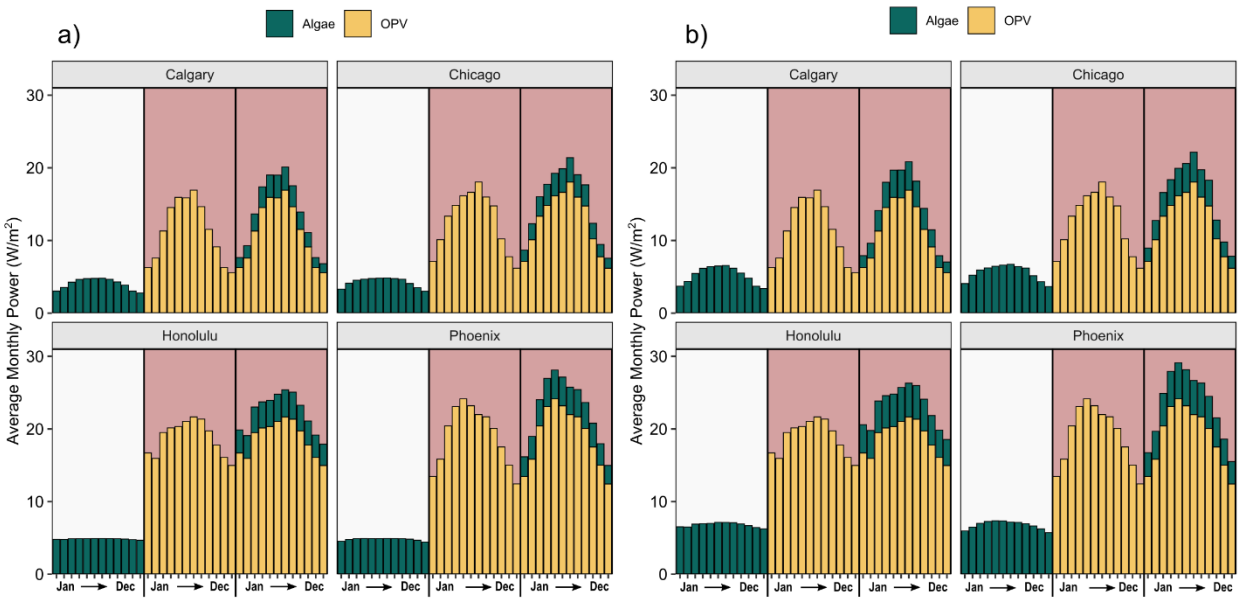



**Supplementary Figure 4.** Photosynthetic electron transport rate of the cyanobacteria consortium under different light intensities. Error bars show standard deviation from three culture replicates.

**Supplementary Figure 5**. Photograph of culture bottles after experiment with highest light. The experiment consisted of 10 hours in direct sunlight with an average light intensity of > 1200 µmol photons/$m^2$/s (> 580 W/$m^2$). Bottles are arranged sequentially from left to right: Samples 1→ 12. Samples 1-3: no filter, samples 4-6: LF-1, samples 7-9: LF-2, samples 10-12: LF-3.




**Supplementary Figure 6**. Data from light attenuation experiments and Beer's Law equation. A) Light attenuation measurements. Depth refers to depth under the surface of the bioreactor, while light intensity refers to the light intensity measured at that depth. Shade refers to measurements done underneath a shade cloth to simulate cloudy conditions. Filter and no filter refer to measurements done with and without a light filter over the bioreactor. B) Beer's Law attenuation data fit to Beer's Law equation.




**Supplementary Figure 7.** Predicted power generation of algae and OPV technologies for four North American cities with a) 0.1 g/L and b) 0.5 g/L algae cultures.