**Link:** <https://solar-power-tech.com/e-posters/sfs_eposter_07/>

**Abstract**

World energy consumption is rising fast due to the increasing world urbanization and industrialization, leading to the almost complete depletion of petroleum resources and to an aggravation of global warming caused by carbon dioxide emissions. This situation is a fertile ground for the development of efficient renewable technologies, able to gradually replace carbon-rich fossil fuels in sustaining world energy demand. Solar fuels, *i.e.* hydrogen and CO2 reduction products, represent a promising solution to this problem, as they can be generated by using the most abundant form of renewable energy.

In this field, photoelectrochemical (PEC) systems for water splitting into H2 can convert solar energy into a storable, dispatchable and green fuel. The viability of these device has been intensively proven, but the main challenge remains the development of systems that are economically and environmentally advantageous compared to the actual hydrogen production. This work briefly illustrates a research conducted to determine the most suitable and well-established PEC technologies at the state-of-the-art (SoA) and the experimental proof-of-concept of a photovoltaic-electrocatalytic (PV-EC) device for the direct sun-driven water splitting.

PEC devices can be classified in various configurations: particulate catalyst (PC), photoelectrochemical (PEC) and photovoltaic-electrocatalytic (PV-EC). In PC systems, the photoabsorber material is directly immersed into the electrolytic solution containing the reactants, PEC cells are made of photoelectrodes (photoanodes and/or photocathodes) electrically connected to each other and, finally, PV-EC systems are composed by photovoltaic devices connected to well-selected electrocatalyst. According to a techno-economic analysis, solar-to-hydrogen efficiency (ηSTH) higher than 10% and lifetime of 10 years are required to make hydrogen economically feasible [1]. PV-EC systems stand out as the technology with the highest solar-to-hydrogen efficiency; their complexity and, consequently, their cost is primary due to the photovoltaic and electrocatalyst components. To minimize electrocatalytic cell cost, noble metal electrocatalyst should be replaced by cheaper Ni-, Mo-, Co-based materials. Recent studies demonstrate that such materials can perform the overall reaction with the same or lower overpotentials, but the experimental preparation techniques must be refined [2]. On the other hand, photovoltaic is the limiting factor for an optimization because solar panels that can provide high currents with little active areas are expensive and owns excessive complexity. The future of photovoltaic is directed towards perovskite-based cells, an emerging and easy manufacturable material, that could depreciate overall PV-EC device costs and complexity. Unassisted PV-EC water splitting feasibility was proved in a prototype made by the connection of a silicon minimodule with a 3D-printed electrocatalytic cell, constructed by the Green Independence (GI) startup. The reaction was performed in an alkaline medium, using a Pt3Co/C GDE as cathode and a Pt mesh as anode. The compartments of the cell were divided by a Nafion anion exchange membrane. The overall ηSTH obtained in this configuration was 5%. It analyzes how this result could be boosted up to 9% by improving PV and EC, e.g. employing higher electrodes surface.