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Cost assessment of hydrogen production from PV and electrolysis

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Executive summary

CSIRO has been leading the development of a roadmap for the Australian solar fuels industry. The roadmap aims to define the research, development and demonstration priorities to establish and foster an industry using solar thermal technologies. During the three-year project, the cost of photovoltaic (PV) technologies has significantly reduced, while interest has grown in the production of hydrogen from electrolysis. This report, commissioned by ARENA, assesses hydrogen production from PV and electrolysis. It is intended as both a standalone document and a useful reference point for comparison with solar thermal technologies. It considers the likely current cost as well as a 'realistic, optimistic' view of future possibilities, as presented in the solar thermal fuels roadmap.

Our evaluation of the current and future (2030) cost of hydrogen from PV and electrolysis shows that the potential cost using currently available technology is approximately \$18.70/kg H_2. The base case system consists of a PV module with power electronics connected to a proton exchange membrane electrolysis plant, which produces hydrogen only when the PV system is producing power. The assessment is based on an estimated system cost of \$2300/kW for a large scale, non-tracking PV system with a mid-range capacity factor of 20.5% and a weighted average cost of capital of 6.4%, as recently published by the CO2CRC (2015). It is assumed that the uninstalled cost of the electrolyser and associated components is \$2,285/kW, in line with recent estimates from the European Fuel Cell and Hydrogen Joint Undertaking (Bertuccioli et al., 2014). Significant cost reductions are predicted for both these technologies, cutting the estimated cost of hydrogen to \$9.10/kg by 2030.

The study also examined the potential of battery storage to reduce the cost of hydrogen production. In this scenario, the battery system was used to condition the power supply from the PV system, with sufficient storage capacity provided to enable continuous operation of the electrolyser. Lithium-ion battery technology was selected as the most appropriate. In both current and future scenarios, battery storage increased the cost of hydrogen relative to the base case, due to its relatively high cost compared with energy production from PV. Based on current and future battery costs of \$540 and \$200/kWh, the estimated cost of hydrogen was \$28.40 and \$11.30/kg in 2015 and 2030 respectively. While the current cost with battery storage is much higher than the case without storage, the gap is expected to be close if projected battery cost targets are met. It was also interesting to note that the addition of any amount of Li-ion battery storage to the system increased the hydrogen production cost relative to the base case.

The estimates of hydrogen production costs are significantly higher than the current cost of its production from steam methane reforming, which is typically in the range of \$1.50-2.50/kg H_2. Naturally, however, fossil fuels such as methane produce significant greenhouse gas emissions, while PV-electrolysis systems are instead based on renewable solar resources and produce zero-emission fuel.