

# **Solar Water Heating for Enhanced Electrolysis in Hydrogen Production**

## **Introduction**

Heated water can boost sustainable hydrogen and methanol production, smoothing our transition away from fossil fuels, by “trapping” heat developed in solar panels using it for water electrolysis, “cleaning up” polluting activities.

## **Main Text**

By combining retrofit and parabolic solar collectors, we can generate the exact operational water temperature range needed to produce green hydrogen efficiently, paving the way for sustainable fuels that turns our means of transportation into running without demanding more fossil fuels. Climate change demands a radical re-evaluation of how we power our lives. While solar farms are popping up worldwide to “clean up” electricity grids, transportation sectors (like cars, buses, ships and planes) cannot rely on heavily on batteries. This is where electrofuels come in. By capturing carbon dioxide (CO<sub>2</sub>) directly from gaseous pollutants and combining it with green hydrogen, we can synthesize clean methanol. Methanol is a versatile liquid fuel that fits right into our existing gas stations and car engines without needing expensive upgrades. However, creating the hydrogen quantities required for this process usually takes an immense amount of electrical energy. Surprisingly, a method that can make this process cheaper and more sustainable is simply raising the water temperature. Splitting water molecules becomes much easier and demands less electricity.

This thesis project designed and simulated a smart engineering framework tailored to the sunny, semi-arid climate of Vassiliko, Cyprus. At this site, an existing solar park sits right next to a massive cement plant. The goal is to figure out how to heat 123.000 tons of water per year using solar energy to feed low-temperature water electrolysis systems. This amount of water creates enough hydrogen to react with captured pollutants, decreasing a cement factory's carbon footprint by 10%. Using a powerful computer simulator called TRNSYS, various configurations of solar collectors were tested under real-world weather patterns. Traditionally, water backing is used primarily to cool down solar panels to keep them running efficiently. In this project, the primary goal was to maximize the water's temperature as much as possible for the chemical plant downstream, treating any cooling of solar panels as a welcome bonus. The simulation models tested how well solar loops can heat water for Anion Exchange Membrane (AEM), Proton Exchange Membrane (PEM) and Alkaline electrolysis methods, finding out that the PEM method is the most appropriate one for the specific project. Cyprus suffers from severe freshwater shortages, and consequently the water -used for green fuel production- must come from seawater desalination plants. For these engineering layouts to be truly “green”, future work must ensure the desalination plants themselves are powered by clean energy and not fossil fuels. Moreover, this research provides the initial baseline for the development of similar water heating projects, as well as for a broader circular economy project, proving we can harvest the sun's discarded heat to transform localized industrial pollution into a clean, transportable fuel of tomorrow.