



From Industrial Waste to Green Fuel: SPECTRUM's New Findings on Solar Photocatalytic Hydrogen Generation



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The Horizon Europe-funded SPECTRUM project has published new scientific guidelines highlighting how industrial wastewater (IWW) can serve as a valuable resource for renewable hydrogen production. This dual-purpose approach enables pollutant degradation and hydrogen production in a single system, aligning with EU decarbonisation and circular economy objectives.

The guidelines are included in the report developed by IST-ID, LNEG, CIEMAT, and the University of Bologna entitled “Guidelines on the potential of industrial wastewaters as sources of sacrificial agents for photocatalytic hydrogen production” (Deliverable D1.1). It presents a framework to identify the industrial effluents most likely to produce clean hydrogen during a solar photocatalytic treatment, paving the way for a cleaner and more resource-efficient future.

The report reviews the fundamental mechanisms of photocatalysis using TiO_2 -based catalysts and identifies the main factors influencing system efficiency, including chemical oxygen demand (COD), biochemical oxygen demand (BOD), pH, light scattering, and inorganic ion content. It then identifies the various compounds such as alcohol, sugars, and organic acids, known as sacrificial agents, most likely to be present in industrial wastewaters and their potential to enhance hydrogen production under various operational conditions. It concludes with a comprehensive set of guidelines for identifying and utilising industrial wastewaters rich in these sacrificial agents coupled with any limitations or considerations in terms of inhibitory or problematic factors. Case studies presented in the report using real wastewater from the olive oil, brewery, and rice processing sectors demonstrate promising hydrogen yields with significant pollutant degradation, confirming the viability of this approach.

Industry	Wastewater Type	Key SA
Rice Processing	Effluent from milling	Saccharides, cellulose
Brewery/Dairy	Fermentation byproducts	Lactose, ethanol
Olive Oil	Mill wastewater	Phenols, lipids
Wine	Winery wastewater	Ethanol, glucose and fructose, organic acids (lactic, tartaric, citric, malic, and succinic), and glycerin

Figure 1: Examples of industrial sectors and key sacrificial agents

The report identifies critical parameters that determine process performance, including:

- Organic content and composition (COD, BOD)
- pH, dissolved oxygen, and turbidity
- Presence of inhibitory compounds, such as metals or halides
- Light absorption and catalyst surface characteristics



“This study demonstrates that industrial wastewater holds great potential, as it can serve as a low-cost and abundant feedstock for solar hydrogen production,” says Guilherme Pedro (IST-ID), “The work represents a crucial step toward circular and sustainable industrial systems where waste streams are transformed into clean energy.”

A Framework for Sustainable Implementation

Additionally, the report introduces a decision-making framework to support the selection of suitable wastewater streams for integration into solar photocatalytic systems, considering both chemical composition and practical factors such as sample preservation conditions, and seasonal availability.

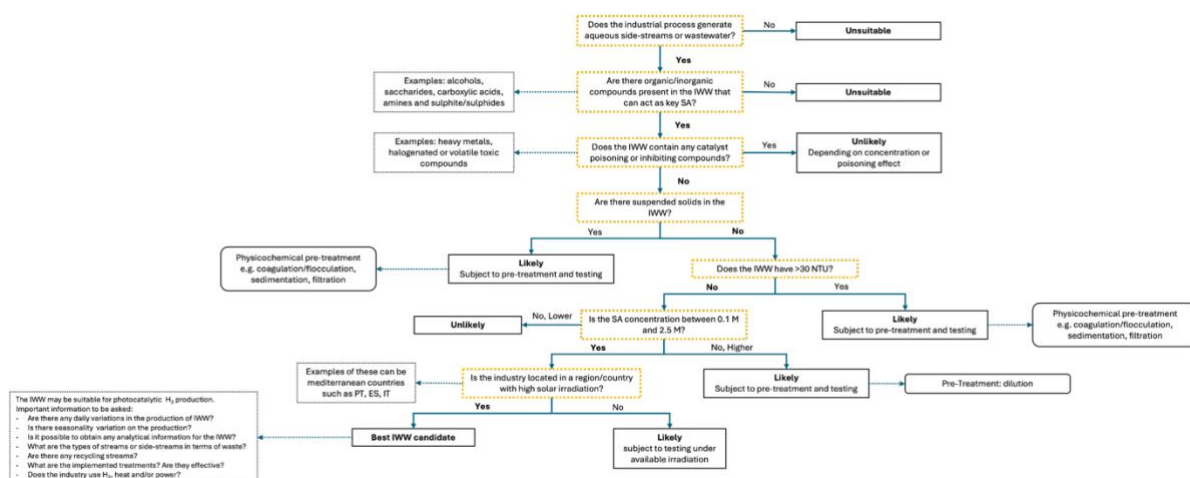


Figure 2: Decision tree on the most favorable IWW candidates for hydrogen production

Next Steps for SPECTRUM

Moving forward, further research is targeting the development of more active dual-function photocatalytic systems, the photoreactor design and its integration in hybrid solar collectors, life-cycle assessments, and the development of robust experimental testing to assess both hydrogen production and IWW pollutant remediation in the novel photocatalytic reactor.

Read the full report: Pedro, G.O., Lanham, A.B., Pinheiro C.I.C., Esteves, A., Brites, M.J., Malato, S., Pellegrini, M., [Guidelines on the potential of Industrial Wastewaters as sources of sacrificial agents for photocatalytic H₂ production](#). Deliverable 1.1, SPECTRUM Project Consortium, 2025.

About SPECTRUM

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