

ASSESSING ENVIRONMENTAL IMPACT AND MATERIAL CRITICALITY IN SCALING PEROVSKITE-SILICON TANDEM PHOTOVOLTAIC MODULES: A COMPREHENSIVE APPROACH

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This study introduces an integrated approach that combines Life Cycle Assessment (LCA) and Critical Raw Materials Analysis to tackle the challenges associated with scaling up perovskite-silicon tandem photovoltaic modules within the PEPPERONI_EU project. The focus is on sustainable production, emphasizing environmental considerations, raw material scarcity, and the nascent nature of the technology.

The LCA conducted in this study will analyse the entire life cycle of the modules, extending from cradle-to-grave. Encompassing tasks such as mining of minerals, manufacturing of materials, cells, and modules, pilot line operation, field operation, and the end-of-life phase, the objective is to identify and mitigate environmental "hot spots" through eco-design principles. Alternative materials and processes will be explored, and their environmental impact will be rigorously evaluated and compared to select the most sustainable options.

Material criticality, a central focus of this research, will be assessed through a multifaceted approach considering economic importance and supply risk. Economic indicators, substitutability, geological, technical, and economic accessibility will be evaluated. A multicriteria analysis will be performed, considering resource abundance, producing countries' distribution, price volatility, and other indicators. Data, primarily from public sources, will be supplemented by an additional dimension: environmental and human health impacts related to the materials' use in the supply chain of perovskite/Si tandem cells and modules.

Acknowledging the uncertainties inherent in low TRL and the novelty of this photovoltaic technology, a global sensitivity analysis will be employed, aiding data visualization and facilitating the construction of probability distributions for the expected environmental impacts. This approach enhances the robustness of the results, considering the dynamic landscape of emerging technologies.

The synergy between LCA and critical raw materials analysis is paramount. The combination offers a holistic perspective, enabling informed choices that balance environmental sustainability, economic feasibility, and material resource resilience. The integrated LCA and critical raw materials analysis approach is poised to contribute valuable insights to the sustainable scaling of emerging photovoltaic technology. The methodology and initial results of this study will be presented in detail on the poster.