# Towards a Sustainable Solar Future: Forecasting Photovoltaic Waste and High-Value Recycling for France

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**Abstract**

The rapid expansion of solar photovoltaic (PV) installations presents a growing challenge in managing end-of-life (EoL) PV waste. Photovoltaic panels contain valuable materials that have the potential to be recovered if the waste stream is managed efficiently. This study employs a System Dynamics (SD) model to forecast PV waste volumes and assess the potential for high-value recycling in France. The model integrates evolving material compositions, feedback mechanisms within the recycling industry, repowering, and recycling capacity expansion. Findings suggest that PV waste volumes will surpass existing estimates, particularly under high-repowering scenarios. High-value recycling emerges as a key strategy to retain material purity, yet economic viability depends on financial incentives, collection success rates, and proximity to PV manufacturers. The study underscores the need for further research into recycler business models, silicon purification challenges, and reuse potential. Proactive policies and investments are critical to establishing a circular economy for PV materials, reducing resource dependency, and mitigating environmental impacts.

**Keywords:** photovoltaic, recycling, circular economy, waste management