Future Solar PV waste streams in the EU

EVERPV

EVERPV factsheet: Deliverable 6.1 Market assessment of PV and quantification of PV waste and waste streams in the EU

1 Introduction

Solar photovoltaic (PV) deployment has grown at unprecedented rates since the early 2000s. By 2030, the EU solar fleet is projected to reach a cumulated installed capacity of 816 GW according to the medium scenario, a significant increase from the 337.5 GW recorded at the end of 2024. As the global PV market increases, so will the volume of decommissioned PV panels, albeit with an interval as solar PV panels have a lifetime of 30 years or more. Hence, large amounts of solar PV waste are expected in the future.

Opportunities for end-of-life recovery

The growing amount of end-of-life solar PV poses a new environmental challenges but also economic opportunities for the solar PV industry. Indeed, crystalline silicon PV modules, mainly composed of glass, aluminium and plastics, also contain a small fraction of high valuable raw materials, such as silver, copper and silicon.

The advantage of solar PV recycling goes beyond the mere economic value of the recycled materials. Crystalline silicon PV modules use materials listed as Critical Raw Materials (CRMs) in the EU, including silicon metal, antimony and copper. With the CRM Act, the European Commission highlighted the importance of ensuring access to a secure and sustainable supply of CRMs, setting benchmarks for domestic capacities, including recycling.

In this context, the management of end-of-life and solar PV recycling become an important activity for EU strategic autonomy, as well as a source of materials for the EU solar industrial ecosystem.

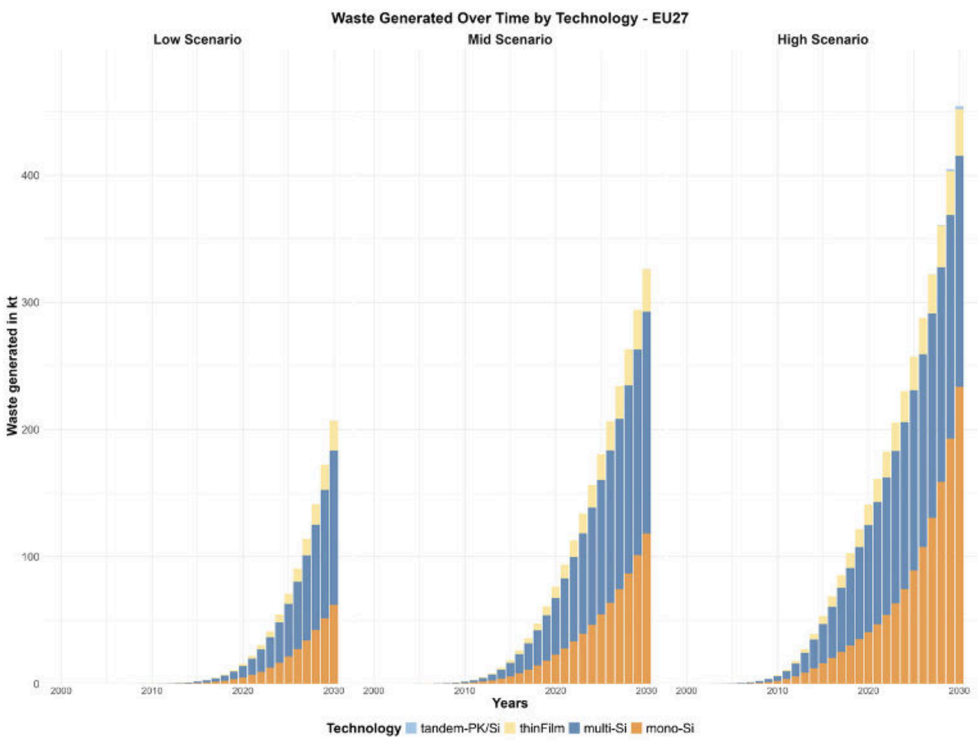
2 Key findings

How much waste do we expect?

The EVERPV project established a measurement framework for quantifying solar PV waste, covering key indicators like solar PV panels placed on the market (POM), installed capacity, and waste flows. It includes a classification system for consistency and presents PV waste data for the 27 European Union (EU) countries from 2010 to 2030, with waste flows reported at the national level.

The framework models three scenarios (Low, Mid, and High) to reflect uncertainties in capacity growth and disposal behaviour, offering a nuanced understanding of future PV waste dynamics shaped by policy and technological trends. The framework categorises solar PV systems into Residential (<10 kW), Commercial (<250 kW), Industrial (<1000 kW) and Utility-scale (>1000 kW, ground-mounted) applications, and considers multiple technologies, including monocrystalline silicon (Mono-Si), multicrystalline silicon (Multi-Si), and Thin-film (TF) technologies.

The results showed conclusively the rapid increase in solar PV waste to be expected within the next years, independent on installation assumptions for future years. However, as segments differ strongly by countries, resulting waste streams highly vary depending of the country assessed.



Projected solar PV waste by 2030:

- Low scenario: 207 kt solar PV waste
- Mid scenario: 326 kt (~3,860 MW)
- High scenario: 454 kt

Waste by applications:

- Utility-scale PV dominates in Mid and High scenarios due to repowering.
- Commercial-scale remains stable; Residential and Industrial-scale waste steadily rise.
- The Low scenario shows a more balanced distribution across segments.

Waste by technology:

- Multi-Si panels dominate early waste streams.
- Mono-Si overtakes by 2028 (High scenario) or just after 2030 (Mid scenario).
- Tandem-PK/Si enter earlier the waste stream due to shorter lifespans.
- Thin-film shares declines across all scenarios.

3 Recommendations

How to handle the future PV waste flows?

Overall, the report recommends improving data transparency, mandating detailed reporting, and expanding research into long-term waste trends and recycling strategies to ensure sustainable resource recovery and reduce environmental risks.

More data is needed beyond 2030
Going forward, future research should focus on evaluating potential waste flows beyond 2030 and possibly to 2050 to enable long-term planning. Long lifetimes and high installation rates entails more complex long-term predictions. A detailed assessment of lifetime parameters across different technologies and applications is recommended because the lifetime variable has a strong impact on the stock driven model developed in the EVERPV project. The lifetime is influenced by multiple variables: policy incentives and interventions, financing schemes for large-scale installations, technological advancements, repowering needs, and the effects of climate change. More extreme weather conditions, for instance, can impact the durability of PV panels. Such variations should be incorporated into modelling frameworks like the one developed in the EVERPV project.

Boost collection rates
The generation of solar PV waste is increasing at a faster rate than its collection, which is reaching 40% on average in the EU in 2022, well below the 85% WEEE Directive target. In the EU-27 region, the average collection rate of solar PV waste has not exhibited substantial growth over the past five years, despite an estimated overall improvement of 3% annually in the period 2020-2025. Enhancing national collection rates is crucial to maximise material recovery, facilitate the reuse of recovered materials as secondary raw materials, and reduce the EU's dependence on external sources for critical materials.

Enhance data reporting
Inconsistencies and data gaps have been highlighted by project partners related to the data officially reported by the Members States to Eurostat. Data reporting should be enhanced and improved to enable the tracking of both commercial and residential PV waste collected.

Monitor exports
Despite the increasing volume of PV installations and their eventual decommissioning, there is a significant lack of both quantitative and qualitative data on the export of used and waste PV panels from the EU to non-EU countries. While general statistics on waste exports exist, they rarely distinguish between different types of WEEE, making it difficult to assess the scale of PV waste exports specifically. Used panels or illegally exported PV also contribute to the discrepancy in collection numbers. Moreover, qualitative insights, such as the destination countries' handling practices, compliance with environmental regulations, and the potential for illegal shipments, remain largely unexamined. This data gap poses challenges for policymakers, industry stakeholders, and environmental regulators in ensuring that waste PV panels are properly recycled or disposed of rather than contributing to environmental harm in recipient countries.

Establish an EU database
The EU should mandate detailed reporting on PV waste collected and exports within existing WEEE tracking frameworks, requiring Member States and businesses to specify quantities, destinations, and treatment methods. Ideally, a publicly accessible database should be established at EU level to track PV waste flows, including data on exports, treatment facilities, and final disposal methods.

4 Conclusion

The EU faces a steep rise in solar PV waste, but with the right policies, infrastructure, and data systems, this challenge can be transformed into a strategic opportunity for sustainable growth and resource independence.

With improved data transparency, detailed reporting and further research into long-term waste trends and recycling strategies Europe can ensure sustainable resource recovery and reduce environmental risks for the solar PV industry.

Read the full report on the EVERPV website

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