Policy summary #4

PV eco-design and materials recycling
Where can the EU accelerate?

Takeaways and recomendations for policy makers from the Resilex workshops series

On the 19th of May 2026, the Resilex project organized a panel discussion in Brussels to discuss a series of topics relevant to the future of Europe. Key stakeholders were invited to engage in an active discussion on the sustainable exploitation and supply of Critical Raw Materials (CRMs) for the PV and battery industries and the takeaways from the Resilex project's results. This document summarizes the second discussion, focused on PV design and recycling. Check **here** for the other summaries

The session opened with a presentation by Marie Nicolle (Group Comet), who presented the work done by Groupe Comet on the recycling of PV panels.

Volumes and capacity: Marie presented crucial industrial data regarding the scalability of dedicated PV recycling. She stated that for a company to viably invest in building a brand-new, standalone PV recycling line, it requires a steady input volume of between 7,000 and 10,000 tonnes of waste panels per year.

Groupe Comet's Operational Advantage: Because current aggregate PV waste volumes across Europe remain relatively low, constructing single-purpose lines can be economically risky. However, Marie explained that Groupe Comet avoids this bottleneck because they do not only recycle PV panels; they also integrate this process into their existing multi-material recycling facilities. This allows them to remain highly profitable and process lower, emerging volumes (handling around 6,000 tonnes) by utilizing pre-existing industrial infrastructure.

Policy and Regional Fragmentation: She pointed out that while the EU WEEE DIRECTIVE enforces an 85% weight-based recycling target, execution differs wildly across borders. For instance, certain countries have raised their domestic mandates to 87%. She concluded that the EoL solar panel market is tightly regulated and bottlenecked by differing national "eco-organisms" (producer responsibility organizations) controlling tenders. To build true resilience, she advanced a major closing recommendation: Europe must establish a unified cross-border legal framework and transparent regulatory landscape for waste trade to allow recyclers to operate at a pan-European scale

The panel discussion moderated by Christina Maria Huber (SolarPower Europe)

The second presentation, delivered by Timea Béjat (CEA) illustrated the project's results and insights regarding eco-design for photovoltaic (PV) modules. Recalling the current situation of the PV market, Timea underlined that Silicon-based technologies dominate the market, with manufacturers transitioning toward TOPCon technology. The market share of silicon heterojunction (SHJ) cells is projected to grow from 5% to 20%, while Tandem cells are seen as the next evolutionary step.

SHJ technology is considered promising due to its reduced silicon consumption and low environmental impact, but it presents challenges related to high cost and the use of critical materials. Inside Resilex, the work of CEA focused on 1) the evaluation of silicon wafers obtained from the valorization of silicon waste for high-efficiency cells, 2) the development of sustainable silver-free (Ag-free) and indium-free (In-free) solar cells and 3) the investigation of bio-based materials and components for low-environmental-footprint modules.

A complete demonstrator module was created with the following eco-design features:

- Cells: 130 µm European wafers with a 72% reduction in indium and a 50% reduction in silver.
- Interconnections: Use of copper ribbon with electrically conductive adhesive (ECA).
- Components (BoM): Standard glass, European TPO encapsulant (partially bio-sourced), fluorine-free PET backsheet, and a wooden frame.

The module showed significant reliability, passed the standard **IEC 61215** requirements, showing a maximum power loss (Pmax) of less than 5% after 1000 hours of damp heat testing (85°C, 85% RH). In addition, the standard SHJ cells showed very promising electrical performance when paired with bio-based components. As for the reduction of Indium, the cells proved to be more sensitive to moisture ingress; to mitigate this impact, a silicon nitride (SiN) layer was added as a protective barrier

Identified Challenges & Bottlenecks

After the presentation, a panel discussion took place with the moderation of Christina Maria Huber (Solar Power Europe), and the participation of Elina Bosch (Becquerel Institute), in addition to Marie Nicolle and Timea Bejat. The outcomes can be found below:

Regulatory Disconnect and Cross-Border Red Tape: the panel discussed in more detail a crucial element already addressed by Marie. Even though the EU Waste Electrical and Electronic Equipment (WEEE) Directive regulates solar panel disposal, its transposition varies wildly from one member state to another. Panelists noted that trying to move waste panels across European borders to centralized PV-specific recycling hubs needs to be improved and differing definitions of hazardous waste between Member States stifle logistical efficiency.

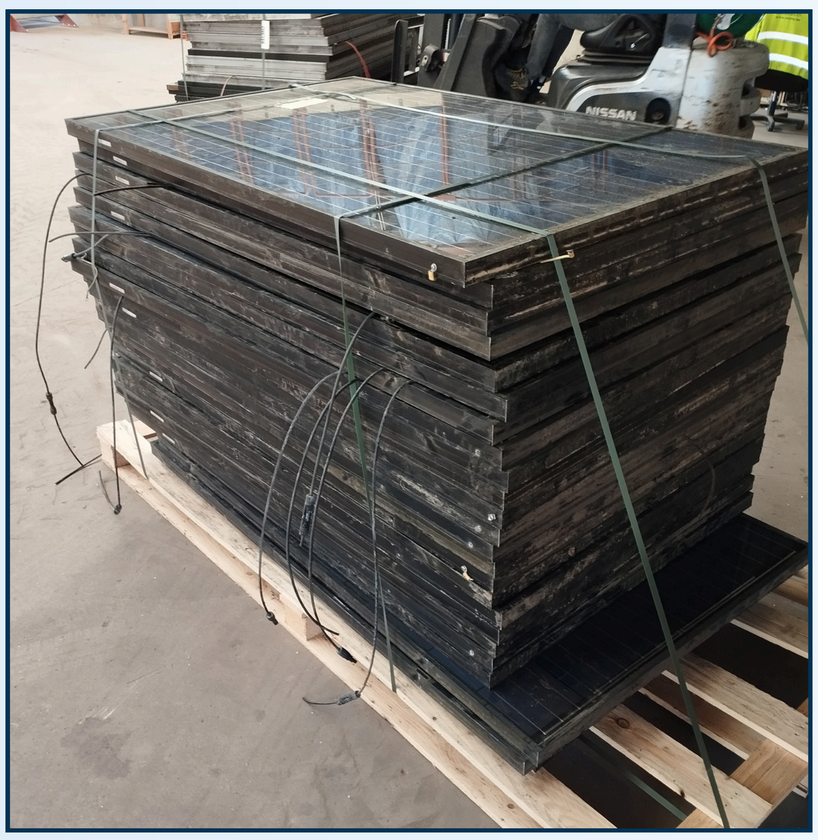
Today's Recycling Realities: PV recycling is already well advanced when compared to other waste streams, with weight-based recycling of 85 % being mandatory and achieved in EU Member States. However, the potential to improve the quality of recovered materials is not fully realised, due to low absolute waste volumes and, therefore, difficulties to invest into PV-specific recycling infrastructure. In addition, the presence of certain recycling disruptors such as fluorinated backsheets, materials reducing the value of secondary raw materials like antimony in glass and product design that focuses on durability compared to recyclability creates challenges that need to be overcome by industry.

Solutions and Paths Forward Advanced by the Panel

To bypass these bottlenecks, the speakers outlined a series of interconnected technical, logistical, and legislative solutions:

- **Harmonizing the WEEE Directive and Waste Logistics**: The speakers collectively recommended that the European Commission enforce a unified, frictionless legal framework for the collection and transport of end-of-life clean-tech components. Simplifying cross-border waste logistics and creating a European Single Market for waste would allow specialized regional hubs to aggregate sufficient volumes from multiple countries to operate at optimal, profitable capacities.

- **Developing "Design for Recycling" Frameworks:** The panel discussed that the industry should continue to transition to thermoplastic encapsulants (like POE) and eliminate fluorinated backsheets. Removing recycling disruptors like fluorinated backsheets will lower the costs of recycling the backsheets of PV modules. However, it is important to note that with the long lifetime of PV modules even a phase out of fluorinated backsheets in newer PV modules – a trend which has been ongoing for several years – will still mean that PV recyclers will see fluorine-containing backsheets for many years to come. Other trends in Ecodesign include a trend to move away from pricey materials such as silver, which is interesting in terms of reducing the pressure on such materials, however carries with it additional negative impacts in terms of the value of materials to be recovered in the recycling process. Ecodesign measures therefore should take a lifecycle approach and consider factors from the performance and longevity of PV modules and the viability of the recycling business case at the end of life.



End of Life Solar panels collected within the RESILEX activities

- **Implementing Digital Product Passports (DPPs):** To solve the issue of recyclers not knowing the chemical composition of incoming waste, the panel discussed the benefits of the rollout of Digital Product Passports. A DPP would allow a recycling plant to scan an old panel and instantly know its exact material makeup (e.g., silver content, presence of lead, type of polymer), allowing them to optimize their chemical and mechanical recovery automated lines.

- **Exploring upcycling Links (The PV-to-Battery Loop):** Current PV panel recycling practices often involve downcycling PV panels into applications like insulation or construction aggregate. With a strengthened focus on recovering critical raw materials from the PV panel waste stream new avenues need to be explored to encourage the recovery and reuse of materials like silicon. The panel discussed the success of the RESILEX workflow, where silicon recovered from solar panels is purified to a degree where it can be reapplied in the battery manufacturing sector for advanced silicon-dominant anodes creates a possible market for secondary recovered silicon

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The secondary market for silicon is currently facing difficulties due to limited possibilities regarding raw material offtakers. Research projects like RESILEX provide important possibilities to explore innovative synergies like these across sectors.

The panel discussion moderated by Christina Maria Huber (SolarPower Europe)

Concluding remarks

Overall the panel noted that while the PV recycling sector is well under way to be able to handle future waste streams that challenges remain. The European Union should focus on delivering on a single market for waste, improve harmonisation between regulations in different Member States with regards to material thresholds and recycling targets and consider the possibilities that integrated Ecodesign principles could bring for the sector. Taking a full lifecycle approach to product design of also new PV applications with the recycling in mind could further improve the outcomes for the sector.

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