

Report on the EVERPV Scientific workshop on 1-2 July at Neuchatel, CH

Agenda:



1-2 July 2026,
CSEM, Jaquet Droz 1 – 2002 Neuchâtel,
Switzerland

**PV Module Recycling: Technologies, Materials
and Circularity Challenges**
Scientific workshop

DAY 1 – 1 July 2026

Time	Duration	Session	Speaker
12:30	30'	Arrival	
13:00	15'	Welcome	CSEM
13:15	20'	Global EVERPV project presentation	CEA
13:35	20'	Mechanical Glass-Backsheet Photovoltaic Modules Delamination: Toward Materials Recycling	CEA
13:55	20'	Backsheet removal: results from the EVERPV equipment and hybridization with downstream recycling process	9-TECH/ENEAC
14:15	20'	Challenges in Recycling PV Module Polymers	PCCL
14:45	20'	Life Cycle Assessment of EVERPV module recycling routes and recovery of secondary materials	CSEM
15:05	30'	Coffee break	
15:35	20'	Industrial decarbonation & reuse	Planair/AEnEc
15:55	20'	Advances in Photovoltaic Module Recycling – IEA PVPS Task 12 and QUASAR Insights	EPRI
16:15	20'	PV module recycling in Switzerland: what is done (or not) and the Smart-Cycling approach of Solar-Loop	Solarloop
16:35	10'	Wrap-up Day 1	CSEM
16:30		Social dinner *please, indicate the attendance in the registration	

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1-2 July 2026,
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Switzerland

**PV Module Recycling: Technologies, Materials
and Circularity Challenges**
Scientific workshop

DAY 2 – 2 July 2026

Time	Duration	Session	Speaker
8:40	20'	Arrival	
9:00	20'	PV module recycling and sustainability	Helmholtz
9:20	20'	High-margin end-of-life photovoltaic panels recycling at industrial scale	ROSI SOLAR
9:40	20'	From recycling cost to material profit "How end-of-life management and recycling of solar panels add value"	Solar Materials
10:00	15'	Coffee break	
10:15	65'	The Future of PV Circularity: Opportunities, Challenges and Market Pathways	ALL
11:20	15'	Closing	CEA
13:00	120'	CSEM visit *please, indicate the attendance in the registration	

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On EVERPV:

The EVERPV project, launched in September 2023 with a budget of €6.7 million, focuses on developing innovative recycling approaches capable of recovering valuable materials from end-of-life PV modules while supporting circular economy objectives. A key ambition of the project has been to move beyond conventional shredding-based recycling and develop technologies that preserve material quality through selective separation and recovery processes

INTRODUCTION

Title: PV Module Recycling: Technologies, Materials and Circularity Challenges

Presentations by: CEA, CSEM, ENEA, Betatech, 9-Tech, PCCL (Polymer Competence Center Leoben), EPRI (Electric Power Research Institute), Planair, AEnEc, SolarLoop, ROSI Solar, Solar Materials, and Helmholtz-Zentrum Berlin (HZB), SolarPower Europe.

On 1–2 July 2026, the EVERPV project organised its planned scientific workshop “*PV Module Recycling: Technologies, Materials and Circularity Challenges*” at CSEM in Neuchâtel, Switzerland.

This report aims to outline the main points of the discussions, gaps, challenges and potential solutions. The event brought together researchers, recycling technology developers,

industrial stakeholders, and circular economy experts to discuss recent advancements in photovoltaic (PV) module recycling and the future development of circular value chains for the European solar sector.

The agenda included presentations covering advanced recycling technologies, polymer recovery, life-cycle assessment and partly eco-design aspects, industrial recycling initiatives and international research activities. The workshop concluded with a roundtable discussion involving representatives from ROSI Solar, EPRI and CEA, exploring opportunities and challenges for establishing a competitive and circular European PV industry.

The workshop featured presentations covering advanced delamination technologies, polymer recycling challenges, material recovery processes, lifecycle assessment results, industrial recycling initiatives and international research activities. It concluded with a roundtable discussion addressing future opportunities and challenges for a circular European PV industry.

Theme 1: Advanced Delamination Technologies and Material Recovery

A central theme of the workshop was the development of advanced recycling technologies capable of separating photovoltaic module components prior to conventional shredding processes. Throughout the different presentations, speakers highlighted how early-stage separation can improve material purity, increase the value of recovered fractions and create opportunities for closed-loop reuse.

The discussions demonstrated a clear shift away from traditional WEEE recycling approaches towards more selective treatment methods. The technologies presented within EVERPV aim to preserve material quality through targeted delamination and downstream purification processes. International examples and benchmarking activities further illustrated the growing maturity of advanced recycling technologies and their potential contribution to European resource security and circularity objectives.

Mechanical Glass-Backsheet Delamination (CEA) – presented by Fabrice Coustier

CEA presented a mechanical sanding process designed to separate PV module layers while preserving intact glass sheets. The technology enables the generation of distinct material fractions suitable for downstream recovery of glass, silicon, silver and copper. The process has already progressed to industrial demonstration, with more than 5,000 tonnes of modules treated and pilot operations established at ENVIE 2E in France.

Further work is required to optimise post-treatment and purification steps and to assess the treatment of damaged and double-glass modules, which are expected to represent an increasing share of future PV waste streams.

Backsheet Removal and Hybrid Recycling Processes (ENEA, Betatech, 9-Tech)- presented by Pietrogiovanni Cerchier

The presentation introduced an infrared-assisted backsheet removal technology combining thermal treatment and mechanical tear-off. The process enables the recovery of cleaner polymer fractions and improves the performance of downstream recycling operations. Results demonstrated successful integration with 9-Tech's recycling process and the development of a TRL7 pilot-scale system capable of processing full-size modules.

While the technology has shown promising technical results, additional efforts are needed to support industrial deployment and establish economically viable pathways for the recovery and reuse of separated polymer fractions.

Challenges in Recycling PV Module Polymers (PCCL)- presented by Gernot Oreski

PCCL focused on the recyclability of polymer materials used in PV modules, including EVA encapsulants and backsheets. The presentation introduced the distinction between theoretical, technical and real recyclability, highlighting that successful recycling depends not only on technology but also on collection systems, material purity and market demand. Novel separation approaches were presented to improve the quality of recovered polymer streams.

Participants agreed that polymer recycling remains one of the least mature aspects of PV circularity. The economic viability of recycling crosslinked EVA and complex polymer mixtures continues to be a major challenge.

Life Cycle Assessment of EVERPV Recycling Routes (CSEM) – presented by Alexis Barrou

The presentation examined the environmental performance of the recycling routes developed within EVERPV. Preliminary results highlighted the importance of assessing recycling technologies using a broader set of indicators, including carbon footprint, resource efficiency, environmental impacts and material value retention.

Further work is needed to compare environmental benefits across different recycling routes and to determine how these assessments can support future policy and investment decisions.

Industrial Decarbonisation and Reuse (Planair / AEnEc)- presented by Mathieu Boccard

Planair and AEnEc explored opportunities to reduce environmental impacts throughout the PV value chain through circular economy approaches, reuse strategies and industrial decarbonisation measures. The presentation highlighted the role of resource efficiency and secondary materials in supporting the sustainability of future PV deployment.

The discussion identified the need for stronger integration between recycling, reuse and industrial manufacturing systems to maximise circularity benefits.

Advances in Photovoltaic Module Recycling – IEA PVPS Task 12 and QUASAR (EPRI)- presented by Alberto Pico

EPRI presented the latest findings from [IEA PVPS Task 12](#) and updates from the QUASAR project. The analysis compared commercial and emerging recycling technologies and

highlighted the increasing performance of hybrid recycling routes combining mechanical, thermal and chemical treatments. Examples from projects and industrial initiatives demonstrated continuing progress towards higher recovery rates and material purity.

The presentation highlighted the need for harmonised benchmarking methodologies, improved data availability and continued collaboration among researchers, recyclers and industry stakeholders to support technology scale-up.

PV Module Recycling in Switzerland and SMART-Cycling Approach (SolarLoop)- Benjamin Strahm

SolarLoop provided the Swiss perspective on PV circularity and introduced its SMART-Cycling approach, which combines recycling, testing, repowering and selective reuse. The presentation emphasised the role of extending module lifetime wherever possible before recycling becomes necessary.

Participants discussed how limited domestic recycling capacity and uncertain future waste volumes remain barriers to developing large-scale circular business models. The need to balance reuse, repowering and recycling strategies was also emphasised.

Theme 2: Towards High-Value and Closed-Loop Recycling: challenges beyond technology

A constant reminder throughout the workshop was that the future of photovoltaic recycling lies not only in recovering materials, but also in preserving their quality and value for future reuse.

One of the most promising achievements presented within EVERPV concerns glass recovery and reuse. The project demonstrated the recovery of intact glass sheets that can potentially be reused directly in photovoltaic manufacturing or reintegrated into industrial glass production. Ongoing industrial validation activities are assessing the incorporation of recycled PV glass into commercial manufacturing processes, creating new opportunities for closed-loop recycling. Similar efforts are being pursued for silver, silicon and selected polymer fractions, although the maturity of these recovery routes varies considerably.

Several speakers highlighted the important distinction between material weight and material value. While glass represents the largest share of a PV module by mass, materials such as silver and silicon account for a significantly larger proportion of the economic value recovered during recycling.

PV Module Recycling and Sustainability (Helmholtz-Zentrum Berlin)- presented by Ian Marius Peters

The presentation addressed the broader sustainability dimensions of photovoltaic recycling and the role of circularity in supporting future solar deployment. Particular attention was given to the need to integrate end-of-life considerations into technology development and

module design, ensuring that future generations of photovoltaic technologies are compatible with efficient recycling and material recovery processes.

As photovoltaic technologies continue to evolve, recycling solutions must adapt accordingly. Participants highlighted the importance of anticipating future recycling challenges associated with emerging technologies and ensuring that sustainability considerations are incorporated from the earliest design stages.

High-Margin End-of-Life Photovoltaic Panel Recycling at Industrial Scale (Rosi Solar) – presented by Yun Luo

ROSI Solar presented its industrial-scale recycling model focused on recovering high-purity silicon and silver from end-of-life photovoltaic modules. The company demonstrated how advanced recovery technologies can transform recycling from a waste treatment activity into a source of strategic secondary raw materials. Particular emphasis was placed on recovering high-value materials that can contribute to the economic viability of recycling operations and strengthen European resource security.

While advanced recovery technologies continue to improve, scaling operations and securing sufficient waste volumes remain important challenges. The discussion highlighted the need for supportive market conditions and long-term investment to facilitate industrial deployment.

From Recycling Cost to Material Profit (Solar Materials) - presented by Jan- Philipp Mai

Solar Materials presented a business-oriented perspective on photovoltaic recycling, focusing on value creation through material recovery. The presentation demonstrated that although silver represents only a very small fraction of a module's total weight, it contributes disproportionately to the overall recoverable value. This observation supports a transition away from weight-based recycling metrics towards value-oriented recovery strategies.

Participants discussed the challenge of balancing environmental objectives with economic performance. The presentation demonstrated that improved recovery of high-value materials will be essential for developing profitable and sustainable recycling business models.

Theme 3: Polymer Recycling

Despite substantial progress in the recovery of glass, silver and silicon, polymer recycling remained one of the most challenging topics discussed throughout the workshop. Presentations from PCCL and project partners highlighted that while many polymers used in photovoltaic modules are theoretically recyclable, only a limited fraction is currently recycled in practice. Modern PV modules contain complex combinations of encapsulants, backsheets and additives that are difficult to separate and process economically.

Particular attention was given to crosslinked EVA encapsulants and fluorinated backsheets. Although several recovery and reuse pathways are being explored, including applications in new materials and industrial products, identifying economically viable end-markets remains difficult. Similar challenges were reported for PET recovery, which competes with well-established recycling streams from packaging applications.

The discussions introduced the distinction between theoretical, technical and real recyclability. Participants stressed that recyclability does not depend solely on technological feasibility, but also on collection systems, material quality, processing costs and market demand. As a result, successful circularity requires not only technological innovation but also functioning value chains capable of absorbing recovered materials.

Workshop participants agreed that polymer recycling remains one of the least mature areas of PV circularity. Further research is required to improve material separation, identify high-value applications for recovered polymers and determine when recycling provides greater environmental benefits than alternative end-of-life pathways.

Roundtable Discussion: Key Messages

The workshop concluded with a roundtable discussion entitled “*The Future of PV Circularity: Opportunities, Challenges and Market Pathways*”, bringing together representatives from ROSI Solar, EPRI, CEA and moderated by Solar Power Europe.

Point 1:

The discussion focused on the transition from successful pilot projects towards a mature European recycling industry. While participants acknowledged the significant technological progress made in recent years, they agreed that technology alone will not be sufficient to establish a circular PV industry.

Market demand, supportive regulation, infrastructure development and value-chain collaboration were repeatedly identified as essential conditions for large-scale deployment.

Point 2:

Another important point raised during the discussion was the need to adopt a bottom-up approach when developing future research and innovation activities. Participants emphasised that successful circularity projects should be built around the needs of manufacturers, recyclers and other market actors, rather than focusing solely on technological development. Starting from clearly identified industrial challenges and market demand can help ensure that research outcomes are aligned with real-world needs and have a clear pathway towards commercial deployment. This approach was considered essential for strengthening both European research and industrial capacity, while increasing the likelihood of rapid market uptake and long-term impact once projects are completed.

Additionally the challenge of scaling recycling solutions commercially. Speaker explored the barriers that continue to limit industrial deployment, including feedstock availability, collection systems, investment certainty and the need for economically viable business models. The discussion highlighted that Europe must develop recycling infrastructure and market capacity before the largest wave of end-of-life photovoltaic modules becomes available.

Point 3:

The panel also examined the prospects for developing a closed-loop photovoltaic industry in Europe. The panel touched the recovery of strategic materials such as silicon and silver and their contribution to European resource security. The discussion highlighted that the future

competitiveness of recycling operations may increasingly depend on the recovery of high-purity and high-value materials rather than solely on recovering large material volumes.

Point 4:

Another recurring theme was the relationship between profitability and regulation. The panel debated whether future growth of the recycling sector would be primarily driven by economic value creation or by regulatory requirements. Participants discussed the importance of developing business models capable of transforming recovered materials into valuable secondary resources while maintaining economic viability under changing market conditions.

Point 5:

Research priorities for the coming years were also addressed. The discussion highlighted the importance of continued benchmarking of recycling technologies, assessment of environmental performance, improvement of material purity and identification of the most effective recycling pathways for different module designs. Participants noted that no single recycling solution is likely to address all future photovoltaic waste streams, and that multiple complementary approaches may be required.

The roundtable concluded with a broader reflection on the future of PV circularity in Europe. Participants agreed that achieving circularity will require coordinated action across the entire value chain, involving manufacturers, recyclers, researchers, policymakers and investors. While industrial solutions are already emerging, continued collaboration will be essential to transform current technological achievements into a resilient and competitive circular photovoltaic ecosystem.

Conclusions

The EVERPV Scientific Workshop demonstrated substantial progress in photovoltaic recycling technologies and highlighted Europe's growing leadership in circular solutions for the solar sector. The project successfully developed and demonstrated innovative delamination technologies that enable high-quality material recovery while reducing dependence on conventional shredding-based approaches.

Across the workshop, a clear shift emerged from simple material recovery towards preservation of material quality and value. At the same time, discussions showed that polymer recycling continues to face important technical and economic challenges that require further research and market development.

Perhaps the strongest conclusion from the workshop was that successful circular PV value chains will depend on collection systems, industrial collaboration, supportive policies, viable business models and market demand for recovered materials. As Europe prepares for increasing volumes of end-of-life photovoltaic modules, projects such as EVERPV provide important foundations for the transition towards a circular solar industry.