Bridging innovation and regulation with HEPAFLEX's perovskite technology

15 September 2026, Online

Report

1. Introduction

On 15 September 2026, LOMARTOV organised the second HEPAFLEX webinar, connecting the project's technical advances with regulatory readiness, environmental performance and circular business models. Building on the first organised webinar (January 2026) *Dialogue on Perovskite Regulation*, the event examined how flexible photovoltaic technologies could progress towards market uptake. A central conclusion was that manufacturing innovation must be supported by evidence on durability, safety and life-cycle performance, alongside practical arrangements for collection and end-of-life treatment.

2. Audience

The webinar addressed researchers, technology developers, industry representatives and stakeholders interested in photovoltaic innovation, sustainability and regulation. Contributions from connected research and environmental assessment with industrial perspectives. The discussion also considered how technical information can become understandable and useful to future consumers.

3. Objectives

The webinar was organised with the following objectives:

- Present the HEPAFLEX research results across key areas, including environmental performance, production, legislation, and exploitation.
- Demonstrate how HEPAFLEX technologies can support regulatory alignment and policy objectives within the photovoltaic sector.
- Foster a multidisciplinary discussion on future business cases, market readiness, and the regulatory implications of perovskite-based technologies.
- Encourage stakeholder engagement on the technical, environmental, and legal challenges affecting the future deployment of innovative photovoltaic solutions.

4. Workshop results and conclusions

Regulatory readiness and market entry. LOMARTOV presented the project's mapping of legislation, standards and certification pathways. Screening more than 4,300 standards identified 57 potentially useful standards and six potential certification schemes. The analysis highlighted the lack of perovskite-specific standards and the limited suitability of some existing testing approaches. HEPAFLEX can contribute experimental data to future standardisation, particularly for testing, production and end-of-life management.

The presentation also linked market uptake to competitiveness, sustainability evidence and transparent product information. Standardisation alone cannot resolve price competition with established photovoltaic products. Life-cycle assessment, costing and preparation of data for future

digital product passports were therefore presented as complementary ways to demonstrate value and support circularity.

Faster processing compatible with flexible substrates. EPFL presented flash infrared annealing (FIRA), which replaces a conventional annealing step of around 10–60 minutes with a light pulse lasting less than one second. Selective heating limits thermal exposure of the substrate and removes the anti-solvent step in the processing route presented. Computer-vision analysis of grain formation provides a basis for measuring film morphology and improving process control.

For the perovskite devices discussed, the presentation reported efficiencies around 20% and retention of more than 90% of initial power over 4,000 hours of maximum-power-point tracking at 35 °C under dry conditions, using the TEMPO additive. These laboratory results should be distinguished from the flexible perovskite devices, whose performance was reported at around 10% and whose integration remains under development. The discussion placed FIRA mainly at laboratory scale, with pilot-oriented development also mentioned; industrial deployment remains a further step. Energy and environmental benefits depend on the device, process and basis of comparison.

Environmental performance and safer material choices. Universitat Jaume I presented work combining Safe and Sustainable by Design screening, material criticality assessment and life-cycle inventories. Hazard screening supports decisions on substitution, redesign and exposure control. Where hazardous substances cannot yet be replaced, encapsulation and other protective measures remain relevant. The work also examines supply risks across the full device, including materials that may be overlooked when attention is limited to the absorber layer.

A case study compared a conventional DMA-based processing route with a nickel-acetate route that avoids several solvents and additives and reduces processing energy. The reported climate-change impact fell by approximately 70% for the assessed production of one square centimetre of absorber layer. This is not a whole-module or lifetime electricity-generation result. Most assessed impacts improved, but mineral-resource impacts worsened and toxicity benefits were more limited, with lead remaining a major contributor. The result illustrates the need to assess environmental trade-offs alongside reductions in hazardous inputs.

Circular business models and digital traceability. GE4A proposed incorporating product identification and traceability from manufacture, linking information on composition, ownership, performance and end-of-life treatment. Such information could support maintenance, sorting, reuse and recycling. Deposit-return incentives and additional revenue from data services or printable surfaces were presented as possible business-model options, rather than established HEPAFLEX features.

A key concern was whether the recoverable material value of lightweight perovskite modules would be sufficient to motivate collection and treatment. Reliable take-back arrangements and clear responsibilities would therefore need to be designed alongside the product. Digital tools could support these arrangements, but their practical and economic feasibility remains to be demonstrated.

Cross-cutting findings from the discussion. The exchange highlighted that recycling does not automatically deliver a net environmental benefit: energy use, reagents, recovery performance and cost must also be assessed. Lead separation and management were identified as priorities for safety, regulatory readiness and public confidence. Replacing glass with a flexible polymer can reduce manufacturing impacts, but lower efficiency or durability may offset those gains when performance is assessed over the use phase.

Recycled plastic substrates were discussed as a development opportunity, without establishing a validated HEPAFLEX solution. Their environmental benefit must account for collection and recycling processes; recycled content alone does not demonstrate a negative carbon footprint. Preliminary

indications of low electricity costs were likewise conditional on achieving the required efficiency and stability.

The discussion also stressed that product data must be translated into information that different users can understand. For industry, composition and traceability can support operational decisions; for consumers, communication should explain implications for safety, maintenance, affordability and return options. Transparent information and credible management of remaining risks were identified as important for trust.

Overall, the webinar identified linked priorities: demonstrate reliable flexible devices at larger scale; substantiate sustainability and cost claims across the life cycle; and develop workable traceability and take-back models. These findings will inform HEPAFLEX's continuing regulatory, sustainability, exploitation and communication work.

AGENDA

Time	**Topic**
11:30-11:40	***Welcome and introduction*** • *Presentation of the webinar aims and Overview of the agenda* - Mihaela Mirea (LOMARTOV)
11:40-12:40	***HEPAFLEX's groundbreaking innovation results*** • *From Innovation to Compliance: How HEPAFLEX Responds to Regulatory and Technical Challenges* - Ignacio Zurano (LOMARTOV) • *Flash Infrared Annealing for Greener and Flexible-Compatible Perovskite Photovoltaics* - Sandy Sanchez (EPFL • *HEPAFLEX: Toward Sustainable Solar Cells* - Rosario Vidal (UJI) • *Digital Circular Economy in Photovoltaics: Unlocking Digital and Sustainable Resource Management* - Toralf Nitsch (GE4A)
12:40 -13:20	***Roundtable Discussion*** • *Moderated dialogue on regulatory needs affecting HEPAFLEX technologies deployment* • *Q&A from the audience*
13:20 - 13:30	***Wrap up and closing*** • *Brief summarising of potential next steps to take*