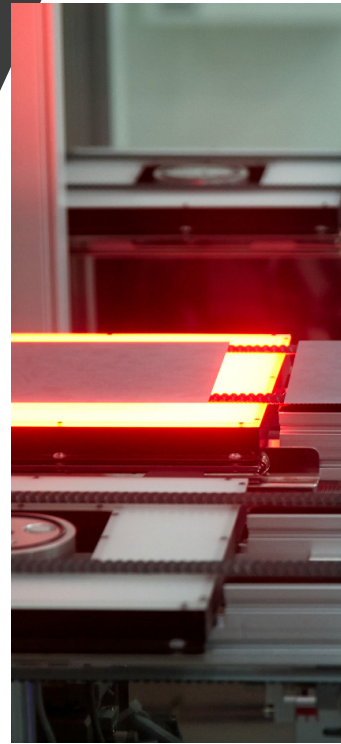
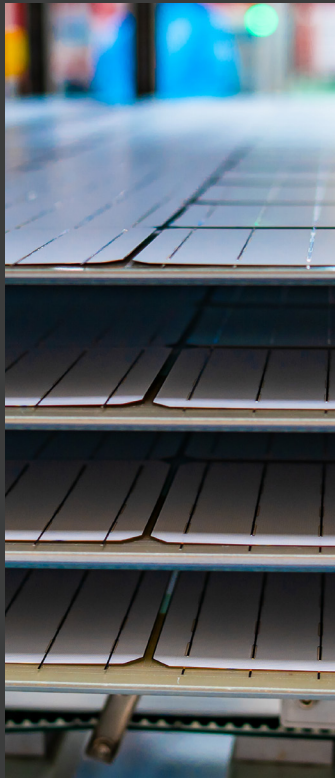


Shaping the future of solar energy with tandem technology



pepperoni-project.eu



Newsletter #1

Welcome to the first issue of the bi-annual newsletter of the PEPPERONI project!

“This research advances the perovskite/silicon tandem solar cell and module technology. At a time of unprecedented pressures on the current energy system, it is exciting to realise this transformative step towards industrial-scale manufacturing of next-generation PV technology in Europe”. - says Fabian Fertig, Director Global R&D Wafer & Cells at Qcells.



Based on the impact assessment on possible pathways to make European Union climate neutral by 2050, [the European Commission announces new recommendations.](#)

On 6 February 2024, the EC opts for a 90% target on greenhouse gas emissions reduction by 2040 and the need for manufacturing capacity growth of various sectors, including solar PV.

Join us and explore the complex landscape of PV research and industry. Learn about the challenges and technology developments contributing to the sustainable and green future.

p.1 Industry insights

p.2 Project insights

p.4 Technical Advances

p.5 News & collaborations

Industry insights

what is the target?

The target is to have the minimum average levelized cost of electricity (LCOE), meaning the minimum cost of generating kWh of electricity. The key influencing factors are:

- **Initial costs:** modules, Balance of system (BOS), installation, development and financing.
- **Ongoing costs:** operations and maintenance, insurance, taxes, others.
- **Energy yield:** kWh, irradiation, power plant performance, module degradation, low-light-behaviour, temperature coefficient.

A report from Ernst & Young (EY) says that the global weighted LCOE for PV is now 29% lower than the cheapest fossil fuel alternative.

Attributes of a commercially successful solar cell and module technology that enables low LCOE include:

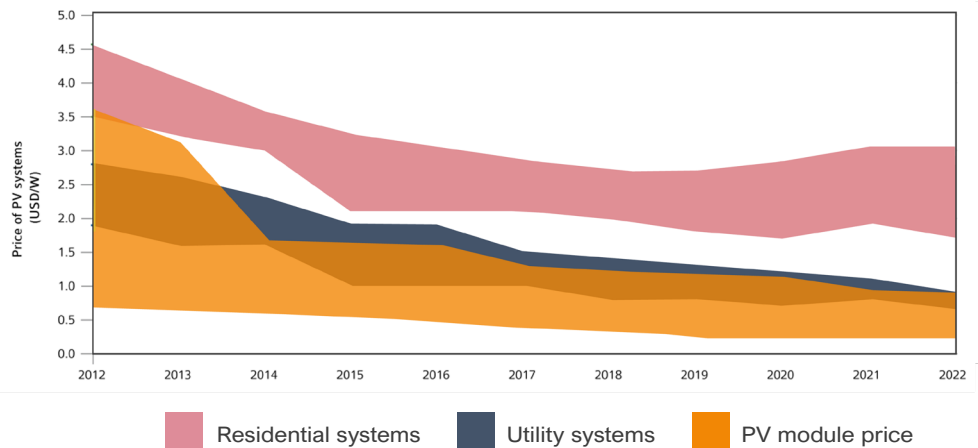
- **Lean & cost-effective manufacturing process:** equipment, processes, etc.
- **High quality of products** and reproducibility of processes.
- **Effective suppression** of degradation effects: long-term reliability, degradation mechanisms analysis, accelerated testing, field-relevant data.

These are even more important with new technologies, as they compete with mature and proven silicon PV technology.

why perovskite/silicon tandem?

Perovskite/silicon tandem technology promises the best ratio of performance over manufacturing costs. Perovskite takes advantage of the parts of the solar spectrum that typical silicon PV materials cannot utilise very efficiently. The tandem design benefits from the industrial expertise of silicon PV and extends the range of attainable power conversion efficiency (PCE) beyond the practical limits of silicon. Increasing the PCE of solar cells is important for various reasons. It is the most effective way to reduce the LCOE. In the short term, it is the best way to promote PV for residential applications and /or limited area. Moreover, it is important to reduce the price carbon footprint of PV installations.

“If perovskite/Si tandem modules can be produced on a large scale”, Fabian Fertig says, “they should be able to generate electricity at a typical cost of 2.5 €/kWh — competitive with silicon PV”.



In 2021 and 2022, the rise in energy expenses, especially electricity prices, has made PV more competitive in many countries. However, there is a significant gap between the price of residential and utility systems and the price of the PV module. This is especially noticeable for residential systems. Most of the module costs are linked to the BOS components, which roughly scale with the number of square meters (m²). To lower the cost of residential PV systems, more watts (W) must be produced per m².

Here the perovskite/silicon tandems become the most attractive, as the technology is the most economically promising route to reach efficiencies above 30%. Costs for reaching the same power output per module with silicon would be much higher, and modules would exceed common residential module dimensions. Comparable efficiencies cannot be reached with silicon PV due to physical limitations.

Ref: International Energy Agency. 2023. “Trends In Photovoltaic Applications 2023” <http://www.iea-pvps.org/>

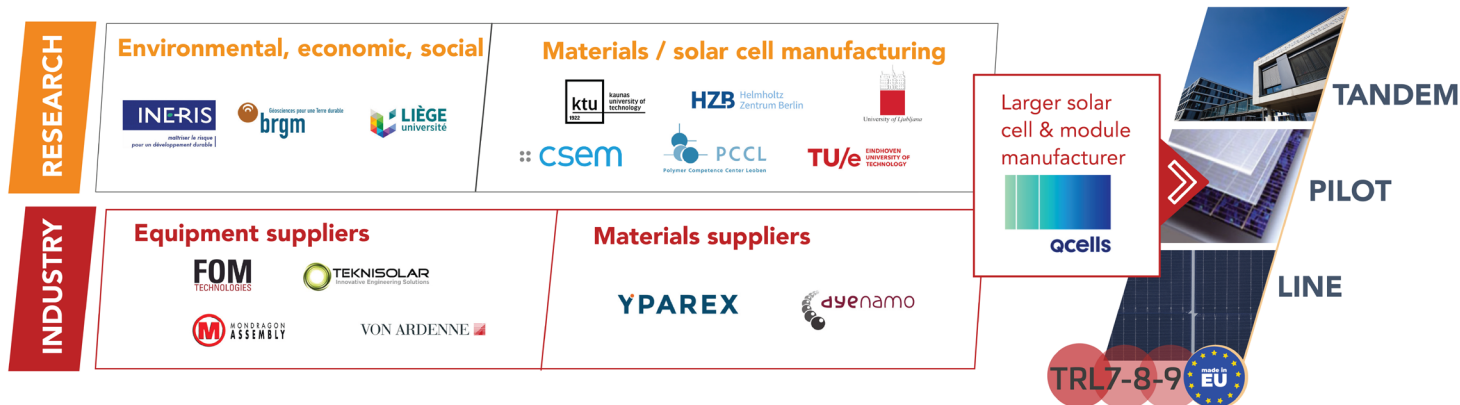
Project insights

what is PEPPERONI about?

PEPPERONI, a four-year Research and Innovation project co-funded under Horizon Europe and jointly coordinated by Helmholtz-Zentrum Berlin (HZB) and Qcells (QC) aims to remove the different scientific, technological and economic barriers to performance, manufacturing and socio-economic aspects hindering the industrial deployment of perovskite/silicon tandems.

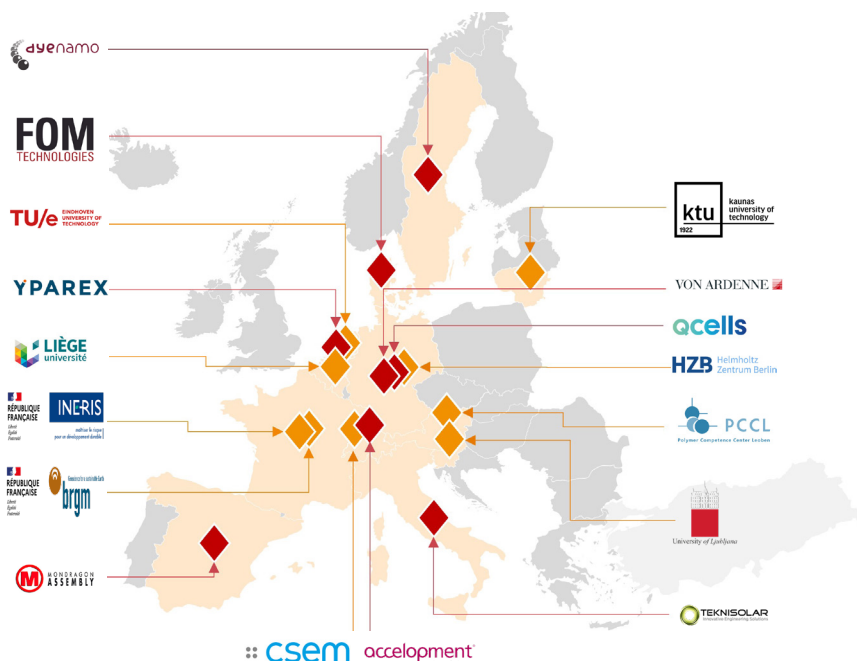
To do so, the project brings together world-leading European experts covering the full PV value chain to advance the technology readiness level to a prototype demonstration in an operational environment.

See our goals



who is involved?

The PEPPERONI consortium counts **17 partners from 12 countries** spanning across Europe. A total of about 80 researchers and experts from the PV value chain are committed to realise the project goals and establish a solid European PV innovation capacity. With a starting point of 40% female researchers involved, PEPPERONI also strives for a gender balance. Learn more about PEPPERONI partners, their contributions to the project and the team members.



Meet partners

Partners spotlights

where did you see us in 2023?

PEPPERONI partners presented at key PV conferences and events, including



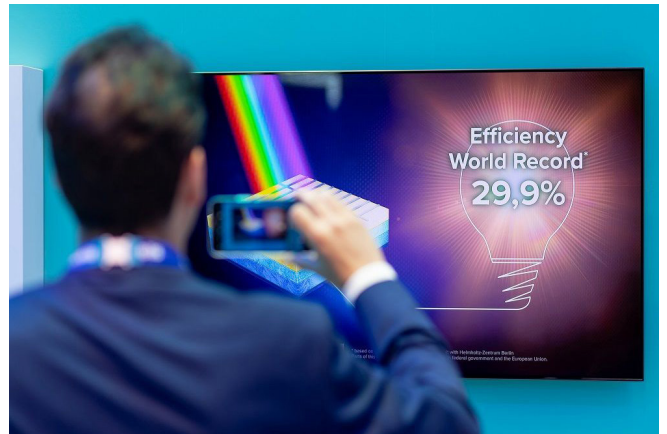
13-14 March - LCA Methodology Harmonization Workshop [Read more](#)



14 March - PV Cell Tech 2023 [Read more](#)



06-08 June - TandemPV workshop [Read more](#)



14-16 June - Intersolar Europe 2023 [Read more](#)



18-20 September - PSCO 2023 [Read more](#)



18-20 September - EU PVSEC 2023 [Read more](#)

where will we present in 2024?

With the project progress, PEPPERONI partners are actively disseminating the research results at key PV conferences and events. Join us and gain insights into technology advancements, including encapsulation materials and strategies, tandem cells degradation processes and more.

[See calendar](#)



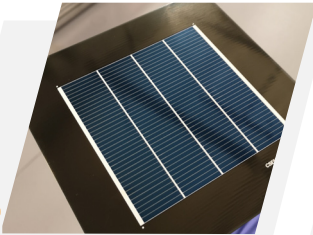
Technical advances

how do we work?

Innovation development is a complex task that requires resource-sensible planning and implementation, especially with so many players from PV innovation involved. In PEPPERONI work occurs on different levels with a continuous exchange between key players of PV innovation. We implement activities through nine strategically designed Work Packages (WPs). Seven of these

are technical, four dedicated to the technology development, two to the technology assessment and one to the development of the pilot line. Technical WPs are complemented by WPs dedicated to coordination and outreach with a clear strategy to further ensure the impact of the project.

[Read more](#)



Technology development



Technology assessment



Tandem cell & module pilot line



Coordination & outreach

what is the technical progress?

Samples and know-how obtained in the technology development WPs are used not only to test and assess the operational stability of the tandem solar cells but also to evaluate the environmental and societal impacts of the technology.

Within the first year, PEPPERONI partners produced five technical deliverables, including four on **the technology development**:

- WP3: Improved silicon bottom cell for perovskite/silicon tandem cell.
- WP4: Interconnection of perovskite/silicon solar cells with low PCE loss.
- WP5: Development of the evaporation concept suitable for the pilot manufacturing.
- WP5: Installation of lab-scale slot-die coater for perovskite and contact layers.

and one on **the technology assessment**:

- WP7: Accelerated test strategy for tandem cells and modules.

“After the first year, we are well on track with all milestones achieved and deliverables produced. Together, we are shaping the future of sustainable energy through innovation and collaboration.”



Bernd Stannowski (HZB) the project co-coordinator

We also asked Fabian Fertig, PEPPERONI technology co-coordinator from Qcells, about the first year of the project. **Watch the video.**



Dr Fabian Fertig

Director of Global R&D for Wafer & Cells, Qcells, Germany
PEPPERONI technology development coordinator

I work at Qcells in Germany

[Read more](#)

what did you miss?

On 10 November 2023, PEPPERONI held the webinar on: [Empowering Future Solar Energy: Unveiling PEPPERONI's Perovskite/Silicon Tandem PV Ambitions](#). This online event attracted around 70 participants from around the world. Most attendees foresee that the tandem modules would enter the market in 3-5 years, with perovskite/silicon lab cells reaching efficiencies of 36% by 2028.

The webinar was the first from the series that PEPPERONI plans to hold.

Contact us at info@pepperoni-project.eu if you would like to get access to the webinar recording.

In 2023, the PEPPERONI consortium met twice to discuss the project progress and define next steps:

- General Assembly (GA) hosted by University of Liège, Belgium on 24-25 May brought together more than 30 experts for in-person meeting.
- The consortium members met again in Neuchatel, Switzerland on 9-10 November during the GA hosted by the Swiss Centre for Electronics and Microtechnology (CSEM). The meeting not only marked one year into the project, but also included a lab tour.



[More news](#)

EU perovskite technology focus

Cross-project initiatives not only enhance knowledge sharing but also demonstrate the dedicated PV research community in Europe tackling the challenges of perovskite PV technologies. We joint collaborative efforts with nine EU-funded projects focused on perovskite technology.

Stay informed about groundbreaking research, advancements, and innovations of perovskite-related EU projects. **Subscribe to our newsletters!**



PEPPERONI: Pilot line for European Production of PEROVskite-silicon taNdem modules on Industrial scale



SuPERTandem: Sustainable materials & manufacturing for high efficiency, flexible, all-Perovskite Tandem PV modules



VIPERLAB: Fully Connected Virtual and Physical Perovskite Photovoltaic Lab



TRIUMPH: Triple junction solar modules based on perovskites & silicon



VALHALLA: Perovskite Solar Cells with Enhanced Stability and Applicability



PEARL: Flexible perovskite solar cells with carbon electrodes



NEXUS: Next Generation of Sustainable Perovskite-Silicon Tandem Cells



TESTARE: Twinning for excellence in Testing new generation PV



DIAMOND: Next Generation of Sustainable Perovskite-Silicon Tandem Cells



SUNREY: Boosting SUSTaiNability, Reliability and Efficiency of perovskite PV

Stay connected

what is in there for you?

The PEPPERONI newsletter not only brings you closer to our project but also provides:

- Updates on the latest advancements and breakthroughs in perovskite/silicon tandem technology from PEPPERONI partners.
- Valuable insights, analysis, and expert opinions in PV value chain innovation.
- A community of like-minded individuals and experts, fostering collaboration and knowledge exchange.
- Potential opportunities for partnerships, investments, or career advancements in PV research/industry.

Stay informed and at the forefront of innovation in PV technologies. Subscribe today to embark on an exciting journey towards a sustainable energy future.

In **the next issue of the PEPPERONI newsletter**, we will:

- Investigate the market trends for different PV technologies.
- Delve into project updates, including progress from the developments of small areas of perovskite/silicon tandem prototypes.
- Share insights into EC strategies and initiatives to support European PV manufacturers and industry
- Uncover the landscape of EU-funded projects focused on perovskite technologies.



how to get in touch?

Are you interested in collaboration or just keen on knowing more about the project?

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info@pepperoni-project.eu



acknowledgement



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