



Picture by @Qcells

## European pilot line for innovative photovoltaic technology based on tandem solar cells

PEPPERONI, a four-year Research and Innovation project co-funded under Horizon Europe and jointly coordinated by Helmholtz-Zentrum Berlin and Qcells, will support Europe in reaching its renewable energy target of climate neutrality by 2050. The project will help advance perovskite/silicon tandem photovoltaics (PV) technology's journey towards the market introduction and mass manufacturing. PEPPERONI's goal is to identify and address the barriers to tandem solar technology's market introduction, and ultimately lay the foundations for new production capacity in Europe. A pilot line enabling this development will be established at Qcells' European headquarters in Thalheim, Germany. The project began on 1 November 2022, with the long-term vision of enabling European industrial leadership on PV production in the global market.

## Clean energy for Europe

The European Union (EU) targets climate neutrality by 2050 in a scenario whereby renewable energy plays a central role. Currently, energy is responsible for more than 75% of the EU's greenhouse gas emissions. The research and innovation (R&I) programme, Horizon Europe (which runs until 2027 with a budget of €95.5 billion) is one of the key actions taken by the European Commission (EC) to tackle climate change and speed up the energy transition towards renewables. R&I are critical for delivering solutions and system transformations. On the European level, there is an urgent need to increase the efficiency of the entire renewable energy value chain and integrate sustainability throughout it. Moreover, the new geopolitical and energy market reality requires us to drastically accelerate the clean energy transition by increasing Europe's energy independence and reducing the continent's reliance on unreliable suppliers and volatile fossil fuels.



Co-funded by  
the European Union



Funded by the European Union and supported by the Swiss State Secretariat for Education, Research and Innovation (SERI). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Project No: 101084251  
Author(s): accelCH, Q CELLS, HZB  
Date: 23 November 2022



PEPPERONI, a new R&I project co-funded by the EU under Horizon Europe and supported by the Swiss State Secretariat for Education, Research and Innovation (SERI), will significantly contribute towards reaching these targets.

## Harnessing solar technologies to enable European manufacturing

PEPPERONI aims to set up a pilot line to develop solar modules with perovskite/silicon (Si) tandem technology. Funding will total approximately €14.5 million over four years, with the consortium covering the full value chain of PV innovation. The most widely established solar cell technologies to date are made with silicon, and silicon PV is now one of the cheapest means of electricity production in many parts of the world. The solar industry's success in recent years has pushed the industry towards the current practical limits of efficiency for silicon technology. To exceed the limits of single-material cells, scientists have proposed to add one complementary solar cell to form so-called "tandem" solar cells.

PEPPERONI has selected technology that promises **the best ratio of performance over manufacturing costs – silicon/perovskite tandem**. Perovskite, a novel class material with a special crystal structure, can be fine-tuned to take advantage of the parts of the solar spectrum that typical silicon PV materials cannot utilise very efficiently, meaning they make excellent hybrid-tandem partners. **PEPPERONI will 'spice up' industrial silicon cells with a perovskite top cell**. This 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 two reasons. In the long run, it is the most effective way to reduce the levelised cost of electricity (LCOE). And in the short term, it is the best way to promote photovoltaics for applications where space is limited e.g., rooftops, facades, or vehicles.

Within PEPPERONI, a pilot line for the development of industrial-type tandem cells and modules will be established at the Qcells European headquarters in Thalheim, Germany, and will feature innovative equipment, processes and materials to produce high-efficiency tandem cells and modules. The project aims to scale up the active area of perovskite/Si tandems from the 1cm<sup>2</sup> of today's record devices to industry-relevant dimensions. PEPPERONI's approach promises a fast and cost-competitive route to mass-production of PV modules of high performance and long durability.

**Fabian Fertig**, Director Global R&D Wafer & Cells at Qcells, said: *"Qcells is proud to be part of the PEPPERONI consortium with its world-class technology partners. This research promises to break new ground in the advancement of 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 first and transformative step towards industrial-scale manufacturing of next-generation PV technology in Europe."*

## Q.ANTUM Technology

PEPPERONI proposes to use a type of silicon bottom cell, which is based on technology that is already produced at a gigawatt scale globally: [Q.ANTUM technology](#), which was first introduced in 2012 by the project partner leading the technology development, Qcells. As part of its proprietary Q.ANTUM Technology, Qcells has developed several innovations, from first ideas to mass production readiness, and successfully transferred these innovations into high-volume production. Examples include the introduction of PERC-like (passivated emitter and rear cell) solar cell technology, as well as half-cell, wire-based interconnection and zero-gap solar module technology. Recently, Qcells has expanded its Q.ANTUM technology by developing a passivating contact technology (Q.ANTUM NEO) to further boost solar cell and module efficiency. Q.ANTUM

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technology enables Qcells' unique Yield Security, which offers a number of additional benefits regarding cell performance and reliability. Applying the same proven product requirements to the PEPPERONI tandem technology is a crucial task of the project.

## Making solar energy accessible

PEPPERONI's strong and complementary consortium aims to tackle the challenges currently hindering the deployment of tandem solar cells. The project's key goals include:

- minimise scaling losses thanks to innovations in used materials and equipment
- develop thin-film deposition processes and equipment
- extend the operational stability of perovskites thanks to in-depth analyses of performance losses
- remove any human health or environmental hotspots
- establish a robust and competitive European innovation base and PV supply chain

In addition to promising higher module efficiencies, the deposition of a perovskite top cell onto silicon bottom cells in only a few extra process steps allows for cost-effective production scale up, building on the extensive industry expertise and low costs of silicon PV to help ensure the rapid deployment of this new tandem technology.

**Bernd Stannowski**, head of group Industry compatible processes, solar cells and modules at HZB added: *"At HZB we have developed the tandem technology to world-record efficiency level on lab scale. We are now looking forward to cooperate in the PEPPERONI consortium with partners from science and industry to jointly scale this new and very promising technology up and transfer it to industry."*

## About the consortium

PEPPERONI combines European knowledge and expertise from fundamental research to small-scale testing and development of solar cells all the way to high-throughput industrial manufacturing of large solar modules. The PEPPERONI consortium counts 17 partners from 12 countries spanning across Europe who will meet for the project's kick-off meeting on 24 and 25 November at Qcells in Thalheim, Germany.

## Network

- Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (RTO)
- Hanwha Qcells GmbH (IND)
- Mondragon Assembly S.COOP (IND)
- Von Ardenne GmbH Business Area PV (IND)
- FOM Technologies APS (SME)
- Teknisolar SRL (SME)
- Dyenamo AB (SME)
- Yparex BV (SME)
- Institut National de L'Environnement et des Risques (RTO)
- Polymer Competence Center Leoben GmbH (RTO)
- Bureau de Recherches Géologiques et Minières (RTO)
- University of Ljubljana (UNI)
- Kauno Technologijos Universitetas Department of Organic Chemistry (UNI)
- Université de Liège Chemical Engineering (UNI)
- Technische Universiteit Eindhoven Applied Physics (UNI)
- Centre Suisse d'Electronique et de Microtechnique - Recherche et Développement (RTO)

### PEPPERONI facts and figures

- **Funding Programme: HORIZON-CL5-2021**
- **Budget: 18.85 million euro**
- **Duration: 01.11.2022 – 31.10.2026**
- **Partners: 17**

## About PEPPERONI

PEPPERONI is a four-year Research and Innovation project co-funded by the European Union under Horizon Europe and supported by the Swiss State Secretariat for Education, Research and Innovation that started on 1 November 2022. PEPPERONI will advance the perovskite/silicon tandem photovoltaics (PV) technology towards market introduction and mass manufacturing. The project, coordinated by Helmholtz-Zentrum Berlin (DE) and Qcells (DE) will identify and address the barriers to tandem solar technology's market introduction, and ultimately lay the foundations for fast implementation of new production capacity in Europe as a cost-effective and resource-efficient solution to decarbonise the energy system. The PEPPERONI consortium counts 17 partners from 12 European countries and it combines knowledge and expertise from fundamental research to small-scale testing and development of solar cells all the way to high-throughput industrial manufacturing of large solar modules.

Website: [www.pepperoni-project.eu](http://www.pepperoni-project.eu)



## About Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB) explores solutions for a climate-neutral society. Researchers are developing and optimising efficient and cost-effective materials for solar cells, batteries and catalysts. These energy materials are essential components for achieving a CO<sub>2</sub> neutral and secure energy supply. The most important tool is the X-ray source BESSY II, run by HZB, which delivers intensely bright light in the soft X-ray spectral region. Researchers are using this to study the structure and function of energy and quantum materials.



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## About Qcells

Qcells is one of the world's leading clean energy companies, recognized for its established reputation as a manufacturer of high-performance, high-quality solar cells and modules, portfolio of intelligent storage systems, and growing international pipeline of large-scale renewable energy projects. Qcells also provides renewable electricity retail services and packages to end customers the world over. The company is headquartered in Seoul, South Korea (Global Executive HQ) and Thalheim, Germany (Technology & Innovation HQ) with its diverse international manufacturing facilities in the U.S., Malaysia, China, and South Korea. Qcells offers Completely Clean Energy through the full spectrum of photovoltaic products, storage solutions, renewable electricity contracting and large-scale solar power plants. Through its growing global business network spanning Europe, North America, Asia, South America, Africa and the Middle East, Qcells provides excellent services and long-term partnerships to its customers in the utility, commercial, governmental and residential markets.



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