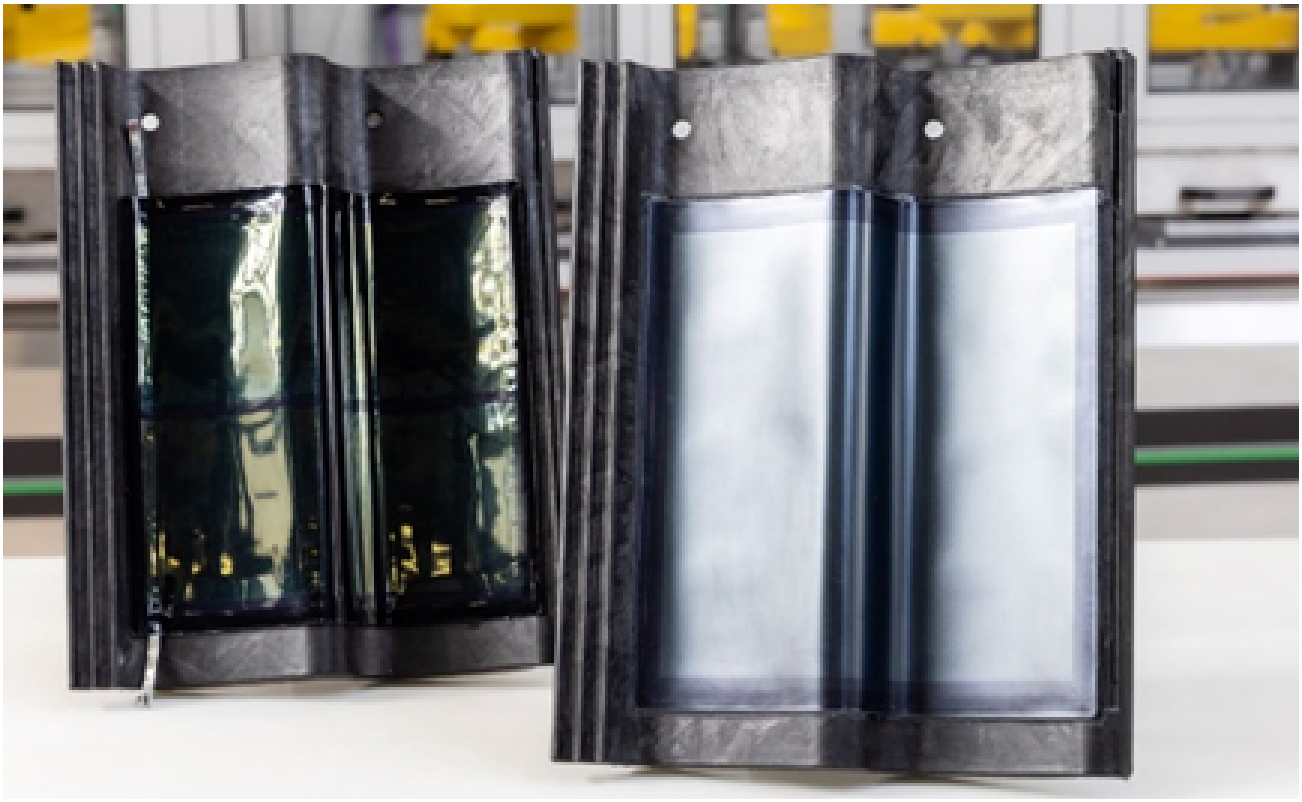
PRESS RELEASE

TNO unveils world's first flexible perovskite solar roof tile

Eindhoven, Netherlands – TNO has taken a major step forward in solar energy innovation by **developing what is believed to be the world's first electrically functioning perovskite solar roof tile.** The breakthrough enables solar power generation to be seamlessly integrated into buildings, creating renewable electricity **without additional pressure on land use or infrastructure.**

Researchers at TNO successfully developed and applied a **flexible perovskite solar module onto a curved composite roof tile**, achieving an energy efficiency of **12.4%** despite the tile's non-flat geometry. Individual flexible modules reached efficiencies of up to **13.8%** prior to integration, demonstrating the strong potential of this technology for building-integrated photovoltaics.



Perovskite solar roof tile
Image credit: TNO

A WORLD- FIRST ENABLED BY EUROPEAN RESEARCH

The solar roof tile was co-developed within the framework Dutch national and European projects, including **LUMINOSITY,** a European Union–funded project under the Horizon Europe programme, coordinated by TNO. LUMINOSITY played a key role in advancing **lightweight, flexible, and scalable perovskite photovoltaics**, suitable for ambient fast Roll-2-Roll (R2R) production process, which aligns with the aims of the project on strengthening Europe's position in next-generation solar manufacturing.

To *the best of my knowledge, this is the world's first electrically functioning solar roof tile concept based on flexible perovskite solar cells,* says Ilker Dogan, Senior Scientist at TNO Solar and Coordinator of the LUMINOSITY project.

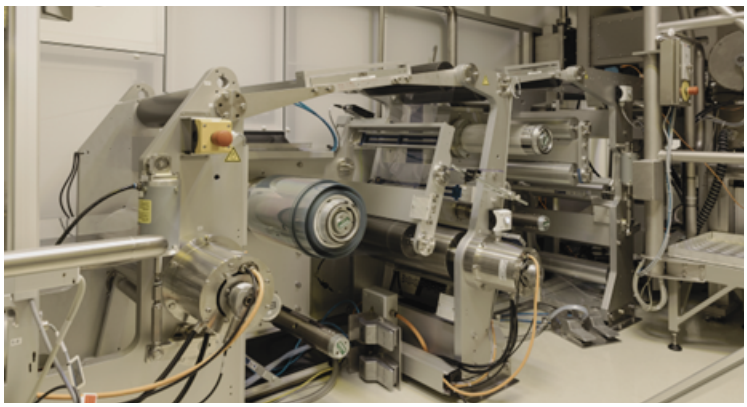
Measurements confirm that bending the solar module onto the roof tile has only a limited effect on performance, confirming the robustness of the flexible perovskite technology.

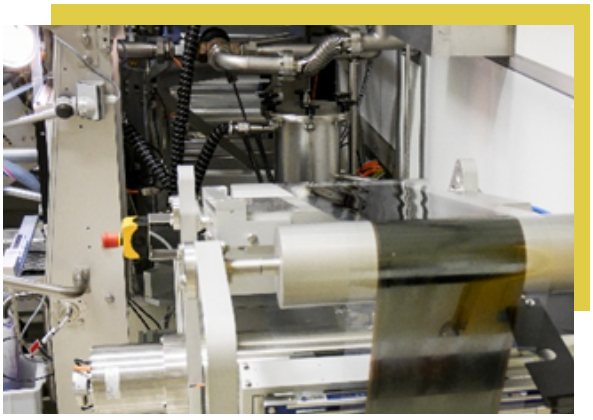
FROM LABORATORY INNOVATION TO INDUSTRIAL READINESS

The importance of this breakthrough lies not only in performance, but also in **industrial readiness.** The materials and production processes used are compatible with l**arge-scale roll-to-roll manufacturing**, operating under standard industrial conditions.

TNO has completed the full innovation pathway: from laboratory test cells, to **10 × 10 cm flexible modules**, and finally to a **solar roof tile towards real-world applications**. This opens new possibilities for generating renewable electricity while preserving architectural aesthetics.

> *This technology allows roofs and infrastructure to produce sustainable electricity without compromising design,* says Roland Valckenborg, Senior Project Manager at TNO Solar.





R2R perovskite development line of TNO
Image credit: TNO

STRENGTHENING EUROPE'S SOLAR MANUFACTURING VALUE CHAIN

The development was achieved through close collaboration within the TNO Solar Program, combining expertise in materials science, production technologies, and testing. Together with Dutch and European partners, the work supports Europe's ambitions in **energy transition, sustainability, and energy security**.

According to Dogan: "Through LUMINOSITY and other collaborations, we are moving perovskite technology toward a fully integrated roll-to-roll manufacturing platform, demonstrating what flexible perovskite photovoltaics can achieve at scale. One of the key performance indicator of LUMINOSITY is to enable large area uniform perovskite solar cell deposition via R2R techniques, and close the efficiency gap between small scale processing and R2R processing. With this roof tile, LUMINOSITY has shown the developments on three different platforms, extending its initially plotted impact further than anticipated:

- *Minimal loss from a lab scale cell (~20 mm^2) to a module system (up to 400 cm^2) is achievable even after x1000 order increase in scale*
- *R2R compatible flexible substrates, materials and solvents can be used to produce efficient perovskite solar cells*
- *Functionality can be demonstrated on an integrated product, opening up the possible application areas and create societal awareness and impact early on, bringing the exploitation points into a reality even during the project"*

NEXT STEPS TOWARD MARKET DEPLOYMENT

TNO will now focus on further improving the lifetime, reliability, and scalability of flexible perovskite solar modules. To support commercial deployment, TNO recently launched the spin-out company Perovion Technologies, accelerating the path from research to market.

LUMINOSITY "Large area uniform industry compatible perovskite solar cell technology"

The project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement No 101147653.

https://luminosity-project.eu/

@LUMINOSITY_EU