

PerovskiteSolarCells

Weekly Intelligence Report

2026-07-26 | 25 articles | 8 countries

troy-technical.jp

This Week's Keyword

Perovskite Tandems

Efficiency & Stability Drive Commercialization

25

articles

Total Articles Analyzed

8

countries

Source Countries

34.82

%

Highest Cell Efficiency

31.0

%

Highest Mini-Module Eff.

All 25 Articles This Week — 5-Axis Evaluation Matrix

How to read columns — Tech Novelty: degree of breakthrough Market Proximity: closeness to commercialization Market Impact: industry-wide effect Data Reliability: quantitative data & peer review US/EU Relevance: direct impact on US/European companies & supply chains

#	Article Title	Type	Tech Novelty	Market Proximity	Market Impact	Data Reliability	US/EU Relevance	Summary
#01	UCL Transparent BIPV	Research						UCL developed transparent perovskite solar cells with 22% indoor light efficiency, demonstrating a scalable 30x30cm module for BIPV.
#02	US DOE Startup Prize	Corporate Strategy						US DOE launched a \$3M prize to accelerate perovskite solar cell commercialization by supporting domestic startups.
#03	Hanwha Qcells NASA Cert	Corporate Strategy						Hanwha Qcells invests \$100M in tandem tech, secures IEC/UL cert, and will supply NASA lunar project.
#04	SEU Stability & Eff.	Research						SEU achieved 27.69% efficiency (small) and 23.63% (large) with extreme stability using electron-resonance SAM.
#05	Pb-Sn Perovskite Stability	Research						Additive engineering improved Pb-Sn perovskite stability, achieving 21.5% efficiency for all-perovskite tandem cells.
#06	AI Materials Foundry	Research						Oxford PV and Caelux joined UK's CuspAI 'AI Materials Foundry' to accelerate perovskite material discovery.
#07	JACS Interfacial Stab.	Research						JACS paper reports 26.53% efficiency with 96% retention after 1000 hours via bidirectional interfacial stabilization.
#08	US DOE Perovskite Report	Market Overview						US DOE reports perovskite cells exceed 26% and tandems 34%, focusing on stability, manufacturing, and validation.
#09	Sofab Inks \$6M Funding	Corporate Strategy						Sofab Inks raised \$6M to scale perovskite materials, achieving 22.3% on 30cm modules with metal oxide ETL.
#10	Oxford PV 25%+ Modules	New Product						Oxford PV's perovskite-silicon tandem modules exceed 25% efficiency, targeting 27% by 2027 for pilot customers.
#11	German Indium-Free 31%	Research						German researchers developed indium-free perovskite-silicon mini-modules with 31% efficiency via RPD, reducing costs.
#12	JinkoSolar 34.82% Record	Research						JinkoSolar set a new world record with 34.82% efficiency for its perovskite-silicon tandem solar cell.

#	Article Title	Type	Tech Novelty	Market Proximity	Market Impact	Data Reliability	US/EU Relevance	Summary
#13	Tandem PV US Breakthroughs	Corporate Strategy	●●●●○ ○	●●●●○ ○	●●●●● ○	●●●●○ ○	●●●●● ●	US-based Tandem PV announced breakthroughs in perovskite-silicon tandem cells, accelerating market introduction.
#14	Caelux India 10GW Mfg.	Corporate Strategy	●●●●○ ○	●●●●● ○	●●●●● ●	●●●●○ ○	●●●●● ○	Caelux partnered with Indian firms for 10 GW perovskite-silicon hybrid tandem module manufacturing by 2028.
#15	2026 Reality Check	Market Overview	●○○○○ ○	●○○○○ ○	●●●●○ ○	●●●●○ ○	●●●●○ ○	2026 report highlights durability, scalability, and certification as key barriers to perovskite commercialization.
#16	UC Davis AI/ML Materials	Research	●●●●● ○	●○○○○ ○	●●●●○ ○	●●●●● ○	●●●●● ●	UC Davis developed an AI/ML framework to accelerate discovery of durable perovskite solar cell materials.
#17	AI Materials Foundry	Duplicate	●●●●○ ○	●●○○○ ○	●●●●○ ○	●●○○○ ○	●●●●● ●	Duplicate of #06: Oxford PV and Caelux joined UK's CusPAI 'AI Materials Foundry' to accelerate perovskite material discovery.
#18	2028 Mass Market Entry	Market Overview	●○○○○ ○	●○○○○ ○	●●●●● ○	●●●●○ ○	●●●●○ ○	TaiyangNews reports stabilizing solar module prices, with perovskite tandems poised for 2028 mass market entry.
#19	Caelux India 10GW Mfg.	Duplicate	●●●●○ ○	●●●●● ○	●●●●● ●	●●●●○ ○	●●●●● ○	Duplicate of #14: Caelux partnered with Indian firms for 10 GW perovskite-silicon hybrid tandem module manufacturing by 2028.
#20	ML Lead-Free 32.5%	Research	●●●●● ○	●○○○○ ○	●●●●○ ○	●●●●● ●	●●●●● ●	ML framework accelerates lead-free dual-absorber perovskite design, paving way for 32.5% efficiency.
#21	SUSTech Dip-Coating 27%	Research	●●●●● ○	●●○○○ ○	●●●●● ○	●●●●● ○	●●●●○ ○	SUSTech achieved 27.23% certified efficiency via 5-minute dip-coating with SAM, improving manufacturing speed.
#22	Qcells TÜV Rheinland Cert	New Product	●●●●○ ○	●●●●● ○	●●●●● ○	●●●●● ○	●●●●● ●	Qcells secured TÜV Rheinland certification for 28.6% efficient perovskite-silicon tandem solar cell technology.
#23	IDTechEx Commercial Demo	Market Overview	●○○○○ ○	●○○○○ ○	●●●●○ ○	●●●●○ ○	●●●●○ ○	IDTechEx reports perovskite solar cells are transitioning from lab records to commercial demonstration projects.
#24	Hanwha Qcells NASA US Mfg	Corporate Strategy	●●●●○ ○	●●●●● ○	●●●●● ○	●●●●○ ○	●●●●● ●	Hanwha Qcells to supply perovskite-silicon tandem cells for NASA lunar project, bolstering US manufacturing.
#25	HKUST PEDOT:PSS-Free	Research	●●●●● ○	●●○○○ ○	●●●●● ○	●●●●● ●	●●●●○ ○	HKUST achieved 29.1% efficiency and 800-hour stability in PEDOT:PSS-free all-perovskite tandem cells.

●●●●○ High ●●●○○ Med-High ●●○○○ Med ●○○○○ Low | Yellow highlight = featured article

Three Questions That Demand Your Decision This Week

① Are your tandem cell roadmaps competitive with Asian leaders?

JinkoSolar's 34.82% record (#12) and Hanwha Qcells' \$100M investment and NASA project (#03, #24) signal aggressive commercialization. How do your efficiency targets and deployment timelines compare?

② Have you integrated the latest stability breakthroughs?

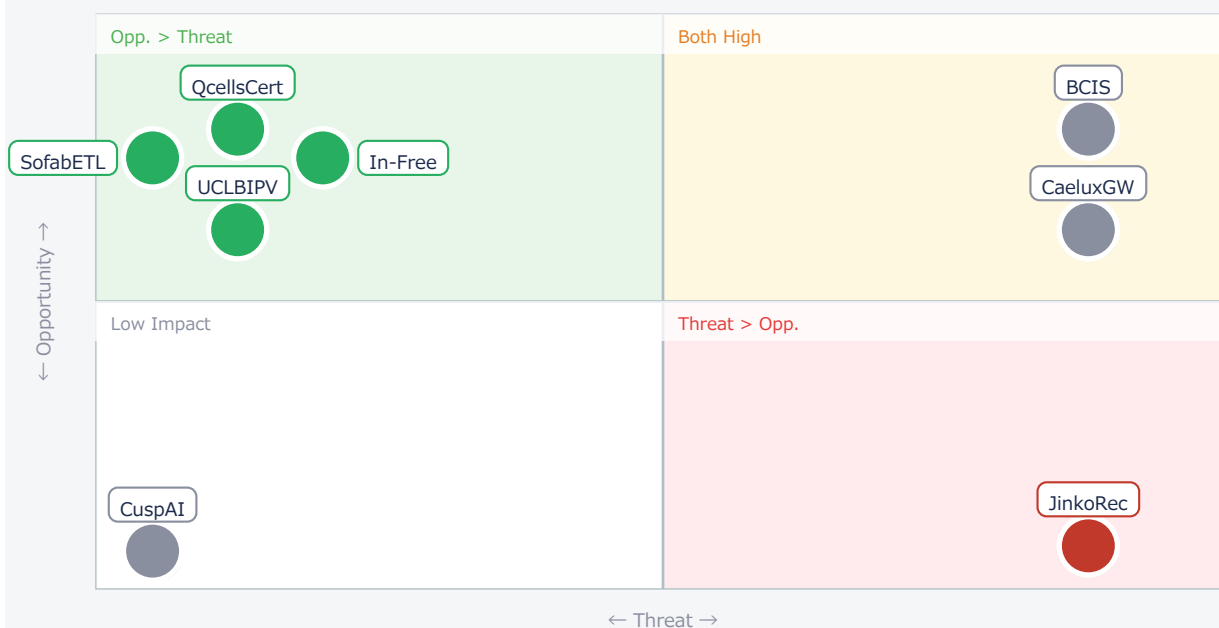
New interfacial stabilization (#07), SAMs (#04, #21), and PEDOT:PSS-free designs (#25) are addressing perovskite's Achilles' heel. Does your R&D leverage these to ensure 20+ year lifetimes?

③ What's your strategy for new perovskite applications and materials?

Transparent BIPV (#01), indium-free materials (#11), and AI-driven discovery (#06, #16, #20) are opening new markets and accelerating R&D.; Are you exploring these beyond traditional PV?

Opportunities vs. Threats for US/European Companies

Opportunity vs. Threat Matrix for US/European Companies



Item	Quadrant	↑ Opportunity	↓ Threat
● BCIS	Critical	New IP, stable tech	Obsolete designs
● QcellsCert	Opp.	Market entry, LCOE	Certification bar
● CaeluxGW	Critical	Market scale	Asian dominance
● JinkoRec	Threat	Efficiency gains	Competitive pressure
● UCLBIPV	Opp.	New markets	Niche focus
● SofabETL	Opp.	Reliability fix	Material shift
● In-Free	Opp.	Cost reduction	Material sourcing
● CuspAI	Ref.	Faster R&D;	Lagging AI adoption

Deep Dive ① — Breakthrough in Perovskite Stability & Robustness

#07 | 2026/07/16 | Journal of the American Chemical Society | Tech Novelty●●●●● Proximity●●○○○ Market Impact●●●●○ Data Reliability●●●●● US/EU Relevance●●●●●

A new study demonstrates a "bidirectional chemical and mechanical interfacial stabilization (BCIS)" effect, achieving 26.53% PCE and 96% efficiency retention after 1,000 hours of continuous operation.

This novel strategy significantly enhances operational stability and mechanical robustness, addressing a critical barrier for commercialization. An 818 cm² module also achieved 20.08% PCE, showing scalability.

► Strategic Analyst's Perspective

Strategic Analyst's Perspective: The published numbers for stability (96% retention over 1000 hours) are highly promising and appear reliable given the peer-reviewed source. However, 1000 hours is still short of the 20-25 year commercial lifetime required. Technical barriers include scaling the BCIS process to gigawatt-scale manufacturing without compromising performance or adding significant cost. [Opportunity] for US/EU materials & component suppliers to license or develop advanced interfacial materials. OEMs & device manufacturers can integrate this to differentiate products with superior durability. [Threat] for companies relying on less stable perovskite designs, as this breakthrough sets a new performance bar. Next actions: [R&D;] immediately assess BCIS technology for integration into next-gen designs; [Legal/IP] initiate patent landscape analysis around interfacial stabilization by end of month.

Deep Dive ② — Qcells Secures TÜV Rheinland Certification

#22 | 2026/07/16 | pv magazine Global | Tech Novelty●●●○○ Proximity●●●●○ Market Impact●●●●○ Data Reliability●●●●○ US/EU Relevance●●●●●

Qcells' perovskite-silicon tandem solar cell technology has secured dual certification from TÜV Rheinland (IEC 61215 and UL 61215), demonstrating 28.6% cell efficiency.

Manufactured at their German pilot line, this certification is a crucial quality milestone, paving the way for broader commercial market entry and boosting investor confidence in perovskite technology.

► Strategic Analyst's Perspective

Strategic Analyst's Perspective: The 28.6% cell efficiency is realistic and validated by TÜV Rheinland, a highly reliable third-party. This certification is a major de-risking event, indicating that Qcells has overcome significant reliability and safety hurdles for pilot production. The main technical barrier remaining is scaling this certified performance and reliability to mass production volumes at competitive costs. [Opportunity] for US/EU OEMs & device manufacturers to partner with Qcells or accelerate their own certification efforts, leveraging this precedent. Procurement managers should evaluate Qcells' offerings as a viable high-efficiency option. [Threat] for US/EU companies lagging in certification or with less mature tandem technologies, as Qcells gains a significant first-mover advantage in market acceptance. Next actions: [Business Dev] initiate discussions with Qcells on potential partnerships/licensing by end of month; [Strategy] review internal certification roadmaps and accelerate testing protocols within 3 months.

Deep Dive ③ — Caelux's 10 GW Perovskite Tandem Deal in India

#14 | 2026/07/23 | PV Tech | Tech Novelty●●●○○ Proximity●●●●○ Market Impact●●●●● Data Reliability●●●○○ US/EU Relevance●●●●○

US firm Caelux signed two five-year agreements with Indian manufacturers (Navitas Solar, Rayzon Solar) to produce 10 GW of perovskite-silicon 'Hybrid Tandem' modules.

These modules, targeting up to 28% efficiency, combine Caelux's perovskite-coated solar glass with n-type TOPCon modules, with commercial availability expected by 2028.

► Strategic Analyst's Perspective

Strategic Analyst's Perspective: The 10 GW target and 28% efficiency are ambitious but plausible given Caelux's expertise and the rapid growth of the Indian market. The key technical barrier is ensuring consistent quality and long-term reliability at this massive scale, especially in diverse Indian environmental conditions. [Opportunity] for US/EU materials & component suppliers to become part of Caelux's expanded supply chain for perovskite precursors or manufacturing equipment. Technology licensors and IP holders could explore similar large-scale partnerships in other high-growth regions. [Threat] for US/EU OEMs & device manufacturers who do not have a strong presence or partnership strategy in emerging markets like India, as this deal solidifies a major competitor's foothold. Next actions: [Procurement] assess Caelux's supply chain needs and potential entry points by end of month; [Strategy] analyze market share implications in India and other emerging markets within 1 quarter.

Other Notable Articles

JinkoSolar Achieves 34.82% Efficiency with Perovskite-Silicon Tandem Solar Cell, Sets New World Record (Winssolutions)

TN●●●●○ PM●●○○○ MI●●●●○

New world record efficiency sets a high bar, driving intense competition in tandem cell development.

UCL Team Achieves 22% Indoor Light Efficiency with Transparent Perovskite Solar Cells, Demonstrates Scalable Module for BIPV (UCL News)

TN●●●●○ PM●●●○○ MI●●●○○

Transparent indoor solar cells for BIPV open new energy harvesting avenues in urban environments.

Sofab Inks Raises \$6 Million Seed Funding to Scale Perovskite Solar Cell Material Production and Enhance Reliability with Metal Oxide ETL (Renewables Now)

TN●●●●○ PM●●●○○ MI●●●●○

US startup's metal oxide ETL breakthrough addresses critical reliability issues for perovskite commercialization.

German Researchers Develop Indium-Free Perovskite-Silicon Mini-Modules with 31% Efficiency via Reactive Plasma Deposition (PV Magazine)

TN●●●●○ PM●●○○○ MI●●●●○

Indium-free, high-efficiency mini-modules reduce material costs and supply chain risks for tandem cells.

Southeast University Boosts Perovskite Solar Cell Stability & Efficiency with Electron-Resonance SAM: 27.69% Small-Area, 23.63% Large-Area Achieved (SEU News Network)

TN●●●●○ PM●●○○○ MI●●●●○

Significant stability and efficiency gains under extreme conditions overcome a major barrier to commercial viability.

Recommended Actions This Week

Action recommendations based on article evaluation matrix and opportunity/threat analysis.

■ Immediate (this week)

- [Executive] Review competitive landscape for perovskite tandem cells, especially Asian players' efficiency records and certification milestones.
- [Procurement] Identify potential supply chain vulnerabilities related to indium or other critical materials in current PV technologies.
- [R&D;] Task materials science teams to analyze recent stability breakthroughs (e.g., BCIS, SAMs, PEDOT:PSS-free) for applicability to current projects.

■ Short-term (1 month)

- [Strategy] Evaluate potential market entry points for BIPV/transparent solar, considering UCL's scalable module and emerging applications.
- [Business Dev] Assess partnership opportunities with US startups (e.g., Sofab Inks, Tandem PV) or AI material discovery platforms (e.g., CuspAI).
- [R&D;] Investigate metal oxide ETLs and advanced SAM technologies as alternatives to current charge transport layers for improved stability and manufacturability.

■ Medium-long term (quarter+)

- [Strategy] Develop a comprehensive perovskite strategy, including IP acquisition, manufacturing scale-up, and certification roadmap for next-gen products.
- [R&D;] Initiate internal projects or collaborations focused on lead-free perovskites and AI-driven materials discovery for long-term competitive advantage.
- [Legal/IP] Conduct a thorough IP landscape analysis for perovskite stability and scalable manufacturing processes, especially for tandem structures.

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PerovskiteSolarCells — Selected Articles

Date: 2026-07-26

Articles: 25

Table of Contents

- #01 UCL Team Achieves 22% Indoor Light Efficiency with Transparent Perovskite Solar Cells, Demonstrates Scalable Module for BIPV
- #02 U.S. Department of Energy Launches \$3 Million Perovskite Startup Prize to Accelerate Commercialization
- #03 Hanwha Qcells Invests \$100 Million in Perovskite-Silicon Tandem Technology, Secures IEC/UL Certification for NASA Moon Mission Supply
- #04 Southeast University Boosts Perovskite Solar Cell Stability & Efficiency with Electron-Resonance SAM: 27.69% Small-Area, 23.63% Large-Area Achieved
- #05 Additive Engineering Boosts Pb-Sn Perovskite Solar Cell Stability, Achieves 21.5% Efficiency for All-Perovskite Tandem Cells
- #06 Oxford PV and Caelux Join CuspAI-Led 'AI Materials Foundry' to Accelerate Perovskite Solar Cell Material Discovery
- #07 JACS Paper: Bidirectional Interfacial Stabilization Achieves 26.53% Perovskite Solar Cell Efficiency, 96% Retention After 1000 Hours
- #08 U.S. DOE Reports Perovskite Solar Cells Exceed 26% Efficiency, Tandem Cells Over 34%, Focuses on Stability, Scalable Manufacturing, and Validation
- #09 Sofab Inks Raises \$6 Million Seed Funding to Scale Perovskite Solar Cell Material Production and Enhance Reliability with Metal Oxide ETL
- #10 Oxford PV Tandem Modules Exceed 25% Efficiency, Sets Ambitious 27% Target by 2027
- #11 German Researchers Develop Indium-Free Perovskite-Silicon Mini-Modules with 31% Efficiency via Reactive Plasma Deposition
- #12 JinkoSolar Achieves 34.82% Efficiency with Perovskite-Silicon Tandem Solar Cell, Sets New World Record
- #13 US-Based Tandem PV Announces Breakthroughs in Perovskite-Silicon Solar Cell Technology, Accelerating Market Introduction
- #14 Caelux Partners with Rayzon Solar and Navitas Solar for 10 GW Perovskite-Silicon Hybrid Tandem Module Manufacturing in India
- #15 Perovskite Solar Cells: 2026 Reality Check Highlights Durability and Scaling as Key Barriers to Mass Commercialization Despite Lab Efficiency Records
- #16 UC Davis Leverages AI and Machine Learning to Accelerate Discovery of Durable Perovskite Solar Cell Materials

- #17 Oxford PV, Caelux Join UK's CuspAI "AI Materials Foundry" to Accelerate Perovskite and Advanced Materials Discovery
- #18 Solar Module Prices Stabilize, Perovskite Tandem Cells Poised for 2028 Mass Market Entry with 30%+ Efficiency Potential
- #19 Caelux Partners with India's Rayzon Solar & Navitas for 10 GW Perovskite-Silicon Tandem Module Development in India
- #20 Machine Learning Accelerates Lead-Free Dual-Absorber Perovskite Solar Cell Design, Paving Way for 32.5% Efficiency
- #21 SUSTech's Xu Zongxiang Team Achieves 27.23% Certified Perovskite Solar Cell Efficiency via 5-Minute Dip-Coating with SAM
- #22 Qcells Achieves TÜV Rheinland Certification for 28.6% Efficient Perovskite-Silicon Tandem Solar Technology
- #23 IDTechEx Report: Perovskite Solar Cells Transition to Commercial Demonstration, Driving High Efficiency with Silicon Tandems
- #24 Hanwha Qcells to Supply Perovskite-Silicon Tandem Solar Cells for NASA Lunar Power Project, Bolstering US Manufacturing
- #25 HKUST Achieves 29.1% Efficiency and 800-Hour Stability in PEDOT:PSS-Free All-Perovskite Tandem Solar Cells via Molecular Interface Engineering

#01 UCL Team Achieves 22% Indoor Light Efficiency with Transparent Perovskite Solar Cells, Demonstrates Scalable Module for BIPV

Published July 16, 2026 UCL News UK



OVERVIEW

Researchers at University College London (UCL) have developed transparent perovskite solar cells that achieve a 22% power conversion efficiency under bright indoor light (1000 lux). This pioneering work also includes the first demonstration of a scalable 30x30 square centimeter module of its kind. The technology holds immense potential for building-integrated photovoltaics (BIPV), allowing windows and facades to actively generate electricity and significantly enhance building energy autonomy.

Key Findings

A research team at University College London (UCL) has made a significant breakthrough in transparent perovskite solar cell technology. They reported an impressive 22% power conversion efficiency (PCE) for transparent perovskite solar cells under ambient indoor lighting conditions, specifically at 1000 lux. This high performance in low-light environments is a crucial step for broader applications. Furthermore, the team successfully demonstrated the first scalable module of this type, measuring 30x30 square centimeters, marking a crucial advance towards practical deployment.

Technical / Clinical Details

The core of this innovation lies in the specialized design of the perovskite material, which allows for high transparency while maintaining efficient light absorption. Unlike traditional opaque solar panels, UCL's device selectively absorbs non-visible light (such as UV and infrared) to generate electricity, allowing visible light to pass through. This capability opens up new avenues for energy harvesting in spaces previously considered unsuitable for solar power, like windows and building facades. The successful scale-up to a 30x30 cm module is a vital step, proving the feasibility of translating laboratory findings into practical applications. The high indoor light efficiency also makes these cells ideal for powering smart devices, IoT sensors, and potentially even contributing to internal building lighting systems, offering continuous power even without direct sunlight.

Background & Context

The Building-Integrated Photovoltaics (BIPV) market is rapidly gaining traction as a solution for achieving energy self-sufficiency in modern architecture. Transparent solar cells are particularly attractive for urban environments as they can be seamlessly integrated into a building's aesthetics without compromising its design. However, historical challenges for transparent solar cells included low efficiency and high manufacturing costs. The UCL technology addresses these limitations, making BIPV a more viable and attractive option. The exceptional performance under indoor illumination extends the applicability beyond traditional outdoor solar, paving the way for 'power-generating windows' and smart glass technologies that could transform urban energy landscapes.

Strategic Significance & Outlook

This breakthrough by the UCL research team significantly propels the commercialization prospects of transparent perovskite solar cells. In the BIPV sector, the realization of 'solar windows' that generate power could fundamentally alter architectural design, dramatically reducing a building's overall energy consumption. Future development will focus on further enhancing efficiency, ensuring long-term stability in diverse environmental conditions, and scaling up manufacturing processes for larger modules. Widespread adoption of this technology promises to accelerate the global transition to sustainable energy by transforming passive building elements into active energy generators, thus making substantial contributions to carbon neutrality goals.

Source: <https://www.ucl.ac.uk/news/2026/jul/solar-windows-could-harvest-energy-sun-and-indoor-light>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#02 U.S. Department of Energy Launches \$3 Million Perovskite Startup Prize to Accelerate Commercialization

Published July 16, 2026 Department of Energy USA



OVERVIEW

The U.S. Department of Energy (DOE) has announced a \$3 million two-phase 'American-Made Challenges: Perovskite Startup Prize' to accelerate the development and manufacturing of perovskite solar cells. This initiative aims to transition world-class research from laboratories to U.S. startups, fostering the creation of manufacturing entities capable of bringing market-ready perovskite products to market. This funding is a strategic move to bolster the domestic clean energy supply chain and advance the U.S. position in the next-generation solar technology landscape.

Key Findings

The U.S. Department of Energy (DOE), through its Solar Energy Technologies Office, has unveiled a new \$3 million 'American-Made Challenges: Perovskite Startup Prize' to fast-track the commercialization of perovskite solar cell technology. This two-phase competition is specifically designed to support American startups in translating cutting-edge perovskite research from the lab into viable, marketable products. The direct financial assistance and structured competition serve as a critical mechanism to enhance the nation's competitive edge in the rapidly evolving clean energy sector.

Technical / Clinical Details

The 'Perovskite Startup Prize' challenges participants to address key hurdles in perovskite solar cell development, including improving material stability, demonstrating scalable manufacturing processes, and optimizing device architectures for higher efficiency. The program goes beyond pure research and development, requiring companies to present robust business plans and develop functional prototypes that show clear pathways to market success. This holistic approach aims to bridge the gap between scientific discovery and industrial production, facilitating the rapid maturation of perovskite technology for real-world applications.

Background & Context

Perovskite solar cells have emerged as a highly promising next-generation photovoltaic technology, renowned for their high efficiency, potential for low-cost manufacturing, and versatility in application. However, their broad commercial deployment has been hindered by challenges related to long-term stability and scalable production techniques. The DOE's investment through this startup prize is a strategic effort to overcome these barriers and ensure the U.S. maintains a leadership position in clean energy innovation. By nurturing domestic startups, the program strengthens the national innovation ecosystem and aims to accelerate the deployment of perovskite technology into the market, enhancing the U.S. industrial base in the global clean energy race.

Strategic Significance & Outlook

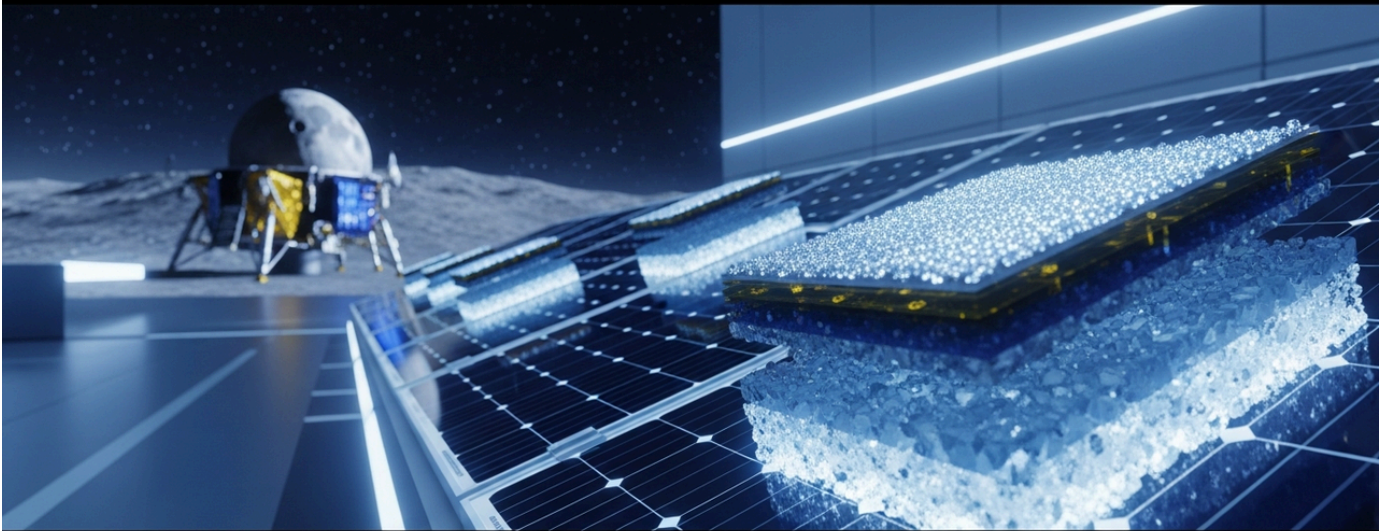
The \$3 million funding and expert support offered by the 'American-Made Challenges: Perovskite Startup Prize' provide a substantial incentive for startups with innovative perovskite technologies. Companies fostered through this program are expected to develop highly efficient and stable perovskite solar cells, which could complement or even surpass existing silicon solar cell markets in the future. In the long term, this initiative seeks to establish robust domestic perovskite manufacturing capabilities, bolstering energy security and creating new high-tech jobs within the United States. The DOE's commitment is anticipated to be a significant accelerator for the commercial success of perovskite technology, driving towards a more sustainable and energy-independent future.

Source: <https://www.energy.gov/cmei/systems/american-made-challenges-perovskite-startup-prize>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#03 Hanwha Qcells Invests \$100 Million in Perovskite-Silicon Tandem Technology, Secures IEC/UL Certification for NASA Moon Mission Supply

Published July 16, 2026 TÜV Rheinland South Korea



OVERVIEW

Hanwha Qcells has committed \$100 million to a pilot production line to accelerate the commercialization of its high-efficiency perovskite-silicon tandem cell technology. The company also announced it will supply its advanced tandem perovskite solar cells for a NASA-backed lunar power demonstration project, showcasing the technology's reliability for extreme environments. Furthermore, Hanwha Qcells' perovskite-silicon tandem solar cell technology has received IEC and UL standard certifications from TÜV Rheinland, paving the way for its global commercial deployment.

Key Findings

Hanwha Qcells, a leading global solar energy company, has announced a substantial \$100 million investment into a pilot production line to accelerate the commercialization of its high-efficiency perovskite-silicon tandem cell technology. This investment signals a strong commitment to bringing next-generation solar solutions to market. A significant validation of this technology comes from its selection to supply advanced tandem perovskite solar cells for a NASA-supported lunar power demonstration project, attesting to its robust performance in extreme conditions. Crucially, the technology has also secured reliability and safety certifications from TÜV Rheinland under both IEC and UL standards, making it ready for international commercial deployment.

Technical Details

The perovskite-silicon tandem technology developed by Hanwha Qcells is designed to surpass the efficiency limits of conventional silicon solar cells. The perovskite layer effectively absorbs high-energy photons in the visible light spectrum, while the underlying silicon cell captures lower-energy photons, thus converting a broader range of sunlight into electricity. The \$100 million investment will fund the establishment of a dedicated pilot production line, facilitating the optimization of materials, refinement of deposition processes, and enhancement of long-term stability testing for these tandem cells. The involvement in NASA's lunar project demonstrates the technology's resilience and reliability in harsh environments, such as extreme temperature fluctuations and radiation exposure in space, which bodes well for diverse terrestrial applications. The IEC and UL certifications from TÜV Rheinland provide independent assurance of compliance with international quality and safety standards, removing a significant hurdle for market entry.

Background & Context

The global solar market is intensely seeking more efficient and cost-competitive technologies to accelerate the energy transition. Perovskite-silicon tandem cells are considered a 'game-changer' because they promise substantial efficiency gains while leveraging existing silicon manufacturing infrastructure. Hanwha Qcells' aggressive investment indicates the imminent potential for this technology to enter the mainstream solar market. Endorsement by space agencies like NASA provides powerful validation of its durability and reliability, which will be instrumental in building confidence among consumers and commercial clients. This strategic move by Hanwha Qcells is likely to catalyze further investment in tandem technology across the industry, driving overall technological innovation.

Strategic Significance & Outlook

The \$100 million investment, contribution to the NASA project, and attainment of international certifications collectively underscore Hanwha Qcells' strategic intent to establish leadership in perovskite-silicon tandem technology. The experience and data gathered from the pilot production line will provide invaluable insights for future gigawatt-scale manufacturing. The space-based demonstration will further validate the technology's robustness, alleviating concerns about its reliability in a wide range of terrestrial installation environments, including residential, commercial, and industrial settings. As full-scale commercial deployment is anticipated post-2027, Hanwha Qcells aims to expand its market share by offering highly efficient and durable solar cells, thereby making a significant contribution to renewable energy adoption and climate change mitigation efforts.

Source: <https://www.finanznachrichten.de/nachrichten-2026-07/69046158-qcells-secures-tuev-rheinland-certification-for-perovskite-silicon-tandem-solar-tech-451.htm>

#04 Southeast University Boosts Perovskite Solar Cell Stability & Efficiency with Electron-Resonance SAM: 27.69% Small-Area, 23.63% Large-Area Achieved

Published July 23, 2026 SEU News Network China



OVERVIEW

A research team at Southeast University has significantly improved both the stability and efficiency of perovskite solar cells by incorporating a self-assembled monolayer (SAM) with a powerful 'electron-resonance' structure in the interface layer. This innovation led to a 27.69% power conversion efficiency (PCE) for small devices (0.063 cm^2) and 23.63% for larger module devices (15.64 cm^2). Crucially, the cells demonstrated remarkable long-term stability, maintaining over 90% of initial efficiency under extreme conditions like -40°C to 85°C temperature cycling and 85°C thermal aging with illumination, overcoming a major barrier to commercialization.

Key Findings

Researchers at Southeast University have achieved a significant breakthrough in perovskite solar cell technology by simultaneously enhancing both efficiency and long-term stability. Their innovative approach involved designing and incorporating a self-assembled monolayer (SAM) with a robust 'electron-resonance' structure into the interface layer of the solar cells. This led to an impressive 27.69% power conversion efficiency (PCE) for small-area devices (0.063 cm^2), positioning it among the highest reported. Furthermore, a module-level device with a practical area of 15.64 cm^2 achieved a PCE of 23.63%. Critically, these devices exhibited unprecedented stability, retaining over 90% of their initial efficiency after prolonged operation under harsh conditions, including temperature cycling from -40°C to 85°C and thermal aging at 85°C with continuous illumination. This addresses one of the most significant challenges hindering the commercialization of perovskite solar cells.

Technical / Clinical Details

The developed SAM is precisely engineered and strategically positioned between the perovskite layer and the charge transport layer. The 'electron-resonance' structure within this SAM is key to its dual function: it optimizes the transport of charge carriers while effectively suppressing non-radiative recombination at the interface. This optimization leads to an improvement in both the open-circuit voltage (V_{oc}) and fill factor (FF), contributing to the high PCE. More importantly, the SAM acts as a protective barrier, inhibiting degradation pathways of the perovskite material. It specifically prevents the decomposition of the perovskite structure caused by external environmental factors such as humidity, oxygen, and heat, dramatically extending the device's operational lifetime. Detailed experimental data confirmed that devices incorporating this SAM maintain their structural integrity and performance even when exposed to extreme temperature variations and prolonged high-temperature illumination.

Background & Context

Perovskite solar cells have garnered significant attention as a promising next-generation photovoltaic technology due to their potential for high efficiency and low-cost manufacturing, often rivaling or exceeding conventional silicon solar cells. However, the inherent instability of perovskite materials has been the primary impediment to their commercial viability. Previous research often involved a trade-off between efficiency and stability, but the work by Southeast University suggests a pathway to overcome this limitation. Demonstrating stability under a wide range of temperature cycles and thermal aging is crucial for ensuring a practical lifespan in real-world applications, making this technology's impact on the future solar market potentially transformative. This breakthrough could pave the way for widespread adoption of perovskite solar cells in residential, industrial, and specialized energy applications.

Strategic Significance & Outlook

This breakthrough from Southeast University marks a substantial advancement towards the commercialization of perovskite solar cells. The confirmed improvement in stability enhances confidence in future mass production, long-term warranties, and deployment in diverse environmental conditions. The research team will likely focus on scaling this SAM technology to larger modules and further streamlining manufacturing processes to reduce costs. This achievement also offers new design principles for enhancing stability in other perovskite materials and device architectures. Widespread adoption of this technology could further improve the cost-performance ratio of solar power, playing an indispensable role in realizing a sustainable energy society and contributing to global carbon reduction efforts.

Source: <https://www.seu.edu.cn/english/2026/0723/c65369a578017/page.htm>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#05 Additive Engineering Boosts Pb-Sn Perovskite Solar Cell Stability, Achieves 21.5% Efficiency for All-Perovskite Tandem Cells

Published July 18, 2026 ACS Energy Letters USA



OVERVIEW

New research demonstrates that additive engineering using phenylethylammonium halides significantly improves the stability of lead-tin (Pb-Sn) perovskite solar cells, a critical step towards viable all-perovskite tandem cells. Previously limited by Sn^{2+} instability, optimized devices now achieve a power conversion efficiency of 21.5%. This breakthrough addresses a major hurdle for the commercialization of highly efficient and cost-effective all-perovskite tandem solar cells.

Key Findings

A significant challenge in the performance of lead-tin (Pb-Sn) metal-halide perovskite solar cells, primarily the instability of Sn^{2+} , has been overcome through innovative additive engineering. This research introduced phenylethylammonium iodide (PEAI), 4-fluorophenylethylammonium iodide (4F-PEAI), and 4-fluorophenylethylammonium bromide (4F-PEABr) as additives. This strategy enabled precise control over the crystallization of the Pb-Sn perovskite, leading to a remarkable improvement in its stability. Consequently, the optimized devices achieved a high power conversion efficiency of 21.5%, marking a crucial advancement towards the practical application of all-perovskite tandem solar cells.

Technical / Clinical Details

With a bandgap of approximately 1.24 eV, Pb-Sn perovskites are theoretically ideal bottom cell materials for all-perovskite tandem solar cells. However, a fundamental issue has been the rapid degradation of device performance due to the susceptibility of Sn^{2+} to oxidation to Sn^{4+} upon exposure to air and moisture. The research team employed phenylethylammonium halide derivatives as additives to modulate the growth process of the perovskite crystals, thereby reducing defect density. These additives facilitate a passivation effect on the perovskite thin film surface, acting as a protective layer that suppresses the oxidation of Sn^{2+} . Through precise additive formulation and process control, improved carrier transport and suppressed non-radiative recombination were achieved, leading to the simultaneous realization of 21.5% high efficiency and enhanced stability.

Background & Context

All-perovskite tandem solar cells, unlike silicon-based tandem cells, are composed entirely of perovskite materials in both layers, potentially leading to further reductions in manufacturing costs. Specifically, low-bandgap Pb-Sn perovskites, when combined with a high-bandgap perovskite top cell, can efficiently utilize the entire solar spectrum, promising ultra-high efficiencies unattainable by single-junction cells. The instability of Sn^{2+} has been a major impediment to the commercialization of this promising technology, and the current research outcome significantly lowers this barrier towards practical implementation. The emergence of stable Pb-Sn perovskites further enhances the competitive advantage of all-perovskite tandem technology in the race to develop next-generation solar cells.

Strategic Significance & Outlook

The achievement of enhanced stability and high efficiency in Pb-Sn perovskites through additive engineering significantly advances the commercialization pathway for all-perovskite tandem solar cells. Future R&D efforts will likely focus on further optimizing this additive technology, its application to larger-scale devices, and more rigorous long-term reliability testing. Considering the ongoing move towards lead-free alternatives, the development and integration of less toxic substitute materials may also become a critical area of focus. If stable, high-efficiency all-perovskite tandem solar cells become widely available, they are expected to offer an extremely competitive clean energy solution for a variety of applications, from rooftop installations to large-scale power plants, and even flexible and transparent solar cells. This progress is essential for further lowering the cost of solar electricity and accelerating its global adoption.

Source: <https://pubs.acs.org/doi/abs/10.1021/acsenergylett.6c00858>

#06 Oxford PV and Caelux Join CuspAI-Led 'AI Materials Foundry' to Accelerate Perovskite Solar Cell Material Discovery

Published July 22, 2026 PV Tech UK



OVERVIEW

Leading perovskite PV companies Oxford PV and Caelux have joined the 'AI Materials Foundry,' a new AI-driven research network aimed at accelerating breakthroughs in materials science. Launched by UK venture CuspAI, this initiative will leverage AI for the research and design of novel materials across semiconductors, clean energy, and advanced manufacturing. The collaboration seeks to dramatically shorten the development cycle for next-generation materials, including those for perovskite solar cells, thereby expediting their market introduction.

Key Findings

Oxford PV and Caelux, two frontrunners in perovskite photovoltaic technology, have become founding members of the 'AI Materials Foundry,' a new global AI-powered research network dedicated to accelerating discoveries in materials science. This groundbreaking venture, spearheaded by the UK startup CuspAI, aims to harness artificial intelligence to dramatically speed up the research, design, and optimization of novel materials across key industrial sectors, including semiconductors, clean energy, and advanced manufacturing. This collaboration holds the potential to fundamentally transform the traditional material discovery process, especially for perovskite solar cells.

Technical / Clinical Details

The 'AI Materials Foundry' integrates machine learning algorithms with vast datasets to predict material properties and optimize synthesis pathways. Specifically, it combines advanced simulations, data mining, and automated experimental systems (robot labs) to efficiently identify the most promising perovskite compositions and structures from an immense pool of candidates. This approach significantly shortens research and development cycles, reducing the time and cost associated with trial-and-error experimentation in the laboratory. Oxford PV and Caelux will contribute their extensive data and expertise in perovskite material stability, efficiency, and manufacturability to train and validate AI models, aiming to discover higher-performing and more durable solar cell materials. This collaborative effort applies AI to solve complex problems ranging from atomic-level material interactions to the comprehensive performance evaluation of entire devices.

Background & Context

The commercialization of perovskite solar cells hinges on achieving high efficiency, long-term stability, and low-cost, large-scale production. Conventional trial-and-error approaches have proven insufficient for these goals, making the rapid discovery and optimization of new materials an urgent priority. The convergence of AI and materials science offers a powerful solution to this challenge. AI can identify complex correlations between material properties that human researchers might overlook, providing critical guidance for novel material design. The participation of industry leaders like Oxford PV and Caelux in the AI Materials Foundry signals a clear recognition that data-driven approaches are essential for perovskite technology to advance to its next evolutionary stage. This reflects the current demand for faster and more efficient innovation in a globally competitive landscape.

Strategic Significance & Outlook

Joining the AI Materials Foundry is a strategic move for Oxford PV and Caelux to accelerate innovation in perovskite solar cell technology. By leveraging AI, the material development process, which previously took years, could potentially be compressed into months, enabling quicker market introduction of next-generation, high-efficiency, and highly stable perovskite materials. In the long term, new materials discovered through this network are expected to not only further improve the cost-effectiveness of solar power and accelerate renewable energy adoption but also to redefine the paradigm of material design across a broad spectrum of industries, including semiconductors, clean energy, and advanced manufacturing. This initiative is poised to make significant contributions to the realization of a sustainable society and the growth of technology-driven economies.

Source: <https://www.pv-tech.org/oxford-pv-caelux-join-global-ai-venture-to-advance-materials-discovery/>

#07 JACS Paper: Bidirectional Interfacial Stabilization Achieves 26.53% Perovskite Solar Cell Efficiency, 96% Retention After 1000 Hours

Published July 16, 2026 Journal of the American Chemical Society USA



OVERVIEW

A new study in the Journal of the American Chemical Society demonstrates a "bidirectional chemical and mechanical interfacial stabilization (BCIS)" effect, dramatically enhancing the operational stability and mechanical robustness of perovskite solar cells. This novel strategy resulted in devices achieving a power conversion efficiency (PCE) of up to 26.53% and retaining 96% of their initial efficiency after 1,000 hours of continuous operation under ISOS-L-1I protocols. Furthermore, a large-area module of 818 cm² achieved a PCE of 20.08%, indicating strong compatibility with industrial manufacturing.

Key Findings

A groundbreaking demonstration of "bidirectional chemical and mechanical interfacial stabilization (BCIS)" has significantly advanced the operational stability and mechanical reliability of perovskite solar cells, as reported in the Journal of the American Chemical Society. This innovative strategy enabled perovskite solar cells to achieve a high power conversion efficiency (PCE) of up to 26.53%. Crucially, the devices maintained an outstanding 96% of their initial efficiency after 1,000 hours of continuous operation under the international standard ISOS-L-1I protocol, signifying a major step towards the commercial viability of perovskite technology. Additionally, a large-area module device, measuring 818 cm², also achieved a respectable PCE of 20.08%, underscoring its compatibility with industrial-scale manufacturing.

Technical Details

The BCIS strategy is realized by introducing a specialized molecular layer at the interface between the perovskite and adjacent charge transport layers, providing both chemical bonding and mechanical reinforcement. The chemical stabilization effectively suppresses non-radiative recombination of charge carriers at the interface, thereby improving device efficiency. Concurrently, the mechanical stabilization prevents cracking and delamination of the perovskite thin film, which can occur during manufacturing or operation due to stress, particularly from thermal expansion and contraction. This dual approach allows the devices to maintain superior optoelectronic properties while significantly enhancing their physical robustness. The 96% efficiency retention over 1,000 hours offers a potent solution to the long-standing problem of long-term stability in perovskite solar cells, and the 20.08% efficiency for an 818 cm² module indicates that lab-scale performance can be maintained when scaled up.

Background & Context

Perovskite solar cells have generated considerable excitement as a 'wonder material' in photovoltaics, owing to their potential for high efficiency comparable to or exceeding silicon, and their low-cost solution-process manufacturing. However, the most significant barrier to their commercialization has been their long-term instability against heat, humidity, light, and mechanical stress. Specifically, the inherent fragility of the material's crystal structure and interface degradation have been major contributors to short device lifetimes. The BCIS technology offers a fundamental solution to these complex, interconnected problems, representing a decisive step for perovskite solar cells to be accepted as a practical product in the market. This will solidify perovskite technology's position as a strong contender to revolutionize the existing photovoltaic market.

Strategic Significance & Outlook

The success of bidirectional chemical and mechanical interfacial stabilization technology will profoundly impact the commercialization roadmap for perovskite solar cells. The demonstration of high efficiency and exceptional long-term stability is expected to boost investor and industry confidence, accelerating investment in mass production. The next focus will be to apply this technology to even larger modules and develop cost-effective manufacturing processes. This breakthrough lays the foundation for widespread adoption of perovskite solar cells across a range of applications, including residential, commercial, and utility-scale power generation. Improved reliability and durability will also have ripple effects on the development of diverse solar cell forms, such as flexible and transparent photovoltaics, making it an indispensable technology in shaping the future of renewable energy.

Source: <https://pubs.acs.org/doi/10.1021/jacs.6c06932>

#08 U.S. DOE Reports Perovskite Solar Cells Exceed 26% Efficiency, Tandem Cells Over 34%, Focuses on Stability, Scalable Manufacturing, and Validation

Published July 22, 2026 Department of Energy USA



OVERVIEW

The U.S. Department of Energy (DOE) is actively supporting R&D projects for metal-halide perovskite solar cells to enhance efficiency, extend lifespan, and reduce manufacturing costs. According to recent NREL charts, perovskite solar cells achieve over 26% efficiency in small-area devices and nearly 34% in perovskite-silicon tandem cells, demonstrating significant commercialization progress. The DOE is intently addressing four key challenges: cell stability, scalable efficiency, manufacturability, and technical validation, to accelerate the practical deployment of this innovative technology.

Key Findings

The U.S. Department of Energy (DOE) is robustly supporting comprehensive research and development projects aimed at improving the efficiency and lifespan, reducing manufacturing costs, and ultimately accelerating the commercialization of metal-halide perovskite solar cells. Latest efficiency charts from the National Renewable Energy Laboratory (NREL) indicate that perovskite solar cells have achieved over 26% power conversion efficiency in small-area devices, with perovskite-silicon tandem cells reaching an astonishing nearly 34% efficiency. These figures highlight the potential for perovskite technology to rival, and even surpass, existing solar cell technologies, underscoring the success of the DOE's focused efforts on identified key challenges.

Technical / Clinical Details

The research supported by the DOE involves a multi-pronged approach to maximize perovskite solar cell performance. Specifically, efforts are concentrated on four critical areas:

1. **Cell Stability:** Developing material science and interfacial engineering solutions to suppress degradation from environmental factors (humidity, heat, light) and ensure practical device lifetimes.
2. **Scalable Efficiency:** Advancing technologies to maintain and improve high efficiencies achieved in small-area devices when scaled to larger modules (e.g., large-area deposition techniques, defect control).
3. **Manufacturability:** Developing and optimizing low-cost, efficient, and high-throughput manufacturing processes (e.g., solution processing, roll-to-roll printing).
4. **Technical Validation:** Ensuring rigorous, independent evaluation and certification of performance and reliability by third-party institutions. Through these initiatives, the DOE aims to establish perovskite solar cells as a reliable and economically viable energy solution.

Background & Context

As the global transition to clean energy accelerates, solar photovoltaics play an indispensable role. However, conventional silicon solar cells are approaching their theoretical efficiency limits, fueling expectations for more efficient and cost-effective next-generation technologies. Perovskite solar cells, with their high potential, are widely recognized as this 'next frontier.' The strategic investment by the U.S. Department of Energy is designed to unlock the full market-disrupting potential of this technology and ensure the U.S. maintains global leadership in renewable energy. This R&D effort aims to remove technical barriers and foster domestic innovation and manufacturing capabilities, thereby achieving both energy security and economic growth.

Strategic Significance & Outlook

The DOE's continued support for R&D projects will significantly accelerate the commercialization of perovskite solar cell technology. As demonstrated by the over 34% efficiency in tandem cells, this technology has the potential to substantially exceed the theoretical limits of single-junction silicon cells. Once challenges in stability, scalability, manufacturability, and validation are addressed, perovskite solar cells are poised to replace or complement existing technologies in a wide array of applications, including residential, commercial, and utility-scale power generation. This will further reduce the cost of solar electricity, making clean energy accessible in more regions and providing an indispensable contribution to achieving global decarbonization goals.

Source: <https://www.energy.gov/cmei/systems/perovskite-solar-cells>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#09 Sofab Inks Raises \$6 Million Seed Funding to Scale Perovskite Solar Cell Material Production and Enhance Reliability with Metal Oxide ETL

Published July 21, 2026 Renewables Now USA



OVERVIEW

U.S. solar material startup Sofab Inks has raised \$6 million in seed funding to expand the production of specialized perovskite solar cell materials and dramatically improve long-term reliability. The company claims a significant technical breakthrough by replacing traditional fullerene-based electron transport layers (ETL) with metal oxide nanoparticle materials, which they believe solves critical reliability issues. Sofab Inks has reported 22.3% efficiency on 30cm single-junction modules and plans to expand its engineering team for 1x2 meter commercial module production with the new capital.

Key Findings

Sofab Inks, a promising U.S. startup specializing in solar cell materials, has successfully secured \$6 million in seed funding. This capital injection is aimed at scaling up the production of specialized perovskite solar cell materials and fundamentally improving their long-term reliability. The company announced a significant technical breakthrough in the electron transport layer (ETL), a critical component of solar cells, by replacing conventional fullerene-based materials with novel metal oxide nanoparticle materials. Sofab Inks is confident that this innovative approach holds the key to solving the persistent reliability issues that have hampered the broad market adoption of perovskite solar cells. The company has already demonstrated an impressive 22.3% efficiency on 30cm single-junction modules and plans to utilize the newly raised funds to expand its engineering team, focusing on developing 1x2 meter commercial module production.

Technical / Clinical Details

Many of the reliability problems in perovskite solar cells stem from the degradation of organic electron transport layers (ETL). Fullerene-based ETLs are known to be susceptible to light and heat, thereby limiting the lifespan of the devices. The metal oxide nanoparticle-based ETL developed by Sofab Inks demonstrates superior stability against these environmental factors, enabling the perovskite layer to maintain its performance over extended periods. Metal oxide materials are generally more thermally and chemically stable than organic counterparts and also exhibit better UV absorption characteristics, which significantly enhances device durability. Furthermore, these nanoparticle materials can be easily applied using solution processing, making them suitable for low-cost, large-scale manufacturing. The 22.3% efficiency achieved with a 30cm module indicates that this technology can enhance reliability without compromising performance, with future applications in larger 1x2 meter commercial modules anticipated.

Background & Context

Perovskite solar cells have garnered significant excitement as a next-generation photovoltaic technology due to their potential for power conversion efficiencies comparable to or exceeding silicon cells, coupled with the promise of low-cost manufacturing. However, the most substantial hurdle has been establishing long-term reliability to ensure a practical product lifespan. Sofab Inks' funding and technical breakthrough represent a decisive step towards overcoming this reliability barrier, enabling perovskite solar cells to enter the mainstream market. The innovation in ETL materials is a crucial research area for improving perovskite solar cell stability, and the company's achievement could accelerate the overall development competition in the industry. This movement is expected to surmount key commercialization obstacles for perovskite technology, bringing significant transformation to the renewable energy market.

Strategic Significance & Outlook

The \$6 million seed funding secured by Sofab Inks is crucial for the company's transition from pilot-scale to commercial-scale manufacturing of perovskite solar cell materials. The metal oxide nanoparticle ETL technology is an indispensable component for establishing the long-term reliability of perovskite solar cells, opening up applications in sectors previously challenging for organic ETLs, such as automotive, IoT devices, and even space applications. The company is expanding its engineering team and preparing for 1x2 meter commercial module production, likely introducing disruptive products to the market within the next few years. If successful, this technology is expected to drive the widespread adoption of perovskite solar cells as high-efficiency and high-durability photovoltaic solutions, making an essential contribution to global clean energy goals.

Source: <https://renewablesnow.com/news/sofab-inks-raises-usd-6m-seed-funding-to-scale-perovskite-solar-materials-1298382/>

#10 Oxford PV Tandem Modules Exceed 25% Efficiency, Sets Ambitious 27% Target by 2027

Published July 16, 2026 pv magazine Global UK



OVERVIEW

Oxford PV has announced that its perovskite-silicon tandem modules, now being supplied to pilot customers, have achieved power conversion efficiencies slightly exceeding 25%. The company aims to boost module efficiency to 27% by next year (2027), advancing optimization through extensive field testing and performance monitoring. This progress unequivocally demonstrates the commercial viability of perovskite tandem technology and its potential to drive the next wave of high-efficiency solar power in the market.

Key Findings

Oxford PV, a pioneer in perovskite solar cell technology, has announced that its perovskite-silicon tandem modules are currently achieving power conversion efficiencies just over 25%. This achievement comes as the company has already begun supplying products to pilot customers, underscoring the high performance of the technology in a near-commercial setting. Furthermore, Oxford PV has set an ambitious target to increase module efficiency to 27% by 2027, pursuing this goal through extensive field testing and continuous performance monitoring. This progress indicates that the commercial introduction of this next-generation solar cell technology is rapidly approaching.

Technical Details

Oxford PV's tandem modules are designed to utilize a broader spectrum of sunlight more efficiently by layering a thin perovskite cell on top of a conventional crystalline silicon solar cell. The perovskite layer captures high-energy blue light, which silicon absorbs less effectively, while the silicon layer absorbs the remaining lower-energy photons. This complementary structure enables higher efficiencies than either technology could achieve independently. The current efficiency exceeding 25% already outperforms many mainstream silicon modules, and the 27% target for 2027 promises to significantly improve the cost-effectiveness of solar power. The company's field tests are critically evaluating performance under various weather conditions, long-term stability, and durability, which are essential for ensuring the commercial robustness of the technology.

Background & Context

Amidst escalating global energy demands and the urgency of addressing climate change, solar photovoltaics are expanding their role as a primary renewable energy source. However, further reductions in installation footprint and generation costs necessitate even more efficient solar cell technologies. Perovskite-silicon tandem technology is a leading candidate to meet this demand, and its ability to leverage existing silicon manufacturing infrastructure promises relatively rapid market introduction. Oxford PV, as a global leader in this field, is vigorously driving its technological development. Many research institutions and private companies across Europe are also actively involved in advancing and commercializing this technology, indicating growing industry-wide enthusiasm for tandem solutions.

Strategic Significance & Outlook

Oxford PV's achievement of over 25% efficiency with its tandem modules and the setting of a 27% target are groundbreaking news for the solar energy industry. If widely adopted, this technology could dramatically increase the power output per unit area of solar installations, accelerating renewable energy deployment in more regions. High-efficiency modules offer particular advantages for rooftop installations and urban areas with limited space. Future challenges will include maintaining this high efficiency and stability in mass production processes, while also enhancing cost competitiveness. Oxford PV's ongoing R&D and field tests are poised to overcome these challenges, paving the way for perovskite-silicon tandem solar cells to play a central role in the global energy transition.

Source: <https://www.pv-magazine.com/2026/07/16/oxford-pv-targets-27-efficiency-for-tandem-modules-by-2027/>

#11 German Researchers Develop Indium-Free Perovskite-Silicon Mini-Modules with 31% Efficiency via Reactive Plasma Deposition

Published July 17, 2026 PV Magazine Germany



OVERVIEW

German researchers have innovatively utilized a low-damage reactive plasma deposition (RPD) process to create indium-free perovskite-silicon tandem solar cells. This technology achieved certified efficiencies of 33.6% for small-area devices and 31.0% for mini-modules. This breakthrough is a significant step towards commercialization, dramatically reducing material costs by replacing conventional indium-based transparent conductive oxides with cheaper, abundant tin oxide while maintaining high conversion efficiency.

Key Findings

Researchers in Germany have achieved a groundbreaking milestone in next-generation solar cell technology. They successfully fabricated indium-free perovskite-silicon tandem solar cells using an innovative low-damage reactive plasma deposition (RPD) process. This advanced technique resulted in a certified efficiency of 33.6% for small-area devices and an impressive 31.0% certified efficiency for mini-modules. This accomplishment is a significant step towards the commercialization of perovskite solar cells, as it substantially reduces material costs by replacing expensive indium with cheaper and more abundant tin oxide, all while preserving high conversion efficiency.

Technical / Clinical Details

The core of this research lies in replacing Indium Tin Oxide (ITO), a widely used transparent conductive oxide (TCO), with readily available and inexpensive tin oxide (SnO_2). Indium-free technology offers substantial benefits in both resource sustainability and cost reduction. However, a challenge with using SnO_2 as a TCO has been the potential for its deposition process to damage underlying perovskite or silicon materials. The research team overcame this by developing a low-damage RPD process. RPD is a plasma-based thin-film deposition technique that allows for precise control over deposition temperature and plasma conditions. This minimizes damage to the underlying layers while forming high-quality, highly transparent SnO_2 films. Consequently, the high conversion efficiency and stability of the overall perovskite-silicon tandem cell were ensured.

Background & Context

Perovskite-silicon tandem solar cells are considered the most promising candidates for next-generation photovoltaics, offering the potential to surpass the theoretical efficiency limit of single-junction silicon solar cells (approximately 29%). However, maintaining high efficiency, ensuring long-term stability, and reducing manufacturing costs are crucial for their commercialization. Indium, being a rare and expensive material, makes indium-free development critically important for significantly lowering manufacturing costs and mitigating supply chain risks. This German research outcome enhances the attractiveness of perovskite tandem technology from both cost and performance perspectives, widely opening the path for its large-scale adoption. This marks a vital step forward for the broader deployment of solar power and the realization of a sustainable energy society.

Strategic Significance & Outlook

The development of indium-free perovskite-silicon mini-modules achieving 31% efficiency has the potential to redefine the future of photovoltaic technology. Future research and development will likely focus on further optimizing the RPD process and validating its applicability for larger-scale commercial module production. Strengthening long-term reliability tests and evaluating performance under various environmental conditions will also be essential. If this technology gains widespread adoption, it is expected to further reduce the installation cost of solar power, accelerating the deployment of renewable energy in more countries and regions. This will contribute significantly to enhancing energy security and combating global climate change.

Source: <https://www.pv-magazine.com/2026/07/17/research-breakthrough-develops-indium-free-tandem-solar-cell-with-31-efficiency/>

#12 JinkoSolar Achieves 34.82% Efficiency with Perovskite-Silicon Tandem Solar Cell, Sets New World Record

Published July 20, 2026 Winssolutions China



OVERVIEW

Chinese solar giant JinkoSolar has reported a new world record power conversion efficiency of 34.82% for its perovskite-silicon tandem solar cell. This achievement, independently certified by the Shanghai Institute of Microsystem and Information Technology (SIMIT) of the Chinese Academy of Sciences, underscores the company's leading technological prowess. JinkoSolar has steadily improved its efficiency from 34.76% in December 2025 to 34.82% in June 2026, demonstrating the success of its strategic focus and investment in next-generation perovskite-silicon tandem technology.

Key Findings

JinkoSolar, a prominent Chinese solar module manufacturer, has announced a new world record in the development of perovskite-silicon tandem solar cells, achieving an impressive power conversion efficiency of 34.82%. This remarkable efficiency has been rigorously certified by the Shanghai Institute of Microsystem and Information Technology (SIMIT) of the Chinese Academy of Sciences, clearly positioning JinkoSolar as a global leader in next-generation solar cell R&D. The company successfully improved upon its previous record of 34.76% achieved in December 2025, demonstrating a steady gain of 0.06 percentage points in just six months. This highlights the rapid evolution of perovskite-silicon tandem technology and JinkoSolar's continuous innovation capabilities.

Technical Details

JinkoSolar's perovskite-silicon tandem solar cell is engineered to surpass the limitations of conventional crystalline silicon solar cells. The technology operates by layering two semiconductor materials with different bandgaps—perovskite and silicon—to efficiently capture photons. The perovskite layer absorbs the high-energy portion of the solar spectrum (e.g., blue light), while the underlying silicon layer absorbs the remaining lower-energy portion (e.g., red light). This complementary absorption maximizes the utilization of the solar spectrum, achieving efficiencies unattainable with single-junction cells. JinkoSolar attributes this record-breaking efficiency to its focus on interface optimization, improvements in charge transport layers, and the development of proprietary perovskite material compositions. Crucially, precise defect control and minimization of carrier recombination losses played a significant role.

Background & Context

The solar photovoltaic industry is relentlessly pursuing technological innovations to accelerate the global transition to sustainable energy. Conventional single-junction silicon solar cells are mature, and their efficiency improvements are nearing physical limits. Consequently, perovskite-silicon tandem solar cells are attracting significant attention as a 'game-changer.' The continuous breaking of world records in this field by major manufacturers like JinkoSolar indicates that this technology is moving beyond the research phase and is highly likely to be commercialized in the near future. Tandem technology allows for increased power output per unit area of solar energy systems, offering particular advantages in space-constrained locations and for large-scale projects demanding higher energy yields. This will further enhance the global competitiveness of solar photovoltaics.

Strategic Significance & Outlook

JinkoSolar's achievement of 34.82% power conversion efficiency significantly advances the commercialization pathway for perovskite-silicon tandem solar cells. The company is actively pursuing a roadmap to deploy this technology at a mass-production scale, aiming to introduce even higher-efficiency and more cost-effective products to the market. While challenges in technology stability, durability, and large-scale manufacturing remain, this latest achievement signals strong confidence in overcoming these hurdles. The widespread adoption of high-efficiency tandem modules could accelerate solar deployment across a broad range of sectors, including residential, commercial, industrial applications, and utility-scale solar farms, making an indispensable contribution to increasing renewable energy's share in the global energy mix and achieving global decarbonization targets.

Source: <https://www.winssolutions.org/jinkosolar-34-82-perovskite-tandem-cell/>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#13 US-Based Tandem PV Announces Breakthroughs in Perovskite-Silicon Solar Cell Technology, Accelerating Market Introduction

Published July 20, 2026 everything PE USA



OVERVIEW

U.S. solar technology company Tandem PV has announced groundbreaking advancements in its perovskite-silicon tandem solar cell technology. Their innovations push beyond existing solar cell performance limits, achieving higher efficiencies and enhanced long-term stability. This progress is set to accelerate the transition to clean energy by significantly improving the cost-performance ratio of solar power, facilitating widespread adoption from residential to utility-scale applications.

Key Findings

Tandem PV, a U.S.-based solar technology company, has unveiled significant advancements in its perovskite-silicon tandem solar cell technology, a key area for next-generation photovoltaics. The company's latest breakthroughs promise to substantially exceed the performance limits of existing solar cell technologies, achieving unprecedented levels of both power conversion efficiency and long-term reliability. This progress is attracting considerable attention within the industry as it opens new possibilities for solar power and paves the way for a more sustainable energy future.

Technical Details

The perovskite-silicon tandem solar cells under development by Tandem PV utilize an innovative stacked architecture. The upper perovskite layer efficiently absorbs the high-energy portion of the solar spectrum, which single-junction silicon cells typically struggle with, while the lower silicon layer captures the remaining light. This complementary light absorption maximizes the utilization efficiency of sunlight, theoretically allowing for significantly higher efficiencies than conventional silicon solar cells. The company achieves this high efficiency and stability through proprietary material compositions, advanced interface passivation techniques, and optimized device structures. Particular emphasis has been placed on reducing defect density within the perovskite layer and optimizing charge carrier transport between layers, successfully enhancing both device performance and lifespan.

Background & Context

Increasing global energy demands and the urgency of climate change mitigation necessitate further improvements in the efficiency and cost reduction of renewable energy technologies, particularly solar photovoltaics. With single-junction silicon solar cells nearing their physical efficiency limits, the industry is placing high hopes on perovskite tandem technology as the next growth engine. Significant progress by specialized companies like Tandem PV is crucial for solar power to become an economically viable option across broader markets. This technology not only promises higher efficiency but also has the potential to offer new functionalities like flexibility and transparency in the future, making it suitable for diverse applications such as building-integrated photovoltaics (BIPV) and portable devices.

Strategic Significance & Outlook

Tandem PV's advancements in perovskite-silicon tandem technology will significantly impact the solar power commercialization roadmap. The company aims to rapidly bring these innovative technologies to market, intending to either replace existing systems or substantially improve their performance in residential, commercial, and utility-scale solar projects. Future focus will be on smoothly transitioning laboratory-scale achievements to large-scale production processes and further establishing the long-term durability and reliability of their products. Tandem PV's efforts are expected to further reduce the cost of solar power and accelerate its widespread adoption, making an indispensable contribution to the global energy transition and the realization of a sustainable society.

Source: <#>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#14 Caelux Partners with Rayzon Solar and Navitas Solar for 10 GW Perovskite-Silicon Hybrid Tandem Module Manufacturing in India

Published July 23, 2026 PV Tech India

Caelux, India's Rayzon Solar, and Navitas Solar
10GW of perovskite-silicon hybrid Tandem modules

July 23 2026



OVERVIEW

US perovskite solar technology firm Caelux has signed two five-year agreements with Indian solar manufacturers Navitas Solar and Rayzon Solar to produce a combined 10 GW of perovskite-silicon 'Hybrid Tandem' modules. These strategic partnerships aim to integrate Caelux's perovskite-coated solar glass with n-type TOPCon modules, targeting conversion efficiencies of up to 28%. Commercial availability is expected by 2028, with early deployments already underway, signaling a major drive for high-efficiency solar deployment in the Indian renewable energy market.

Key Findings

Caelux, a prominent U.S. perovskite solar technology company, has entered into two five-year agreements with leading Indian solar manufacturers, Navitas Solar and Rayzon Solar. These landmark partnerships are set to facilitate the production of a staggering 10 GW of perovskite-silicon 'Hybrid Tandem' modules, marking a substantial commitment to high-efficiency solar technology commercialization within the Indian market.

Technical / Clinical Details

The essence of these collaborations lies in combining Caelux's innovative perovskite-coated solar glass with the established n-type TOPCon (Tunnel Oxide Passivated Contact) module technology from Navitas Solar and Rayzon Solar. N-type TOPCon modules are already recognized for their high efficiency in conventional silicon PV. By overlaying them with a perovskite layer, the tandem modules can absorb a broader spectrum of sunlight, leading to significantly higher energy conversion. The targeted conversion efficiency for these hybrid tandem modules is up to 28%, which represents a considerable increase over current mainstream silicon module efficiencies. This advancement promises to dramatically boost the power output per unit area of solar installations. Crucially, this hybrid tandem technology is expected to be relatively compatible with existing silicon manufacturing infrastructures, facilitating a quicker and more streamlined market entry.

Background & Context

India's burgeoning economy and population growth have led to an exponential increase in energy demand. Concurrently, the Indian government has set ambitious renewable energy targets, with solar power playing a central role. A key challenge is optimizing energy generation within limited land resources. The 10 GW partnership between Caelux and the Indian manufacturers directly addresses this by introducing high-efficiency tandem modules. This move is expected to contribute significantly to reducing the Levelized Cost of Energy (LCOE) and bolstering India's clean energy goals. Moreover, such international technological alliances are instrumental in establishing perovskite solar cells as a mainstream technology in the global market, demonstrating confidence in their performance and scalability.

Strategic Significance & Outlook

Commercial availability of the perovskite-silicon hybrid tandem modules from this Caelux-led partnership is anticipated by 2028, with initial deployments already in progress. When fully scaled, this technology is poised to have a transformative impact not only on India's solar market but also on the global solar industry. The up to 28% efficiency will be particularly valuable for applications with space constraints, such as residential rooftops and commercial buildings, as well as for maximizing output in large-scale solar farms. Future success will depend on further optimizing manufacturing costs, demonstrating robust long-term reliability through extensive field testing, and establishing a resilient global supply chain. Nevertheless, these partnerships shine a bright light on the future of perovskite solar cells and their potential to accelerate the transition to a sustainable energy future.

Source: <https://www.pv-tech.org/caelux-links-up-with-rayzon-navitas-on-10gw-perovskite-pv-commercialisation-deals-in-india/>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#15 Perovskite Solar Cells: 2026 Reality Check Highlights Durability and Scaling as Key Barriers to Mass Commercialization Despite Lab Efficiency Records

Published July 19, 2026 SolarVision AI Unknown



OVERVIEW

A 2026 report by SolarVision AI indicates that despite achieving over 30% efficiency in laboratory settings, perovskite solar cells face significant hurdles in durability, manufacturing scalability, and certification maturity, delaying widespread market adoption. Silicon technology remains the commercial standard, underscoring the gap between lab performance and real-world application. Industry experts anticipate broader commercialization in the coming years once these key challenges are effectively addressed.

Key Findings

As of 2026, perovskite solar cells demonstrate remarkable potential with laboratory efficiency records exceeding 30%. However, their widespread commercialization is still hampered by unaddressed challenges in long-term durability, manufacturing scalability, and the maturation of robust certification standards for real-world deployment.

Technical / Clinical Details

Recent research frequently reports high laboratory efficiencies, particularly for perovskite-on-silicon tandem cells, with figures surpassing 30%. This theoretically pushes beyond the traditional efficiency limits of single-junction silicon solar cells. Yet, these record-breaking efficiencies are typically achieved under highly controlled laboratory conditions and on relatively small cell areas. The primary commercialization barriers stem from the inherent instability of perovskite materials against moisture, heat, and UV radiation, making it difficult to guarantee decades of stable performance in harsh outdoor environments. Furthermore, cost-effective optimization of large-scale manufacturing processes and yield remains in development. Establishing international performance and safety certification standards, alongside proven real-world reliability, is a prerequisite for market acceptance.

Background & Context

The global solar photovoltaic market is predominantly driven by crystalline silicon technology, whose efficiency and cost-effectiveness have been refined over decades of R&D and mass production. Perovskite solar cells are seen as a promising alternative or complement to silicon, but to penetrate the existing market, they must offer comparable or superior performance and reliability at a competitive price point. While numerous companies and research institutions are actively working on these challenges in 2026, a true commercial breakthrough for widespread adoption has not yet materialized.

Strategic Significance & Outlook

Industry experts project that as perovskite solar cells overcome manufacturing challenges, address durability concerns, and establish unified certification standards, broader market introduction is expected in the coming years. Specifically, a significant commercialization phase is anticipated from late 2027 to early 2028. This will allow perovskite tandem cells to elevate the efficiency of the existing solar market to new levels, positioning them as a potential "game-changer" that could further accelerate the global adoption of solar energy.

Source: <https://solarvisionai.com/perovskite-solar-panels/>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#16 UC Davis Leverages AI and Machine Learning to Accelerate Discovery of Durable Perovskite Solar Cell Materials

Published July 21, 2026 University of California, Davis USA



OVERVIEW

Researchers at the University of California, Davis, have developed a novel machine learning framework that dramatically accelerates the search for highly durable perovskite solar cell materials. This AI-driven approach accurately predicts how new material compositions react to thermal stress by learning from thousands of automated experiments, rapidly identifying promising stabilization candidates. This breakthrough provides a critical roadmap for overcoming the stability bottleneck, a major barrier to perovskite solar cell commercialization.

Key Findings

A research team at the University of California, Davis, has developed a novel methodology leveraging machine learning (AI) to dramatically accelerate the discovery of materials that enhance the long-term durability of perovskite solar cells. This AI-powered approach allows for the automated analysis of thousands of experimental data points, accurately predicting the thermal response of new material compositions and thereby offering a significant advancement in solving the stability issue, a primary obstacle to commercialization.

Technical / Clinical Details

The research involved building a machine learning model integrated with a robotic high-throughput synthesis and characterization platform. This integrated system efficiently gathers and analyzes thermal stability data for various perovskite material compositions. The AI learns patterns from historical experimental data, developing algorithms that predict how specific material combinations will maintain their stability over time, especially under elevated temperatures. This capability allows for the identification of optimal material candidates far more rapidly than traditional human-led trial-and-error methods.

Conventional material discovery processes are notoriously time-consuming and expensive. This AI-driven approach has the potential to reduce that timeline from months to just days, offering a tangible pathway to overcome the vulnerability of perovskite solar cells to environmental stressors, which has been a major inhibitor of their practical commercial deployment.

Background & Context

Perovskite solar cells are widely regarded as a pivotal technology for the future of photovoltaics due to their high power conversion efficiency and potential for low manufacturing costs. However, one of their most significant weaknesses has been their lack of stability against environmental factors such as heat, humidity, and UV light. This has made it challenging to achieve practical device lifetimes, posing a substantial barrier to commercialization. The application of AI in materials science has rapidly advanced in recent years, ushering in a new paradigm for accelerating the discovery and optimization of novel materials. The UC Davis achievement stands as a powerful demonstration of AI's effective application in this field.

Strategic Significance & Outlook

This machine learning-based materials discovery platform is a versatile tool applicable not only to enhancing perovskite solar cell stability but also to the development of other novel materials. It is expected to significantly shorten the time-to-market for more durable perovskite materials. In the long term, this will improve the cost-effectiveness and reliability of perovskite solar cells, accelerating their adoption in new markets such as building-integrated photovoltaics, flexible electronics, and even space applications. Ultimately, this research contributes to the broader deployment of clean energy and the realization of a sustainable society.

Source: <https://www.ucdavis.edu/blog/machine-learning-accelerates-search-longer-lasting-materials-solar-cells>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#17 Oxford PV, Caelux Join UK's CuspAI "AI Materials Foundry" to Accelerate Perovskite and Advanced Materials Discovery

Published July 22, 2026 PV-Tech UK



OVERVIEW

Perovskite solar cell innovators Oxford PV and Caelux have become founding members of the "AI Materials Foundry," a new AI-driven research network launched by UK-based CuspAI. This strategic collaboration aims to significantly accelerate the discovery and design of novel materials across semiconductors, clean energy, and advanced manufacturing. Caelux's CEO emphasizes this partnership's crucial role in rapidly developing new perovskite technologies, signaling a new era for AI-driven materials science breakthroughs.

Key Findings

Oxford PV and Caelux, prominent innovators in perovskite solar cell technology, have joined the "AI Materials Foundry" as founding members. This new AI-driven research network, established by UK-based AI firm CuspAI, aims to significantly accelerate the discovery and development of next-generation materials, including perovskites.

Technical / Clinical Details

The "AI Materials Foundry" integrates advanced machine learning algorithms with computational chemistry to optimize the materials discovery process. This platform is capable of simulating a vast number of potential material compositions and their properties, rapidly identifying the most promising candidates worthy of experimental validation. This approach dramatically reduces the lead time and costs associated with new material development compared to traditional trial-and-error methodologies.

In the perovskite solar cell sector, there is an urgent need to discover new materials that simultaneously optimize stability, efficiency, and manufacturability. AI demonstrates efficiency far beyond human capabilities in finding optimal solutions for these complex multi-variable problems. The CEO of Caelux has stated that participation in this network is critical for accelerating the development of perovskite technologies, particularly for improving durability and discovering materials suitable for large-scale production.

Background & Context

Advancements in materials science are foundational to numerous high-tech industries, including semiconductors, energy storage, clean energy, and advanced manufacturing. Historically, the discovery and optimization of new materials have been resource-intensive and time-consuming processes. Recent developments in machine learning and AI are revolutionizing this field. Oxford PV and Caelux are world leaders in perovskite-silicon tandem solar cell development and perovskite coating technologies, respectively, and their integration with AI technology is set to further drive innovation in this sector.

Strategic Significance & Outlook

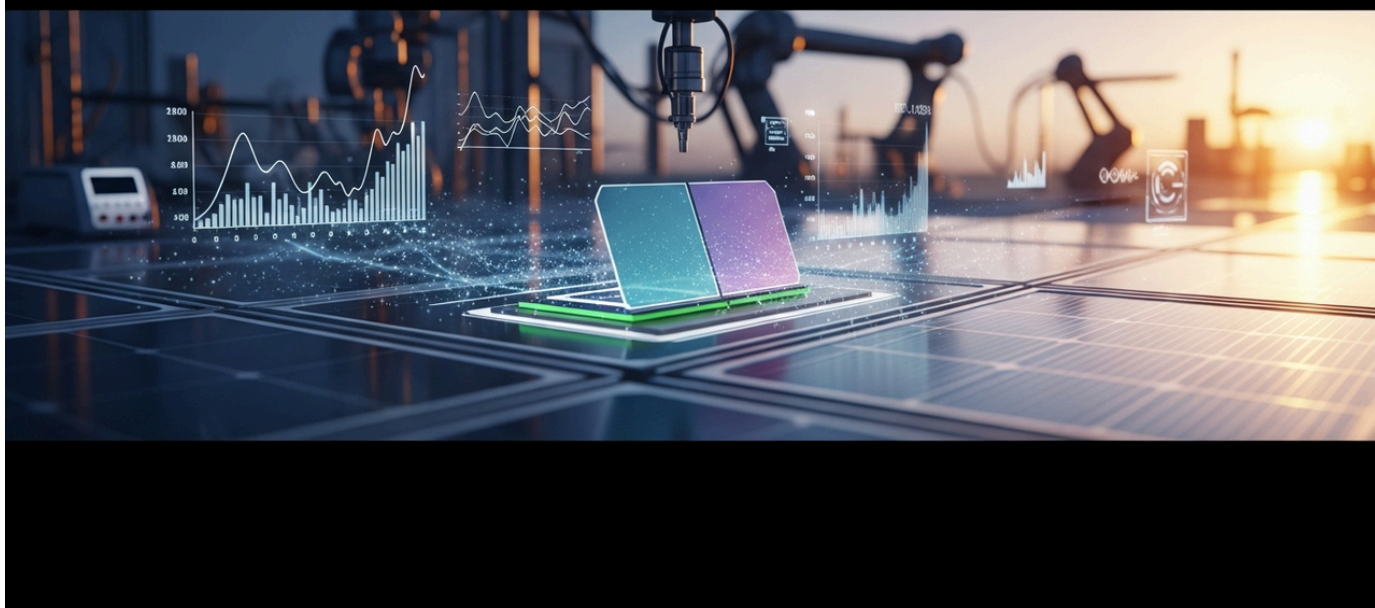
The establishment of the "AI Materials Foundry" sets a new model for collaboration and digitalization in materials science research. This partnership is expected to accelerate the market introduction of innovative materials essential for perovskite solar cells, a wide range of clean energy technologies, high-performance semiconductors, and advanced manufacturing processes. In the long term, AI-driven materials discovery is poised to accelerate the pace of sustainable technological development and enhance the competitiveness of industries globally, marking a strategic move in the evolution of material engineering.

Source: <https://www.pv-tech.org/oxford-pv-caelux-perovskite-ai-materials-science/>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#18 Solar Module Prices Stabilize, Perovskite Tandem Cells Poised for 2028 Mass Market Entry with 30%+ Efficiency Potential

Published July 21, 2026 TaiyangNews Unknown



OVERVIEW

TaiyangNews reports stabilizing solar module prices driven by TOPCon and BC module demand, while manufacturers intensify efforts in perovskite solar cell technology. Perovskite tandem cells, in particular, show promise for over 30% module efficiency, though large-scale production remains limited due to manufacturing complexity and long-term durability concerns. With initial commercial deployments underway by Oxford PV, a broader market introduction is anticipated from late 2027 to early 2028, positioning them as potential game-changers in the photovoltaic market.

Key Findings

The solar module market is experiencing price stabilization, driven by increasing demand for advanced TOPCon (Tunnel Oxide Passivated Contact) and Back Contact (BC) modules. Amidst this backdrop, solar cell manufacturers are intensifying their focus on next-generation perovskite solar cell technology, with perovskite tandem cells highlighted for their potential to achieve module efficiencies exceeding 30%.

Technical / Clinical Details

Perovskite tandem cells are engineered by stacking a perovskite layer atop a conventional silicon cell. This innovative architecture enables the perovskite layer to efficiently absorb shorter-wavelength light, while the underlying silicon cell captures longer wavelengths, resulting in significantly higher power conversion efficiencies than single-junction cells alone. Laboratory records already surpass 30%, pushing the theoretical efficiency limits of solar photovoltaics.

However, the path to commercial large-scale production still faces significant hurdles, primarily concerning manufacturing complexity and ensuring long-term durability. The stability of perovskite materials against outdoor environmental stressors such as heat, humidity, and UV radiation is a critical factor influencing their widespread adoption. While large-scale production is currently limited, pioneers like Oxford PV have initiated early commercial deployments, validating the technology's real-world performance.

Background & Context

The photovoltaic industry is characterized by intense technological innovation and cost competition. The transition from older PERC (Passivated Emitter and Rear Cell) technology to more efficient TOPCon and Heterojunction Technology (HJT) is ongoing, with perovskite solar cells representing the next anticipated breakthrough. Perovskite is a promising material that may offer lower energy costs and relatively simpler manufacturing processes, which could significantly reduce the future Levelized Cost of Energy (LCOE). A stable market environment creates favorable conditions for investment and the integration of new, advanced technologies.

Strategic Significance & Outlook

Industry experts project that as perovskite solar cells overcome manufacturing challenges, address durability concerns, and establish unified certification standards, broader market introduction is expected in the coming years. Specifically, a significant commercialization phase is anticipated from late 2027 to early 2028. This will allow perovskite tandem cells to elevate the efficiency of the existing solar market to new levels, positioning them as a potential "game-changer" that could further accelerate the global adoption of solar energy.

Source: <https://taiyangnews.info/business/solar-module-prices-stabilize-as-back-contact-demand-grows>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#19 Caelux Partners with India's Rayzon Solar & Navitas for 10 GW Perovskite-Silicon Tandem Module Development in India

Published July 24, 2026 pv magazine Global India



OVERVIEW

US perovskite technology firm Caelux has signed five-year partnership agreements with Indian solar manufacturers Rayzon Solar and Navitas Solar to develop and produce a combined 10 GW of perovskite-silicon "hybrid tandem" modules in India. This collaboration aims to achieve up to 28% conversion efficiency by integrating Caelux's perovskite-coated solar glass with N-type TOPCon module technology. Commercial production is slated to begin in 2028, marking a significant step towards perovskite commercialization and India's renewable energy goals.

Key Findings

Caelux, a U.S.-based perovskite solar technology company, has forged strategic partnerships with leading Indian solar manufacturers Rayzon Solar and Navitas Solar. These agreements will see the development and production of a massive 10 GW combined capacity of perovskite-silicon "hybrid tandem" solar modules within India, marking a pivotal milestone in the commercialization of perovskite technology.

Technical / Clinical Details

Central to these partnerships is the integration of Caelux's innovative perovskite-coated solar glass with Rayzon Solar's and Navitas Solar's established N-type TOPCon (Tunnel Oxide Passivated Contact) module manufacturing capabilities. The objective is to combine these technologies to achieve power conversion efficiencies of up to 28%. This represents a substantial improvement over standalone silicon modules, enabling higher energy output from a smaller footprint.

Each partnership is structured as a five-year agreement, with commercial production slated to commence in 2028, contributing significantly to India's ambitious renewable energy targets. These hybrid tandem modules are designed to harness the full solar spectrum, with the perovskite layer efficiently absorbing shorter-wavelength light and the TOPCon silicon layer capturing longer wavelengths, thereby maximizing energy extraction.

Background & Context

India's rapidly growing economy and population have led to a surge in energy demand, making renewable energy deployment a national strategic priority. Solar power plays a central role in this agenda, fueling heightened interest in high-efficiency, low-cost, next-generation solar cell technologies. Caelux's perovskite technology is positioned to complement and enhance the performance of conventional silicon solar cells, and these collaborations with Indian firms demonstrate its growing acceptance in global markets. The combined 10 GW production target is a substantial volume, even by global solar industry standards, and could represent a turning point for the industrialization of perovskite technology.

Strategic Significance & Outlook

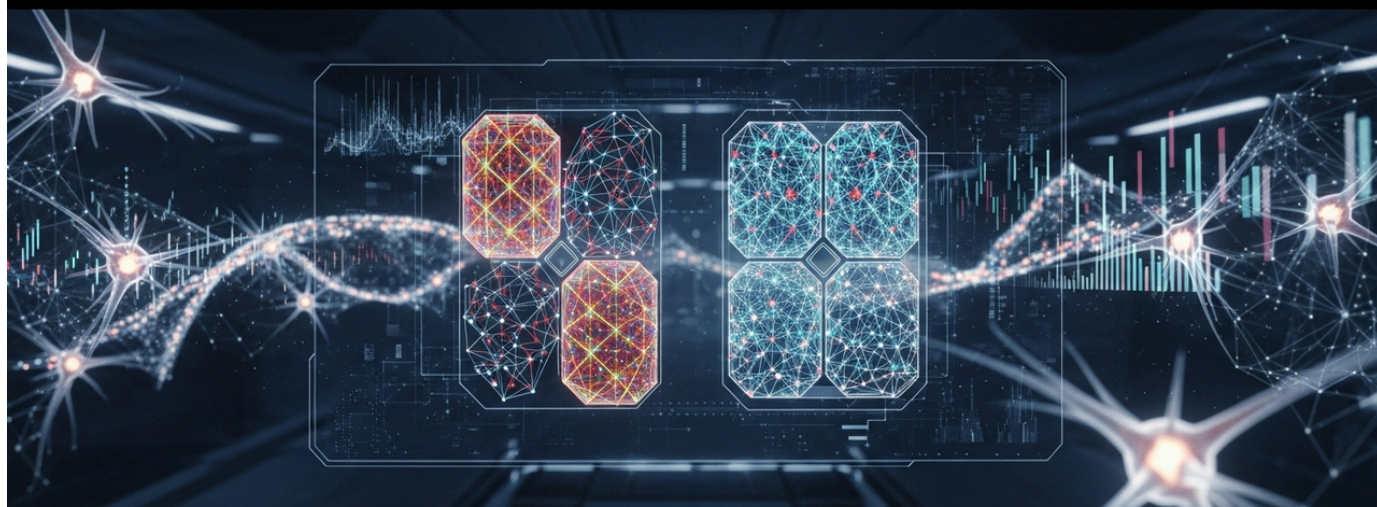
These strategic partnerships are set to bring transformative change to India's solar power industry, significantly bolstering the nation's ability to meet its aggressive renewable energy targets. The initiation of commercial production for perovskite-silicon tandem modules will dramatically improve the cost-efficiency of solar power and the energy yield per unit area, offering distinct advantages for installations in urban areas and locations with limited land availability. This collaboration is a crucial initial step for Caelux's technology adoption in a major global market, suggesting potential for similar partnerships in other regions. The 2028 commercial production launch is keenly watched by the entire industry as the expected period for perovskite solar cells' full transition from laboratory to large-scale market presence.

Source: <https://www.pv-magazine.com/2026/07/24/rayzon-solar-navitas-partner-us-based-caelux-to-develop-10-gw-of-perovskite-silicon-tandem-modules-in-india/>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#20 Machine Learning Accelerates Lead-Free Dual-Absorber Perovskite Solar Cell Design, Paving Way for 32.5% Efficiency

Published July 17, 2026 MDPI (Materials journal) Switzerland



OVERVIEW

A new study published in MDPI's Materials journal introduces an automated optimization framework integrating SCAPS-1D simulation with machine learning to accelerate the design of lead-free dual-absorber perovskite solar cells. This approach demonstrates that dual-absorber devices can achieve over 30% power conversion efficiency by more effectively utilizing the solar spectrum. Notably, perovskite/silicon tandem cells reached 32.5% efficiency, marking a significant contribution to high-efficiency solar cell development.

Key Findings

A recent study published in MDPI's "Materials" journal introduces an automated optimization framework that integrates SCAPS-1D simulation with advanced machine learning techniques. This innovative approach dramatically accelerates the design of lead-free double-absorber perovskite solar cells, demonstrating the potential to achieve power conversion efficiencies of 32.5% in perovskite/silicon tandem configurations.

Technical / Clinical Details

The researchers employed various machine learning methods, including surrogate model-assisted reinforcement learning, multi-algorithm optimization comparison, and transfer learning, to optimize the structure and material composition of perovskite solar cells. The double-absorber architecture, in particular, enables efficient absorption across a broader range of the solar spectrum, allowing for power conversion efficiencies that surpass the limits of single-absorber devices. Simulations have shown that these double-absorber devices can achieve PCEs exceeding 30%.

This framework identifies optimal parameters such as material layer thicknesses, compositions, and doping concentrations with unprecedented speed and accuracy, outperforming traditional experimental trial-and-error or simple simulation methods. By specifically focusing on environmentally friendly lead-free perovskite materials, the research pioneers a path toward combining high performance with sustainability.

Background & Context

Perovskite solar cells are widely regarded as a pivotal technology for the future of photovoltaics due to their high efficiency potential and low manufacturing costs. Concurrently, there is a strong imperative to develop lead-free materials for environmental reasons, and tandem structures, which break through the efficiency limits of existing silicon solar cells, are at the forefront of research. However, the design space for these complex multi-layered devices is vast, making it challenging to find optimal designs using conventional methods. The integration of machine learning streamlines this design process, enabling much faster technological development.

Strategic Significance & Outlook

The machine learning-based optimization framework developed in this study is versatile and applicable not only to perovskite solar cell design but also to the development of other multi-layered optoelectronic devices and novel materials. The achievement of 32.5% efficiency represents a significant contribution towards setting new world records in photovoltaics, with the potential to profoundly impact the entire energy industry. Realizing high-efficiency, lead-free perovskite solar cells is a crucial step towards accelerating the commercialization of next-generation clean energy technologies and contributing to a sustainable society.

Source: <https://www.mdpi.com/1996-1944/19/14/3091>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#21 SUSTech's Xu Zongxiang Team Achieves 27.23% Certified Perovskite Solar Cell Efficiency via 5-Minute Dip-Coating with SAM

Published July 16, 2026 J&K Scientific China



OVERVIEW

Professor Xu Zongxiang's team at Southern University of Science and Technology (SUSTech) announced a groundbreaking breakthrough, achieving a certified 27.23% efficiency for a 0.071cm^2 perovskite solar cell using a 5-minute dip-coating process with a self-assembled monolayer (SAM). This technique also recorded 25.75% PCE for a 1cm^2 device and 23.25% for a 12cm^2 mini-module, along with excellent stability and recyclability. This marks a critical step towards the commercialization and mass production of flexible perovskite solar cells, setting a new benchmark for manufacturing efficiency and performance.

Key Findings

Professor Xu Zongxiang's team at the Southern University of Science and Technology (SUSTech) has reported a significant advancement in perovskite solar cell manufacturing. They achieved a world-leading certified power conversion efficiency (PCE) of 27.23% for perovskite solar cells using a rapid 5-minute dip-coating process combined with a MOLEC-SAM-006 self-assembled monolayer (SAM). This technology simultaneously demonstrates high efficiency and accelerated manufacturing, substantially advancing the commercial prospects of perovskite solar cells.

Technical / Clinical Details

The core innovation of this research lies in the simplified "5-minute dip-coating" process and the effective passivation of interfacial defects using the MOLEC-SAM-006 self-assembled monolayer (SAM). This SAM technology optimizes the interface between the perovskite layer and the charge transport layer, enhancing charge extraction efficiency and suppressing recombination losses. As a result, a certified PCE of 27.23% was achieved on a small-area cell (0.071cm^2). Furthermore, performance was verified on devices closer to practical size: a 1cm^2 device recorded a PCE of 25.75%, and a 12cm^2 mini-module achieved 23.25% PCE.

Notably, this technique also exhibited excellent device stability. The dip-coating process is highly scalable for mass production and improves material utilization efficiency, contributing to reduced manufacturing costs. Its excellent recyclability further positions it as an environmentally friendly production approach.

Background & Context

Perovskite solar cells are considered promising candidates for the future of photovoltaics due to their high efficiency and potential for low-cost manufacturing. However, challenges in reproducibility of efficiency at scale, device stability, and simplification of manufacturing processes have persisted. Solution-based processes like dip-coating are highly attractive for industrial applications due to their cost-effectiveness and ease of large-area fabrication. Professor Xu Zongxiang's team's achievement provides a breakthrough by not only reaching world-class efficiencies with a solution process but also ensuring stability through SAM technology, fulfilling a critical industry demand.

Strategic Significance & Outlook

The combination of this 5-minute dip-coating and SAM technology represents a major step towards accelerating the commercialization of perovskite solar cells in areas such as flexible photovoltaics and building-integrated photovoltaics (BIPV). The simplification and speed-up of the manufacturing process will lead to dramatic reductions in production costs, significantly enhancing the market competitiveness of perovskite solar cells. In the future, this technology could be integrated into existing silicon solar cell manufacturing lines to form tandem structures, potentially realizing even higher efficiencies and broader applications. This is expected to make a crucial contribution to the proliferation of sustainable energy solutions.

Source: <https://www.jk-sci.com/blogs/innportal/perovskite-solar-cell-sam-materials>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#22 Qcells Achieves TÜV Rheinland Certification for 28.6% Efficient Perovskite-Silicon Tandem Solar Technology

Published July 16, 2026 pv magazine Global Germany



OVERVIEW

Qcells announced its perovskite-silicon tandem solar cell technology has secured dual certification from TÜV Rheinland against both IEC 61215 and UL 61215 requirements. Manufactured at their German pilot line, these devices demonstrated a record 28.6% tandem cell efficiency while meeting stringent reliability and safety standards. This certification signifies a crucial quality milestone for perovskite tandem technology, paving the way for broader commercial market entry and boosting investor confidence.

Key Findings

Qcells has announced that its innovative perovskite-silicon tandem solar cell technology has received certification from the esteemed German testing agency TÜV Rheinland, complying with both the International Electrotechnical Commission's (IEC) 61215 and Underwriters Laboratories' (UL) 61215 standards for reliability and safety. This dual certification marks a critical step towards the commercial viability of this advanced photovoltaic technology.

Technical / Clinical Details

The certified perovskite-silicon tandem solar cell devices were produced at Qcells' pilot line in Germany. These devices have achieved an impressive record tandem cell efficiency of 28.6%, significantly surpassing the theoretical efficiency limits of standalone silicon solar cells. IEC 61215 is an international standard evaluating the design qualification of crystalline silicon terrestrial and thin-film photovoltaic (PV) modules, while UL 61215 is a US certification standard for electrical product safety. Meeting these rigorous requirements demonstrates that Qcells' tandem technology possesses the necessary practical durability and safety for real-world applications.

The tandem structure enables the perovskite layer to efficiently absorb blue light, while the underlying silicon layer captures red light, thereby converting a broader spectrum of sunlight into electricity. This allows for higher power generation from the same installation area, making it ideal for space-constrained locations and applications demanding high efficiency.

Background & Context

Qcells is a major player in the global photovoltaic market, with a long history at the forefront of silicon solar cell technology. Its investment in perovskite technology represents a strategic move to lead the next generation of solar energy solutions. TÜV Rheinland's certification is essential for new technologies like perovskite solar cells, as it demonstrates compliance with established industry standards, thereby increasing confidence among investors, developers, and consumers. Historically, perovskites have garnered attention for high lab efficiencies, but assuring product reliability has been a significant challenge for commercialization.

Strategic Significance & Outlook

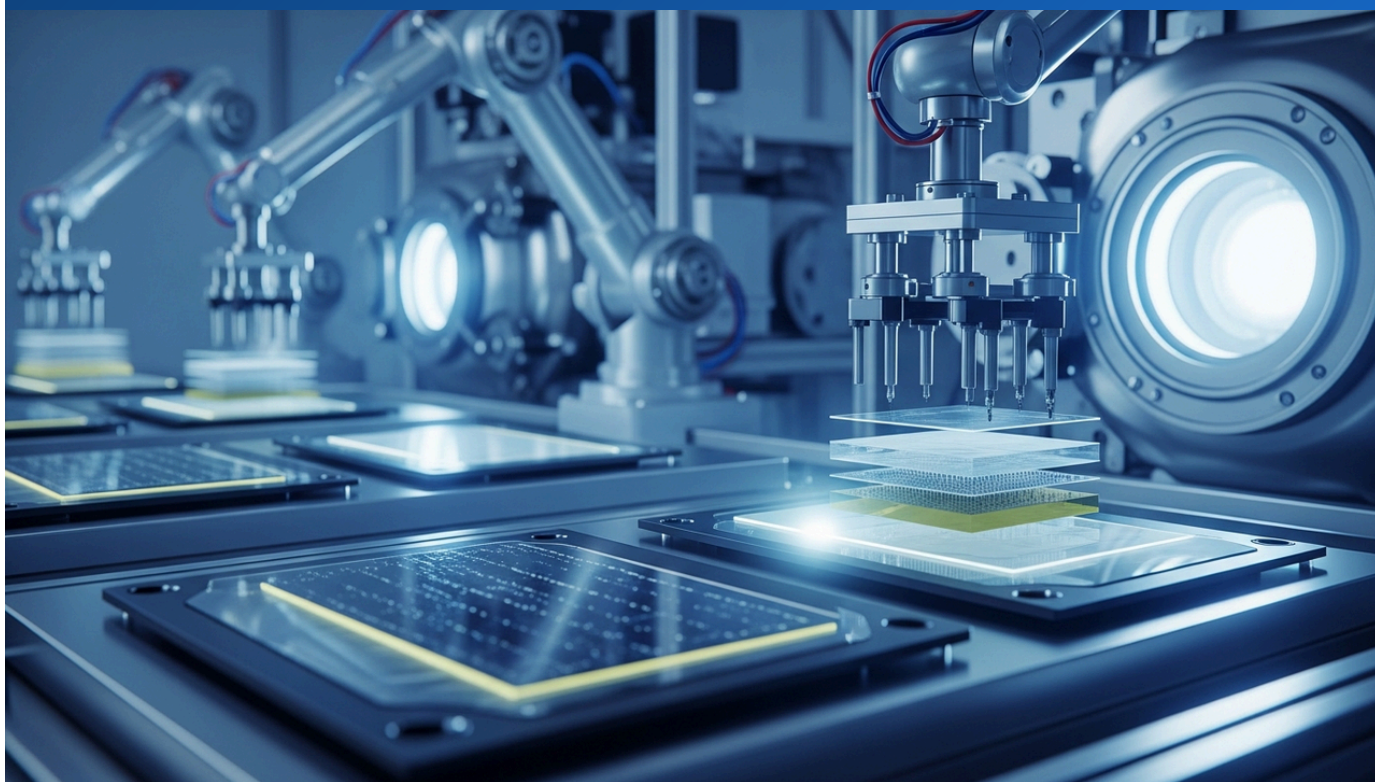
This certification is a crucial milestone for Qcells as it transitions its perovskite-silicon tandem technology towards mass manufacturing. It heralds a new era of competition in solar efficiency improvement and positions Qcells to be a leader amid accelerating global commercialization efforts for perovskite technology, such as the 10 GW partnership between Caelux and Indian firms (Article 9) slated for 2028. The market introduction of certified high-efficiency modules is expected to further reduce the Levelized Cost of Energy (LCOE) for solar power, making a substantial contribution to the widespread adoption of clean energy.

Source: <https://www.pv-magazine.com/2026/07/16/qcells-secures-tuv-rheinland-certification-for-perovskite-silicon-tandem-solar-tech/>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#23 IDTechEx Report: Perovskite Solar Cells Transition to Commercial Demonstration, Driving High Efficiency with Silicon Tandems

Published July 21, 2026 IDTechEx Unknown



OVERVIEW

This article provides an overview of a market research report published by IDTechEx. According to the latest IDTechEx report, perovskite solar cell technology has entered a new phase, moving from lab records to commercial demonstration projects, with improved manufacturing yields and validated reliability for large-area modules in real-world conditions. Perovskite-silicon tandem solar cells, in particular, hold potential to significantly exceed conventional silicon cell efficiencies. Initial commercialization is projected to target applications where high efficiency, lightweight, and flexibility offer distinct advantages.

Key Findings

This article provides an overview of a market research report published by IDTechEx.

According to IDTechEx's latest analysis, perovskite solar cell technology has moved beyond merely achieving laboratory records and has entered a new phase characterized by commercial demonstration projects, improved manufacturing yields, and validated reliability for large-area modules under real-world conditions. This evolution signifies an expanding role for perovskites in the photovoltaic industry.

Report Overview

The IDTechEx report provides an in-depth analysis of perovskite solar cell technology trends, market potential, and the roadmap to commercialization. The covered market focuses on photovoltaic technologies within the broader energy industry, specifically highlighting perovskite solar cells as a next-generation material. The research period spans from recent years of R&D to future market forecasts, assessing the technology's maturity and market entry strategies.

Key Research Findings

- **Commercialization Progress:** Perovskite technology is transitioning from high-efficiency lab demonstrations to performance validation in actual industrial environments. Several companies have initiated pilot lines and small-scale production, with reported improvements in manufacturing yields.
- **Tandem Structure Advantage:** Perovskites, especially when integrated into tandem structures with silicon solar cells, hold the potential to achieve power conversion efficiencies well over 30%, significantly surpassing the Shockley-Queisser theoretical limit of conventional single-junction silicon cells. This enables maximum power generation from limited installation areas.
- **Differentiated Applications:** The initial wave of perovskite commercialization is predicted to target niche applications where its unique properties—lightweight, flexibility, semi-transparency, and high efficiency—offer clear advantages. These include building-integrated photovoltaics (BIPV), flexible electronics, IoT devices, space applications, and portable chargers, allowing the technology to carve out new market segments without direct competition with established silicon markets.

- **Improved Reliability and Durability:** Innovations in material science and device architecture are steadily enhancing the long-term stability and durability of perovskite solar cells, with ongoing research focused on meeting the necessary lifetime criteria for commercial deployment.

About the Publisher

IDTechEx is a global firm specializing in market research, consulting, and events for emerging technologies. The company is renowned for providing deep insights into the latest technology trends and market dynamics across diverse industrial sectors, including electronics, energy, mobility, and healthcare. Their reports serve as crucial resources for businesses and investors making strategic decisions.

Source: <https://markhamhislop.substack.com/p/the-solar-technology-that-could-change>

Collected: July 24, 2026 | Automated Research System (Gemini API)

#24 Hanwha Qcells to Supply Perovskite-Silicon Tandem Solar Cells for NASA Lunar Power Project, Bolstering US Manufacturing

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OVERVIEW

Hanwha Qcells has secured a strategic contract to supply perovskite-silicon tandem solar cells for NASA's lunar power demonstration project as part of its 2026 strategic partnerships. This agreement showcases the technology's high performance in harsh extraterrestrial environments. Alongside a significant DOE loan, this collaboration aims to establish a comprehensive domestic solar supply chain in the U.S., reinforcing American leadership in clean energy and advanced photovoltaic solutions.

Key Findings

Hanwha Qcells has signed a strategic contract to supply its innovative perovskite-silicon tandem solar cells for NASA's lunar power demonstration project. This groundbreaking partnership demonstrates the reliability and high performance of Qcells' advanced solar technology even in extreme extraterrestrial environments. Complementing this, Qcells is also leveraging a \$1.45 billion loan from the U.S. Department of Energy (DOE) to enhance its domestic solar supply chain capabilities within the United States.

Technical / Clinical Details

The lunar environment presents far harsher conditions than Earth, characterized by extreme temperature fluctuations, cosmic radiation, micrometeoroids, and abrasive regolith (lunar dust). The perovskite-silicon tandem solar cells supplied by Qcells are specifically designed and optimized to function stably under these rigorous conditions. The tandem structure, which combines a perovskite layer with a silicon layer, allows for a broader utilization of the solar spectrum, achieving higher power conversion efficiencies. This is crucial for maximizing power supply within the limited surface area available on lunar bases or probes.

The contract with NASA not only underscores the robustness and cutting-edge nature of Qcells' technology but also signifies a successful demonstration of perovskite technology in one of the most demanding environments: space. This success further validates the technology's reliability for broader commercial deployment back on Earth.

Background & Context

The U.S. government is strongly committed to maintaining leadership in space exploration and fostering the growth of its domestic clean energy industry. As part of this commitment, Hanwha Qcells secured a conditional loan guarantee of \$1.45 billion from the DOE, planning to significantly expand its solar manufacturing capacity within the U.S. This DOE funding aims to strengthen American manufacturing, create jobs, and enhance the resilience of the clean energy technology supply chain. The NASA lunar project is an integral part of this broader strategy, illustrating Qcells' evolution from a mere solar cell manufacturer to a comprehensive energy solutions provider.

Strategic Significance & Outlook

Participation in the NASA lunar power demonstration project provides a powerful endorsement of the reliability and durability of Qcells' perovskite-silicon tandem technology. This achievement is expected to further boost confidence in Qcells' products across terrestrial residential, commercial, and utility-scale solar markets. Technology proven to withstand harsh space conditions is anticipated to perform exceptionally well in diverse Earth environments. Qcells' enhanced domestic manufacturing capabilities will mitigate supply chain risks and play a vital role in achieving U.S. renewable energy targets, while simultaneously showcasing the potential for perovskite technology to drive energy revolutions both on Earth and beyond.

Source: <https://enki.ai.com/solar-energy/hanwha-qcells-us-manufacturing-investment/>

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#25 HKUST Achieves 29.1% Efficiency and 800-Hour Stability in PEDOT:PSS-Free All-Perovskite Tandem Solar Cells via Molecular Interface Engineering

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OVERVIEW

Researchers at Hong Kong University of Science and Technology (HKUST) have significantly boosted the performance and durability of all-perovskite tandem solar cells through molecular interface engineering. Their innovative PEDOT:PSS-free device achieved 29.1% power conversion efficiency (PCE) and maintained 90% of its initial efficiency after 800 hours of continuous operation at $\sim 40^{\circ}\text{C}$. Furthermore, a four-terminal all-inorganic perovskite tandem cell secured a certified 21.54% efficiency, retaining 80% of its initial performance after 1,210 hours at 65°C and 650 hours at 85°C . This breakthrough substantially addresses the critical stability challenge for perovskite solar cell commercialization.

Key Findings

A research team at the Hong Kong University of Science and Technology (HKUST) has reported a significant breakthrough in improving the performance and long-term durability of all-perovskite tandem solar cells through the strategic application of molecular interface engineering. Notably, their PEDOT:PSS-free all-perovskite tandem solar cell achieved a high power conversion efficiency (PCE) of 29.1% and demonstrated outstanding operational stability.

Technical / Clinical Details

The key to this research lies in designing new interface layers that enable efficient and stable charge transport without the use of PEDOT:PSS. While PEDOT:PSS is a common hole-transporting material, it is known to cause long-term stability issues due to its hygroscopic nature and chemical instability. By eliminating this organic material, the HKUST team substantially enhanced the intrinsic stability of the device.

The developed all-perovskite tandem solar cell achieved a PCE of 29.1%, an efficiency that significantly outperforms single perovskite or silicon layers. More importantly, it demonstrated exceptional operational stability, maintaining 90% of its initial efficiency after 800 hours of continuous maximum power point tracking (MPPT) testing under ambient conditions of approximately 40°C. This is one of the most critical durability metrics for commercialization.

The team also reported success with a four-terminal all-inorganic perovskite tandem cell, achieving a certified efficiency of 21.54%. This inorganic tandem cell was further validated for stability under more rigorous conditions, retaining 80% of its initial efficiency after 1,210 hours of continuous operation at 65°C and 650 hours at 85°C, indicating robustness in high-temperature environments and for prolonged use.

Background & Context

All-perovskite tandem solar cells, unlike conventional silicon-based tandems, use perovskite materials for both absorbing layers, promising more flexible designs and potential reductions in manufacturing costs. However, their realization has been hindered by challenges in charge transport and stability at interfaces, in addition to optimizing each perovskite layer. The use of organic materials often represents a major bottleneck for long-term device reliability. Therefore, a PEDOT:PSS-free approach holds significant industry importance. Hong Kong is recognized as a hub for advanced materials science research and manufacturing technology, and this research further solidifies its position.

Strategic Significance & Outlook

This breakthrough in molecular interface engineering by HKUST presents a practical solution to a major durability issue facing perovskite solar cells. The combination of 29.1% high efficiency and excellent long-term stability will accelerate the commercialization of all-perovskite tandem solar cells, opening pathways for widespread adoption in various applications such as building-integrated photovoltaics (BIPV), flexible solar cells, and even vehicle-integrated photovoltaics (VIPV). Critically, avoiding organic materials enables deployment in harsher environments, laying the groundwork for perovskite technology to play a larger role in the energy market.

Source: <https://www.eurekalert.org/news-releases/1136571>

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