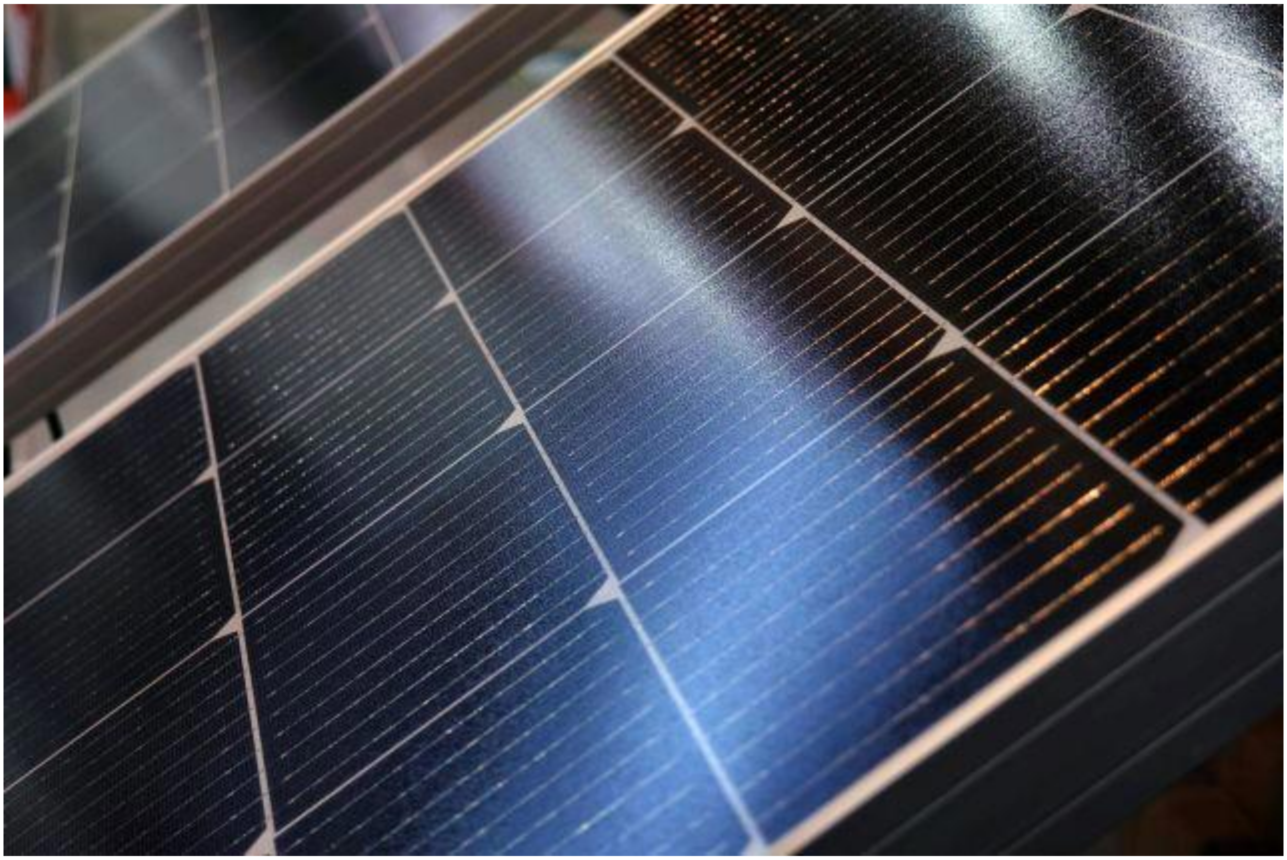
SOLAR PROGRESS



The emergence of these resilient, efficient, and bendy solar cells opens up a host of applications.© Provided by The Cool Down

Solar panels help us capture the abundant power of the sun to provide clean, sustainable energy, and experts have been working hard to improve the technology these past few years.

One of the latest breakthroughs comes in the form of a flexible perovskite-and-silicon solar cell with a record efficiency of 22.8%, as reported by Interesting Engineering.

The pairing of the two materials helps to increase the overall efficiency of the cell. Silicon tends to max out at around 33% on its own, according to CleanTechnica, and it's known to be brittle and crack under stress.

Perovskite is a natural mineral with special electrical and optical properties, but it's also flexible in its own right. By combining the two, scientists in China were able to compose a much thinner product that's only 30 micrometers thick, or 30 millionths of a meter.

These flexible cells have undergone extensive bend tests, and after 3,000 cycles, they still managed to retain 98.2% of their initial performance.

The emergence of these resilient, efficient, and bendy solar cells opens up a host of applications. They can more easily be applied to boats, RVs, and other oddly shaped structures to help increase our overall solar capacity and support our growing energy needs.

Currently, around 67% of small-scale solar capacity is being used in residential areas, with 27% in commercial settings and 6% for industrial applications, per the Energy Information Administration. All three segments combined are expected to grow in capacity from 44 gigawatts in June 2023 to about 55 gigawatts by the end of 2024.

NASA has already been testing the use of bendable solar cells, though those peak at around 17.6% efficiency. Korean researchers have been working on organic solar cells with elastic properties for use in wearable applications. Some have simply been trying to decrease the weight of normal panels for safer rooftop use.

Expanding the use of solar panels is just one way to generate clean, sustainable energy. By pairing that with other renewables such as wind, hydro, and geothermal, we can dramatically reduce our reliance on dirty fuels.

You can be a part of the shift toward more renewable solar energy and save money while you're at it. The Inflation Reduction Act offers tax rebates that cover up to 30% of the cost to install your own rooftop solar system.

Researchers develop 'self-healing' solar cells that could revolutionize clean energy: 'This breakthrough could pave the way'© Provided by The Cool Down

Creating and storing energy can be degrading — at least to the sensitive technology needed for the work.

As a result, scientists at Australia's Monash University are developing a coveted "self-healing" capability for a sun-catching material that can form solar cells.

The specialized perovskite (explained here by the U.S. Department of Energy) uses a unique "healing agent" with chemical bonds that can "break and recover under heat and moisture," the typical factors that degrade the crystalline mineral. The layers of chemicals, which are slowly released, react or attach to defects that develop as the cells operate, minimizing them, according to nonprofit news site Anthropocene.

"This breakthrough could pave the way for more reliable and efficient perovskite solar cells contributing to the global transition towards sustainable energy solutions," lead author Udo Bach — who is a professor of chemical and biological engineering at Monash — said in a press release, per Anthropocene.

Perovskite has huge potential as a solar cell material, providing a greater than 25% efficiency rate. That's the amount of sunlight that can be converted to electricity, per the DOE.

What's more, the material can outperform the silicon common in most panels. Most panels have efficiency rates of less than 23%, according to MarketWatch. Perovskites are also abundant and "could be" more easily recycled, as Anthropocene notes.

The Monash team is touting a 25.1% rate and "remarkable stability" after 1,000 hours of "accelerated aging tests" at 185 degrees Fahrenheit.

"This work addresses critical issues related to defect passivation in perovskites that have hindered widespread adoption of this promising technology," Bach said in a university lab summary.

Work on so-called self-healing technology is ongoing in other labs, too. A battery cathode being developed at the University of California San Diego can repair itself.

It's part of the way to make renewable energy more accessible and cost-friendly. If the Monash invention can help perovskites become a standard solar-cell material, it could help to lower the price of the tech, as well as reduce some of the waste concerns about end-of-life panels.

In fact, experts around the world are researching how to best harvest the valuable metals and electronic waste that are part of the setups as multimillion-panel farms go online. Some experts even think the solar recycling business could be worth hundreds of millions of dollars in the coming years, Yahoo Finance reports.

The good news is that solar power is readily available now and can be accessed with zero equipment installed at your home. Community solar programs let you tap into sunpower from nearby sun-catching farms. With some simple online research from a service like EnergySage, you can save up to $150 a year on your electricity bill.

The big win is reducing planet-warming fumes, linked in recent studies to increased dementia risks, per the Alzheimer's Association, among other health problems.

At Monash, the team is continuing to prepare its self-healing perovskites for real-world conditions, with the goal of putting them on panels soon.

"Our slow-release strategy represents a significant advancement in the field of perovskite photovoltaics," Bach said in the lab summary.

At the very least, it's© Provided by The Cool Down

Scientists in Germany are looking to nature for inspiration on how to absorb light to create energy. The result could be a pace-setting efficiency rate for an industry already flush with innovations.

Plants use photosynthesis to turn sunlight, water, and air pollution into oxygen and sugar. They are good at absorbing a lot of light energy using a relatively small mass, according to experts from the Julius-Maximilians-Universität (JMU) Würzburg in Bavaria.

A hurdle with solar energy tech to date, according to the JMU experts, is that bulky silicon panels are required to capture enough light to create energy. Thinner, light-sensitive organic dyes weigh less but are not very efficient on their own.

The JMU breakthrough tech can absorb energy from the "entire" visible range using the light-gathering qualities of organic dyes. The method stacked and folded four dye molecules capable of absorbing four crucial wavelengths: ultraviolet, red, purple, and blue, per the lab report.

"As a result, it can absorb a great deal of light energy in a relatively thin layer, similar to natural light-harvesting systems," JMU chemistry professor Frank Würthner said in the lab summary.

The team achieved an impressive 38% conversion "of the irradiated light energy over a broad spectral range into fluorescence," the report reads. Fluorescence typically happens when chemicals show visible light after absorbing radiation that is not normally visible, such as ultraviolet light, per a McGill University description.

Conversely, when the four dyes the JMU researchers were working with were not stacked, only 1% to less than 3% of light was converted to fluorescence.

"The right combination and skilful spatial arrangement of dye molecules in the stack therefore make a big difference," the researchers note.

The project leveraged JMU expertise in organic chemistry, nanosystems chemistry, and physical and theoretical chemistry.

A rendering of the researchers' progress might be the best representation. It shows the chemical structure of the four dyes on the left and then depicts them on the right stacked on top of each other, creating the crucial structure to capture the four light wavelengths.

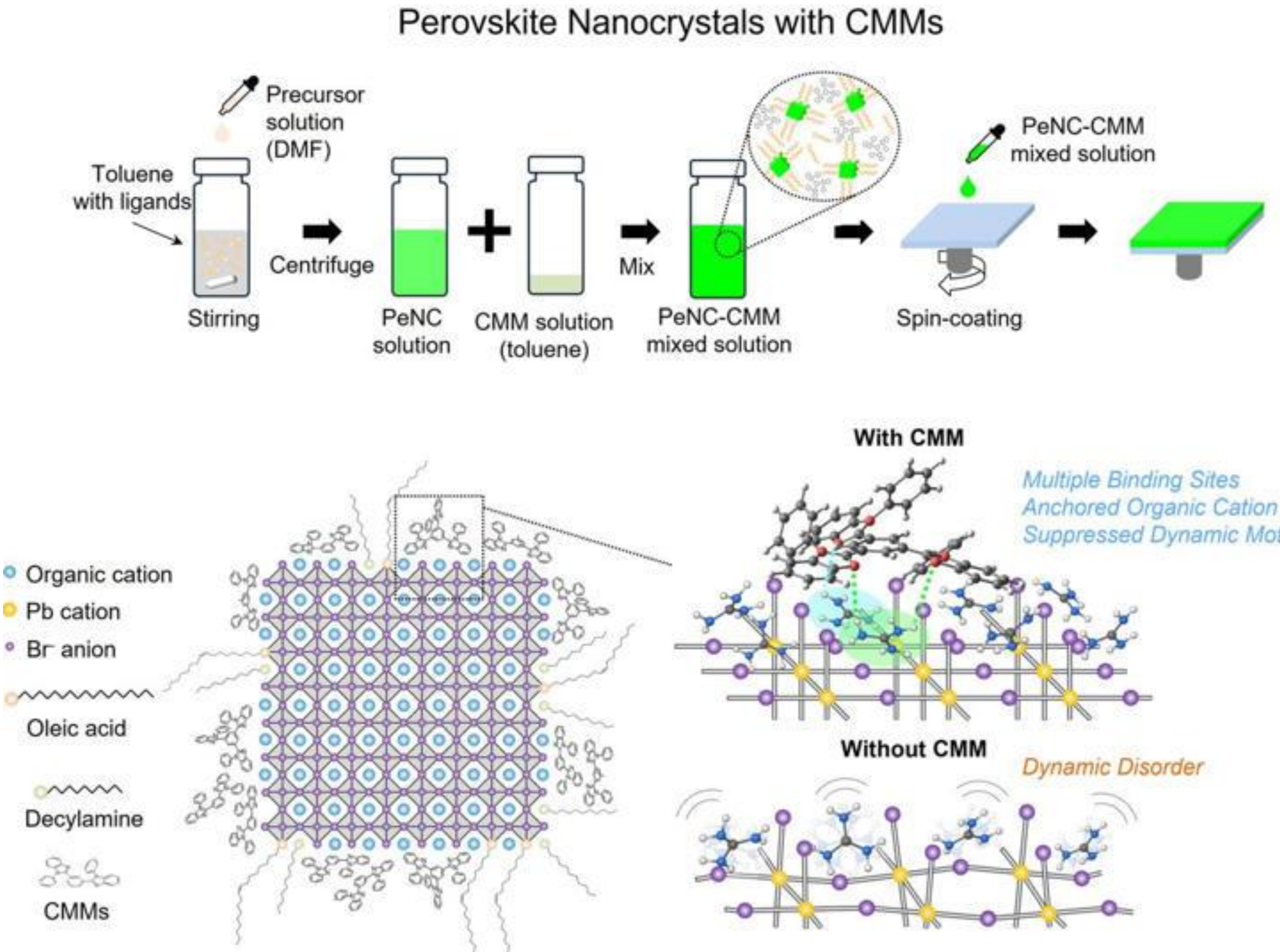
Experts around the world are working on ways to better capture light energy — and convert it into usable electricity. For example, WAVJA has developed small spheres that can harvest natural and artificial light. The company envisions the unique contraptions one day powering vehicles.

Better tech and government incentives are making solar setups more accessible to homeowners. Installing a home-based solar system could also save you $1,500 a year on electricity. SaveOnEnergy is an online site that offers free expertise to find a product, installer, and other key information about solar panel systems.

Switching to renewable electricity can help limit the amount of heat-trapping pollution being churned out by burning fossil fuels. Scientists are learning more about how air pollution, including aerosols and other types, are linked to extreme floods, droughts, and wildfires, per Climate.gov. Research is more clear about how breathing in dirty air, especially for longer periods of time, is linked to severe health problems, including cancer.

JMU's nature-inspired dye stacking might be another breakthrough to expand renewable solar to more places and limiting the fumes.

At the very least, it's "progress on the road to more efficient utilization of solar energy," per the summary.



Schematic diagram of the fabrication process of perovskite nanocrystal thin films with conjugated molecular multipods and the lattice-strengthening mechanism at the surface of the perovskite nanocrystals. Credit: Nature Communications (2024). DOI: 10.1038/s41467-024-49751-7

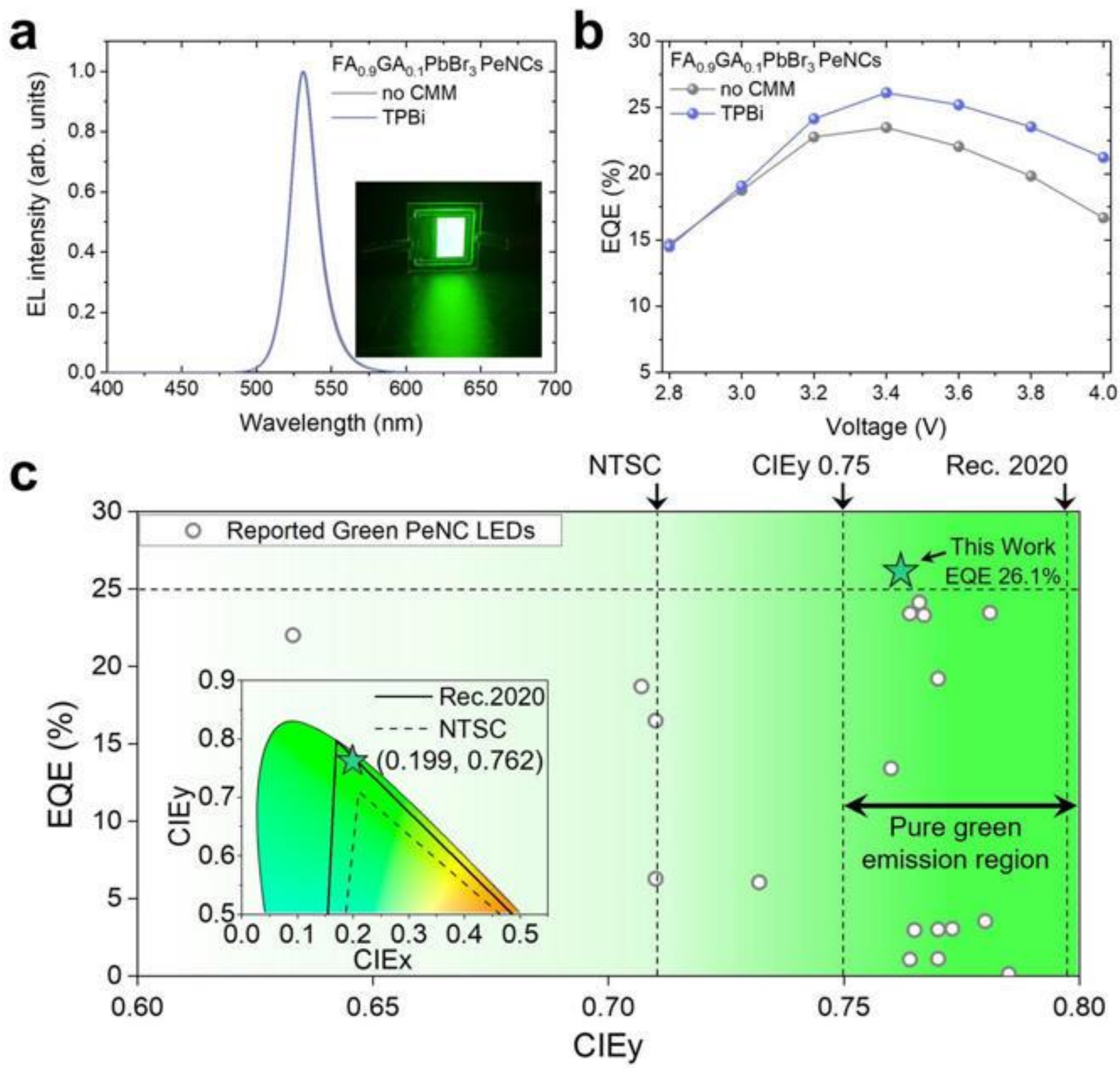
A research team has developed ultra-high efficiency perovskite nanocrystal light-emitting diodes (LEDs) by strengthening the perovskite lattice and suppressing the material's inherent low-frequency dynamics.

The research findings were published in the journal *Nature Communications* on July 24. The team was led by Professor Tae-Woo Lee from the Department of Materials Science and Engineering at Seoul National University, in collaboration with Professor Andrew M. Rappe of the University of Pennsylvania, Perovskite is a semiconductor material composed of cube-shaped nanocrystals consisting of organic cations, metal cations, and halogen elements. Perovskite light emitters have garnered attention as promising next-generation emitters due to their excellent color purity, tunability, and cost-effectiveness.

However, prior to 2014, perovskites were primarily used in solar cells, as their luminescence was not bright enough to be visible at room temperature. Despite this limitation, Professor Lee recognized the potential of perovskite as a next-generation emitter early on and secured a portfolio of fundamental patents for perovskite light-emitting materials in 2014.

Additionally, in 2015, his team published the first research paper demonstrating the enhancement of the efficiency in perovskite LED from a mere 0.1% to 8.53%, comparable to the level of phosphorescent OLEDs. This achievement has inspired researchers worldwide to conduct intensive and in-depth research on improving the efficiency of perovskite emitters.

Professor Lee's team further advanced perovskite self-emissive devices in 2022, achieving an external quantum efficiency (EQE) of 28.9% (nearly theoretically achievable maximum), peak brightness of 470,000 nits, and an operational lifetime of up to 30,000 hours. Moving towards commercialization, Professor Lee's startup company, SN Display Co. Ltd., showcased TV and tablet display prototypes at the CES (Consumer Electronics Show) in 2022 and 2023, making a great appeal to industry insiders.



(a) Electroluminescence spectrum of the perovskite nanocrystal LEDs. (b) External quantum efficiency (up to 26.1%) of the perovskite nanocrystal LEDs. (c) Graph of EQE versus CIEy coordinates for perovskite nanocrystal LEDs without light outcoupling enhancement techniques. Credit: Nature Communications (2024). DOI: 10.1038/s41467-024-49751-7

However, the research team realized the need to address a key challenge: the reduction in luminescence efficiency due to the inherent ionic nature of the perovskite. Unlike traditional inorganic semiconductors, perovskite materials are composed of weak ionic bonds, and large-amplitude displacement of the atoms in their crystal lattices can cause dynamic disorder. This dynamic disorder interferes with the radiative recombination process in perovskite materials, leading to exciton dissociation and reduced luminescence efficiency.

Despite the need to overcome this critical limitation, there has been little research on how dynamic disorder affects the luminescent properties of perovskites or on strategies to improve efficiency by reducing dynamic disorder.

In collaboration with Professor Rappe of the University of Pennsylvania in the US and Professor Omer Yaffe of the Weizmann Institute of Science in Israel, Professor Lee's team suggested a novel mechanism that enhances the luminescence efficiency of the perovskite emitters by incorporating conjugated molecular multipods (CMMs).

The mechanism is that when CMM binds to the surface of the perovskite lattice, the lattice is strengthened, suppressing low-frequency dynamics and reducing dynamic disorder in the perovskite lattice. This consequence finally led to improved luminescence efficiency in perovskite materials.

A particularly noteworthy achievement is the realization of ultra-high-efficiency LEDs with an EQE of 26.1%. This value is among the highest efficiency in perovskite nanocrystal LEDs and is especially significant because the efficiency improvement was achieved by enhancing the intrinsic emission efficiency of the material itself, rather than through engineering the device structure that enhances light outcoupling efficiency.

The perovskite emitters developed by Professor Lee's team are recognized for their high potential as next-generation display emitters. Because green color contributes the largest portion of the Rec. 2020 color standard for ultra-high-definition displays, achieving high color purity and high-efficiency green emitters is essential for display development.

The LEDs developed by the research team exhibit electroluminescence wavelengths that nearly approach the green primary color in the Rec. 2020 standard. This achievement is expected to significantly accelerate the commercialization of next-generation displays.

Professor Lee stated, "This research presents a new material-based approach to overcoming the intrinsic limitations of perovskite light emitters. We anticipate that this will significantly contribute to the development of high-efficiency, long-lifetime perovskite light-emitting devices and the commercialization of next-generation displays."

Professor Rappe agreed, saying "Together we have shown the power of molecules in strengthening perovskites and making them better light emitters. By combining the powers of molecular chemistry, physics, mechanics, and optics, we are inventing new materials to lead us into a bright and energy-efficient future."

Scientists Created a New Solar Cell That Produces 1,000 Times More Power© Organically Human

This new technology could revolutionize how we power our world, offering a cleaner and more sustainable alternative to traditional energy sources.

The energy generation of ferroelectric crystals in solar cells can be increased by a factor of a thousand thanks to an innovation involving the arrangement of thin layers of the materials, according to a statement from Martin Luther University Halle-Wittenberg (MLU).

Researchers from MLU found that alternately placed crystalline layers of barium titanate, strontium titanate, and calcium titanate could significantly increase the efficiency of solar panels. Their findings are published in the journal *Science Advances*.

Most solar cells are made out of silicon due to their low cost and relative efficiency; however, limits to the material's overall efficiency have led to researchers experimenting with new materials, including ferroelectric crystals.

One of the benefits of ferroelectric crystals is that they do not require a pn junction, meaning any positively and negatively doped layers - as is the case with silicon solar cells.

However, pure barium titanate, a ferroelectric crystal tested by MLU researchers, for example, absorbs little sunlight. By experimenting with different combinations of materials, the scientists found that they could combine fragile layers of different materials to increase their solar energy yield significantly.

"The important thing here is that a ferroelectric material is alternated with a paraelectric material. Although the latter does not have separated charges, it can become ferroelectric under certain conditions, for example, at low temperatures or when its chemical structure is slightly modified," Dr. Akash Bhatnagar, from MLU's Centre for Innovation Competence SiLi-nano, explained in the MLU press release.

Layered power surge

Bhatnagar and his team embedded barium titanate between strontium titanate and calcium titanate by vaporizing the crystals with a high-power laser and redepositing them on carrier substrates. The resulting material was composed of 500 layers and was 200 nanometers thick.

The researchers found that their layered material enabled a current flow 1,000 times stronger than measured in pure barium titanate of the equivalent thickness.

"The interaction between the lattice layers appears to lead to a much higher permittivity – in other words, the electrons can flow much more easily due to the excitation by the light photons," Bhatnagar explained.

The team also showed that the measurements remained almost constant over six months, meaning the material may be robust enough for commercial application.

Next, they will continue to research the exact cause of the photoelectric effect in their layered material, with a view to eventual deployment at a mass scale.

Their work promises to be part of a potential revolution in ferroelectric materials, with possible applications in computer memory, capacitors, and other electronic devices.

A coating 100 times thinner than a human hair could be "ink-jetted" onto your backpack, cell phone or car roof to harness the sun's energy, new research shows, in a development that could reduce the world's need for solar farms that take up huge swaths of land.

Scientists from Oxford University's physics department have developed a micro-thin, light-absorbing material flexible enough to apply to the surface of almost any building or object — with the potential to generate up to nearly twice the amount of energy of current solar panels.

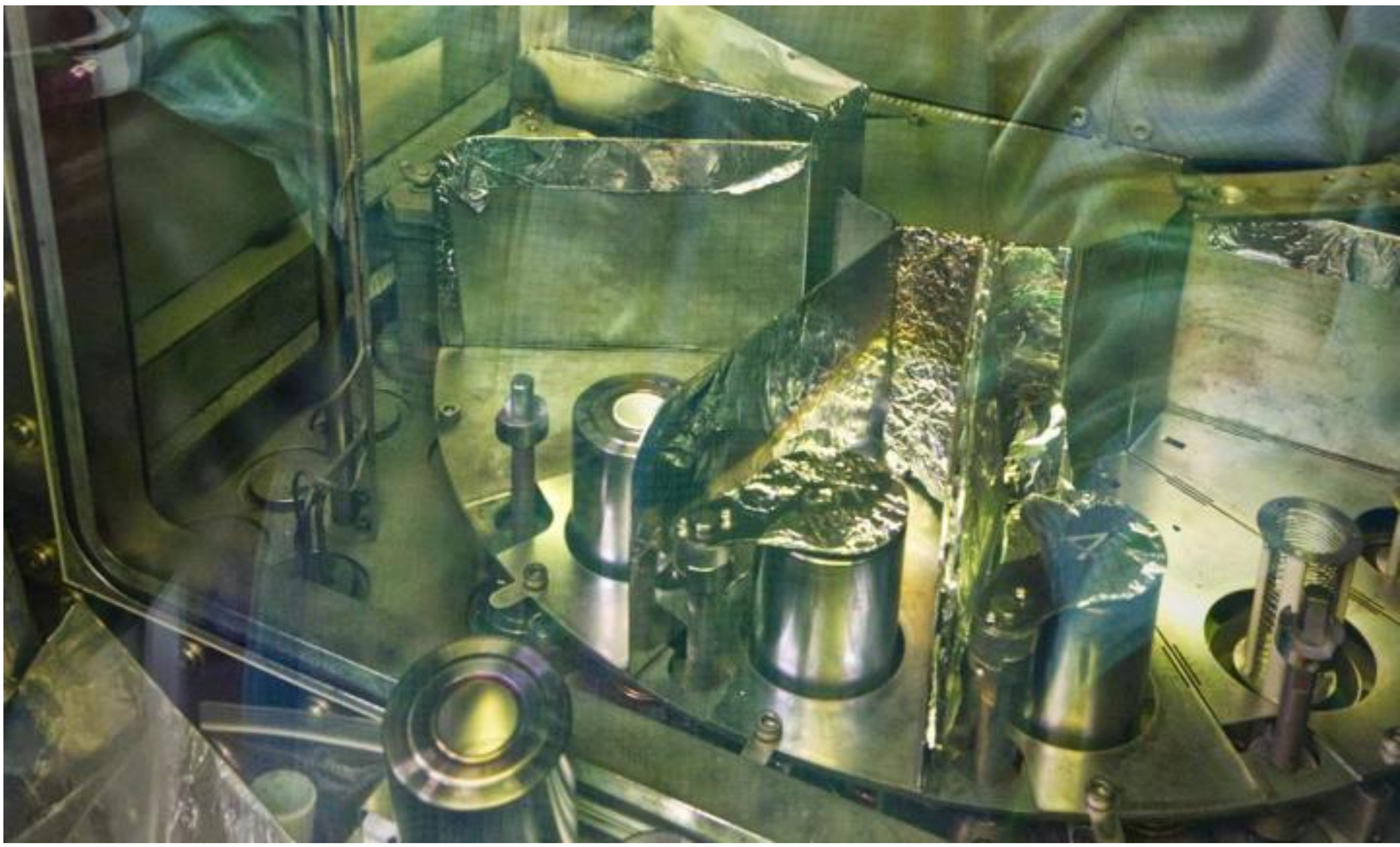
The technology comes at a critical time for the solar power boom as human-caused climate change is rapidly warming the planet, forcing the world to accelerate its transition to clean energy.

Here's how it works: The solar coating is made of materials called perovskites, which are more efficient at absorbing the sun's energy than the silicon-based panels widely used today. That because its light-absorbing layers can capture a wider range of light from the sun's spectrum than traditional panels. And more light means more energy.

The Oxford scientists aren't the only ones who have produced this type of coating, but theirs is notably efficient, capturing around 27% of the energy in sunlight. Today's solar panels that use silicon cells, by comparison, typically covert up to 22% of sunlight into power.

The researchers believe that over time, perovskites will be able to deliver efficiency exceeding 45%, pointing to the increase in yield they were able to achieve during just five years of experimenting, from 6% to 27%.

“This is important because it promises more solar power without the need for silicon-based panels or specially-built solar farms,” Junke Wang, one of the Oxford scientists said. “We can envisage perovskite coatings being applied to broader types of surface to generate cheap solar power, such as the roof of cars and buildings and even the backs of mobile phones.”



Scientists from Oxford University's Physics Department experiment with a new thin-film photovoltaic material in their custom-built robotic lab. - Martin Small

At just over one micron thick, the coating is 150 times thinner than a silicon wafter used in today’s solar panels. And unlike existing silicon panels, the perovskites can be applied to almost any surface, including plastics and paper, using tools like an inkjet printer.

Globally, solar panel installations have skyrocketed, growing by 80% in 2023 compared to 2022, according to Wood Mackenzie, a company specializing in data and analytics for the clean energy transition. Solar was the fastest-growing source of electricity in 2023 for the 19th consecutive year, according to climate think tank Ember's 2024 Global Electricity Review.

A major driver of this boom is the falling cost of solar, which has now become cheaper to produce than any other form of energy, including fossil fuels. Another important factor fueling solar's rise is its growing efficiency in converting the sun's energy.

But ground-based solar farms take up a lot of land, and they are often at the heart of conflict between the agricultural industry and the governments and companies behind the renewable installations.

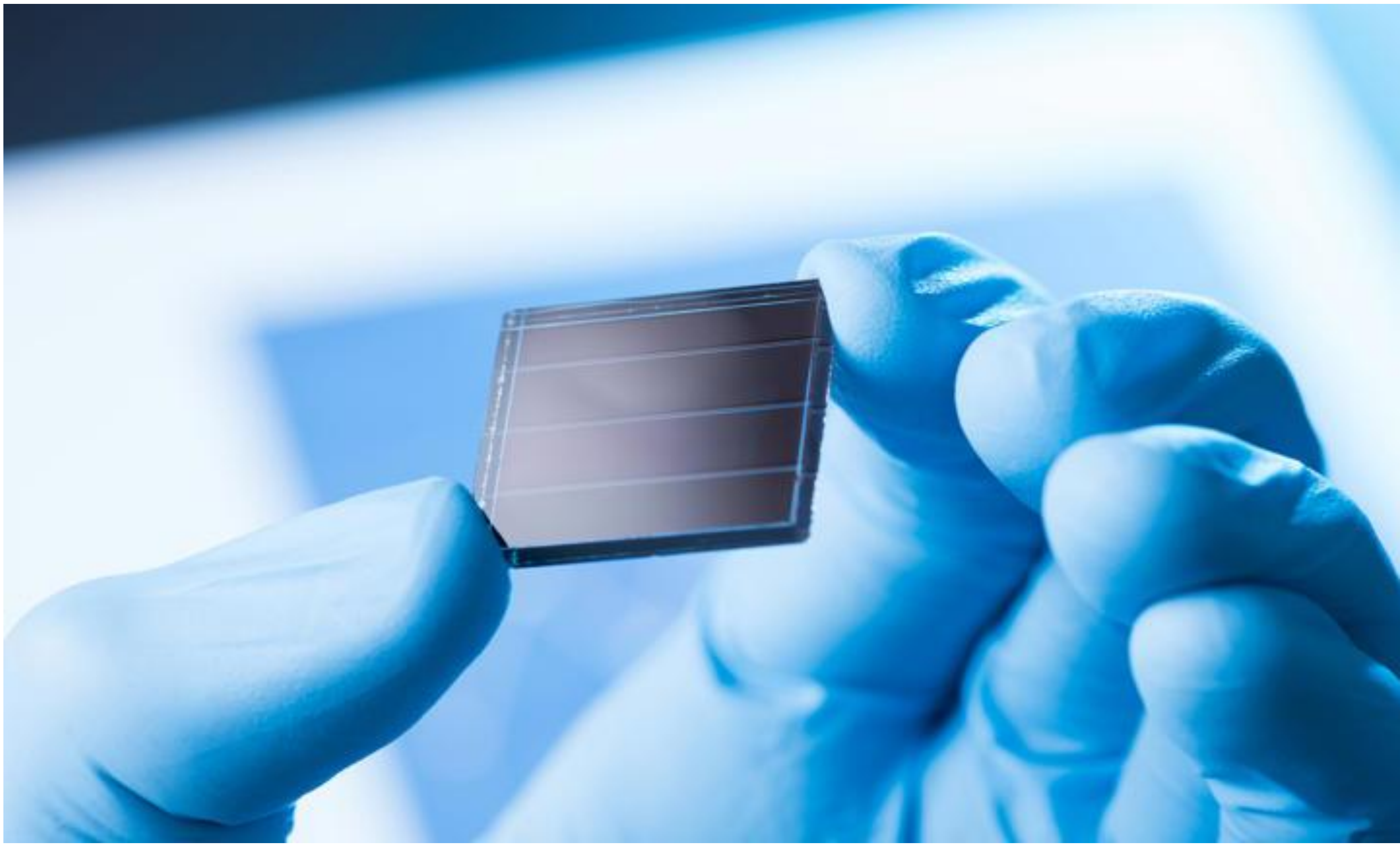
Oxford's researchers say their technology could offer a solution to that problem, while driving down energy costs. But Wang noted that the research group is not advocating for the end of solar farms.

"I wouldn't say we want to eliminate solar farms because obviously we need lots of areas or surfaces to generate sufficient amount of solar energy," he told CNN.

A persistent problem with perovskites, however, is stability, which has prevented its developers from commercializing the technology. Some coatings in lab settings have dissolved or broken down over shirt periods of time, so are regarded as less durable than today's solar panels. Scientists are working toward improving its lifespan.

Henry Snaith, the Oxford team's lead researcher, said their work has strong commercial potential and could be used in industries like construction and car manufacturing.

"The latest innovations in solar materials and techniques demonstrated in our labs could become a platform for a new industry, manufacturing materials to generate solar energy more sustainably and cheaply by using existing buildings, vehicles, and objects," he said.


Silicon days over? Organic solar panel turns 20% of sunlight into electricity© Provided by Interesting Engineering

Researchers at the University of Kansas have made a breakthrough in understanding organic semiconductors, hinting at more efficient and versatile solar cells.

For years, silicon has dominated the solar energy landscape. Its efficiency and durability have made it the go-to material for photovoltaic panels. However, silicon-based solar cells are rigid and expensive to produce, limiting their potential for curved surfaces.

Organic semiconductors, these carbon-based materials offer a viable alternative at a lower cost and with greater flexibility. “They can potentially lower the production cost for solar panels because these materials can be coated on arbitrary surfaces using solution-based methods — just like how we paint a wall,” explained Wai-Lun Chan, associate professor of physics & astronomy at the University of Kansas.

But these organic semiconductors aren't just about cost savings. They boast an ability to be tuned to absorb specific wavelengths of light, opening up a plethora of new possibilities. "These characteristics make organic solar panels particularly suitable for use in next-generation green and sustainable buildings," noted Chan. Imagine transparent and colored solar panels, seamlessly integrated into architectural designs.

For all these advantages, organic solar cells have struggled to match the efficiency of their silicon counterparts. While silicon panels can convert up to 25% of sunlight into electricity, organic cells have typically hovered around 12% efficiency. This gap has proved to be a significant obstacle to widespread adoption.

Unlocking efficiency

Recent developments have rejuvenated the excitement around organic semiconductors. A new class of materials called non-fullerene acceptors (NFAs) pushed organic solar cell efficiency closer to 20%, narrowing the gap with silicon.

The Kansas research team set out to understand why NFAs perform so much better than other organic semiconductors. Their investigation led to a surprising discovery: in certain circumstances, excited electrons in NFAs can gain energy from their surroundings instead of losing it.

This finding flies in the face of conventional wisdom. "This observation is counterintuitive because excited electrons typically lose their energy to the environment like a cup of hot coffee losing its heat to the surrounding," Chan explained.

Led by graduate student Kushal Rijal, the team experimented with a sophisticated technique called time-resolved two-photon photoemission spectroscopy. This method allowed them to track the energy of excited electrons to less than a trillionth of a second.

An unlikely ally

The researchers believe this unusual energy gain stems from a combination of quantum mechanics and thermodynamics. At the quantum level, excited electrons can appear to exist on multiple molecules simultaneously.

Coupled with the second law of thermodynamics, this quantum behavior reverses the direction of heat flow.

"For organic molecules arranged in a specific nanoscale structure, the typical direction of the heat flow is reversed for the total entropy to increase," Rijal explained in a press release. "This reversed heat flow allows neutral excitons to gain heat from the environment and dissociates into a pair of positive and negative charges. These free charges can in turn produce electrical current."

Beyond solar cells

Beyond improving solar cells, the team believes that their findings are applicable in other areas of renewable energy research. They think the discovered mechanism will lead to more efficient photocatalysts to convert carbon dioxide into organic fuels.

"Despite entropy being a well-known concept in physics and chemistry, it's rarely been actively utilized to improve the performance of energy conversion devices,

Tech company unveils tiny spheres that outperform solar panels using both sun and artificial light — and the company says they could hit 60 times the current capacity© Provided by The Cool Down

Solar panels may be replaced by light-catching spheres if innovation company WAVJA's ingenious contraptions fulfill their potential.

That's because the business, which has operations in New York City, says its experts have created tiny globes — from a little more than an inch to nearly 4 inches in size — that can harness both sunlight and artificial light to make electricity, according to the manufacturer.

Called a Photon Energy System, the tech uses "multiple layers of cutting-edge materials in specialized spheres," according to Executive President Shereen Chen, who outlined a list of performance metrics in a video. Each one has a specification that's multiple times better than traditional panels.

The spheres, which resemble tiny Death Stars (or, perhaps for a more niche Star Wars reference, normal-sized training remotes), are 30 times smaller than solar panels, with 7.5 times the output. Astoundingly, she said they are more than 200 times more efficient.

"It revolutionizes how we harness sunlight," Chen said.

In the clip, four spheres are shown sitting atop a square-shaped device, possibly a part of the system that converts light to electricity. Typically, there's no external battery connection involved. Chen said the invention is a "separate battery system."

For the example scenario, the spheres are shown powering a battery. Chen later notes that the power pack can be connected to the system "in various ways compared to solar panels."

Throughout the video, LED lights are used to energize the setup, which in turn charges tablets and phones. The vision gets fairly futuristic from there. Renderings shared by Chen show concept big rigs and flying machines powered by groups of spheres, all providing a 24-hour electricity supply regardless of the weather conditions.

One concept closer to reality is a vehicle being tested to run on a package of 20 spheres, per Chen.

"You are actually looking at real time, current, proof of concept that we are working on," she said about the car.

The tour of the future wrapped up with a rendering of a community powered by a bank of spheres. If the tech can in fact provide the power as advertised, it will be an amazing feat. The third generation is said to be 60 times more powerful than a similar-sized solar panel, per the clip.

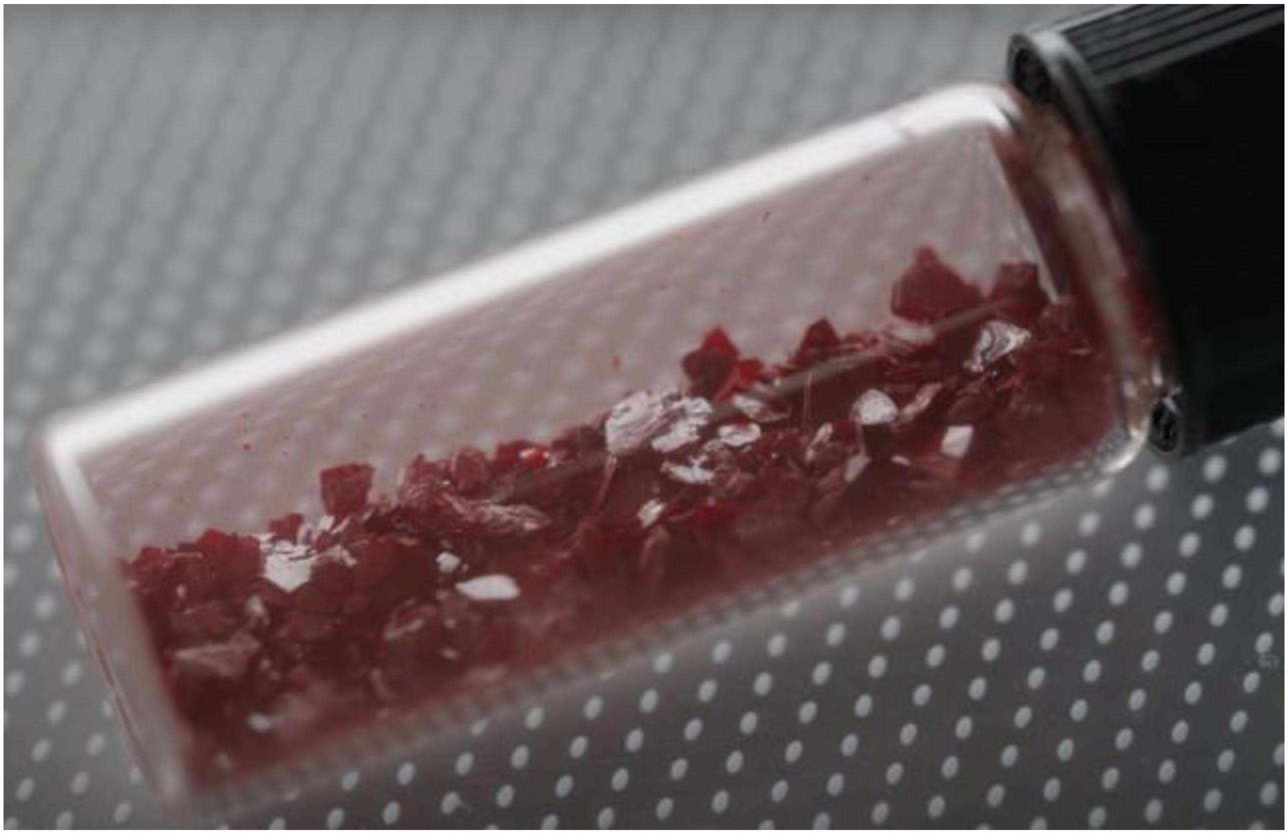
"Our commitment to innovation drives us to create transformative solutions," Chen says.

WAVJA cites planet-warming-fueled extreme weather, forest fires, and other calamities as inspiration for the innovations. Its designers even have a proposed fire-extinguishing drone, powered by its spheres, that will "patrol forests for extended periods of time and extinguish fires promptly upon discovery."

Solar innovations are marking impressive milestones. A team in Japan is working on a flexible sun-catching material that can survive a run through a washing machine. But even common sense can provide big results in the effort to be more sustainable. Simply replacing your old light bulbs with LEDs can save you hundreds of dollars a year while also negating the creation of hundreds of pounds of air pollution.

As for the big picture, while WAVJA doesn't get deep into how the technology works, the concept offers appealing potential. The company is looking for partners to start bringing the technology to action, from powering devices to industrial settings, according to its website.

"The future of energy is bright, sustainable, and within reach,"



Researchers unveil breakthrough solar energy structure that is significantly cheaper than traditional solar panels: 'The holy grail'© Provided by The Cool Down

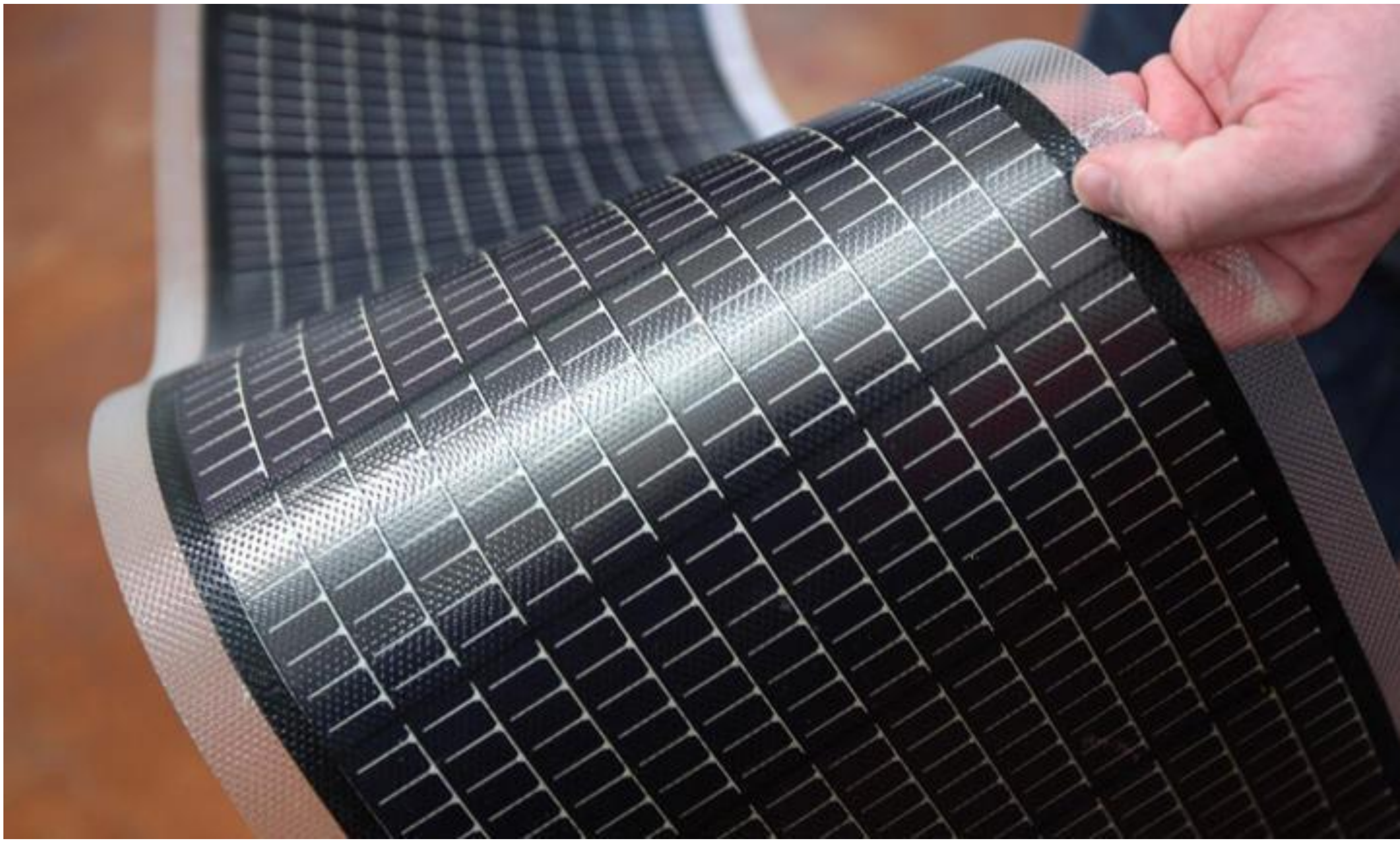
Scientists have created perovskite solar cells that can theoretically last as long as traditional silicon-based solar cells in what might be a major breakthrough for clean energy, LiveScience reported.

Perovskites, which refer to a material with the crystal structure that is naturally found in calcium titanium oxide, has been called a "miracle material," "the holy grail," and "like Michael Jordan on the basketball court" by clean energy researchers due to being potentially cheaper and more efficient to make along with high performance when harvesting solar energy. However, it is far less durable than traditionally used silicon, meaning that most of its (still impressive) applications so far have been in perovskite-silicon tandems.

But now, researchers at Rice University have developed a new method of creating perovskite solar cells that addresses stability and durability issues. By treating the perovskite with a precursor solution of formamidinium iodide, the researchers created "ultra-stable" cells, as LiveScience detailed.

"Perovskite solar cells are kind of the holy grail of this new solar cell technology. And that's because perovskites can be made in theory significantly cheaper than inorganic solar cells like silicon or gallium arsenide," said Isaac Metcalf, graduate student of materials science and nanoengineering at Rice University, per the news platform.

"The reason why is because they can be solution-processed at low temperatures. Basically, you can take an ink of a perovskite precursor and you can spread it across a piece of glass, and then heat it up, and then you have a perovskite."



hand holding sheet of thin film solar cells© John Moore/Getty Images

As the name implies, thin film solar panels are composed of solar cells that are much thinner than what you'll find in your average solar panel. To the point where, in most cases, they can quite literally flex and bend without breaking — though not so much if they're attached to rigid materials like glass or metal.

Thin film solar panels are also much lighter than more traditional style (i.e. rigid) panels and are comparably easier to install. They might not be the best idea for powering an entire home (we'll get to that), but they work well with RVs, sheds, and so on. Basically if something is too small or not sturdy enough to accommodate the size or weight of regular solar panels, thin film panels could be a solution.

There are four basic kinds of thin film solar panels, with each offering its own benefits and drawbacks. And when compared to their more common polycrystalline and monocrystalline counterparts (with average efficiencies between 13- to 16-percent or 15- to 23-percent, respectively) they don't perform quite as well.

Amorphous Silicon (a-Si)


amorphous silicon solar cells at factory© Soonthorn Wongsaita/Shutterstock

Amorphous silicon panels predate all other thin film panels, and have been in use for decades in small electronics like solar-powered calculators and watches. Additionally, they can still be found in lots of modern devices like solar-powered exterior lights — and those ever-present calculators.

These panels are basically just a thin layer of silicon spread over another surface like plastic, glass, or metal, while their flexibility makes them tougher to physically break. Low light conditions doesn't hamper the performance of a-Si panels very much, either, and they're also the least expensive to produce of the four main thin film panel types. Making these the cheapest (on a cost per-panel basis) option, though not necessarily the best or most overall-affordable one.

On the other hand, the overall efficiency of a-Si panels isn't great at around 6-8%. That low efficiency only gets lower over time, too, with levels often dropping as soon as they're installed in whatever device they're intended for. They don't usually last as long as other panel types, either.

Organic Photovoltaic (OPV)

RV with solar panels on roof© Voyagerix/Shutterstock

Organic photovoltaic solar panels provide better efficiency (with an 11% average rating) than a-Si panels and won't lose efficiency as quickly. The materials used in their construction are also quite common, so manufacturing is relatively inexpensive when compared to other thin film models.

Something a bit more unique to OPV panels is the variety of colors they can be produced in when different kinds of absorbers are used during production (they can even be transparent). Which can work well for less visually intrusive sun-powered energy setups like solar shingles.

While this does make OPV panels comparably affordable (though maybe not quite as low-cost as a-Si panels), they don't tend to last as long as other non-organic options. Currently you're looking at an approximate lifetime of around 10 years or so. The general cost and aesthetic options can be a good fit for the short-term (or short-ish, anyway), but OPV panels are likely to need replacing far more often than other types of thin film panels.

Cadmium Telluride (CdTe)

cadmium telluride solar panels at Desert Sunlight Solar Farm© Tim Rue/Getty Images

From the oldest, now to the most prolific. Cadmium telluride solar panels are currently the most commonly used kind of thin film solar panel, and will also pay for themselves the fastest out of the other thin panel types.

CdTe panels are also the less expensive option when it comes to consumer-level thin film panels — yes, a-Si panels are even cheaper but they're not suited for powering a home. They're also more efficient at around 9-15%, making them not quite but almost on-par with polycrystalline panels. On top of that, CdTe panels provide the lowest overall carbon footprint of the thin film lot. So they're comparably affordable, relatively efficient, and are the most environmentally friendly.

The catch is the cadmium, which is very toxic. It's no danger when the panels are being installed or used, but it does pose a potential health risk to the people who manufacture them and that toxicity makes getting rid of CdTe panels (i.e. throwing them away) a problem.

Copper Indium Gallium Selenide (CIGS)

CIGS Thin-Film Flexible Solar Panel© Amaazon

Copper indium gallium selenide panels boast an efficiency of 12-14%, putting them pretty much neck-and-neck with CdTe and very close to polycrystalline panels, energy-wise. They're composed of layers of each element (copper, indium, etc) stacked on top of each other — like a cake — and can be spread over a variety of materials like glass, plastic, and some metals.

CIGS panels do sometimes contain cadmium, in which case they're just as safe to use and risky to dispose of as their CdTe counterparts, however some CIGS panels are built using much safer zinc oxides. Ideally these would be the go-to for thin film solar panels, even over CdTe, but one major factor is holding them back.

Cost is the biggest issue with CGIS as the manufacturing process is significantly more expensive. This means they're less accessible (price-wise) than a lot of other solar options, and it takes much longer for them to pay for themselves in energy savings.

With new types of solar panels, including lightweight and flexible designs, there are opportunities to expand distribution to new areas that previously seemed unlikely.

Recent research shows how to improve silicon and perovskite solar cell efficiency by applying a coating to smooth out surface defects, according to a report by Interesting Engineering.

There have been several advances in photovoltaic cells that combine silicon, a material that absorbs mostly red and infrared light, along with perovskite, a mineral that efficiently captures visible light, as detailed by the news outlet.

One of the latest reached efficiencies for solar cells was around 23%, but this new study shows the potential for improved efficiency while reducing costs, as the report detailed.

Tandem solar cells are made with a combination of two semiconductors that help capture more wavelengths of light at once, the news report explained. Monolithic tandem cells are when two semiconductor coatings are placed on top of one another, such as silicon wafers with perovskite.

Many wafers go through an expensive process that polishes their surface. However, those produced through the Czochralski method have tiny pyramidal structures and are much cheaper, per Interesting Engineering. The microtextures capture more light since they're less reflective. But when perovskite is applied, defects are created in the crystal lattice that reduce efficiency.

Now, a team of researchers has developed a new strategy for surface passivation that can smooth out those defects.

"A thiophenethylammonium compound with a trifluoromethyl group (CF3-TEA) is applied by a dynamic spray coating process. This forms a very uniform coat—even on microtextured surfaces," according to a release shared in the article.

"Surface modification with CF3-TEA allows perovskite/silicon tandem solar cells based on common textured wafers made of Czochralski silicon to attain a very high efficiency of nearly 31% and maintain long-term stability."

As of 2019, the share of U.S. energy derived from dirty fuels was 80%, although renewables surpassed coal that year. Solar power is growing quickly, which is great news, as moving toward sustainable energy will help reduce planet-warming pollution, according to the U.S. Energy Information Administration.

Solar is a pollution-free generation method, which can help improve air quality, reduce water use related to energy production, and has many crossover benefits when it replaces dirty energy electricity generation. The land where large-scale arrays are installed can be seeded with native plants and attract pollinators, which help drive biodiversity and improve crops.

With new types of solar panels, including lightweight and flexible designs, there are opportunities to expand distribution to new areas that previously seemed unlikely. Transparent coatings could be applied to windows, and flexible and stretchable designs could be used on bike charging stands and even clothing.

New scientific breakthrough could prevent a major childhood health problem: 'Similar to concerns related to lead exposure'© Provided by The Cool Down

Join our free newsletter for weekly updates on the latest innovations **improving our lives** and **shaping our future**, and don't miss this cool list of easy ways to help yourself while helping the planet.

Scientists Created a New Solar Cell That Produces 1,000 Times More Power© Organically Human

This new technology could revolutionize how we power our world, offering a cleaner and more sustainable alternative to traditional energy sources.

The energy generation of ferroelectric crystals in solar cells can be increased by a factor of a thousand thanks to an innovation involving the arrangement of thin layers of the materials, according to a statement from Martin Luther University Halle-Wittenberg (MLU).

Researchers from MLU found that alternately placed crystalline layers of barium titanate, strontium titanate, and calcium titanate could significantly increase the efficiency of solar panels. Their findings are published in the journal *Science Advances*.

Most solar cells are made out of silicon due to their low cost and relative efficiency; however, limits to the material's overall efficiency have led to researchers experimenting with new materials, including ferroelectric crystals.

One of the benefits of ferroelectric crystals is that they do not require a pn junction, meaning any positively and negatively doped layers - as is the case with silicon solar cells.

However, pure barium titanate, a ferroelectric crystal tested by MLU researchers, for example, absorbs little sunlight. By experimenting with different combinations of materials, the scientists found that they could combine fragile layers of different materials to increase their solar energy yield significantly.

"The important thing here is that a ferroelectric material is alternated with a paraelectric material. Although the latter does not have separated charges, it can become ferroelectric under certain conditions, for example, at low temperatures or when its chemical structure is slightly modified," Dr. Akash Bhatnagar, from MLU's Centre for Innovation Competence SiLi-nano, explained in the MLU press release.

Layered power surge

Bhatnagar and his team embedded barium titanate between strontium titanate and calcium titanate by vaporizing the crystals with a high-power laser and redepositing them on carrier substrates. The resulting material was composed of 500 layers and was 200 nanometers thick.

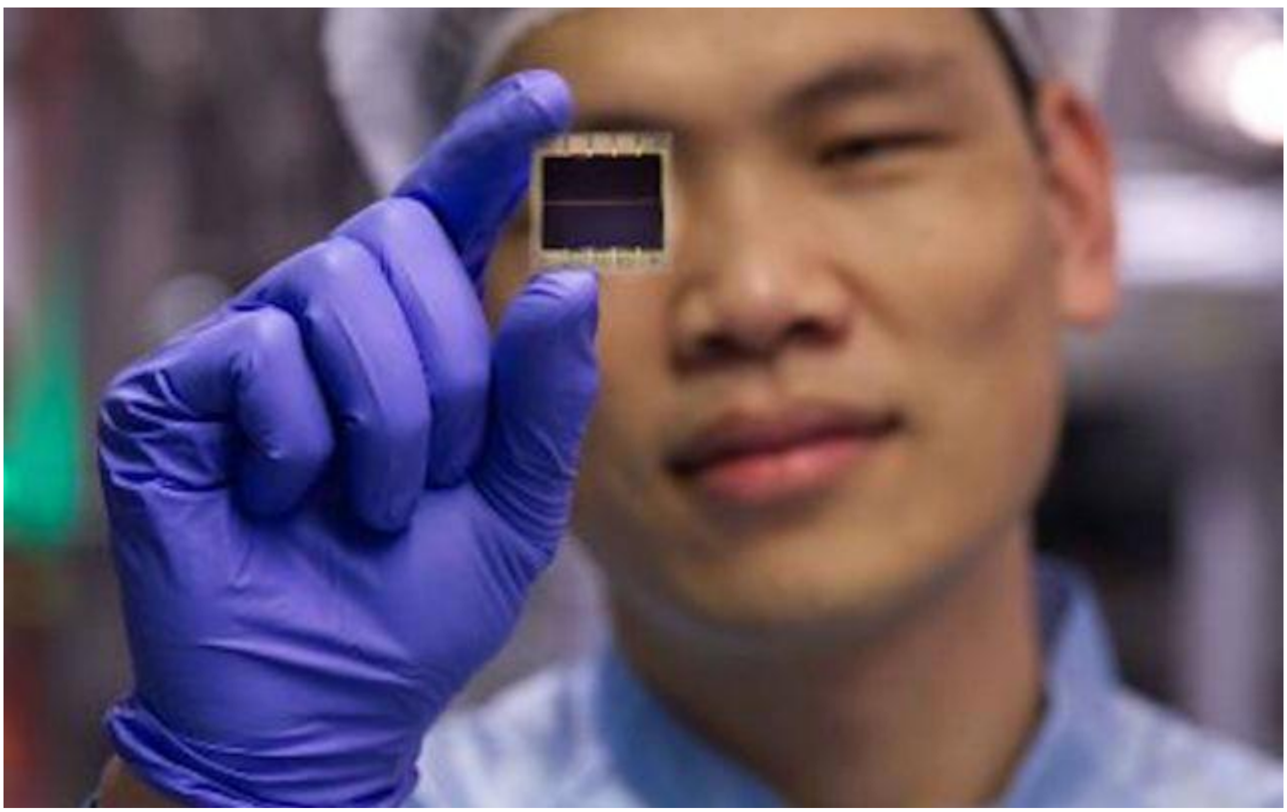
The researchers found that their layered material enabled a current flow 1,000 times stronger than measured in pure barium titanate of the equivalent thickness.

"The interaction between the lattice layers appears to lead to a much higher permittivity – in other words, the electrons can flow much more easily due to the excitation by the light photons," Bhatnagar explained.

The team also showed that the measurements remained almost constant over six months, meaning the material may be robust enough for commercial application. Next, they will continue to research the exact cause of the photoelectric effect in their layered material, with a view to eventual deployment at a mass scale.

Their work promises to be part of a potential revolution in ferroelectric materials, with possible applications in computer memory, capacitors, and other electronic devices.

Written by: Chris Young



Oxford scientists make remarkable advancement with material that generates solar power without traditional panels: 'The future is brighter'

University of Oxford scientists have made a remarkable breakthrough that could lead to more efficient solar panels that are thin enough to cover any common object, potentially opening up a new frontier in adopting clean, low-cost energy solutions.

In August, the team from Oxford's physics department announced that it developed an "ultra-thin material" that provides 27% energy efficiency in converting sunlight into energy.

This is significant because the most commercially available solar panels peak at roughly 23% efficiency, according to MarketWatch. And while solar paints have shown promise as a less bulky option to traditional panels, scientists are still working to improve their efficiency.

The release notes that Oxford researchers have already been working with thin-film perovskite for around 10 years, with Oxford PV ultimately birthed from the physics lab. The company's high-efficiency perovskite solar cell technology integrates with conventional panels and is moving toward commercialization.

With further development, the Oxford team believes its latest photovoltaic device could exceed 45% efficiency — with no need for the assistance of the panels.

"During just five years experimenting with our stacking or multi-junction approach, we have raised power conversion efficiency from around 6% to over 27%," Oxford postdoctoral fellow Dr. Shuaifeng Hu said in the release.

"We believe that, over time, this approach could enable the photovoltaic devices to achieve far greater efficiencies," Hu added.

Home solar panel systems have already garnered buzz for their ability to drastically lower electric bills and improve climate resilience during extreme weather, which has become more intense and frequent as the planet has warmed.

However, Oxford researchers suggested their new method could cut those costs even further because thin-film perovskite is much cheaper than silicone typically used for panels.

Furthermore, the technology could be used to power cleaner modes of transportation like electric vehicles and everyday necessities such as mobile phones. This would reduce the dependence on grids that are adding more renewable options but still have a long way to move away from dirty fuels.

According to S&P Global, Energy Institute data found that oil, gas, and coal accounted for 82% of the global energy mix in 2023. Air pollution from these fuels doesn't just contribute to unsightly haze hanging over some cities, but it also has a significant impact on public health and is responsible for millions of deaths every year.

It is unclear when the thin-film perovskite technology could be readily available.

One hurdle in adopting new solar technologies is the available incentives to manufacture them on a large scale, according to Professor Henry Snaith, the co-founder and chief scientific officer of Oxford PV. If fully realized, however, Snaith believes they could be a game-changer.

"The latest innovations in solar materials and techniques demonstrated in our labs could become a platform for a new industry, manufacturing materials to generate solar energy more sustainably and cheaply," Snaith said in the release.

"Versatile and efficient," one commenter marveled at Electrek's coverage of the technology. "The future is brighter!"


installing solar panels© Artistgndphotography/Getty Images

The landscape of solar energy production and use is widespread and comprehensively developed today. Sure, research still hasn't created a consistently efficient means of storing solar power in the long term. But photovoltaic (PV) cells do translate solar power into electrical energy that can be used to charge (and then discharge) lithium-ion batteries, among others, though efficiency loss along the way can make it a challenge for residential users. Even so, solar farms around the country and world have transformed the way humans produce electrical energy, and residential systems are delivering increased energy independence alongside improved environmental security.

The journey from early exploits in harvesting the sun's energy to this present moment and beyond is a fascinating one. Ancient humans harnessed our star's potential in many ways, and modern inhabitants of the Earth have followed suit, albeit with increasingly impressive technological breakthroughs that make the sun increasingly valuable. The contemporary solar panel owes its existence to a long string of advancements that begin far back in history — but really came into their own over the last couple hundred years. This is the evolution of the solar panel.

Read more: 5 Of The Best RV Deep Cycle Battery Brands, Ranked

Harvesting The Sun's Rays In Antiquity

people visiting Stonehenge© Oversnap/Getty Images

As early as the 7th century B.C., humans were using the sun to start fires with the help of rudimentary magnifying glass technology. These experiments with solar power set the baseline for humanity's partnership with the sky's ancient energy producer, and they stand the test of time — young students still go outside to create heat and tiny burn marks under the supervision of their teachers. Thousands of years after those early harnessers, Chinese and Greek civilizations built cities with the sun's position in mind.

These communities crafted homes and gathering places directly affected by the sun's position in the sky, changing them throughout the year to accommodate weather patterns and comfort requirements. They used the sun's trajectory and the year's seasonal pattern to harness the star's heat during the winter and create a cooling effect in the summer months. These early efforts to capture the sun's radiant energy colored the way humans thought about the celestial body for centuries to come. It would be thousands of years before humanity found that it could truly capture and manipulate the sun's energy, but that voyage starts here, in antiquity's first steps.

The First Solar Cell Is Developed In 1767

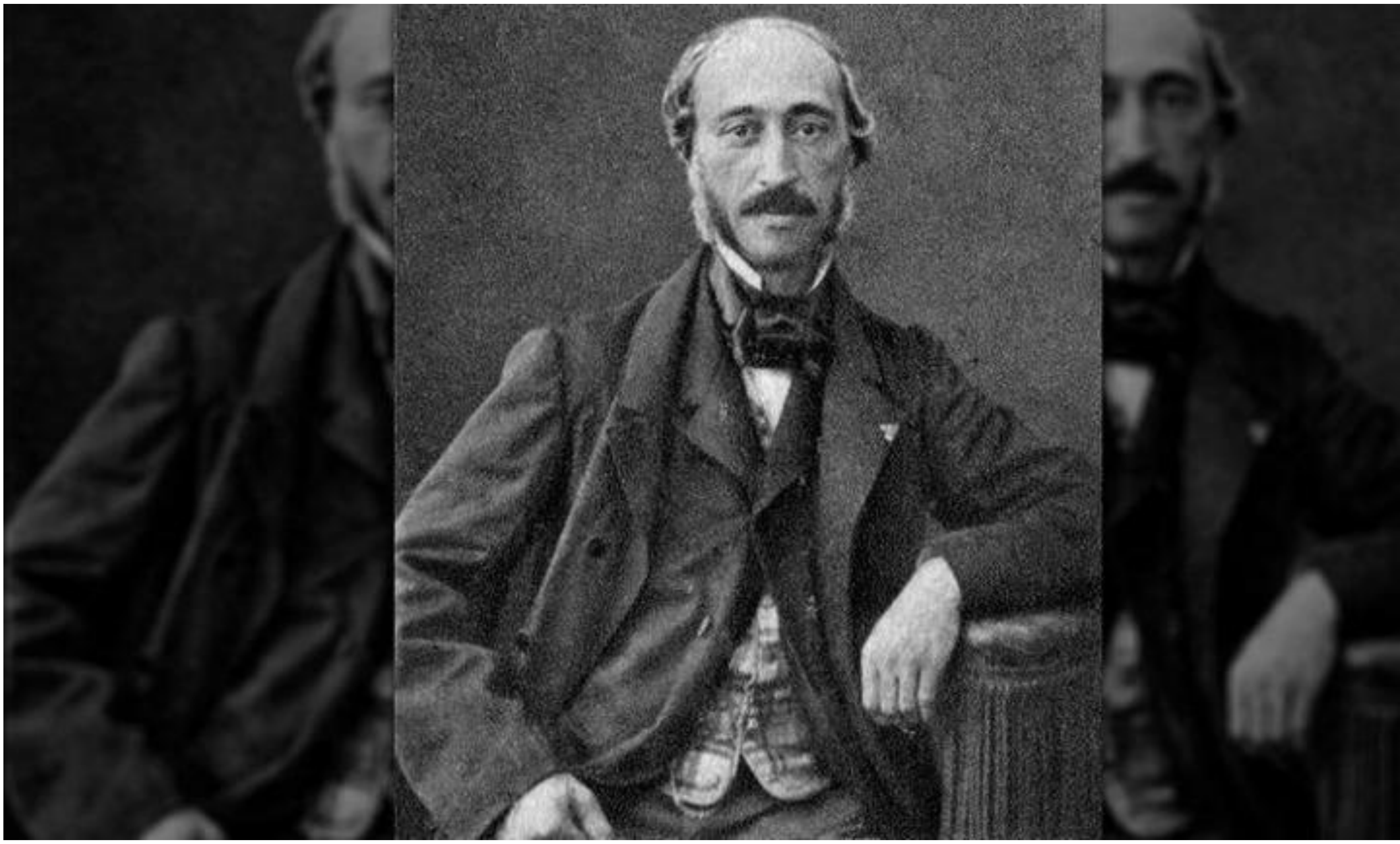
Horace Benedicte de Saussure© Jens Juel/Wikimedia Commons

Solar energy was conceptualized in a whole new light after Horace Benedicte de Saussure created the first cell in 1767. The Swiss intellectual began toying with a design for solar capture that might help harness the sun's energy. Saussure is famous for exploring the Alps and performing a range of geological testing and measurements. In 1767, he created the heliothermometer, a device that magnified incoming sunlight to produce an increased heat output. Saussure's heliothermometer was constructed of layered glass in an insulated box. Essentially the device acted like a small greenhouse that would gradually raise the temperature so that the sun's light energy could be transformed into heat. The device amplified the heat enough to reach 108 degrees Celsius, breaching the boiling point of water and allowing users to leverage the sun's energy for cooking and other rudimentary tasks.

At this point, solar capture technology obviously wasn't very efficient, but Saussure's breakthrough laid the foundation for all other solar cell technologies that arrived over the next 250-plus years. It might be hard to believe that this cutting-edge technology got its start such a long time ago, but it really begins here with the understanding of how to reliably convert sunlight into a usable alternative energy format.

Featured image by Jens Juel via Wikimedia Commons | Cropped and scaled | Public domain]

The Photovoltaic Effect Is Discovered In 1839



Edmond Becquerel© Nadar/Wikimedia Commons

In 1839, roughly 70 years after the first solar cell was created, Edmond Becquerel observed the photovoltaic effect in action, kick-starting a revolution in human understanding of solar energy — and power production and usage more broadly. At this point, experimentation with electrical power is in full swing, although the first American power grid technology was still a few decades away. The photovoltaic effect is a foundational principle underpinning the very existence of modern solar technology. In a nutshell, Becquerel observed that certain materials produce electric current when they're exposed to sunlight or even radiant heat.

At just 19, Becquerel made this breakthrough while researching in his father's lab. After this inflection point, it became clear that solar capture technology doesn't require an additional translation of energy to utilize the resource after it has been collected as light. Early solar capture revolved around creating heat, but this must be translated again in order to develop an electric charge that might power a machine, light bulb, or automotive vehicle. With each conversion, energy is lost — another foundational principle — meaning the ability to generate electrical current directly from collected sunlight saved incredible space, time, and energy itself.

[Featured image by Nadar via Wikimedia Commons | Cropped and scaled | Public Domain]

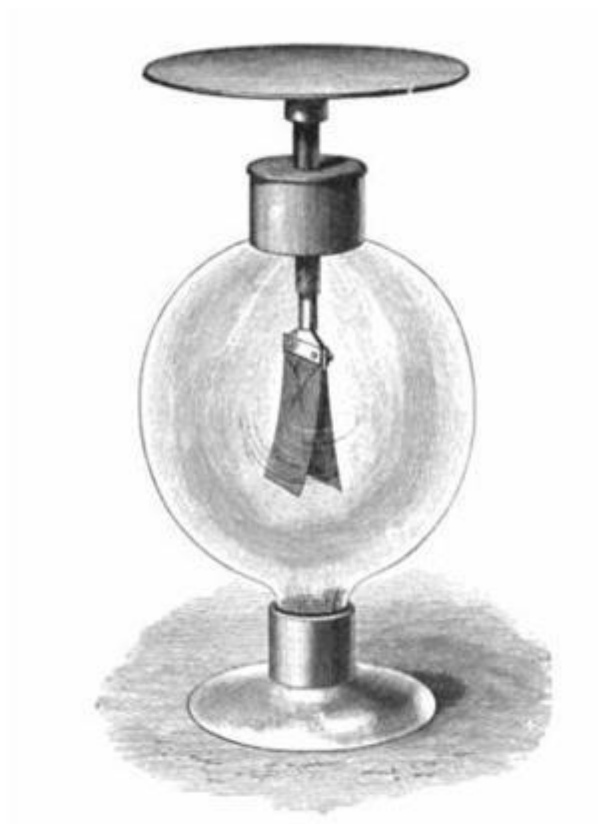
1883: Charles Fritts Builds A Modern Solar Capture Cell

solar panels sun© bombermoon/Shutterstock

The selenium cell is the next major breakthrough for solar power production. Charles Fritts continued the progress of many other inventors in the arena, settling on selenium after other pioneering research into its photoconductivity. In 1883, Fritts successfully created the first solid material solar cell, requiring no moving parts to capture sunlight and output an electric charge that could be harnessed to support human needs.

Fritts' cell created electricity at an efficiency conversion rate of about 1% or 2%, but it was the breakthrough required for crafting increasingly useful electricity-generating solar cells. As reported by Smithsonian Magazine, Fritts joyfully noted of his selenium creation that it produced an electric current that was "continuous, constant, and of considerable force." The improvement made for a major leap forward in solar power creation. No longer did users have to rely on bulky productions or moving components that made the tool far more complicated. The solar cell was coming into form.

Photoelectric Processes Are Observed And Improved Cells Make Their Appearance



Electroscope demonstrating photoelectric effect© James Edward Henry Gordon/Wikimedia Commons

Building on the existing principles of the photovoltaic effect, a similar phenomenon — photoelectric effect — was observed in 1887 by German physicist Heinrich Hertz. This is when electrons are emitted into space rather than entering what is known as the conduction band of the material in question. Hertz noticed that shining UV light on the nodes created sparks between electrodes, eventually uncovering this related phenomenon.

A year later, Aleksandr Stoletov had built a working photoelectric cell, the first of its kind. Perhaps the most important feature of this competing design was found in Hertz's discovery that more electric power is created from exposure to ultraviolet light than in the visible spectrum. Considering the vast, radiant output of UV rays from the sun, this new finding and resulting breakthrough created an exciting new avenue to pursue in the quest for ever-increasing solar power efficiency and functionality.

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Silicon Solar Cells Hit Commercial Production

A model of Vanguard 1© NASA/Wikimedia Commons

Steady progress continued after these early breakthroughs, but explosive growth began to take root in the 1950s. Early in the decade, Bell Laboratories developed the silicon solar cell, bringing energy-producing efficiency up to 6%. Still notably lower than modern residential efficiency standards (around 20%), this was a big change from the low numbers that the first wave of solar collection tools were able to muster. Indeed, cells of this era were suddenly capable of powering equipment used in labs, homes, and elsewhere. In 1958, solar collection tools were deployed in space exploration equipment to provide consistent power to devices that would live out in the great beyond alongside their energy progenitor.

The boost in production efficiency was due in large part to the inclusion of silicon in the design rather than the earlier use of selenium. It offered greater efficiency, but at this stage the costs remained prohibitive for all but the most specialized uses. Case in point: In 1958 NASA launched Vanguard 1, a satellite that has now traveled nearly 200,000 times around the Earth on the backs of photoelectric solar panels. Research and specialty uses remained the overwhelming use of solar technology, but changes were stirring behind the scenes.

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Exxon Corporation Research Pours Money Into The Technology


NMSU professor showing solar panel© Boyd Norton

Throughout its time in contemporary existence, solar power has faced off against two mortal threats. In the technology's modern framework, price and efficiency act as dual barriers to comprehensive adoption and severely challenge any model of environmental and power grid sustainability that relies primarily on solar to supplant environmentally damaging practices. Coal-fired industrial production might be dirty and unsustainable over the long term, but the excessive costs associated with building solar collectors and then running them at an abysmal efficiency rating make it a non-starter in the present.

In the 1970s, things began to shift in both regards, however. Exxon Corporation research began taking off, and the U.S. government got serious about projects designed to create more robust energy independence. The Solar Energy Research, Development, and Demonstration Act of 1974 saw federal dollars poured into solar projects aimed at making solar practical and affordable so the public could easily access the benefits of this new energy option. Meanwhile, Exxon's studies focused on reducing costs, and the company succeeded in reducing the price of solar-created electricity down from $100 per watt to as low as $20. This still wasn't enough to make it directly competitive with its alternatives, but the framework for a viable path forward was certainly beginning to take shape.

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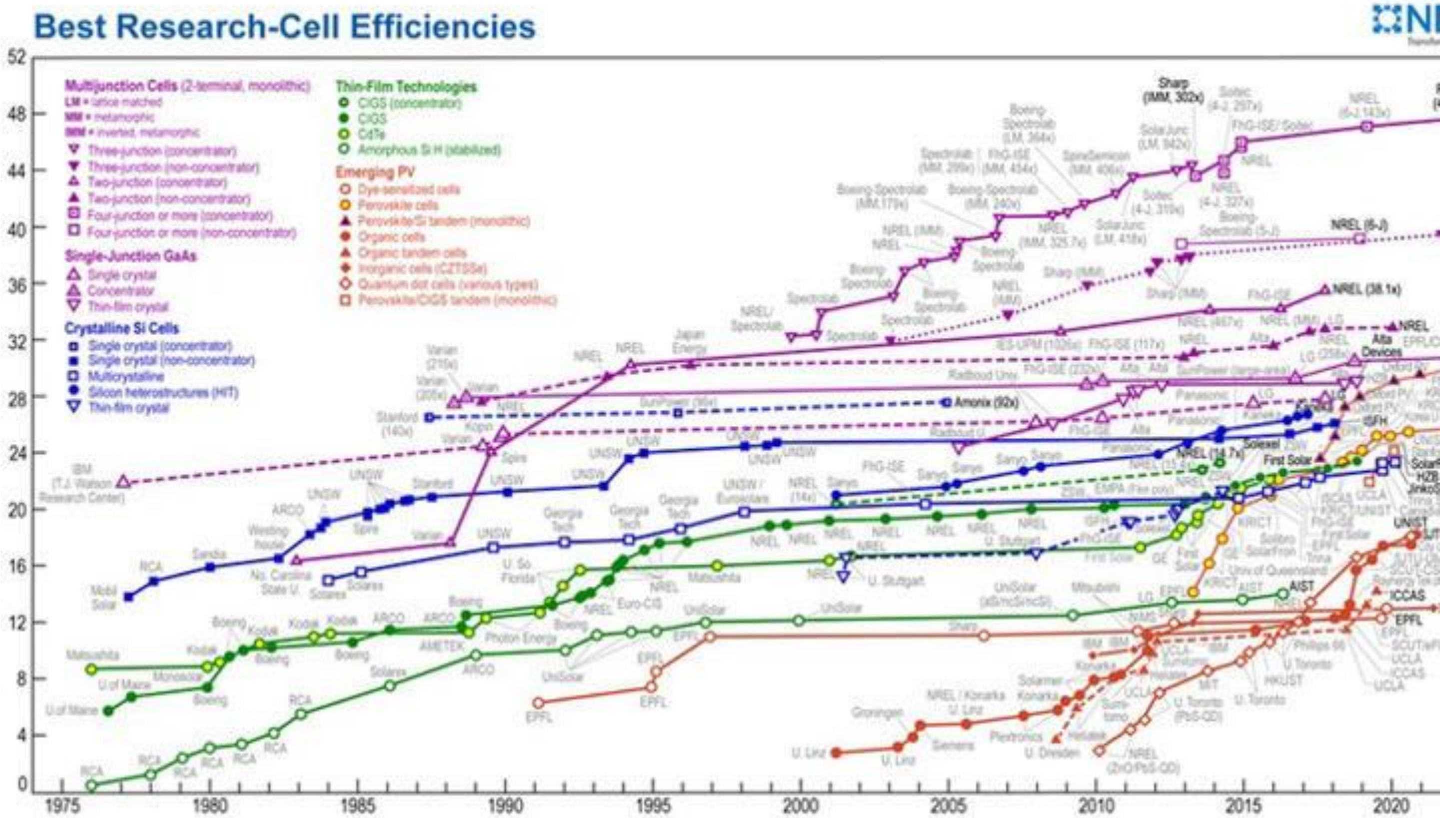
20% Efficiency Is Achieved In 1985



cell efficiency improvements (1976-present)© Nikos Kopidakis/Wikimedia Commons

The second barrier to widespread adoption came in the form of efficiency. Wave energy capture technology has recently found ways to deal with this issue, and in 1985, it appeared that solar cells had as well. The University of South Wales broke the 20% barrier in silicon cells in 1985, and solar buildings, parks, and other large-scale construction projects were cropping up all over the country and globe around this time, too. It's also important to note that the 1980s saw another wave of crippling energy crisis years, spurring a global economic recession.

Just a few years earlier, in 1982, the first solar-powered car was driven from Sydney to Perth (around 2,800 miles) in half the time it took the first gasoline-powered car to achieve the feat. Global adoption rose past 21.3 megawatts of production in 1983, as well. In 1992, a decade after these new developments, researchers at the University of South Florida broke the 15% efficiency barrier for the first time with a thin-film photovoltaic solar cell (made of cadmium telluride and clocking in at 15.9% efficiency). A year after that development Pacific Gas & Electric installed the first grid-supported photovoltaic system. It was a 500-kilowatt endeavor in Kerman, California, and the first solar-distributed power system built. Another year later, the National Renewable Energy Laboratory broke the 30% energy conversion threshold with a new solar cell design that utilized gallium indium phosphide and gallium arsenide.

[Featured image by Nikos Kopidakis via Wikimedia Commons | Cropped and scaled | Public domain]

By 2010, Solar Power Production Is Booming Across The United States

solar projects in 2010© Boston University Institute for Global Sustainability

As Boston University Institute for Global Sustainability documents, power production through solar technology has exploded in the United States over the last two decades. The introduction of the Solar Investment Tax Credit in 2006 spurred a major shift in the way enterprise and residential power production and usage was considered, and by 2010 solar power production had become a nearly monolithic new opportunity. In North Carolina — and California, specifically — new solar power construction projects jump off the map. Following these early adopters, the Maryland and New Jersey-New York coastline and a smattering of insular communities in Colorado, New Mexico, and across the Midwest began to see massive investment in solar power construction.

These projects have brought gigantic financial investment into communities that may have formerly relied on coal mining, oil drilling, fracking, and other formats of energy harvesting. An evolution of the energy sector's workforce began taking place around 2010, and it hasn't slowed down in the 14 years since. In coordination with the 2006 legislation, 2009 saw the American Recovery and Reinvestment Act signed into law, expanding tax breaks, grants, and other incredible financial incentives for companies to develop solar power infrastructure.

Tax Incentives Today Make Residential Solar Energy A True Option

installing residential solar panels© moreimages/Shutterstock

Today, the efficiency of most residential solar panels sits at around the 20% mark, on average. With prices continuing to drop — a 70% reduction in the price of installation over a 10-year period around the time of key legislative victories for the burgeoning solar industry — residential panels are increasingly viable. In fact, the Office of Energy Efficiency & Renewable Energy reported in 2017 that the solar industry created roughly 1,000 new jobs every week. In addition, tax breaks and other financial incentives extended to residential users have made it an affordable solution in both the here and now, and over the long term as a means to reduce continuing energy usage costs. Current tax incentives offer up to a 30%

recovery of installation costs, running between 2017 and 2034, with rollover credits available to installing homeowners (and [perhaps even solar-installing renters]) so that they can utilize the full financial value.

Those who have [installed solar panels on their homes] can also take advantage of banking, net metering, and energy sell backs, as well. With added battery technology in the home, residential users can now bank surplus energy captured through the home system. States have also mandated that users can sell back the surplus energy generated to their power company for an added offset to their electricity bill. Continued technological improvement and government programs have made solar power a truly valuable option both in the commercial and residential space.

Researchers design tech that could 'potentially replace solar cells' in certain applications — novel supercapacitor is charged by light and could appear in a smartphone near you© Santilata Sahoo

Researchers at the Department of Instrumentation and Applied Physics (IAP), Indian Institute of Science (IISc) and collaborators have developed a new supercapacitor that can be charged by light.

This innovation could be used in streetlights and self-powered electronic devices, including sensors, as unlike standard capacitors, which store energy electrostatically, supercapacitors use electrochemical methods to hold significantly more energy, allowing them to “release charge more quickly than batteries,” explained Abha Misra, Professor at IISc’s Department of Instrumentation and Applied Physics, and the study’s author.

The supercapacitor's electrodes are made from Zinc Oxide nanorods on a transparent Fluorine-doped Tin Oxide substrate, allowing light to pass through and charge the device. When exposed to ultraviolet (UV) light, the supercapacitor demonstrated a large increase in capacitance - its ability to store electrical energy. “The ideas were simple... but when combined together, they worked very well,” Misra adds.

Necking behavior

In addition to the impressive increase in capacitance, the researchers discovered two unusual behaviors. First, the device’s capacitance increased with voltage under light exposure, a phenomenon co-author AM Rao from Clemson University refers to as "necking behavior." Second, while energy storage typically decreases when charging faster, the team found that their supercapacitor stored more energy during rapid charging when exposed to UV light.

The research team used a liquid electrolyte to improve performance by enhancing the electric double layer effect, which plays a key role in the high energy storage capacity of supercapacitors. “We have miniaturized supercapacitors to the micron scale so that they can be integrated along with microelectronic chips," Misra notes, pointing to potential applications in mobile phones and other small devices.

Misra believes this new technology could eventually replace solar cells in streetlights due to its faster charging time and high power density.

The research was published in *Journal of Materials Chemistry A*, and the team hopes to further develop the supercapacitor to charge using visible and infrared light.

Breakthrough glass generates energy: Car windows, mobile screens to charge batteries

Researchers have developed a new method that can directly charge a battery from a smartphone screen. Developed by a research team affiliated with UNIST, the method can directly supply energy from glass of buildings, cars, and mobile devices through transparent solar cells.

The new type of transparent solar cell and module offers high efficiency and maintains glass-like colorless and transparent properties.

The transparent solar cell secured colorless and transparentness by introducing an 'all-back-contact' design that places all the components of the solar cell on the back. It has achieved high efficiency and aesthetics that transparent solar cells must have at the same time.

Transparent cell module has high efficiency

The material is developed by Professor Kwanyong Seo and his research team at the School of Energy and Chemical Engineering at UNIST.

Called Seamless Modularization technology, the method eliminates gaps between devices without using metal wires. In the existing modularization method, the gap between devices and opaque metal wires have solved the problem of damaging the aesthetics of transparent solar cells.

The newly developed 16 cm^2-sized transparent solar cell module has high efficiency ranging from 20% to 14.7% in transmittance while maintaining aesthetics similar to that of a single device. It has also succeeded in charging a smartphone using natural sunlight. It also proved the possibility that a screen of a small mobile device can be used as an energy source, according to the study conducted at UNIST.

Transparent solar cells can be used in buildings, automobile glass

"This study fundamentally solved the aesthetic problem of the existing solar cell modularization method through the design of the new device structure," said researcher Jeonghwan Park and Research Assistant Professor Kangmin Lee.

"It presented the possibility that transparent silicon solar cells can be used in various industries such as small devices as well as buildings and automobile glass.

Seo maintained that the study has opened a new path for modularization research, which is essential for commercialization of transparent silicon solar cells.

“We plan to continue further research so that transparent solar cells can become a key technology in the eco-friendly future energy industry,” added Seo.

Published in the international journal Proceedings of the National Academy of Sciences (PNAS), the all-back-contact (ABC) design design not only demonstrates high power conversion efficiency (PCE) in solar cells but also ensures unobstructed visibility through transparent solar modules. Notably, ABC-transparent c-Si solar cells achieved a peak PCE of 15.8% while maintaining an average visible transmittance of 20%.

Through seamlessly interconnecting the unit cells, the output voltage and power were systematically tuned from 0.64 V and 15.8 mW (for a 1 cm2-sized unit cell) to 10.0 V and 235 mW (for a 16 cm2-sized module). Furthermore, we successfully demonstrated the photocharging of a smartphone using a transparent ABC solar module, according to the study.

This development is exciting because it's moving us toward a cleaner yet more climate-resilient grid.

An exciting new solar project is lighting up the horizon in Illinois, showcasing the latest in thin-film solar technology.

Double Black Diamond, set to be the largest solar farm east of the Mississippi River, is bringing 800 megawatts of clean energy to the grid, according to CleanTechnica.

This massive undertaking is great news for solar enthusiasts and a victory for everyone who cares about cleaner air, lower energy costs, and a healthier future. The project uses cutting-edge thin-film solar panels from First Solar, an American company leading the charge in solar manufacturing.

This solar farm is also getting a financial boost from the Inflation Reduction Act, which is helping make clean energy more affordable. CleanTechnica noted Google is even jumping on board with a tax equity investment (thanks to the IRA), highlighting how big tech is betting on solar.

This development is exciting because it's moving us toward a cleaner yet more climate-resilient grid. Thin-film solar panels require less resources to manufacture than traditional ones, meaning they're kinder to our planet.

And here's the kicker: As more solar farms like this pop-up, energy prices could dip. That means more money in your pocket and less pollution in our air. Those benefits are hard to ignore.

The project is under construction but should come online for commercial operations next year, per a news release from the company behind the project, Swift Current Energy.

"As we work to responsibly grow our infrastructure, we need to partner with companies like Swift Current who understand the nuances of the energy markets where we operate and can help unlock new clean energy at a rate that matches the pace and scale of demand growth on electric grids today," Google global head of data center energy Amanda Peterson Corio said.

Swift CEO and co-founder Eric Lammers also indicated that his team is excited about what this means for the future.

"We are delighted to join forces with Google on a ground-breaking structure that will support Double Black Diamond Solar and serve as a guide for other major projects to come," he said.

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Columbia Engineering researchers have been creating novel battery types aiming to adavnce the way renewable energy is stored.

A team has now developed battery “fuel,” K-Na/S batteries using abundant potassium, sodium, and sulfur to provide a low-cost, high-energy solution for long-duration energy storage.

These batteries achieve near-maximum capacity (1655 mAh/g sulfur) at 75°C with 1M sulfur. At 4M sulfur, they deliver 830 mAh/g at $2mA/cm^2$ and retain 71 percent capacity after 1000 cycles.

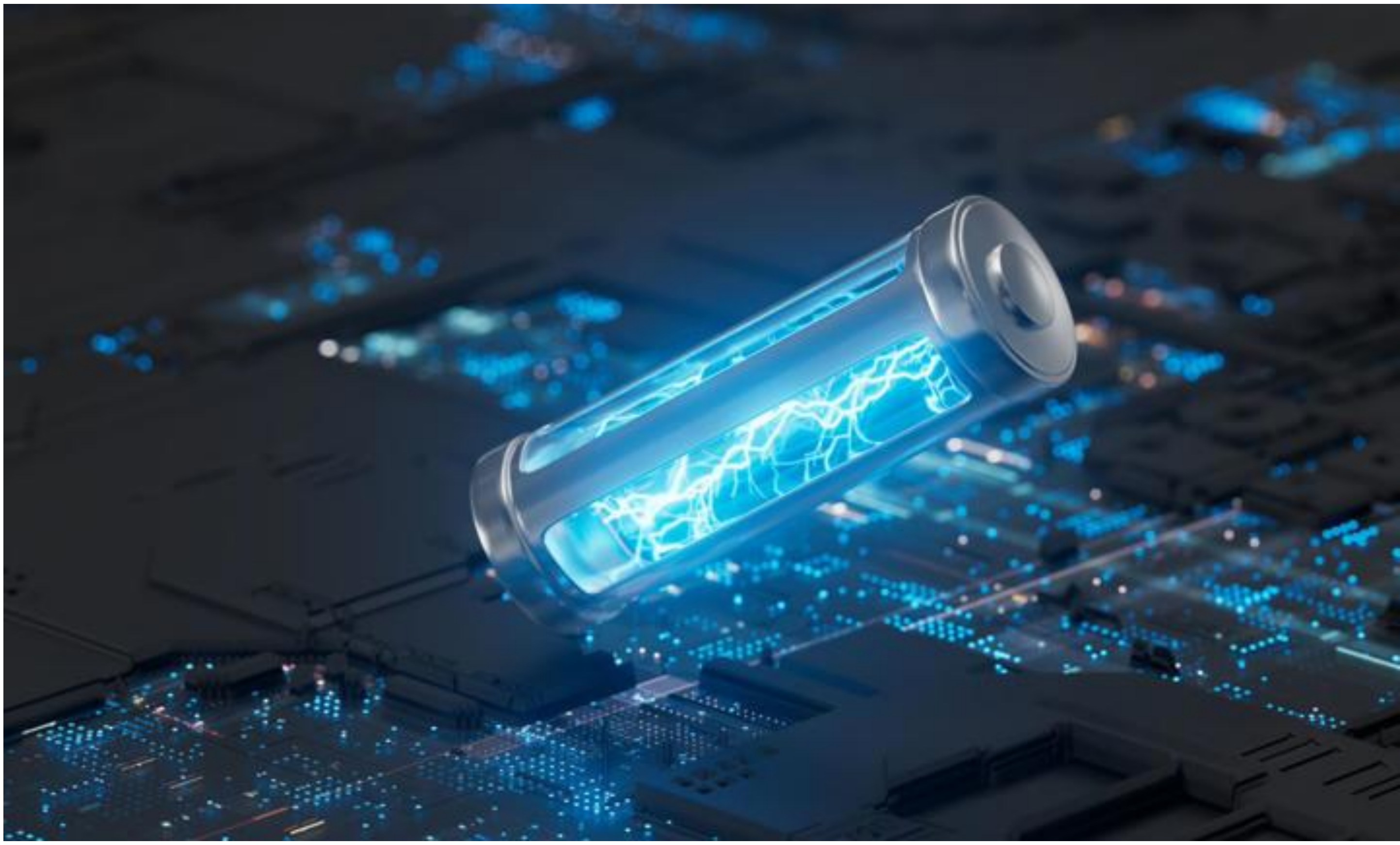
Researchers claim that these batteries are promising for long-term energy storage because they only use materials that are found on Earth and provide 150–250 Wh per kg of energy.

"It's important that we be able to extend the length of time these batteries can operate, and that we can manufacture them easily and cheaply," said Yuan Yang, the team's leader and an associate professor in the Department of Applied Physics and Mathematics at Columbia Engineering, in a statement.

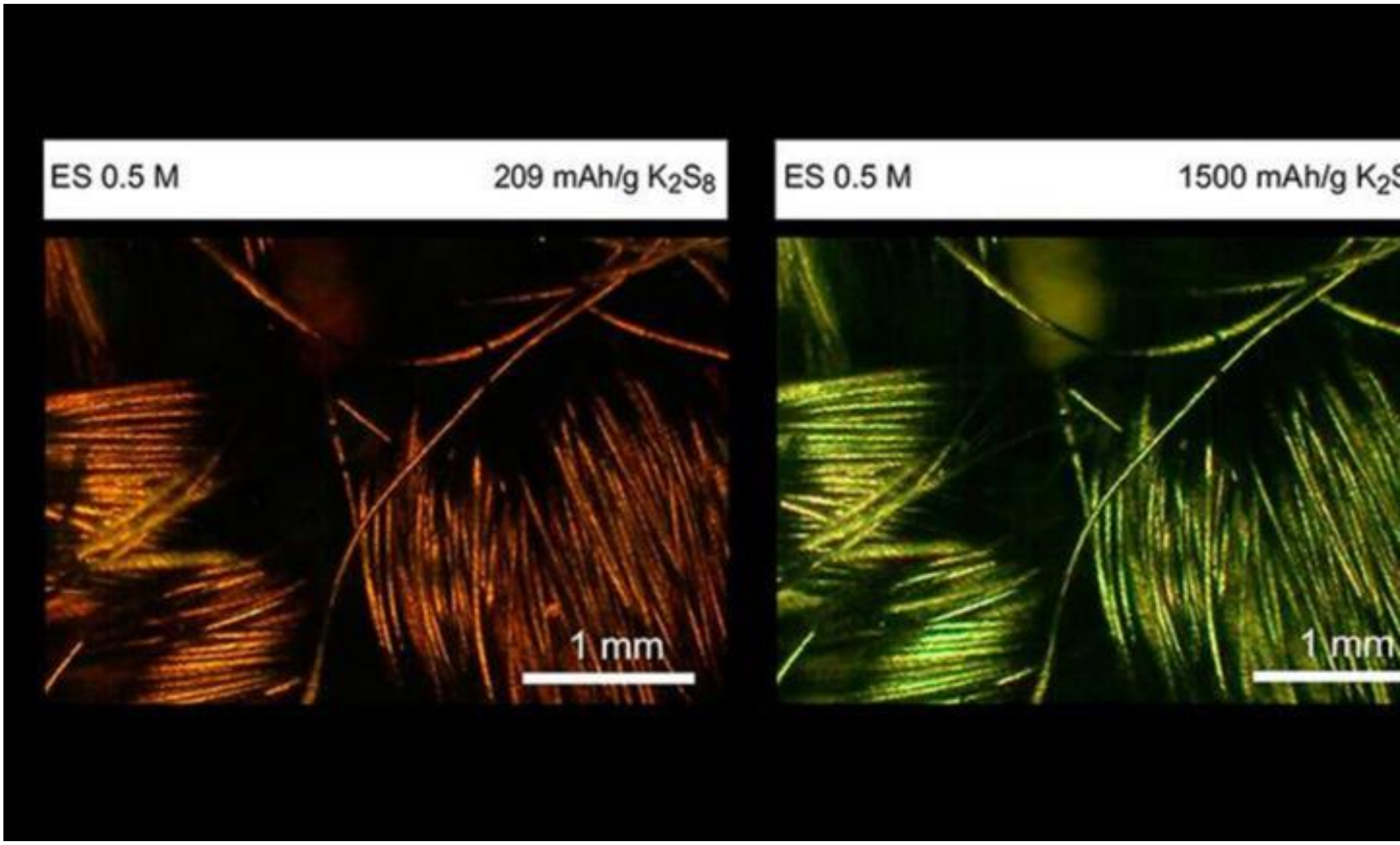
Innovative battery design

Although renewable energy sources, such as solar and wind power, are essential to maintaining our planet, they have a significant drawback in that they don't always produce electricity when it's needed.

To fully utilize them, we must find economical and effective ways to store the energy they generate, ensuring that we always have power, even in the absence of the sun or wind.


New battery technology could boost renewable energy storage.

K-Na/S batteries face two main problems: their low capacity stems from the formation of inactive solid K2S2 and K2S, which obstructs the diffusion process; additionally, their operation necessitates very high temperatures (>250 oC), which requires complex thermal management, raising the process's cost.



Optical microscope images show no solid formation at discharge end. Visible coiled carbon fibers and color change of catholyte during discharge.

Previous research has struggled with low capacity and solid precipitates, so a novel method to enhance these kinds of batteries has been sought after.

To boost battery performance, Professor Yang's team developed a new amide-based electrolyte that improves the solubility of compounds like K2S2 and K2S, enhancing ionic movement and reaction rates.

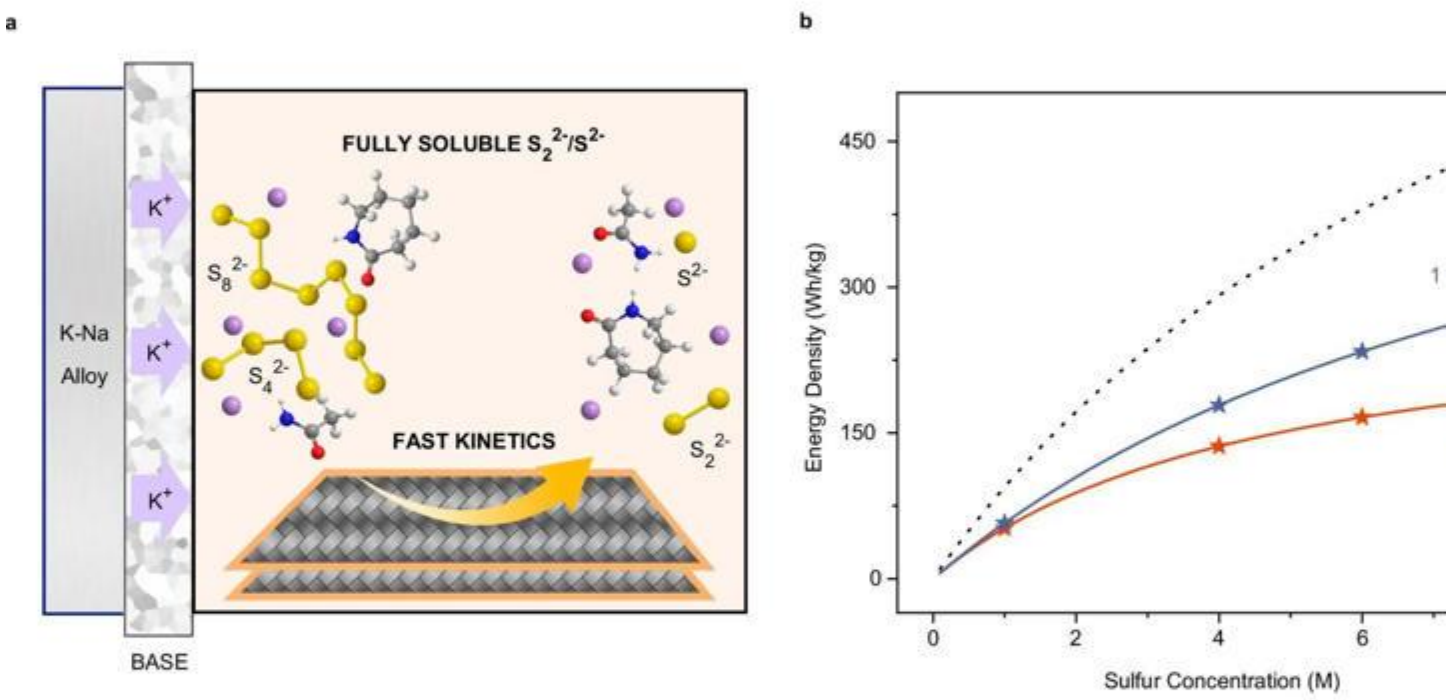
This design is applied to K-Na/S batteries, which offer higher voltage (~2.1V) than traditional Na/S and K/S batteries, and operate at lower temperatures (50-100°C instead of 150°C).

Boosting energy reliability

The team's experiments showed that this electrolyte's ability to dissolve K2S2 and K2S can improve the energy and power density of K/S batteries operating at intermediate temperatures.

Using a mixture of acetamide and ε-caprolactam, which can dissolve K2S up to 1.43M at 75°C, the battery achieves nearly full discharge capacity (1655 mAh per gram of sulfur) at 75°C.

With higher sulfur concentrations (up to 4M), the battery retains 71 percent of its capacity after 1000 cycles. This system provides specific energies of 150-250 Wh per kg and is low-cost due to the abundance of materials used.



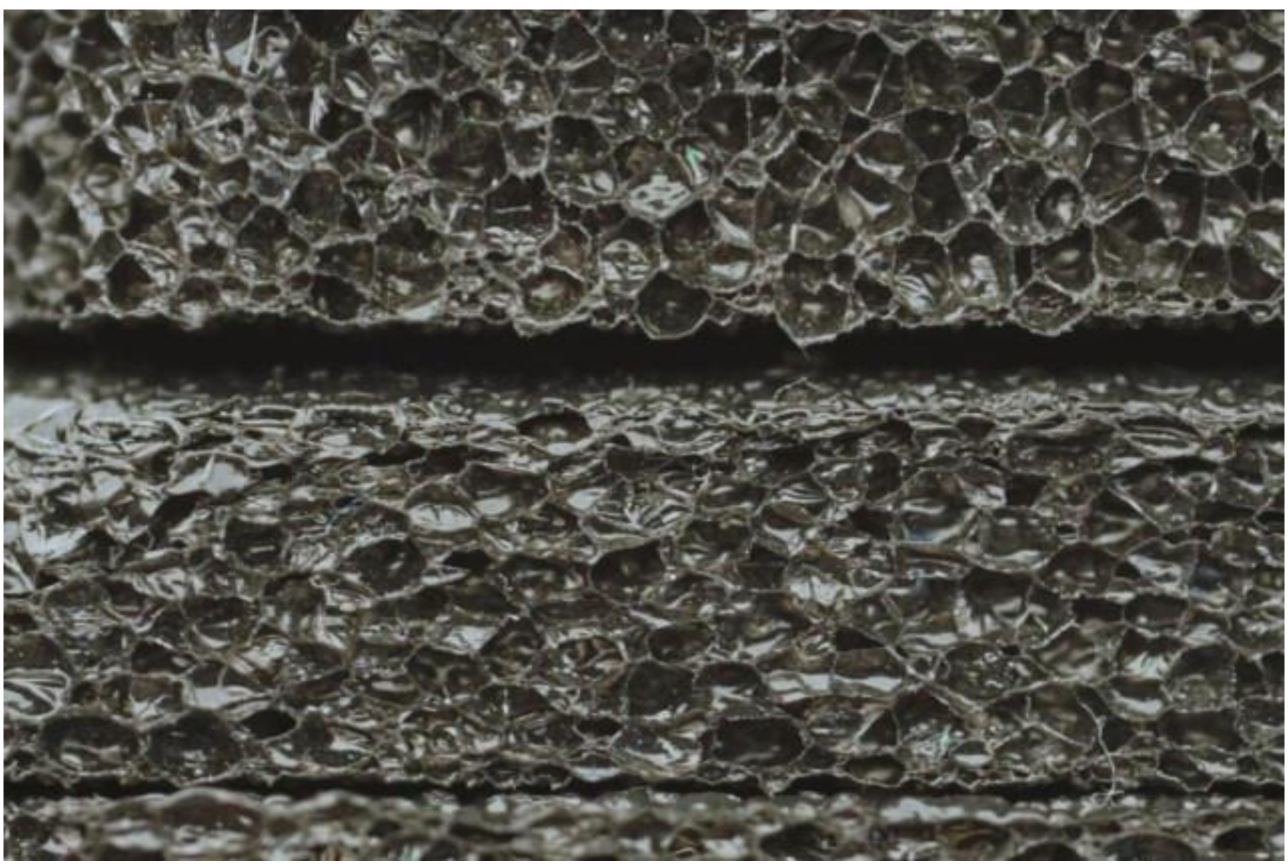
a) Schematic shows K-Na/S battery with low impedance and high energy density at 75°C due to efficient K-BASE and solvent effects. b) Energy density vs. concentration for 1-week (blue) and 1-day (red) discharge times.

"Our approach achieves nearly theoretical discharge capacities and extended cycle life. This is very exciting in the field of intermediate-temperature K/S batteries," said Zhenghao Yang, the study's co-first author and a PhD student with Professor Yang.

Although the group is concentrating on tiny, coin-sized batteries for the time being, they eventually want to scale up this technology to store significant amounts of energy.

Researchers believe that if these new batteries are successful, they may be able to deliver a steady and dependable power supply from renewable sources, even when there isn't much wind or sun. Right now, the group is focusing on electrolyte composition optimization.

"Making renewable energy more reliable will help stabilize our energy grids, reduce our dependence on fossil fuels, and support a more sustainable energy future for all of us," said Professor Yang.



Researchers set new record demonstrating impressive efficiency of solar technology — here's how it could solve a major industrywide problem

Researchers in China have set a new record after their all-perovskite tandem solar cell demonstrated a power conversion efficiency of 28.49%, according to Interesting Engineering.

The team, led by researchers from the Huazhong University of Science and Technology, published its work in the journal Nature and created its solar modules using perovskite — a mineral with a crystal structure that can help capture visible light and convert it into energy.

It has been touted as a "miracle material" since it can be used for lighter, cheaper, and more efficient solar cells than those made with silicon, which is typically the foundation for solar panels. However, those advantages have contributed to their limitations, as stability, durability, and optimization have prevented perovskites from full-scale implementation in solar cells.

The scientists aimed to solve non-radiative energy losses and, ultimately, efficiency issues by implementing surface modifiers 1,4-butanediamine and ethylenediammonium diiodide to fix defects on the tin-lead perovskite top cell, per the news outlet.

"Our strategy not only delivers high-quality Sn–Pb mixed perovskite films with a close-to-ideal stoichiometric ratio surface but also minimizes the non-radiative energy loss at the perovskite/electron transport layer interface," the study read.

The 0.0871-square-centimeter (0.0135-square-inch) solar cell also contained parts like a buckminsterfullerene-based electron transport layer, a hole transport layer made of a conductive polymer called PEDOT:PSS, and a gold metal contact.

Watch now: Solar-powered boats from the Honnold Foundation are making a difference in the Amazon

The highest-performing tandem solar cell achieved a power conversion efficiency of 28.80%, an open-circuit voltage of 2.13, a short-circuit current density of 16.06 milliampere per square centimeter, and a fill factor of 84.19%. It also retained nearly 80% efficiency after running for 550 consecutive hours, all according to Interesting Engineering.

"We also sent one of the best-performing devices to a credible third-party organization and got a certified efficiency of 28.49%, which was one of the highest PCEs [power conversion efficiencies] reported to date for all-perovskite TSCs [tandem solar cells]," the researchers wrote in their report.

To test the scalability of the technology, the researchers tried the surface reconstruction in module-level devices, which still delivered a power conversion efficiency of 23.39%.

That figure is comparable to the marks achieved by a team from the University of North Carolina at Chapel Hill, which hit efficiencies of 19.60% and 19.21% with 84- and 108-centimeter-square-sized (about 13 square inches and 16.7 square inches) perovskite modules treated with zinc trifluoromethane sulfonate.

Meanwhile, the Hong Kong Institute of Science and Technology designed a molecular treatment for perovskite solar cells that could boost their power conversion efficiency to at least 20% and last 1,500-plus hours, according to a separate Interesting Engineering report.

All of these examples are positive developments in our movement to reduce our reliance on dirty energy sources and transition to more sustainable options such as solar, wind, and geothermal power.


Solar panels getting installed© Artistgndphotography/Getty Images

Solar system installations saw a significant uptick in 2023, and that number is only expected to increase over the course of the next decade. Federal incentives, like tax subsidies, have played a major role in the interest this clean energy source has garnered over the years, but the fact is that solar panel systems today are also more efficient than they were before.

In fact, solar panels have changed so much over the years that apart from their energy efficiency increasing, they've also seen a significant, almost 70%, drop in prices and have become more accessible, given the fact that you can even purchase solar panels off Amazon, albeit not without risks. Many of these factors have caused both homeowners and businesses alike to turn to solar energy as a sustainable and cost-efficient energy solution, especially in the face of rising electricity prices. That said, while the benefits of solar panels are clear, it helps to take a slightly more nuanced look at the impact these energy systems have on the environment. Below, we've explored some of the most pertinent environmental concerns associated with the widespread adoption and installation of solar energy panels.

Read more: Major SSD Brands Ranked Worst To Best (And Which Ones To Avoid)

Are Solar Panels Environmentally Friendly?

The most pressing concern at this point is the inadequacy of the recycling infrastructure available to manage end-of-life materials. In fact, a 2016 report that was prepared jointly by the International Renewable Energy Agency (IRENA) and the International Energy Agency Photovoltaic Power Systems Programme (IEA-PVPS) noted that "As the global PV market increases, so will the volume of decommissioned PV panels, and large amounts of annual waste are anticipated by the early 2030s." Another study by the U.S. Environmental Protection Agency in 2023 noted that only about 10% of solar panels are currently recycled.

Given that solar panels have a finite lifespan, usually ranging between 25 and 30 years, many solar panels that were installed in the early aughts or before are potentially reaching the end of their life, presenting a substantial waste management challenge. Keep in mind that solar panels contain many of the same harmful substances as other consumer electronics, which is why proper disposal of the panels and other components of a solar system is essential. As more and more people invest in solar panels or even upgrade to better panels for more energy savings, the discarded panels are bound to pile up and cause environmental and, potentially even, public health risks in the face of limited recycling options.

The good news is that solar panels are recyclable, and many states, including California, Hawaii, North Carolina, New Jersey, and Washington, have passed regulations and policies regarding the recycling and proper disposal of solar panels and related systems; however, more laws at a state and federal level, as well as supporting waste management infrastructure, will help.

Is There Anything Else Negative About Solar Panels?

Solar panels being assembled© IM Imagery/Shutterstock

While waste management is one of the most significant concerns regarding the increased adoption of this clean energy source, there are a few other downsides that solar energy systems pose. For one, solar systems are heavily dependent on sunlight, and this can pose a reliability issue for consumers located in states that don't receive year-round sun exposure. If you reside in such a state, you'll likely still be paying high electricity bills despite having solar panels. In this case, the easiest fix is to invest in a solar battery, which can store excess energy for times when sunlight is scarce.

Also, like most other technology, producing solar systems, a process that includes mining, manufacturing, and transporting the materials, uses energy upfront. That said, no form of energy production is free of environmental impact. What's more, a Stanford University report from 2019 noted, "The energy produced over the lifetime of typical rooftop solar panels more than makes up for the energy it takes to make, mount and then eventually recycle them." As long as you manage to recycle your solar waste responsibly, the net impact of solar panels is more positive than negative. Another thing to take into consideration is the per-foot cost of solar panels, which, despite all the incentives and rebates, still requires some degree of financial preparedness. However, as solar technology continues to see advancements, the cost of solar panels, which has been decreasing over the last few decades, is expected to become even more affordable.

Who Should Install Solar Panels?

Men installing solar panels© Jeremy Poland/Getty Images

Solar energy is accessible to most homeowners, but it isn't a sound investment for everyone. Keep in mind that the effectiveness of a solar system is largely dependent on your geographical location. Given that solar panels take some time to pay off before repair costs begin eating into those savings, make sure to consider whether or not the area in which your house is located receives sufficient sunlight to offset the initial costs of the system and its installation. If you're located in a region that receives hours of sunlight every day for most of the year, a solar system installation might work out great for you.

Even if you get plenty of sunlight where you live, you'll want to consider if your rooftop has enough space for solar panels. If your roof is narrow, shaded, or not completely flat, you may not be able to install enough panels. In this case, portable solar panels might be a solid choice, but that's an extra expense to account for. Solar panels are also best suited for people who don't plan to relocate in the near future. Uninstalling and transporting solar panels can be difficult and expensive, making them a not-so-great option if you have yet to plant your roots somewhere.

Modern solar panels are built on inflexible silicon wafers, but a new technology could make them much more flexible without losing efficiency.© Micha Pawlitzki - Getty Images

- Today's modern solar panels are made from silicon-based photovoltaics, but a new technology from Oxford University based on perovskites could make them more flexible *and* more efficient.
- At only one micron thick, this technology is more like a film that could be applied to a variety of surfaces previously incapable of hosting solar technology.
- A proliferation of these films could lessen the burden of large-scale solar farms to provide a majority of our energy needs.

When you think of "solar power," vast acres of black panels powered by silicon semiconductor solar cells likely come to mind. While these panels, which have helped reduce the global price of solar energy by nearly 90 percent since 2010, deliver much-needed renewable energy, building large swaths of solar farms and affixing panels to our roofs isn't the *only* answer.

According to an upcoming study, scientists from Oxford University have created a new kind of a light-absorbing material that isn't reliant on the impressive-yet-inflexible silicon-based photovoltaics that power solar farms of today. Instead, this technology uses a "multi-junction approach" that stacks multiple light-absorbing layers, called perovskites, into a single solar cell.

Japan's National Institute of Advanced Industrial Science and Technology (AIST), which is well-known for its photovoltaic calibration, standards and measurements team, independently tested that this new solar cell achieved 27 percent efficiency, meaning the tech converted 27 percent of the sun's light into usable energy. That's pretty impressive because only under ideal laboratory conditions can silicon photovoltaics reach a similar level of efficiency, and according to the researchers, this is only the beginning.

"During just five years experimenting with our stacking or multi-junction approach we have raised power conversion efficiency from around 6% to over 27%," Shuaifeng Hu, a postdoctoral fellow at Oxford University Physics, said in a press statement. "We believe that, over time, this approach could enable the photovoltaic devices to achieve far greater efficiencies, exceeding 45%."

While raising those efficiency numbers is essential for sucking up all the sun's free, life-giving energy, this new solar tech comes with one other advantage over its more conventional silicon sibling—it's flexible. Just over one micron thick, which is 150 times thinner than silicon wafers, this technology works more like a coating that can be applied to a nearly endless amount of surfaces, including backpacks, cars, and mobile phones. This provides even more surfaces that could potentially harness the sun's energy that could simultaneously lower energy demand from renewable sources.

This breakthrough comes with a few caveats. For one, perovskites are known for not being as durable as other solar technologies (though scientists have made significant gains in addressing this problem) and creating a solar cells in a lab is a different beast compared to mass producing them. However, Oxford PV, which is a company spun out from Oxford University, formed in 2010 to address many of these issues and primarily commercialize perovskite photovoltaics. According to the co-founder and chief scientific officer Henry Snaith, the company began mass production of perovskite-on-silicon cells with a pilot production line in 2023.

"The latest innovations in solar materials and techniques demonstrated in our labs could become a platform for a new industry, manufacturing materials to generate solar energy more sustainably and cheaply by using existing buildings, vehicles, and objects," Snaith said in a press statement.

These sorts of innovations don't mean we should slow down the construction of solar panels across the country—after all, tackling climate change is an all-hands-on-deck situation. But if solar cells can adorn more surfaces and soak up more free energy, well, everyone wins.

Next-generation solar technology could drastically change the industry: 'These advancements ... expand its application possibilities'

A company and a research institute are working together to bring concentrator photovoltaics (CPV) back into the solar energy spotlight with their micro-CPV technology that boasts 36% conversion efficiency.

Soltec is a Spanish company that works on integrated photovoltaic solutions, with a focus on tracking technology that can direct panels toward the sun throughout the day.

Germany's Fraunhofer Institute for Solar Energy Systems ISE touts a world record with 47.6% solar cell efficiency from its four-junction panel, which it set back in 2022.

Now, it's developed a new micro-CPV setup, which uses optical systems to focus light onto small solar cells made with III-V semiconductor materials, according to CleanTechnica.

Fraunhofer ISE's record-setting panels focused rays into a concentration equal to 665 suns, but the company claims the new CPVs will operate with a concentration of nearly 1,000 suns.

Add to that Soltec's sun-tracking system, and placement in areas with high direct solar irradiance like equatorial regions, and you get a 30% increase in energy generation compared to conventional photovoltaic solutions, as the institute states.

Watch now: World-famous climber shares how he teaches his baby daughter to compost

Since these solar panels concentrate the sun's rays onto small cells, the company will need less semiconductor materials to make them, and it also reduces the physical footprint of the actual photovoltaic array.

"Resource efficiency is becoming an increasingly important topic in photovoltaics. Compared to the state-of-the-art, our micro-CPV technology reduces module areas by 30 percent and semiconductor materials by 1,300 times at comparable power output," Dr. Frank Dimroth, department head of III-V and Concentrator Photovoltaics at Fraunhofer ISE, detailed.

"This helps to [save] precious materials and energy in the production process and therefore improves sustainability."

Solar installations have been growing across the globe, with around 30% of the world's power coming from the clean and sustainable power of the sun. This has also led to large expanses of sun-collecting panels, including the world's largest plant in China, which has over 5 million panels.

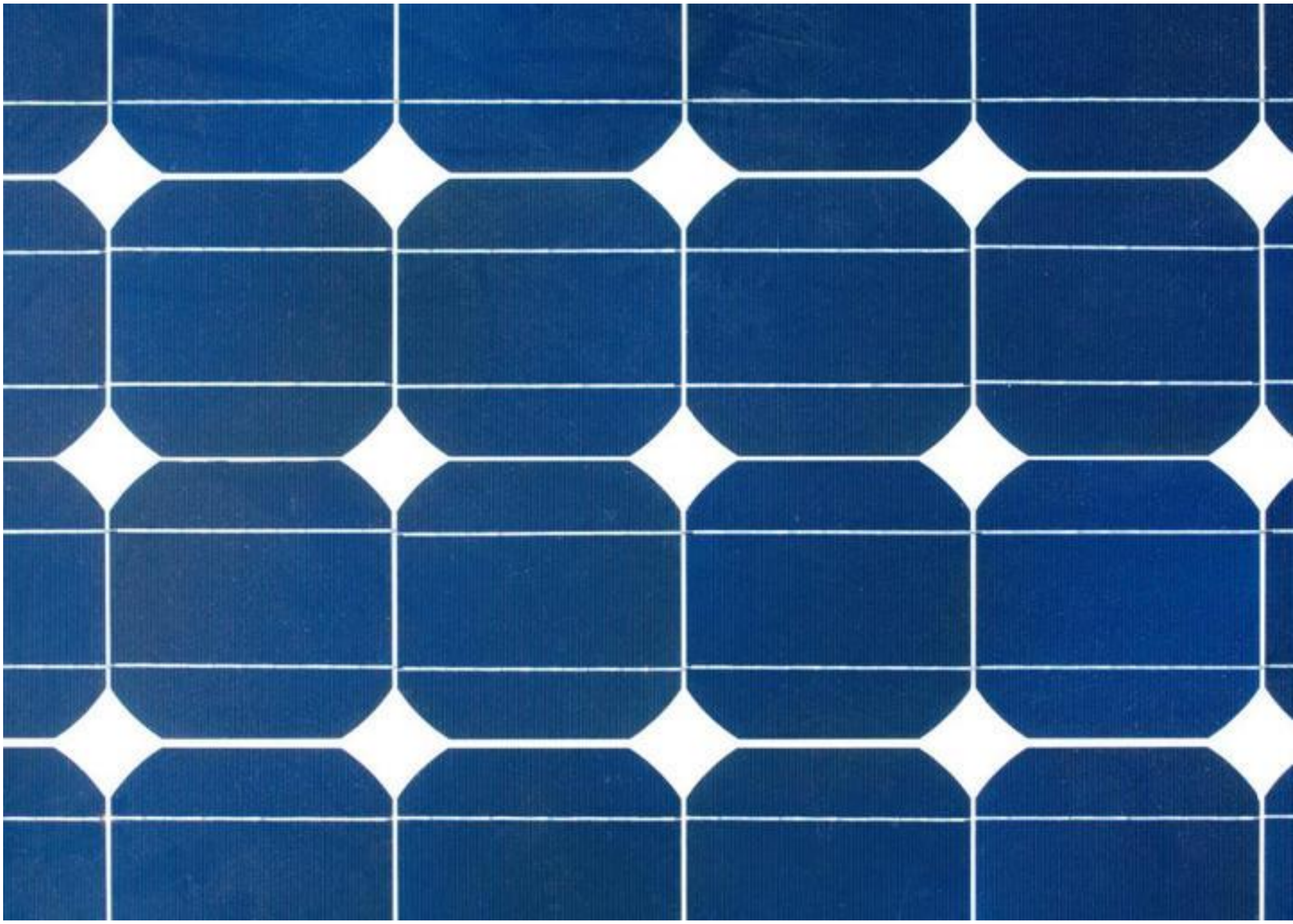
Since the micro-CPV technology offers more efficient energy conversion from a smaller setup, it could drastically change the landscape of future installations, at least in sunnier areas of the world.

The renewable energy sector could also see a boost from this development, driving more investment into cleaner energy sources such as solar and further reducing the need for dirty fuels, which spew planet-warming pollution into the atmosphere.

"This collaboration between Soltec and Fraunhofer ISE confirms the vision of both institutions. We look forward to continuing our collaboration in the future to further elevate the use of solar energy," said Eduardo de San Nicolás, Chief Strategy and Innovation Officer at Soltec, per the statement.

"These advancements not only represent a step forward in photovoltaic solar energy but also expand its application possibilities across various sectors," he added.

Although it's still in the prototype phase, Soltec and Fraunhofer ISE plan to roll out the first test installation in Spain by the end of 2024.



Solar cells consist of layers of silicon that turn sunlight into electricity, but it takes more equipment than just that to get energy from the sun into your toaster. Image Source/Getty Images© Provided by CNET

You've probably wondered what kind of magic in solar panels converts sunlight into electricity.

It's not magic. It's science. Specifically, it's the photovoltaic effect. This phenomenon relies on the interaction between sunlight and the semiconductive materials in the solar cells to create electricity.

As inflation continues eroding the dollar's value, harnessing sunlight and converting it to electricity becomes increasingly compelling. Installing solar panels can relieve your family financially and help you contribute to a more sustainable future.

But how does that sunlight become electricity? Here's a look at what's inside a solar panel and how this equipment gets the energy of daylight into your appliances.

What are the components of a solar panel?

Solar panels are the key part of any solar energy system. They capture the energy of the sun and turn it into usable electricity. Here's a list of all the parts of a solar panel.

- **Solar cells:** These, made of silicon, convert sunlight into electrical energy.
- **Backsheet, encapsulation and frame:** An insulating backsheet, a glass or polymer encapsulation and a metal frame hold the solar cells together and protect them from the elements.
- **Junction box:** The junction box protects diodes, wiring connections and other electrical components.
- **Connectors:** MC4 connectors are commonly used to connect solar panels together as well as to other components of your solar panel system.

Beyond the panels themselves, other components connect the panels to the rest of your home electrical system.

- **Inverter:** The inverter is a critical component of a solar energy system. Solar panels and batteries generate direct current, or DC, electricity, while household appliances and outlets operate on alternating current, or AC. The inverter transforms the direct current electricity from solar panels and batteries into alternating electricity for use with home appliances.
- **DC optimizers and string inverters:** DC optimizers allow each panel to operate independently and run maximum power point tracking, or MPPT, on each panel. The optimized power is then fed to a compatible string inverter for inversion to AC power.
- **Microinverters:** These devices allow each panel to operate independently, track maximum power point, and invert DC to AC directly on the panel, eliminating the need for a central inverter.
- **Rapid shutdown device:** This device ensures a safe shutdown of the solar panel system.
- **Telemetry hub:** This monitors and communicates system performance data.
- **Battery:** A battery, which is not required for a grid-tied solar panel system, stores electricity and allows it to be used later. Batteries are needed for off-grid systems and if you want your solar panels to power your home during a power outage.

How does solar energy power your home?

Solar enthusiasts should understand two closely related phenomena -- the photoelectric effect and the photovoltaic effect -- to grasp how solar panels generate electricity, Rohit Kalyanpur, CEO of the Silicon Valley-based solar company Optivolt, told CNET.

The photoelectric effect occurs when certain materials are exposed to a specific light spectrum and absorb photons from sunlight. Upon absorption, these photons can excite or energize the electrons within the material, causing them to escape their atomic bonds. As these electrons move, they generate voltage and current.

The photovoltaic effect is very similar to the photoelectric effect, but it takes the process a step further, Kalyanpur said. In the photovoltaic effect, photons from the sunlight are absorbed by a solar cell. Those photons energize the electrons within the solar cell material, causing them to escape their atomic bonds and become free. Solar cells have a PN junction composed of semiconductor materials, which directs the flow of free electrons, generating electricity.

Do solar panels mean my house is off-grid?

Having a solar panel installation does not necessarily mean your house is off-grid. An off-grid solar system is a self-contained energy system that independently produces and stores electricity.

Off-grid systems use solar panels to generate electricity and transfer it to a battery for storage. When you need electricity to run an appliance, an inverter converts the energy stored in the battery to AC electricity for power.

Grid-tied systems, on the other hand, don't stand alone. They are connected to the utility grid. They might transmit excess energy generated by the solar panels back to the electric grid, often selling it back through net metering for credits on your power bill. The primary advantage of grid-tied systems is they are significantly cheaper because you don't need to buy expensive batteries to add to the system.

If you're buying a solar panel system for an off-grid location, you're also going to need batteries. Halfpoint/Getty Images© Provided by CNET

What other ways can I use solar energy?

You can use solar energy in several ways without fully committing to expensive electricity-generating solar installation in your home. Here are a few alternative use cases for solar energy.

Solar water heaters: A replacement for your gas or electric water heater, solar water heaters use solar energy to heat water for household use. They can help you save money and reduce energy consumption associated with any activity requiring hot water.

Solar tubes: Also known as sun tunnels or tubular skylights, solar tubes can be used to bring natural light into dimly lit areas of a home.

$318 at Amazon

Solar outdoor lighting: Solar-powered lights are a popular way to illuminate outdoor spaces such as walkways, gardens and patios. They use small solar panels to charge batteries during the day, providing light at night.

$35 at Amazon

Solar pool heaters: Solar pool heaters use solar collectors to heat the water in swimming pools. They are an eco-friendly way to extend the swimming season.

$248 at Amazon

Solar cookers: Solar cookers use the sun's energy to cook food without gas or electricity. They are great for outdoor cooking, camping, emergencies and areas where it's difficult to access electricity or cooking gas.

Solar pumps: Solar water pumps use solar energy to pump water for irrigation, livestock and remote areas without access to the electrical grid.

Solar attic fans: These fans use solar energy to power a ventilation system that regulates the temperature in the attic. These solar fans lower electricity bills by reducing the need for air conditioning.

$429 at Home Depot

Solar chargers: Portable solar chargers allow users to charge their devices with solar energy. They are great for outdoor activities, camping, areas with limited access to the power grid and emergency preparedness.

$50 at Amazon

The original description of the project stated a goal to

The federal government is making a $389 million investment in New England's power grid, with an emphasis on better storing and transmitting renewable energy throughout the region. It will use the largest battery system developed so far in the world in terms of energy capacity, according to a press release on the allocation.

The effort hopes to maximize energy distribution from offshore wind farms that are in development. A unique iron-air battery from Massachusetts-based Form Energy is getting $147 million of the funding. The large battery, with unique chemistry, will store the abundant wind energy at a location in Maine, as Canary Media reports.

It's all part of the U.S. Department of Energy's Grid Innovation Program, a competitive funding opportunity. Through two rounds, the project has funded 65 projects worth $5.7 billion in the eastern and western parts of the country, according to a DOE chart.

"We look forward to working with the New England States as we support projects that will harden systems, improve energy reliability, and affordability — all while generating union jobs for highly skilled workers," DOE Grid Deployment Office Director Maria Robinson said in the press release.

The overall project is called Power Up New England and involves the collection of states in that region, per Canary.

The original description stated a goal to "unlock" as much as 4,800 megawatts of offshore wind, with the battery capacity to store it. A New York-to-New England transmission line called the Clean Resilience Link is also part of the overall effort in the Northeast, per a Massachusetts government press release.

Watch now: Delta chief sustainability officer reveals how company plans to appeal to conscious consumers

The iron-air battery from Form Energy has been making headlines as a cheaper, scalable, and efficient storage unit. The power pack can amazingly store and distribute electricity as rust inside of it turns to iron and rusts again. It leverages chemistry that uses simple ingredients like iron, air, and water, according to Form.

The company said it can also more cleanly prepare iron for steel-making sans fossil fuels and hot furnaces, a bonus secondary use for the process. Continuing the metal connection, Canary reports that Form has completed construction on a factory in Weirton, West Virginia, a traditional steel town.

In New England, iron-air batteries will distribute up to 100 hours of energy to communities, providing crucial grid support if all goes according to the plans.

"Power Up is a big win for electric customers and continues the momentum of federal partnership and regional collaboration here in New England," Massachusetts Lt. Gov. Kim Driscoll said in the press release.

It's all a part of the transition to renewable energy sources. Reducing heat-trapping air pollution is critical to avoiding what the Massachusetts Institute of Technology calls worst-case environmental scenarios if planet-warming proceeds unchecked, a bane to human and planet health alike, as medical experts and scientists noted.

"Extreme weather events fueled by climate change will continue to strain the nation's aging transmission systems, but [these projects will] ensure America's power grid can provide reliable, affordable power," Robinson said.

There are ways to contribute, even if you don't live in a community that is part of a grant-funded program. Washing your clothes on the cold cycle is a great way to save money and reduce energy use. Astoundingly, about 90% of a washer's power is used to heat water.

At Form, reusing defunct sites as part of its battery infrastructure is another layer of its efficient planning. The New England battery system will be located at a former paper mill, for example.

"This iron-air battery system will have the most energy capacity of any battery system announced yet in the world," Form CEO Mateo Jaramillo said in the press release.

This solar-and-battery tag team means fewer worries about blackouts during heat waves and lower energy bills.

As temperatures spike in the Lone Star State, Texans are finding relief in an unexpected place: their power grid.

This summer, while electricity demand hit record highs, the state's use of solar power and batteries increased. The result? A more stable grid that's keeping the lights on and air conditioners humming, according to Canary Media.

Last month, the Electric Reliability Council of Texas, also known as ERCOT, set a record for peak electricity demand at 85,931 megawatts. However, thanks to a whopping 20,799 megawatts of solar power generation, the grid stayed steady while prices remained low.

As the sun set and demand stayed high, batteries stepped in, discharging a record-breaking 3,927 megawatts to keep residents cool.

This solar-and-battery tag team means fewer worries about blackouts during heat waves and lower energy bills. It also reduces the need for dirty fuel-powered plants and cuts down on harmful pollution.

"You end up with a situation where ERCOT can beat its load record, and prices are pretty low — and an hour or two later is when you see your price spike, and you see the deployment of ancillary services and all the things that ERCOT has designed specifically to deal with this," Connor Waldoch, co-founder of Grid Status, told the publication.

What's even more impressive is that Texas achieved this without state-level clean energy mandates, according to Canary Media. The state's competitive power market has naturally allowed these cleaner, cheaper options to outshine their dirty fuel counterparts.

In fact, zero-carbon power sources now make up nearly half of the electricity on ERCOT's grid, with the Lone Star State surpassing California (well-known for planet-friendly policymaking regarding its grid) in various clean-energy categories, including utility-scale solar in 2023.

At the Azure Sky solar and storage project in Haskell County, Tex., 700,000 photovoltaic panels stretch in uniform rows across the desert landscape, shimmering under a relentless summer sun. Beneath the panels, hundreds of

Dorper sheep graze on Bermuda and Johnson grasses, driven there by two border collies named Bucky and Johnny.

The sheep belong to Chad Raines, owner of Key Farms in Lamesa, Tex., and they are part of a new initiative called solar grazing. In addition to providing a low cost, eco-friendly mowing service to energy companies, Raines manages a solar site that provides an estimated 586 gigawatt-hours annually to the booming Texas solar industry.

“We still farm and do everything we used to,” said Raines, “except underneath solar panels.”

Under a Texas sun, agrivoltaics offer farmers a new way to make money


Bucky waits in the truck.

Raines is a fourth-generation farmer who now runs 4,000 sheep at six solar sites in Texas and one in Arkansas.

According to the Energy Department, decarbonizing the electricity grid by 2050 will require solar power to provide nearly half of all U.S. energy production, up from just 3.4 percent today. To meet these federally mandated climate goals, the solar industry requires land, and lots of it, but many rural and predominantly conservative areas remain unfriendly to renewable energy.

"The most existential threat to our industry is not global pandemics, it's not who is in the White House, it's not supply chain issues or the war in Ukraine," said Matt Beasley, chief commercial officer for Silicon Ranch Corp., a solar energy company. "It's local opposition, all centered around land-use questions."

As a result, hundreds of wind and solar projects fail each year.

Agrivoltaics energize ailing farms

As a fourth-generation cotton farmer in West Texas, Raines had experienced a multi-decade drought that had reduced cotton yields while expenses and debt increased. "I was selling cotton for almost the same price my granddad did," said Raines, driving west from Lubbock toward Azure Sky as fields of white-tipped cotton and green-leafed sorghum transitioned to rolling hills of mesquite shrub land. "If I had stuck with cotton, I would have gone broke."

Raines first heard of solar grazing in 2021. Originating in Britain in the 2010s, the practice has expanded largely through word of mouth. The allure was immediate. "You're getting paid to graze your sheep," said Raines, whose contract with solar companies provides a stable income while he manages more-volatile agricultural prices.

Agrivoltaics — the practice of sharing energy and food production on the same plot of land — can include a range of agricultural practices, such as farming, beekeeping, agroforestry, aquaculture and solar grazing. Solar grazing represents the bulk of the agrivoltaic industry, with over 200 grazing sites representing 50,000 acres of land, according to Jordan Macknick, lead energy-water-land analyst for the National Renewable Energy Laboratory. The industry is projected to be valued at $9.3 billion by 2031.

"For those that want agrivoltaics to succeed, we want to see research and incentives for solar firms to make those investments to accommodate things like solar grazing," said Lexie Hain, director of agrivoltaics and land management at Lightsource bp and founder of the American Solar Grazing Association.

Raines now runs 4,000 sheep at six solar sites in Texas and one in Arkansas, managing vegetation to reduce shade and fire risk for the companies. His oldest son oversees the Arkansas site, his mom helps with finances, and his "retired" father, Joe, helps with the Texas operation.

"I think it's great," said Joe Raines, 75, speaking from the driver's seat of a "side-by-side," a dune-buggy-like vehicle he uses to herd sheep. "It's only going to grow."

Sheep graze on Bermuda and Johnson grasses, helping to maintain the solar farm in the process.

This year, Ohio’s largest solar generation project was approved partly because it incorporated 4,000 acres of farmland and 1,000 sheep. The ambitious plans for agrivoltaics have addressed opponents’ concerns over the loss of farmland and convinced regulators that the site would serve the public interest, said Matthew Eisenson, who tracks the legal barriers to renewable energy development nationwide at the Sabin Center for Climate Change Law at Columbia University.

“This is what will sell this to landowners and county municipal boards,” said Raines. “I fully expect that at some point, the government will say that if you’re taking out [agricultural] land, you must include agrivoltaics.”

Solar grazing and cattle production

There is growing interest in grazing cattle underneath solar panels. This year, the Energy Department launched the Large Animal and Solar System Operations (LASSO) Prize, providing millions of dollars for research around solar development and cattle grazing. The potential is immense, given that cattle production is the single most important agricultural industry, with meat and dairy production accounting for 44 percent of all U.S. farmland.

"From a land-use opposition standpoint, it will be a game changer because cattle ranching is more ingrained in the cultural identity of those living in the areas where we are siting new projects," said Loran Shallenberger, senior director of regenerative energy operations for Silicon Ranch, which operates 170 solar sites in North America. Twenty of them have integrated agrivoltaics.

Better soil health and lower emissions

Solar grazing has proven benefits to the land as well. Instead of emission-producing mowers and toxic herbicides, sheep convert vegetation into a natural fertilizer, restoring soil health.

"If they are managed well, they are increasing biodiversity, sequestering carbon and increasing soil organic matter," Shallenberger said. "The benefits are numerous."

Shade under panels enhances the quality and quantity of forage while providing much-needed relief and health benefits for livestock.

"It's not burning up under there," said Raines, whose flock ambled through the shade of the solar array while afternoon temperatures climbed into the triple digits. "This [solar grazing] just makes sense."

Sheep walk between rows of photovoltaic panels at Azure Sky. Shade under the panels enhances the quality and quantity of forage while providing relief from heat for the livestock.

Raw Transcript

Intro

0:00
Perovskites are often hailed as the next big thing for solar panels. They're more
0:03
efficient than silicon photovoltaics (PVs) could ever be, and they have higher yields. However,
0:09
their fragility and short lifespans have relegated them to the lab...so far.
0:13
But 2024 is looking to be the year of the perovskite. The last few months

0:17
have seen new perovskite researchers all over the world smashing records,
0:21
including durability. Because of this, some of these new perovskites are even set to hit
0:25
the market this year. Let’s check out some of the most exciting breakthroughs in the field and see
0:30
for ourselves if perovskites are finally ready for their big debut. And why should you care?
0:35
I’m Matt Ferrell … welcome to Undecided.
0:44
This video is brought to you by Opera, but more on that later.
0:47
It truly feels like we’re at the beginning of a massive paradigm shift for solar. Researchers are
0:51
breaking so many different perovskite records using such widely varied techniques within the
0:56
last few months, it’s mind blowing. Some teams are coming at this from a chemistry angle,
1:01
trying to engineer tougher perovskites. Others are looking at the very architecture
1:05
of a perovskite PV cell, experimenting with under-studied cell blueprints and achieving
1:10
surprising results. Then there’s those who are having those random “eureka” moments that make
1:14
for great science stories, when making one little change causes everything to fall into
1:18
place. There's just so many wild advances all happening at once. With so many discoveries,
1:23
it stands to reason that there’s hope for at least some of them to reach the market.
1:27
Let’s back up first, though. What are perovskites? We’ve talked about them before on the channel,

What are Perovskites

1:32
so here’s a quick TL;DR. They’re a family of crystalline materials with the same crystal
1:36

structure as calcium titanate. Current silicon solar cells only capture around
1:41
20% of usable sunlight, meaning we're leaving about 80% on the table. Perovskites have the
1:46
potential to use more of that sunlight, and many easily break that 20% figure;
1:51
they might be able to break silicon's theoretical maximum efficiency of 29%.
1:55
Better yet, they can be "tuned" to capture light from parts of the spectrum that silicon
2:00
PVs can't touch. This is good on its own merits, and it also allows you to Voltron
2:05
perovskite and silicon layers together to form "tandem" cells that capture much more light
2:10
than either could on their own while sharing the same footprint. To sweeten the deal even further,
2:15
perovskites are also relatively easy to synthesize and produce.
2:19
To give you an idea of just how big of a deal increasing solar panel efficiency is,
2:23
we can take a look at my own home as a point of comparison. I have REC 400 Watt panels on
2:28
my house, which have a rated efficiency of about 21.6%. With four hours of sun a day,
2:33
a single REC 400 panel would generate about 576 kWh/year. These are high level calculations and
2:41
don't take local conditions, inverter hardware, etc. into account. Upping that efficiency
2:46
(with the same exact single panel footprint) to something like 25% may not sound like a big jump,
2:52
but would produce about 682 kWh/year. That's a 15% jump in output overall. That would mean
2:59
instead of needing something like 30 REC panels to achieve my energy goals at 21.6% efficiency,
3:05
I'd only need 25 panels at 25% efficiency.
3:08

So what’s the catch? Cost is usually the issue with these sorts of things, but not here. Believe
3:13
it or not, perovskites aren’t prohibitively expensive. In fact, easy manufacturing
3:17
techniques and widely available materials mean perovskites can be cheaper than silicon PVs.
3:23
That means that in my hypothetical example, I would not only need fewer panels to achieve my
3:27
goals — they’d theoretically be cheaper per panel, too. No, the real issue is their durability.
3:33
While they’ve performed very well in lab conditions, perovskite cells degrade very
3:37
quickly out in the real world. Some can see a capacity dip as large as 80% in two years or less.
3:44
Compare that to my REC 400 panels with a 25 year warranty that guarantees only about an 8% dip by
3:51
the end of the warranty. What’s killing perovskite cells so fast? Heat, moisture, oxygen, and even UV
3:58
rays…y’know, all the things that a solar panel is going to have to face day in and day out.
4:03
We can’t slather our solar panels in a nice coat of sunscreen, so the benefits
4:07
we mentioned a minute ago are effectively locked behind the durability problem. And
4:11
that’s why finding a solution to it has become something like the holy grail of solar tech.
4:19
That brings us to the big question: has anyone made any progress solving this problem, or are
4:24
perovskites a dead end? And if they are, what other pathways are there to solar advancement?
4:30
Well, good news. The UK-based company Oxford PV returns to this channel yet
4:34
again. And this time, they’ve solved the perovskite durability issue! So what do

4:38
you think? Jump in the comments and let me… no, no I'm kidding, don't click off!

Oxford PV

4:41
Now, it is true that Chris Case, Oxford PV's Chief Technology Officer, told the Wall Street
4:46
Journal that the company's cells are designed to meet or beat a 25-year life span. Oxford PV says
4:52
it's proved this by studying full-size modules in outdoor environments for over three years,
4:57
then used that data to predict long-term stability. These studies also show that
5:00
its best tandem cells lose only about 1% efficiency in their first year of
5:05
operation and have a very small rate of decline thereafter. Frustratingly, these results have
5:10
yet to be published, though this could be for proprietary reasons. After all, if you're the
5:14
only one who cracked the tough perovskite code, well, there's going to be a lot of value in that.
5:19
That said, Oxford PV is making definite progress. It's teamed up with the Fraunhofer Institute for
5:24
Solar Energy Systems (FISES) in Germany, which recently used Oxford PV's tandem cells to
5:28
construct a working solar module. FISES just announced that this module achieved a record
5:33
breaking 25% conversion efficiency. Remember what that could mean based on my calculations earlier:
5:39
about a 15% increase in power output over a year. Now that the efficiency is confirmed, FISES and
5:46
Oxford PV are working towards certifying that all-important longevity stat. To this end, they're
5:51

putting the module through a battery of intensive long-term stability tests. And while it pays to be
5:56
skeptical about these sort of breakthroughs, I should note that Oxford PV's factory in
6:00
Brandenburg, Germany, is set to begin commercial production of their tandem solar cells later
6:05
this year. So, if all goes according to plan, we won't have to wait long to put them to the test.
6:09
They aren't the only group with interesting progress, but before we get into those it can get
6:13
a little overwhelming as my team and I research these topics. There's so much news and research
6:17
to sift through that I get lost in my browser tabs ... a lot. Well, today's sponsor, Opera,
6:22
has been a huge help with this. I really love using Workspaces to keep personal tabs separate
6:27
from work tabs when pulling together research. It's really easy to flip back and forth between
6:32
those groups. I've also really been loving tab islands, which automatically consolidates related
6:36
tabs together into groups. This one was kind of an eye opener for me. For instance, as I was
6:41
diving between articles on different perovskite advancements, Opera automatically keeps those
6:45
tabs together in an island. I don't know about you, but I often get lost in a sea of tabs and
6:50
this really helps me out. I also really like the sidebar, which keeps things like my social media
6:55
accounts one quick click away in a nice slide out window, but the thing I've found myself using a
6:59

lot in the sidebar is Aria. Sometimes I come across a paper in another language and can quickly
7:04
translate a section of that article with the help of Aria. Or ask for a quick summary of an article
7:09
to see if I'm heading down the right path quickly. And finally, I love how easy it is to screen
7:13
capture a section of a webpage or article, or even a full webpage image for use in a Notion ticket
7:18
for my team to reference later. Opera really has helped me streamline some of my workflow.
7:23
If you'd like to try out Opera for yourself check out the link in the description. Thanks to Opera,
7:27
for supporting the channel. And thanks to all of you, as well as my patrons, who get early,
7:30
ad-free versions of my videos. So back to who else is making good progress in perovskites.

Saudi PV

7:35
In other developments, an international group of scientists led by the King Abdullah
7:39
University of Science and Technology (KAUST) in Saudi Arabia are taking a
7:42
different approach to perovskites. Rather than focusing on making better materials,
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they're optimizing how we assemble those materials for maximum energy generation and efficiency.
7:51
You see, one of the main limiters of solar cell efficiency is the mobility of its charge
7:55
carriers. Charge carriers are the electrons and "holes" knocked free from their homes
8:00
inside the cell by incoming solar energy. The movement of electrons is, by definition,
8:05
electrical current. "Holes" are places where an electron could go, so their "movement" is
8:09

really the movement of electrons as well. It's actually these charge carriers that we use to
8:14
create the flow of electricity, not the sunlight itself. That's an oversimplification in the
8:18
interest of time, so if you want to know more check out some of my other solar panel videos.
8:23
Anyway, part of what makes perovskites so efficient is that they allow those charge
8:27
carriers more mobility than they get in a silicon cell. Even still, the majority of these carriers
8:32
are usually “captured” by the material they’re conducting through, or defects within the cell,
8:37
long before they can reach the electrodes to be used as electricity. Not great.
8:42
This has led some engineers to add an extra layer to the cells to help facilitate the
8:45
capture of those charge carriers. Solar cells have a P-layer (home of holes) or the N-layer
8:51
(home of electrons). The light capturing “I-layer” of perovskite sits between the
8:56
two layers. This gives us two possible types of architecture depending on which
9:00
layer you want the sunlight to touch first: the hole-layer (P-I-N) or the electron-layer (N-I-P).
9:07
Each architectural style has its strengths and weaknesses, and explaining them all could be its
9:11
own video. To keep it brief, the electron-first N-I-P style is physically easier to construct,
9:17
which means it's more common and better-studied. It also helps that most of the efficiency records
9:22
are currently held by team N-I-P. But recent research suggests that P-I-N variants are much
9:27
more durable than their counterparts, and some can even match the N-I-P’s efficiency.
9:32

This is where the Saudi researchers are making progress. They've developed a novel P-I-N setup
9:37
with enhanced ligands, that's the stuff that bonds the perovskite to the other layers. It
9:42
also acts as a kind of capstone or varnish on top of the perovskite layer to protect them.
9:46
The result is a perovskite P-I-N cell with a very good power conversion efficiency of 25.63%. After
9:54
1,000 hours of testing in 85 C (about 185 F) temperatures, they only degraded by 5%.

SemiTransparent PV

10:01
In yet another recent efficiency and durability breakthrough, a team led
10:05
by scientists from the Korea Institute of Energy Research (KIER) have broken records
10:09
for semi-transparent perovskite PVs. They focused on semi-transparent perovskite cells,
10:14
because they show a lot of promise when used in windows and bifacial PVs. Why?
10:19
A solar cell requires electrodes. For mechanical reasons, these electrode layers are best
10:24
positioned as the outer part of the cells. It's like the bread of our solar sandwich. Of course,
10:29
electrodes aren't perfectly invisible, so they tend to block some of the light. As a result,
10:33
they tend to only end up on one side of the cell. But what if we could make transparent
10:38
electrodes? Well…we can. They've already been around for years. So why aren't all PVs equipped
10:44
with transparent electrodes? Why aren't all our windows doubling as perovskite cells right now?
10:49
Here's the thing: transparent electrodes cause PV cells to degrade much faster because they
10:53
don't screen out high-energy particles that damage the hole-transportation-slash-N-layer — all that

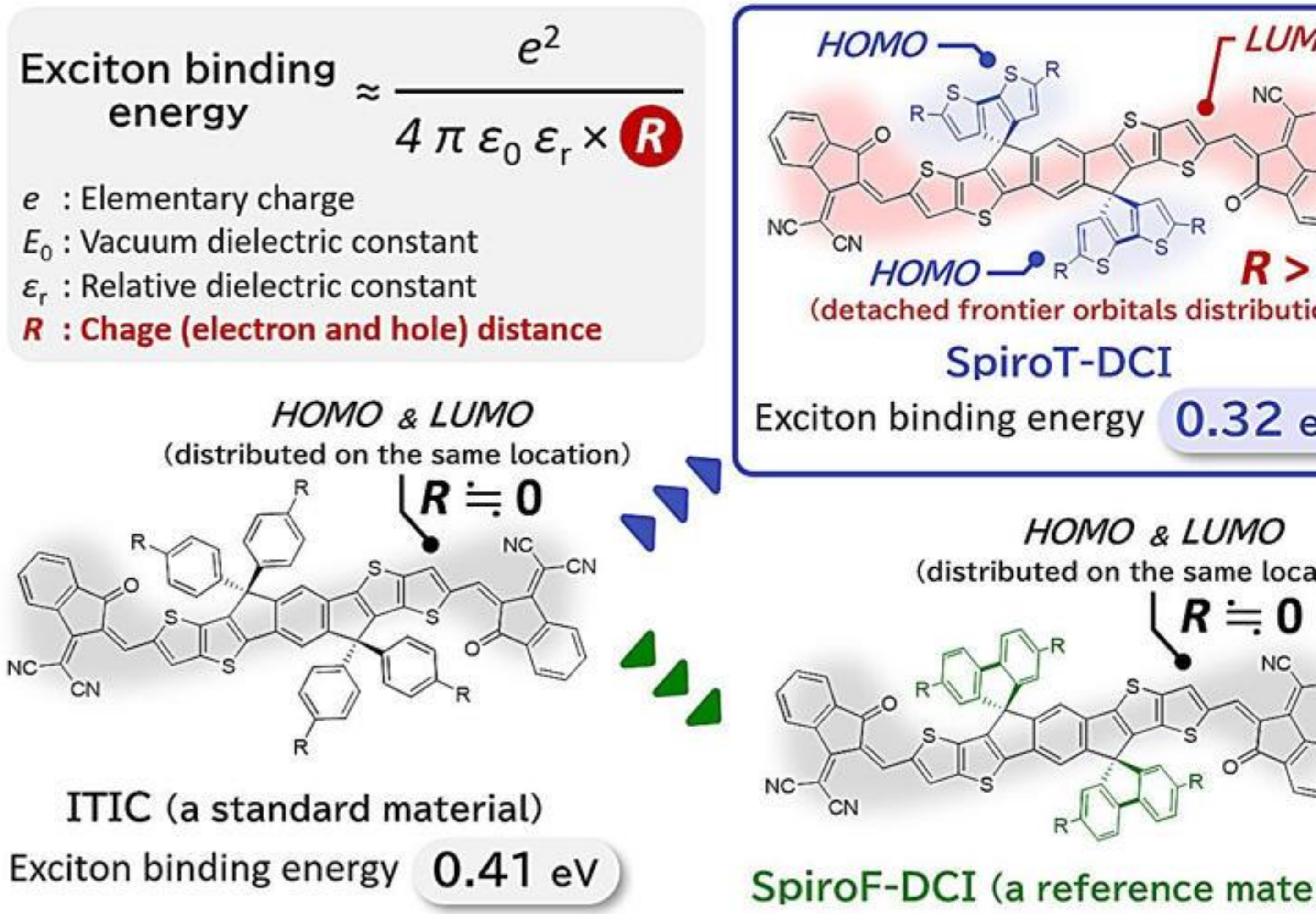
10:59
stuff we talked about earlier. KIER scientists fixed it by adding a metal oxide layer to screen
11:05
out those particles and they found… even more efficiency and fewer degradation issues?!
11:11
The Energy AI and Computational Science wing of the KIER team took a look at the data
11:15
and discovered that the N-layer was reacting unexpectedly with the metal oxide. Normally,
11:20
lithium is added to an N-layer to make it more conductive and improve efficiency. Turns out
11:24
the lithium ions were diffusing into that metal oxide blocker and making them both less effective.
11:30
However, the KIER scientists found a pretty elegant solution. Lithium ions already oxidize
11:35
into lithium oxide. Previously, the lithium oxide was assumed to be a harmless byproduct of this
11:40
process. The KIER team deliberately converted the flighty lithium ions into stable lithium oxide,
11:46
and voila, enhanced durability and efficiency. Their semi-transparent
11:50
solar cells hit an efficiency of 21.68%, making them the most efficient among the
11:55
transparent perovskites electrodes in the world. Better yet, they retained 99% of
11:59
their initial efficiency after 240 hours of operation, and their stability rating
12:04
remained at 99% for 400 hours. If you're curious about transparent solar cells,
12:08
I've got a video that does a deeper dive on them that I'll link to in the description.

Cubic PV

12:12
But it's not all good news. We need to talk…about CubicPV. The company is backed by Bill Gates,
12:17

and given his greentech investing record, it’s up to you if that's a good thing or
12:21
not. Just days after my 2023 solar panel update video was released,
12:25
CubicPV announced that, thanks to incentives in the Inflation Reduction Act (IRA),
12:30
it was going to build a 10 GW conventional mono wafer factory. This was set to fill
12:35
a supply chain gap here in North America and create an estimated 1,500 green energy jobs.
12:41
Awesome. So what’s the bad news? Well, CubicPV recently announced that it’s shifting to tandem
12:47
perovskite cells instead, abandoning the wafer factory in the process. Think about that:
12:52
A major company ran the numbers and was so confident that perovskite tandem cells were
12:56
the future that it abandoned its silicon wafer plans mid-stream. Surely a promising
13:02
sign for the future of perovskites, but definitely not great for the community
13:05
that was looking forward to the previous promise of a bunch of good, green jobs.
13:10
Another thing about CubicPV: it’s claiming to have tackled perovskites durability
13:14
issues through “better chemistry” and by “building intrinsic stability into
13:18
the material itself.” There’s no further data on how the company is planning on doing this,
13:23
which doesn’t make me very confident. Given that they’re working on a proprietary method
13:27
to manufacture a lot of perovskite cells in a fast, cheap, and energy efficient manner,
13:32
it is possible that CubicPV’s perovskite chemistry is proprietary too. Great if
13:37
it ever comes to fruition, but again, I remain skeptical until I see some hard evidence.
13:42
So, perovskites remain the solar MacGuffin, but it does feel like we’re making real progress

13:47
here. If just one of these companies has truly solved the durability issue,
13:50
we could be on the cusp of a solar revolution. The market certainly seems to think we're on our
13:55
way. The global perovskite solar cell market size was just $94.8 million in
14:00
2022. It’s expected to balloon to around $2.479 billion by 2032. Even if these
14:06
predictions are wrong and they’re not the next technological leap in the solar sphere,
14:10
their efficiency ratings are so impressive, they’ll probably find their niche no matter what.



Overview of developed organic semiconductors in this study. Credit: Osaka University

Organic solar cells (OSCs)—promising alternatives to traditional inorganic solar cells—have many features that make them key players in a greener future. One of these features is tunable chemistry, which allows scientists to precisely adjust or modify the properties of chemical systems to achieve desired outcomes. Now, researchers from Japan have tuned them to increase power conversion efficiency.

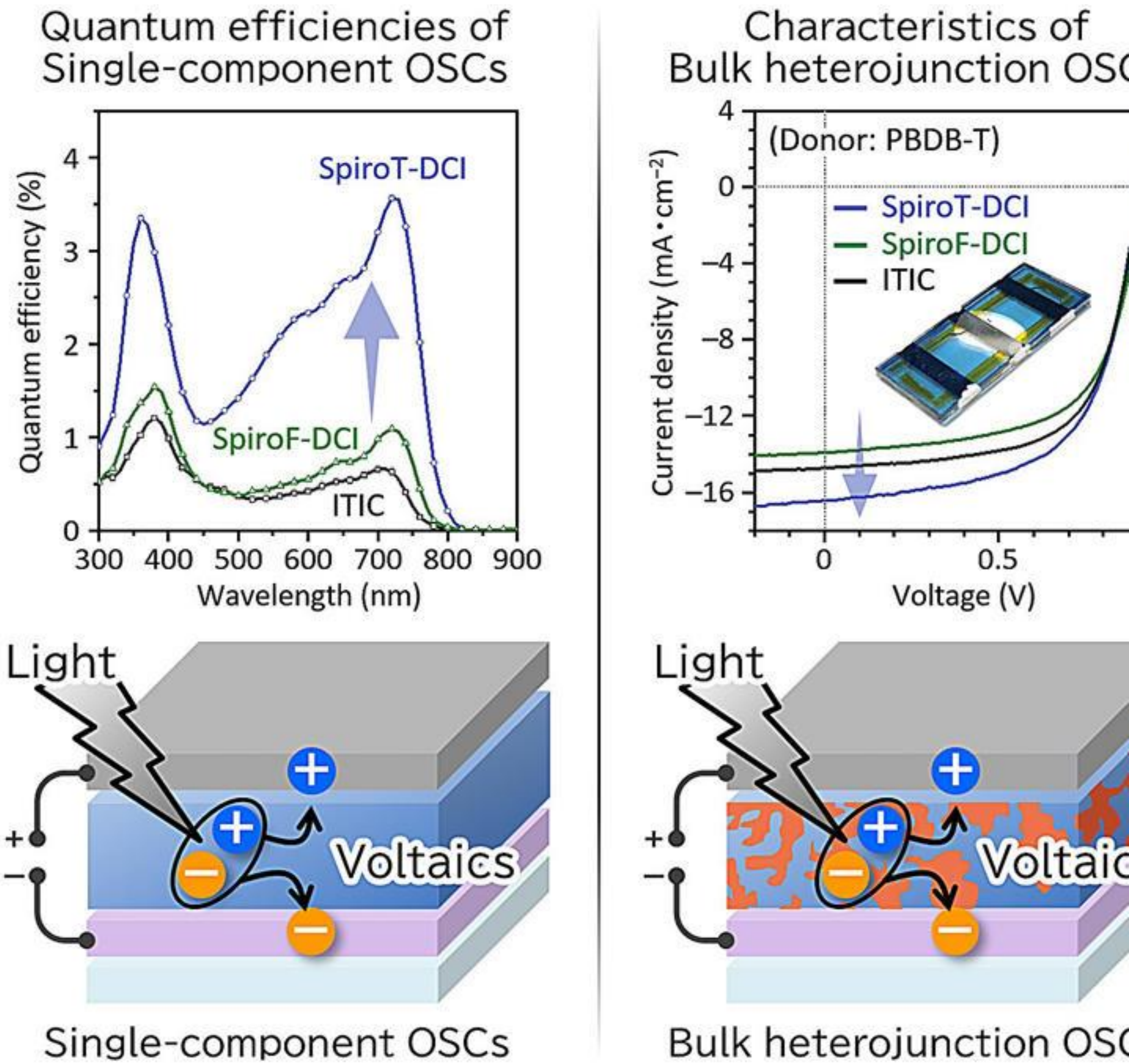
In a study published recently in *Angewandte Chemie International Edition,* researchers from Osaka University have reported a new organic semiconductor that gives better power conversion efficiency than the accepted standard.

OSCs are light and flexible and can be produced on a large scale for relatively low cost. They are therefore highly promising for applications such as agrivoltaics where large areas of land are used to simultaneously grow crops and turn the sun's energy into electricity.

Generally, OSCs contain two organic semiconductors, one to transport charge carriers known as electrons (the acceptor) and one to transport the other carriers known as holes (the donor). A current flows in a semiconductor when excitons—a combination of an electron and a positive hole—are split into these carriers, giving electron-hole pairs. Excitons are bound tightly together, but sunlight with enough energy can cause them to dissociate and generate a current.

"Reducing the amount of energy needed to break up an exciton—the exciton binding energy—makes it easier to convert the light into the desired current," explains lead author of the study Seihou Jinnai. "We therefore focused on the factors that contribute to the binding energy, one of which is the distance between the electron and the hole. If this is increased, then the binding energy should decrease."

The researchers designed a molecule with side units that had the effect of separating the parts of the molecule that accommodate the electron and the hole. The synthesized molecule was used as an acceptor in a bulk heterojunction OSC along with a donor material, and the system showed increased power conversion efficiency compared with the accepted standard. The molecule was also tested as the single component of an OSC and showed better conversion of light to current.



Quantum efficiencies of single-component organic solar cells (right) and performances of bulk heterojunction organic solar cells (left). Credit: Osaka University

"The molecule we designed shows that the nature of side units in acceptor molecules is key to the exciton behavior and its efficiency as a result," says senior author Yutaka Ie. "This result provides an important demonstration of what can be achieved by tuning chemistry for OSCs applications."

The findings indicate the potential of rational design of organic semiconductors and are expected to lead to new devices including high-performance OSCs and wavelength-selective transparent OSCs. General improvements in performance are also expected to enhance the potential of OSCs in large-scale photovoltaic applications, naturally leading to green energy alternatives.

More information: Kai Wang et al, Nonfullerene Acceptors Bearing Spiro-Substituted Bithiophene Units in Organic Solar Cells: Tuning the Frontier Molecular Orbital Distribution to Reduce Exciton Binding Energy, *Angewandte Chemie International Edition* (2024). DOI: 10.1002/anie.202412691

Provided by Osaka University

U.S. government moves to open up over 30 million acres of federal land for solar power: 'A step in the right direction'

The Biden administration has finalized a plan to massively expand the amount of federal land available for solar farms. This comes as an extension of the Western Solar Plan, which had already approved 22 million acres for solar farms, reported Electrek.

This expansion of federal land specifically available for solar power generation is a great step in achieving a fully clean energy grid in the U.S.

The expansion of the Western Solar Plan, seen through by the Bureau of Land Management, will be "putting solar farms closer to transmission lines or on previously disturbed lands and avoiding protected lands, sensitive cultural resources, and important wildlife habitats," as stated by Electrek.

Solar farms create the potential to increase clean energy generation in the U.S., which is crucial in reducing dirty pollution from coal, oil, and natural gas — the main drivers of our increasing global temperatures. They can also give new life to brownfields — former development sites contaminated by hazardous chemicals and toxins, per the Environmental Protection Agency.

A report from The Nature Conservancy details how brownfields created by abandoned mining sites can be repurposed into solar farms.

"Renewable energy development on mine lands is an exceptionally promising avenue to produce clean energy in a way that respects communities and local landscapes," stated Nels Johnson, head of the Mining the Sun project, via the Nature Conservancy.

0

More solar energy will benefit energy consumers and the environment alike. More clean energy means less air pollution, which is beneficial for human health. You can contribute to reducing energy by installing your own solar panels in your home or investing in community solar programs.

In response to the expansion to 31 million acres, Ben Norris, vice president of regulatory affairs at the Solar Energy Industries Association, stated via Electrek: "While this is a step in the right direction, fossil fuels have access to over 80 million acres of public land … One of the fastest ways to decarbonize our grid is to greenlight well-planned clean energy development on federal lands."

Workers install solar modules at the solar park in Langenenslingen, Germany, in August 2024.© Thomas Warnack / ZUMA

HAMBURG — Seldom in human history has one technology spread across the planet so rapidly: at the beginning of the millennium, almost no one generated electricity from solar radiation. But now, photovoltaic plants are ubiquitous — and global capacity is growing exponentially. In the 15 years between 2008 and 2023, the worldwide capacity of solar energy infrastructure has increased about a hundredfold. Growth could continue at a similar pace this year, according to a forecast by London-based energy think tank Ember.

The most striking piece of data is that almost half of all solar plants worldwide are located in China. The Asian superpower is playing a crucial role in the solar boom: not only is it increasingly relying on solar energy for its own energetic supply, but it is also supplying the rest of the world with photovoltaic modules — at unbeatable low prices, thanks, in part, to massive government support. The lowered costs, combined with global climate targets, are the main drivers of the boom. Have we, without even realizing, just recently entered a new era?

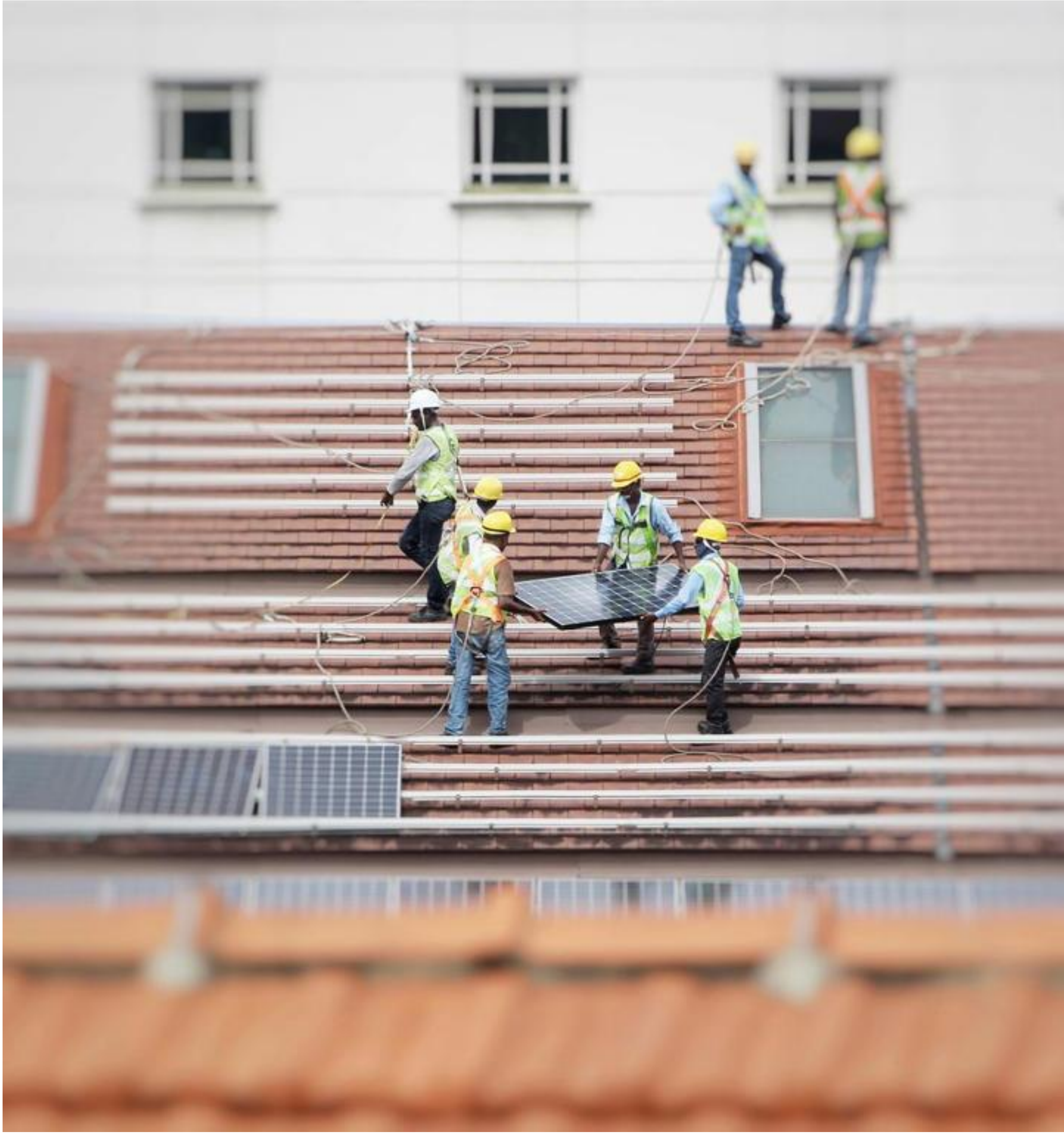
The figures are impressive. Experts from Ember estimate that 593 gigawatts of worldwide solar capacity will be added to the planet's production this year. That's almost a thousand times the output of Germany's largest solar park near Leipzig. Compared to last year, the yearly added capacity has increased by 29%, and compared to 2021, it has tripled. "Solar plants bring huge amounts of cheap energy into the world's power grids," says Euan Graham, from Ember. And the revolution is only just beginning: "Many of the sunniest countries in the world have invested very little in solar energy so far. There is still huge potential."

Falling prices, growing demand

For their analysis, Graham and colleagues evaluated official installation figures from the 15 most important solar countries up to July and extrapolated their data. They also used statistics from the Chinese custom authorities on the export of solar panels. Currently, almost the entire world is reliant on China for solar infrastructure. "We assume that six months after being exported, around 85% of the panels have been installed."

The result: dynamic growth.

Such rapid growth is only possible because production costs have fallen so sharply. This is also due to the so-called economies of scale: the larger the number of units, the cheaper the production cost per unit. Cheaper prices, in turn, generate demand — and the demand has never been higher. According to the Fraunhofer Institute ISE, the price of a photovoltaic power plant has fallen by 70% since 2006. The result: dynamic growth. Recently, the amount of solar power generated worldwide has doubled every three years. At the current growth rate, solar power might cover 64% of the world's global demand in just 18 years.



\u200bWorkers installing solar panels on a roof© Thomas Warnack / ZUMA

Underdog story

In the past, experts have drastically underestimated solar power. At the beginning of 2022, the International Energy Agency published a forecast that predicted an increase of 232 gigawatts worldwide for 2024. Such a prediction had already been surpassed in the first half of this year, and by the end of 2024, the increase will probably be twice as high.

But it's worth remembering that more solar does not necessarily mean less fossil energy. "There is no question that solar energy has incredible momentum," says Ottmar Edenhofer, director and chief economist of the Potsdam Institute for Climate Impact Research. "But as long as we do not have CO2 pricing to push fossil fuels out of the supply chain, we will not have a solar revolution."

Energy experts such as Simone Tagliapietra from the Brussels think tank Bruegel think that it will take at least another 10 years before renewables become the permanent and structural basis of our power intake. Oil, gas and coal are still the leaders — solar energy contributed to only 1% of global energy production last year. Exponential growth can never last forever, at some point every curve flattens out.

But hardly any energy expert thinks that this point is imminent for solar energy. "Solar modules are cheap and will continue to fall in price," says Hanns Koenig from the consulting firm Aurora Energy Research. India and other countries are also entering the market in order to become independent from China and establish their production.

Efficient, but time-consuming

But there is a fundamental problem: The sun does not always shine when and where the electricity is needed. This is why the so-called system costs rise when we rely on solar. Such costs include the power plants that supply electricity when the sun is not shining — and which have to be expensively converted to hydrogen or even built from scratch. Or large power lines that direct solar power to where it is needed. Australia, for example, is currently planning the world's largest solar farm and wants to supply green electricity to Singapore via an underwater cable thousands of kilometers long, which will use it to meet its electricity needs. All of these projects are expensive, time-consuming, and unpopular with citizens. "Solar power is already competitive in terms of production costs, but it is expensive to integrate it into the current, cumbersome grid," says energy expert Tagliapietra from Bruegel.

A growing proportion of electricity in Pakistan comes directly from roofs.

Solar power can also be stored in batteries until it is needed, and the battery prices have been falling at a rate similar to those of solar modules. Conversely, energy usage can be adjusted to the hours of sunshine, but this requires price incentives for consumers. On the energy market, electricity is now often very cheap or even free at midday, but end users usually pay a fixed price per kilowatt hour. The system is slowly adapting, and flexible electricity tariffs will be introduced in Germany next year. Still, it will take some time before citizens and companies adapt to this.

The example of Pakistan shows how solar energy is revolutionizing the market.

In Pakistan, electricity consumption fell by 10% within two years, while the economy continued to grow. For economists, this is unthinkable. But it’s happening, and for a simple reason: a growing proportion of electricity in Pakistan no longer flows through the grid but comes directly from roofs. The country is now the world's third-largest importer of Chinese solar modules — a consequence of the 2022 energy crisis. "Governments around the world are realizing that investing in solar energy makes their energy provision safer," says energy expert Rupert Way from the Institute for New Economic Thinking at Oxford University.

\u200bPeople work at the Shichengzi photovoltaic power station in Hami City, northwest China, September 2024.© Thomas Warnack / ZUMA

Shifting the balance of power

Developments such as those we see in Pakistan or India show that the transition to solar could also change the geopolitical balance of power. Not immediately, of course, says Rainer Quitzow, who researches the geopolitical consequences of energetic and industrial transformation at the Helmholtz Center Potsdam. He emphasizes that the oil and gas exporting countries will continue to earn good money in the coming years. "But in the long term, the switch to solar and wind could shift the balance of power."

Suddenly, countries such as Algeria, Mexico and Colombia are on the political map because they are potential producers of green hydrogen. Those who can harvest a lot of solar energy can store it as hydrogen and ship it around the world, for example to Europe. "The bottom line is that there will be more competition, as there will be more countries that produce green hydrogen than there are countries that export oil and gas," says Quitzow, “and industrial locations are shifting: away from regions where little green energy is produced." That, unfortunately, applies to Germany.

China will be key

It is already becoming clear that the U.S. and China will be leading the change. Washington managed to become independent from energy imports years ago by relying on the country's gas production. And that is unlikely to change in a fossil-free world: "China and the U.S. have enough space for wind and solar plants and will be able to supply themselves with energy," says Quitzow. Europe (and in particular its industrial powerhouse, Germany) will have to decide which industrial sectors it wants to keep active, and invest a lot of money to help them transition.

Once again China — the most important producer of solar modules and the biggest exporter — will play a key role in this reorientation. Because the authoritarian regime is often criticized, be it for its human rights violations or on unfair competition ground, many are worried about relying on Chinese technology too much.

Energy expert Rupert Way, however, calls for a pragmatic approach, hoping that in the medium term more and more countries will start producing modules at low cost: "What is worse: to install a solar module from China every 20 years, or to permanently depend on imports of oil and gas from Russia and other autocratically governed regions?"

With new types of solar panels, including lightweight and flexible designs, there are opportunities to expand distribution to new areas that previously seemed unlikely.

Recent research shows how to improve silicon and perovskite solar cell efficiency by applying a coating to smooth out surface defects, according to a report by Interesting Engineering.

There have been several advances in photovoltaic cells that combine silicon, a material that absorbs mostly red and infrared light, along with perovskite, a mineral that efficiently captures visible light, as detailed by the news outlet.

One of the latest reached efficiencies for solar cells was around 23%, but this new study shows the potential for improved efficiency while reducing costs, as the report detailed.

Tandem solar cells are made with a combination of two semiconductors that help capture more wavelengths of light at once, the news report explained. Monolithic tandem cells are when two semiconductor coatings are placed on top of one another, such as silicon wafers with perovskite.

Many wafers go through an expensive process that polishes their surface. However, those produced through the Czochralski method have tiny pyramidal structures and are much cheaper, per Interesting Engineering. The microtextures capture more light since they're less reflective. But when perovskite is applied, defects are created in the crystal lattice that reduce efficiency.

Now, a team of researchers has developed a new strategy for surface passivation that can smooth out those defects.

Eco-friendly future-energy

Led by Professor Kwanyong Seo, the transparent solar cell and module has a glass-like, colorless, and transparent appearance. The team achieved this by using an "all-back-contact" design, which places all the components of the solar cell on the back, ensuring that the front remains visually unobstructed. The researchers also developed Seamless Modularization technology, which eliminates gaps between solar cells and removes the need for opaque metal wires, both of which previously compromised the appearance of transparent solar cells.

The team's 16 cm^2 transparent solar cell module achieved high efficiency, with transmittance ranging between 20% and 14.7%, and successfully charged a smartphone using natural sunlight, demonstrating the potential for screens to serve as energy sources.

“This study fundamentally solved the aesthetic problem of the existing solar cell modularization method through the design of the new device structure,” researcher Jeonghwan Park and Research Assistant Professor Kangmin Lee noted. “It presents the possibility that transparent silicon solar cells can be used in various industries, such as small devices, as well as in buildings and automobile glass.”

Professor Seo added, “We have opened a new path for modularization research, which is essential for the commercialization of transparent silicon solar cells. We plan to continue further research so that transparent solar cells can become a key technology in the eco-friendly future-energy industry.”The study was published in *Proceedings of the National Academy of Sciences* (PNAS).


The more approved solar projects, the more they can benefit the communities around them.

Las Vegas may be known for the lights of its casinos, but soon, the desert there will also be lit by a large solar facility.

According to [Canary Media](), the Bureau of Land Management approved a "200-megawatt solar installation with 600 megawatts of on-site battery storage." The plant will go online in December 2026 and get a stand-alone battery with a 400-megawatt capacity in 2028.

Heather Reams, executive director of the nonprofit Citizens for Responsible Energy Solutions, said, "We're thrilled to see that this project has been permitted," per Canary Media.

While the Bureau of Land Management has approved some of these lands for gas and oil leases, the Biden Administration has made a goal to approve more of the land for clean energy use to meet its target of no polluting gases by 2035.

Seven gigawatts of geothermal plants, solar arrays, and new transmission lines have been approved since 2021. Additionally, 60 more projects are under review now.

Progress has been made to make it easier to greenlight solar projects. In April, the Bureau of Land Management made leases cheaper for clean energy projects. In August, it "announced a plan to expand solar development on public lands," per Canary Media.

Watch now: Expert highlights major gap in market that limited companies are taking advantage of

Western Solar Plan is striking a balance of protecting public lands while making it faster to approve these projects.

Part of this plan includes not allowing solar projects on 131 million acres of public land while leaving more than 31 million acres for solar projects to be built. Specifying where solar can be constructed will make it easier to review.

The more approved solar projects, the more they can benefit the communities around them. For example, signing up for community solar can save you $150 a year on an average bill of $125.

According to the U.S. Department of Energy, solar power can also improve air quality and reduce polluting gases that are warming the planet.

Another benefit to solar farms is they are helpful for pollinators and native plants. The Department of Energy's Argonne National Laboratory in Illinois and the National Renewable Energy Laboratory in Colorado conducted a study of native plants planted below solar panels. The scientists found that after five years, native bee populations had grown 20 times their previous levels.

In our latest episode of Lexicon, we sat down with Philipp Furler, co-CEO and co-founder of Synhelion, to discuss the company’s work on solar-powered synthetic fuel production technology.

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Synthetic fuels reimagined

Synhelion's vision is to utilize solar power to create sustainable liquid fuels that can directly replace fossil fuels. First developed at ETH Zurich, Synhelion's new technology converts solar energy into synthetic fuels through something called thermochemical processes.

These fuels can be used in sectors like aviation, shipping, and road transportation, which rely heavily on fossil fuels. "We generate high-temperature solar heat, converting sunlight into liquid transportation fuels," explained Furler.

Synhelion's process focuses sunlight onto a central tower using mirrors, where the energy is absorbed and converted into heat. Using this high-temperature heat, chemical reactions can be supercharged to convert a carbon source—such as biomethane or CO2—into something called "syngas."

For the uninitiated, this is a mixture of hydrogen and carbon monoxide. After production, this can then be liquefied to create synthetic crude oil, which can be further refined (like traditional oil) into kerosene, diesel, and gasoline.

The DAWN Plant

The heart of Synhelion's ambitions is its DAWN plant. Located in Jülich, Germany, the plant is the world's first industrial-scale facility for producing solar fuels.

"The DAWN plant is fully compatible with the current global infrastructure," Furler emphasized.

“You can simply co-process it with other crude oil streams,” Furler added. Furler further highlighted that no major infrastructure changes are required to adopt solar fuels. This should be a critical factor in accelerating their deployment.

DAWN’s production capacity is expected to reach several thousand liters of fuel annually. While this may seem modest compared to global fuel demand, it marks the beginning of a larger journey toward mass production.

Synhelion has already announced plans for future plants. The next major facility, RISE, will be ten times larger than DAWN and located in Spain.

Scaling up is always a challenge

Building a solar fuel plant at an industrial scale is no small feat, and Furler acknowledged Synhelion’s challenges in bringing DAWN online. “The major achievement we made with DAWN is to bring our team, which started as researchers, into a company capable of executing complex plant projects at the industrial scale,” he said.

One critical challenge is ensuring the technology can be scaled up efficiently while remaining cost-effective. To achieve this, Synhelion has partnered with industry experts from sectors like oil, gas, and steel, who bring valuable experience building and operating large-scale plants.

Another challenge is ensuring continuous fuel production, even when the sun isn’t shining. DAWN overcomes this with an innovative thermal energy storage system. “Large-scale fuel plants don’t want to ramp up and down just because the sun isn’t shining,” Furler explained.

Synhelion’s solution stores excess solar heat in ceramic materials during the day, which can then keep the chemical reactions running at night or during cloudy periods. “This allows us to operate the plant 24 hours a day, critical for keeping production costs low,” he added.

The dawn of solar fuels

One of the most promising applications for Synhelion's solar fuels is in the aviation sector, which has long been searching for viable alternatives to fossil-derived kerosene. According to Furler, long-haul flights are responsible for around 70% of aviation's carbon emissions, and electric solutions like batteries or hydrogen are impractical due to their lower energy density than kerosene.

"For long-haul flights, you have no choice other than using kerosene because of the energy density," Furler explained. Solar kerosene, produced using Synhelion's technology, can decarbonize aviation without requiring a complete overhaul of aircraft engines or refueling infrastructure.

"We reduce greenhouse gas emissions by around 85% compared to fossil-derived jet fuel," Furler explained. With further optimization, Synhelion aims to push this closer to 100%.

Synhelion has already secured partnerships with key players in the aviation industry, including Lufthansa, Europe's largest consumer of kerosene.

"We set up the value chain with our key customers, including Lufthansa Group and Pilatus, to supply them with solar fuels," Furler noted. By working directly with airlines, Synhelion is helping to build a future where sustainable fuels power the skies.

Shaping up to change everything

While DAWN represents an important milestone, Synhelion's ambitions extend far beyond its first industrial-scale plant. The company is already working on its next major facility, the RISE plant, which will have a production capacity of 1,000 tons of fuel per year and is expected to be operational by 2027. But this is just the beginning.

"We want to have the first competitive plant on the ground, plant Shine, by 2030, producing 100,000 tons per year," Furler said. By 2033, Synhelion aims to have several plants with capacities of several hundred thousand tons per year.

These larger plants will be capable of producing fuel at prices competitive with fossil fuels, paving the way for widespread adoption. "Our mission is to scale this technology to create global impact," Furler emphasized. While Synhelion will not be the only player in the sustainable fuels market, it aims to be significant.

The company's strategy involves moving from being a fuel producer to a technology provider, licensing its solar fuel technology to major oil and gas companies worldwide. This approach will allow for faster global deployment and help Synhelion realize its vision of becoming a leader in sustainable transportation fuels.

Looking to the future

Solar fuels represent a promising solution for sectors that are difficult to electrify, such as aviation, shipping, and long-distance road transport. While electrification will significantly reduce emissions, Furler believes solar fuels will be a critical complementary technology.

"We should stay technology open," Furler said, advocating for a flexible approach to achieving global emissions targets. "I don't believe that one technology will serve all needs. We should use a combination of different approaches to most efficiently reach our goals," he added.

With Synhelion's innovative solar fuel technology, the future of transportation could be powered by the sun. As Furler and his team continue to scale up their plants, the dream of a fossil-free future for aviation and beyond is becoming a reality.

"Our mission is to create global impact," Furler concluded. And with Synhelion's groundbreaking work, they are well on their way to doing just that.

Synhelion's solar fuel technology marks a turning point in the quest for sustainable energy. By converting sunlight into liquid fuels that are compatible with existing infrastructure, the company is poised to revolutionize the transportation sector.

Furler succinctly concluded that "this technology can be scaled to very large sizes, and our mission is to replace a significant part of the fossil kerosene with sustainable alternatives."


New all-electric housing development promises revolutionary clean energy standards: 'We're the vanguard'

A new housing development in upstate New York is making waves with its plan to deliver carbon-neutral, passive houses, which include a strict set of rules to ensure goals are met.

The Catskill Project has pledged to build 11 houses on 90 acres of land in Upstate New York, according to [Yale Climate Connections](). The second wave of homes will include another 14 homes, bringing the total to 25. The site is unique because, apart from being out in the forest of rural New York, it will also have no hookups for [natural gas]() or other fossil fuel energy sources. Instead, all its power will be generated onsite, either via installed [solar panels](), or a subscription to a [community solar]() farm.

The homes will also be built to passive home standards, meaning they are well-insulated and designed with a strong level of ventilation to help regulate temperature in the home. Catskill Project co-founder Greg Hale noted that the homes would have "an energy recovery ventilator that's on 24/7 always bringing fresh air into the house and exhausting stale air," per Yale Climate Connections.

The ventilator also captures and recycles the heat from the outgoing air into the incoming air, ensuring that the house stays warm while minimizing the amount of energy needed to maintain a comfortable temperature.

In fact, Hale noted that the homes are not allowed to use dirty energy for any of their energy needs. The development's HOA guidelines forbid the use of natural gas or fossil fuels for cooking, cleaning, or other power needs.

"There's no reason to be building houses that are going to contribute further to the climate issue," Hale said, "So we look at it both operationally and in our materials."

One study found that insect abundance tripled over five years at two Minnesota solar sites. Native bee populations skyrocketed twentyfold.

Solar farms are stepping up their game, and it's not just about producing clean energy.

These sun-soaking powerhouses are now doubling as havens for wildlife, offering a ray of hope in the fight against biodiversity loss, according to The New York Times.

Across the United States, innovative solar projects are transforming barren fields into thriving ecosystems.

Take a solar meadow in Ramsey, Minnesota, which the Times covered in a new feature. It's not your average energy site. It's a vibrant field of wildflowers and native grasses, buzzing with life. Butterflies fly from bloom to bloom, while birds tweet from the panel structures.

By creating pollinator-friendly habitats, these solar farms are helping struggling insect populations. And that's good news for all of us.

Healthy pollinator populations mean better crop yields and more stable food supplies. Plus, the diverse plant life helps prevent soil erosion and even captures carbon from the atmosphere.

Watch now: Wellness app co-founder shares how she plans to give consumers power over products at the store

This eco-friendly approach saves solar companies money in the long run. Less mowing means lower maintenance costs, making it a mutual victory for business and biodiversity.

And let's remember the community benefits. Who wouldn't prefer a colorful meadow to a plain grass field?

The results speak for themselves. One study found that insect abundance tripled over five years at two Minnesota solar sites. Native bee populations skyrocketed twentyfold. That's some serious pollinator power.

"We have to address both challenges at the same exact time," Rebecca Hernandez, an ecology professor at the University of California, Davis, told the New York Times. She's talking about tackling atmospheric pollution and biodiversity loss simultaneously, and solar meadows are proving to be a brilliant solution.

John Gantner, an engineering director at ENGIE, agrees: "We've calculated and ran the numbers, and there's significant savings." It turns out that doing good for the planet can be good for companies' bottom lines, too.

Source: Pexels/Pixabay

We're all pretty familiar with solar panels now, having seen them installed in fields, on roofs, and even on everyday electrical items like the lights in your yard.

But what if you could become the solar panel, harnessing power from the sun as you go about your daily life?

That's what researchers at the University of Oxford, UK, have turned their expertise to in a recent study.

In a statement, the University's Physics Department explain that the revolutionary technology – a perovskite coating – that they have created is even more efficient and convenient than the silicon used in traditional solar panels:

"The innovation works by coating a new power-generating material onto the surfaces of everyday objects such as rucksacks, cars, and mobile phones.

The new light-absorbing material is, for the first time, thin and flexible enough to apply to the surface of almost any building or common object. Using a pioneering technique developed in Oxford, which stacks multiple light-absorbing layers into one solar cell, the researchers have harnessed a wider range of the light spectrum, allowing more power to be generated from the same amount of sunlight."

So why does this matter?

Firstly, applying this power-generating material to any object is much more convenient.

Unlike traditional solar panels, which require a lot of space – often leading to farms, ranches, and forests having to be cleared, causing habitat, biodiversity and income loss – this material can easily slot into our everyday lives.

While we're out enjoying the sunshine our phone can be recharging, our backpack generating the energy for our evening meal or Netflix binge.

The valuable energy from the sun's rays will not be lost.

Secondly, it is much more efficient in generating power from the sun's rays, as the statement goes on to explain:

"'During just five years experimenting with our stacking or multi-junction approach we have raised power conversion efficiency from around 6% to over 27%, close to the limits of what single-layer photovoltaics can achieve today,' said

Dr Shuaifeng Hu, Post Doctoral Fellow at Oxford University Physics. ‘We believe that, over time, this approach could enable the photovoltaic devices to achieve far greater efficiencies, exceeding 45%.’

This compares with around 22% energy efficiency from solar panels today (meaning they convert around 22% of the energy in sunlight), but the versatility of the new ultra-thin and flexible material is also key. At just over one micron thick, it is almost 150 times thinner than a silicon wafer. Unlike existing photovoltaics, generally applied to silicon panels, this can be applied to almost any surface.”

Source: Pexels/Ray Bilcliff

With plans to manufacture the perovskite coating in the UK, and ultimately apply it to all kinds of everyday items, like cars, mobile phones, this kind of cheap renewable energy could become the norm.

It reduces the need for expensive and large-scale energy generation infrastructure, and will allow us all to play a part in making our environment cleaner and our world a better place.

As we work to tackle the climate crisis, this kind of innovation could be a key player in reaching our targets of clean energy generation.

Explore the frontier of renewable energy with floating solar farms, an innovative concept following the success of offshore wind farms. Companies like Ocean Sun and HelioRec are pioneering this field, developing solar panels reinforced with platforms that float on water.

Ocean Sun revolutionizes floating solar power production with our efficient, low-cost, and robust solution. The technology is based on modified solar PV modules on a thin flexible membrane and can cope with most seastates, from offshore locations to reservoir and lakes.

HelioRec can design a floating solar system that offer power plants in varying sizes, colors and shapes ranging from 10kW systems up to 100MW installations. Their focus is on near-shore locations where half of the global population lives.

Companies can place and stack parts of various sizes for a LumaPort structure that meets their current priorities and needs and then readjust or redesign as they evolve.

World4Solar, an American manufacturing business, just revealed its pioneering LumaPort solar energy system, Renewable Energy Magazine reports.

With an adaptable setup, groundbreakingly simple implementation process, and cost-saving premise, LumaPort could transform how commercial entities are powered going forward.

Solar and wind are, in the long run, more affordable and less harmful energy alternatives to coal, oil, and gas — the standard sources that we use for fuel. These dirty fuels seriously contribute to skyrocketing utility bills, declines in physical and mental health, extreme heat, natural disasters, and economic dysfunction due to the toxic pollution they release.

Solar projects reduce pollution and help conserve resources while contributing to a stronger economy. However, major changes, no matter the positive potential, can be difficult to commit to and integrate — perhaps until now.

According to Renewable Energy Magazine, LumaPort is "a scalable solar power solution." Created especially for corporate organizations, its "unified system … combines everything in a single unit" — with as many components as possible pre-installed. (That "everything" refers to panels, electric vehicle chargers, optional LED lights, and other vital solar equipment.)

As Renewable Energy Magazine explains, World4Solar takes advantage of companies' "unused space, such as parking lots," where LumaPort's cohesive setup "enables customers to produce, store, and distribute energy from the same, single system without clunky exterior boxes."

Watch now: Rare anteater sighting sparks hope for wildlife in South America

It's a practical approach for many modern businesses: Parking lots, abundant in car-dependent cities yet used infrequently throughout the workday, can do double duty as utilities. The system could also provide a boost for those facing office vacancies.

LumaPort is not only attractive (with storage columns to obscure electrical elements) — it's efficient, even in its installation, with Renewable Energy Magazine stating it is built "rather like a large-scale Lego set."

In short, there is no need for custom-design engineering. Companies can place and stack parts of various sizes for a LumaPort structure that meets their current priorities and needs and then readjust or redesign as they evolve. This saves upfront time, labor, space, and cost while still providing customization capabilities.

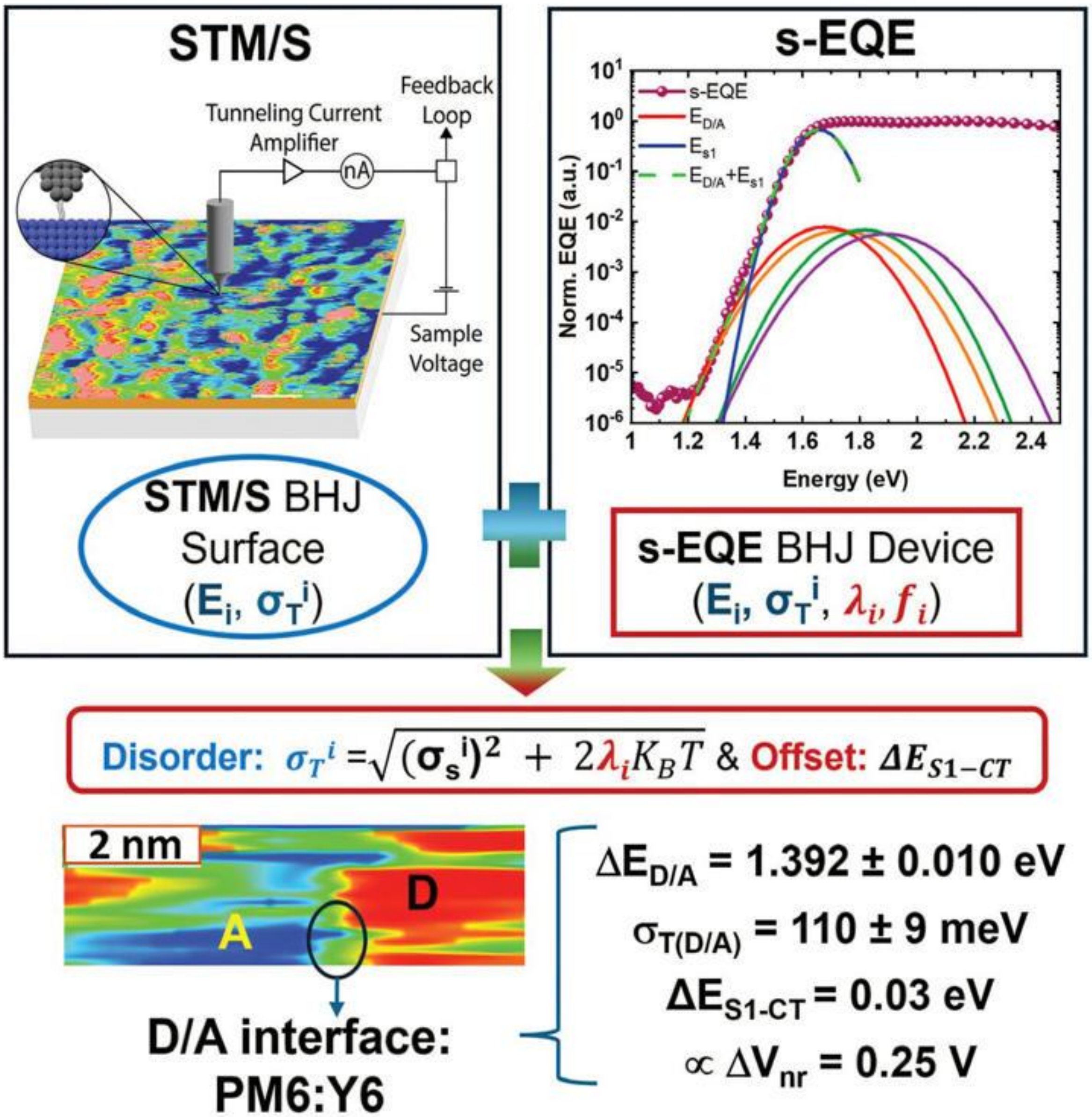
Click your choice to see results and speak your mind
LumaPort isn't the only contributor to solar's growing shine. In 2023, the Solar Energy Industries Association noted that more than half of new electricity added to the grid in the United States came from the sun, a milestone marker.

Many Americans also enjoy lower electric bills through exploring rooftop panels and community solar, while ingenious designs like solar walkways have garnered buzz elsewhere.

Ultimately, by making solar power more adaptable and accessible, LumaPort allows businesses — a crucial sector regarding pollution — to invest in a brighter future without the hassle.

orld4Solar, already known for its inventive HelioWing home solar infrastructure, officially introduced LumaPort in September at the RE+ Solar Energy Trade Show in Anaheim, California.

Linking energy loss to interfaces in organic solar cells could make them much more efficient



Graphical abstract. Credit: Matter (2024). DOI: 10.1016/j.matt.2024.10.007

New research from North Carolina State University provides a deeper understanding of precisely what is happening in organic solar cells as light is converted into electricity. Researchers have developed a new method that visualizes interfaces where sunlight's energy is converted to electrical charges, and they have used the findings to develop a set of design rules that can improve the efficiency of organic solar cells.

The research is published in the journal *Matter*.

Organic solar cells are made with carbon-based polymer materials that have the potential to be low cost, can be made from earth-abundant materials, and have some attractive features—such as the fact that they can be made into semi-transparent or transparent window applications. In addition, as thin film solar cells, they have the potential for lightweight and flexible solar applications amenable to roll-to-roll manufacturing—which could also make them easy to transport and install.

However, organic solar cells have not been as efficient as silicon or perovskite solar technologies at converting light into electricity.

"Organic solar cells are made of a mixture of two materials," says Aram Amassian, co-corresponding author of a paper on the work and a university faculty scholar and professor of materials science and engineering at North Carolina State University.

"Both materials harvest electrons from sunlight. However, one of the materials is a polymer that harvests electrons, but then has to interact with the second material in order to pass those electrons on. The polymer is called a donor material; the other substance, typically a small molecule, is called the acceptor material.

"We knew that interfaces between donor and acceptor materials were responsible for a voltage loss—which is what currently limits the efficiency of organic solar cells. Our goal with this work was to gain a deeper understanding of what aspects of interfaces were responsible for the voltage loss so that we may improve them."

To address this challenge, the researchers developed a scanning-probe microscopy method that allowed them to map not only the topographic characteristics of the donor and acceptor blend, but also the energy characteristics of the donor and acceptor materials at the interfaces—such as the energy gradient at the interface and how disordered the donor and acceptor materials are at the interface.

"This technique allowed us to determine how the degree of disorder of donor and acceptor molecules at the interface impacted the energy disorder," says Daniel Dougherty, co-corresponding author of the paper and a professor of physics at NC State. "Once we had mapped the energetics of all of these interfaces, we were able to compare those findings with the results of conventional methods that characterize the overall performance of an organic solar cell's voltage loss."

The team needed to overcome another key challenge. As the scanning-probe microscopy technique does not directly measure voltage loss, the team could not tell which interface was the main culprit.

"Blends of donor and acceptor materials give rise to many different types of interfaces at once and it is not clear which interfaces are responsible for voltage losses," Amassian says.

"Our study revealed that the functional interface in modern high performance organic solar cells, such as PM6:Y6, is the sharp donor-acceptor interface," Dougherty says. "The findings imply that this type of interface needs to be targeted to further reduce voltage losses."

"Once we identified the functional interface associated with voltage loss, we conducted a series of investigations into which factors influenced voltage loss," Amassian says.

"There has been a longstanding debate in the organic solar cell community between people who argued that voltage loss was driven by energy differential between constituent donor and acceptor materials and people who argued that voltage loss was driven by energetic disorder along interfaces. Our experiments show that both sides are correct—it's a combination of both factors."

The researchers successfully demonstrated that it is possible to "fix" the energy differential and tune the disorder at interfaces by changing the way the donor and acceptor are blended during fabrication in such a way as to reduce the voltage loss as much as possible.

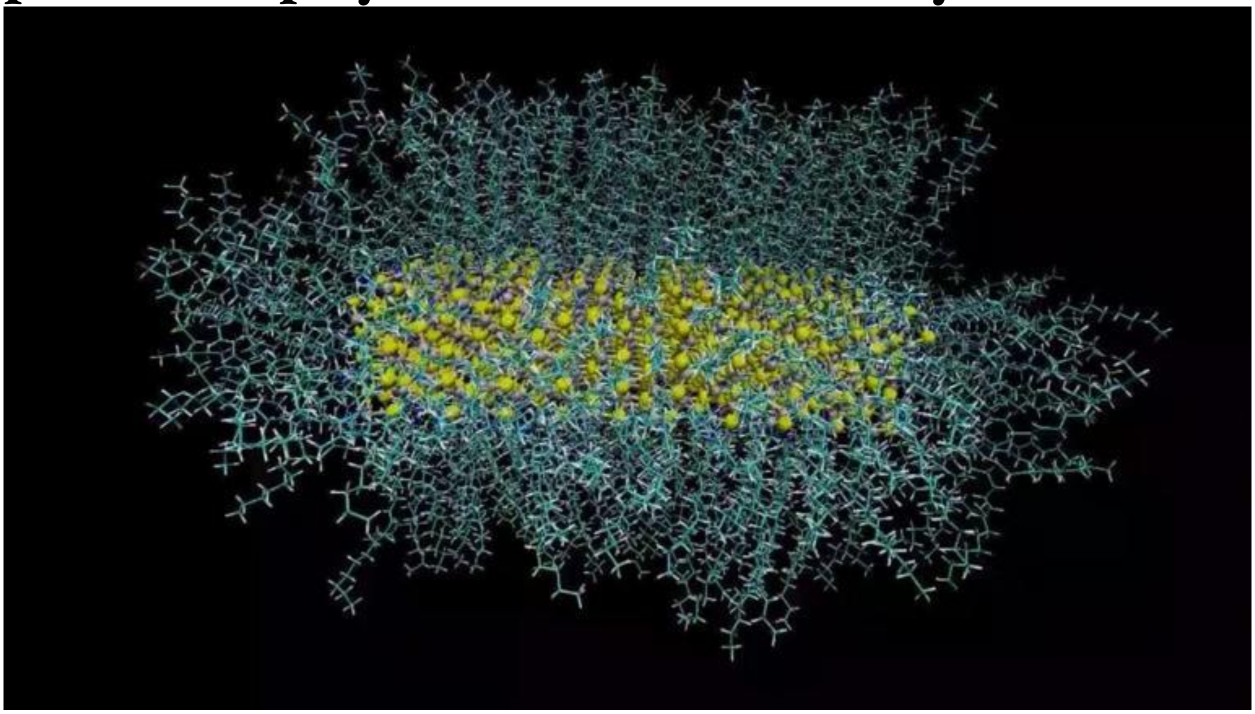
"By controlling for one of the drivers of voltage loss, we were actually able to identify engineering solutions that will help the organic solar cell community minimize the other driver of voltage loss," Amassian says.

"Essentially, voltage losses are reduced by selecting a pair of materials with minimal energy offsets. Practitioners can then further reduce energy losses by identifying a solvent and processing parameters that substantially reduce interfacial disorder. We're optimistic the design rules we developed using this technique can be used to inform organic solar cell research and development moving forward."

More information: Mapping Interfacial Energetic Landscape in Organic Solar Cells Reveals Pathways to Reducing Nonradiative Losses, *Matter* (2024). DOI: 10.1016/j.matt.2024.10.007. www.cell.com/matter/fulltext/S2590-2385(24)00534-4

Provided by North Carolina State University

Nanocrystal shape increases efficiency in solar panels, displays, medical tech: Study



Nanocrystal shape increases efficiency in solar panels, displays, medical tech: Study

Researchers have found a way to increase the number of molecules that adhere to the surface of small nanocrystals.

A team at Curtin University in Australia asserts that the new method could lead to advancements such as brighter TV screens, improved medical diagnostics, and more efficient solar panels.

The study looked into how the form of zinc sulfide nanocrystals affected the ligands' ability to adhere to their surface. A ligand is an ion or molecule that donates a pair of electrons to the central metal atom or ion to form a coordination complex.

"In a discovery that could open new possibilities for developing smarter, more advanced devices, our study found flatter, more even particles called nanoplatelets allow more ligands to attach tightly, compared to other shapes like nanodots and nanorods," said Guohua Jia, associate professor at Curtin's School of Molecular and Life Sciences and lead author of the study, in a statement.

Nanocrystal shape matters

Researchers at Curtin University made significant strides in understanding how the shape of semiconductor nanocrystals (NCs) affects their properties.

Ligands control how zinc sulfide nanocrystals behave and operate in several important technologies. The team investigated zinc sulfide (ZnS) nanocrystals, which can be nanodots, nanorods, or nanoplatelets (NPLs).

The researchers discovered that the shape of nanocrystals influences the density of surface ligands or molecules that cling to their surfaces. One such ligand is oleylamine (OLA), which is frequently employed.

By changing the shape of the particles, the researchers were able to improve their performance in various applications and regulate how they interacted with their environment.

"From brighter LED lights and screens to more efficient solar panels and more detailed medical imaging, the ability to control particle shapes could revolutionize product efficiency and performance," said Jia, in a statement.

Boosting device efficiency

The team used three different experimental methods—thermogravimetric analysis and nuclear magnetic resonance spectroscopy. The ligand density on the nanocrystals was subsequently measured using inductively coupled plasma-optical emission spectrometry.

Their findings demonstrated a distinct pattern: the lowest ligand density was found in nanodots, followed by nanorods, and the maximum density was found in nanoplatelets.

The researchers attributed the increased ligand density in nanoplatelets to their uniformly flat surfaces, which enable OLA molecules to stack tightly together. In contrast, the more irregular surfaces of nanodots and nanorods led to less efficient stacking of the ligands.

The team claims that the discovery could improve the performance of devices known as optoelectronics, which either generate light or utilize light to operate.

“Optoelectronics are important in many modern technologies, including telecommunications, medical devices, and energy production. The ability to efficiently manipulate light and electricity is central to the advancement of faster, more efficient, and more compact electronic systems,” said Jia.

The study also emphasizes the significance of surface chemistry in nanocrystals, showing how their shape can affect their performance in various applications, including more effective solar panels, brighter TV screens, and better medical diagnostics.

The group points out that these discoveries not only improve our knowledge of how to manipulate the shape of semiconductor nanocrystals but also present fresh approaches to adjusting their chemical characteristics. The study is an essential first step in creating cutting-edge materials with specialized properties for a range of technological uses.

The details of the team’s research were published in the *Journal of the American Chemical Society*.

Kesterite solar cells' efficiency boosted with silver doping, defects reduced

Kesterite solar cells' efficiency boosted with silver doping, defects reduced

A team of international researchers has developed a new method for doping silver (Ag) in solar cells aimed at suppressing defects that hinder cell performance and promoting crystal growth.

Composed of copper (Cu), zinc (Zn), tin (Sn), sulfur (S), and selenium (Se), Kesterite CZTSSe solar cells are gaining traction as a low-cost, eco-friendly alternative to traditional solar technology.

These solar cells can be produced on a large scale and are competitively priced because they rely on widely available materials instead of the rare metals found in traditional solar cells.

However, traditional CZTSSe solar cells struggle with low efficiency and high current losses from electron-hole recombination, making their commercialization challenging.

Helping solar cell crystals grow larger and faster

To tackle these problems, the research team doped the solar cell precursor with silver (Ag). This addition helps prevent the loss of tin (Sn) and improves material mixing at lower temperatures. As a result, the crystals grow larger and faster, reducing defects and enhancing the solar cell's performance.

The researchers explored the impact of silver (Ag) placement within the precursor on defect formation and electron-hole recombination. The results show that Ag can greatly enhance solar cell performance by reducing tin (Sn) loss and effectively minimizing defects.

The researchers also discovered that improperly placing silver (Ag) can disrupt the formation of the Zn and Cu alloy, causing zinc (Zn) to stay in the bulk and form defect clusters. This interference can increase electron-hole recombination losses and reduce performance. This finding highlights an important insight: solar cell performance is significantly influenced by the location of Ag doping.

"This study suggests that the location of Ag plays an important role in optimizing the CZTSSe efficiency. Additionally, a precursor containing Ag has been shown to suppress Sn loss during the sulfo-selenization process and improve device performance through liquid-assisted grain growth," the authors explained in the study.

Silver can lower solar cell production costs

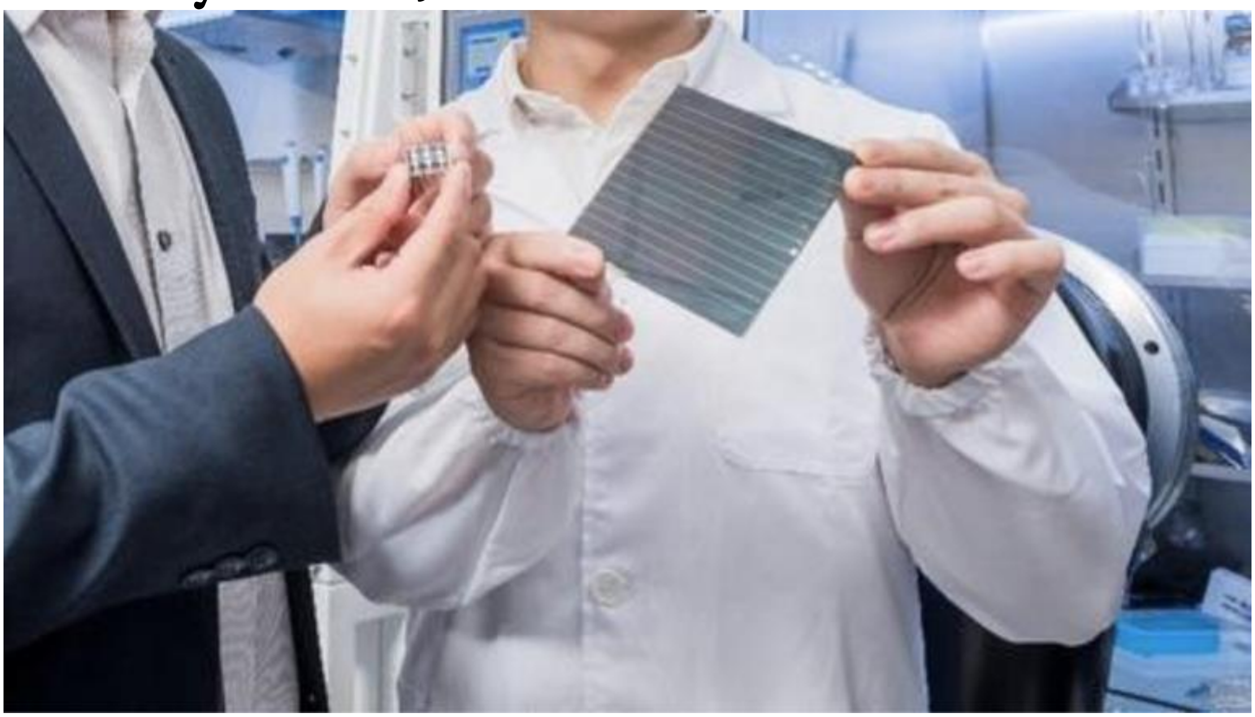
The research team also discovered that the liquid material created by silver (Ag) doping encourages crystal growth, greatly enhancing the density and crystallinity of the absorber layer.

This improvement leads to a better energy band structure and fewer defects, facilitating smoother charge transport within the cell. These findings can also greatly aid in producing high-performance solar cells at a lower cost.

According to the researchers, this study looked at how silver (Ag) doping affects solar cells, breaking it down step by step. They found that silver can help reduce tin loss and fix defects, much like adding a stabilizer to a recipe to improve the final dish.

The findings offer useful insights into designing silver-doped structures to boost solar cell efficiency and are likely to aid in developing different solar technologies.

Stunning solar cells offer 25% efficiency, 95% stability after 2,000 hrs of trial



Stunning solar cells offer 25% efficiency, 95% stability after 2,000 hrs of trial

Researchers have developed a new fabrication technique for substantially enhancing the prospects of commercializing perovskite solar cells.

Developed by researchers at the City University of Hong Kong (CityUHK), the technique improves stability, reliability, efficiency and affordability of perovskite solar cells.

Using the technique, the CityUHK team has built a simple device structure that can facilitate future industrial production and enhance confidence in the commercialization of perovskite solar cells.

Significant step in making solar energy more accessible

They improved the long-term stability of perovskite solar cells with an atomic-layer deposition (ALD) method. The layer replaces the fullerene electron transport layer with tin oxide.

Professor Zhu Zonglong of the Department of Chemistry stated that the mineral perovskite is used extensively to convert sunlight into electricity efficiently.

Zonglong underlined that the improvements in stability and the simplification of the production process of perovskite solar cells represent a significant step forward in making solar energy more accessible and affordable.

In broad terms, the CityUHK team is working on a new type of solar cell that can turn sunlight into electricity more efficiently and last longer than current solar cells, according to a press release.

Operational stability

Two innovations have been developed by the team for creating the structure of solar cells.

The first innovation is the integration of the hole-selective materials and the perovskite layers, which simplifies the manufacturing process. The second is that the operational stability of the device is greatly enhanced by using the inorganic electron transport layer, tin oxide, which has excellent thermal stability, to replace traditional organic materials such as fullerene and BCP, according to researchers.

Dr Gao Danpeng, co-author of the Science paper and a post-doc at CityUHK, stated that the device structure reported in this study represents the most simplified architecture in the current field of perovskite solar cells, offering significant advantages for industrialisation.

This solution does not require a traditional organic transfer layer, effectively reducing the material cost in the manufacturing process while greatly simplifying the production steps, according to Dr Gao.

Power conversion efficiencies exceeding 25%

Professor Zhu claimed that the team has achieved power conversion efficiencies exceeding 25% by optimising oxygen vacancy defects within the tin oxide layer while retaining over 95% efficiency after 2,000 hours of continuous operation under rigorous test conditions.

Researchers maintained that this performance exceeds the stability of traditional perovskite solar cells, meeting several industry benchmarks for longevity. The results pave the way for more reliable and efficient solar cells, simplifying manufacturing processes and making producing solar cells at scale more cost-effective, according to the study.

Professor Zhu claimed that the research has the potential to be implemented in solar energy systems within the next 5 years.

"This research is a critical step towards achieving more sustainable and environmentally friendly energy production globally," added Zhu.

The study titled "Long-term stability in perovskite solar cells through atomic layer deposition of tin oxide" is published in Science.

Imaging advance creates clearer picture of organic solar cells' molecular structure

AFM and AFM-IR images of a 1:1 TQ1:N2200 HMW blend film, spun from CF. The upper row images are 1 × 1 µm2 in size, while the lower row images are 0.5 × 0.5 µm2. Credit: ACS Applied Polymer Materials (2024). DOI: 10.1021/acsapm.4c01883

Research on organic solar cells has been conducted for a long time. Recent advancements in understanding their molecular structures are now paving the way for the development of highly efficient solar cells.

"By using atomic force microscopy-infrared spectroscopy, AFM-IR, we've been able to create clearer images of the morphology or structure of the material," says Ishita Jalan, postdoc in physical chemistry and main author of a recently published article in *ACS Applied Polymer Materials*. This structure and how it can be controlled determines the effect of the solar cell.

Efficient solar cells that are cheap to manufacture

The experiments form part of the research on organic solar cells. The idea is to create materials that can conduct electrical current by mixing molecules in a solvent that you spread out in a thin layer, which then is left to dry. Two different kinds of molecules are needed—those that donate electrons and those that accept them.

In the experiments, a small glass plate is coated with a solution and researchers then study the drying process and the formation of a thin polymer film as the solvent evaporates. This provides information on how to control the structure and properties of the active layer of solar cells to achieve the highest possible energy efficiency.

"Conjugated polymers belong to a class of organic semiconductors used in a wide range of optoelectronic applications, such as organic solar cells and organic light-emitting diodes," says Jalan.

Thin liquid films of two or more conjugated polymers or small molecules are coated from a solution on a substrate. During drying, the solution undergoes a phase separation, forming structures that create a network of donor-rich and acceptor-rich phases. The composition and interconnection of these phases play a crucial role in energy efficiency.

Efficient and environmentally friendly solar cells is part of the solution for eliminating fossil fuel dependency. Currently, solar energy accounts for just a small percent of the human energy consumption worldwide.

However, if we could transform all solar energy that reaches our earth during just one hour into electricity, it would cover the entire planet's energy consumption for approximately a year. In order to replace other energy sources, we need efficient, environmentally friendly solar cells which are cheap to manufacture.

More information: Ishita Jalan et al, AFM-IR Spectromicroscopy Unveils Hidden Phase Separation in Polymer–Polymer Blend Films for Photovoltaic Applications, *ACS Applied Polymer Materials* (2024). DOI: 10.1021/acsapm.4c01883

Provided by Karlstad University

Towards better solar cells: Exploring an anomalous phenomenon of electricity generation

In this study, researchers demonstrated that α-In2Se3 exhibits a peculiar way of generating electricity from light called the bulk photovoltaic effect. Based on their experimental results, α-In2Se3-based devices could achieve remarkable performance in solar cells, paving the way for reliable renewable energy generation to achieve carbon neutrality. Credit: zakzak 7 at Openverse (https://openverse.org/image/46233968-b662-4fb5-bfcd-64d5c2795410)

The bulk photovoltaic (BPV) effect is an uncommon phenomenon that may enable certain materials to outperform the conventional p–n junctions used in solar cells.

Researchers from Japan have experimentally demonstrated the BPV effect in alpha-phase indium selenide (α-In_2Se_3) for the first time along the out-of-plane direction, validating previous theoretical predictions. The remarkable conversion efficiency recorded in their α-In_2Se_3 device signals a promising advancement for future solar cell technologies and photosensors.

A firm understanding of the photovoltaic effect, by which light can be converted into useful electrical energy, lies at the core of solar cell design and development.

Today, most solar cells employ p–n junctions, leveraging the photovoltaic effect that occurs at the interface of different materials.

Such designs are constrained by the Shockley–Queisser limit, which puts a hard cap on their theoretical maximum solar conversion efficiency and imposes a tradeoff between the voltage and current that can be produced via the photovoltaic effect.

However, certain crystalline materials exhibit an intriguing phenomenon known as the bulk photovoltaic (BPV) effect. In materials lacking internal symmetry, electrons excited by light can move coherently in a specific direction instead of returning to their original positions. This results in what is known as "shift currents," leading to the generation of the BPV effect.

Although experts have predicted alpha-phase indium selenide (α-In_2Se_3) to be a possible candidate to demonstrate this phenomenon, it hasn't yet been experimentally investigated.

To fill this knowledge gap, a research team from Japan led by Associate Professor Noriyuki Urakami from Shinshu University set out to explore the BPV effect in α-In_2Se_3. Their findings are published in *Applied Physics Letters*.

"This material has recently become a hot topic in the field of condensed matter physics, as it might be able to generate a shift current. Our study is the first to experimentally demonstrate this prediction," says Prof. Urakami.

First, the researchers produced a layered device composed of a thin α-In_2Se_3 layer sandwiched between two transparent graphite layers.

These graphite layers served as electrodes and were connected to a voltage source and an ammeter to measure any generated currents upon light irradiation. Notably, the team employed this specific arrangement of layers because they focused on the shift currents occurring in the out-of-plane direction in the α-In_2Se_3 layer.

After testing with different external voltages and incident light of various frequencies, the researchers verified the existence of shift currents in the out-of-plane direction, confirming the above-mentioned predictions. The BPV effect occurred throughout a wide range of light frequencies.

Most importantly, the researchers gauged the potential of the BPV effect in α-In_2Se_3 and compared it to that in other materials.

"Our α-In_2Se_3 device demonstrated a quantum efficiency several orders of magnitude higher than other ferroelectric materials, and a comparable one to that of low-dimensional materials with enhanced electric polarization," said Prof. Urakami.

He adds, "This discovery will guide material selection for the development of functional photovoltaic devices in the near future."

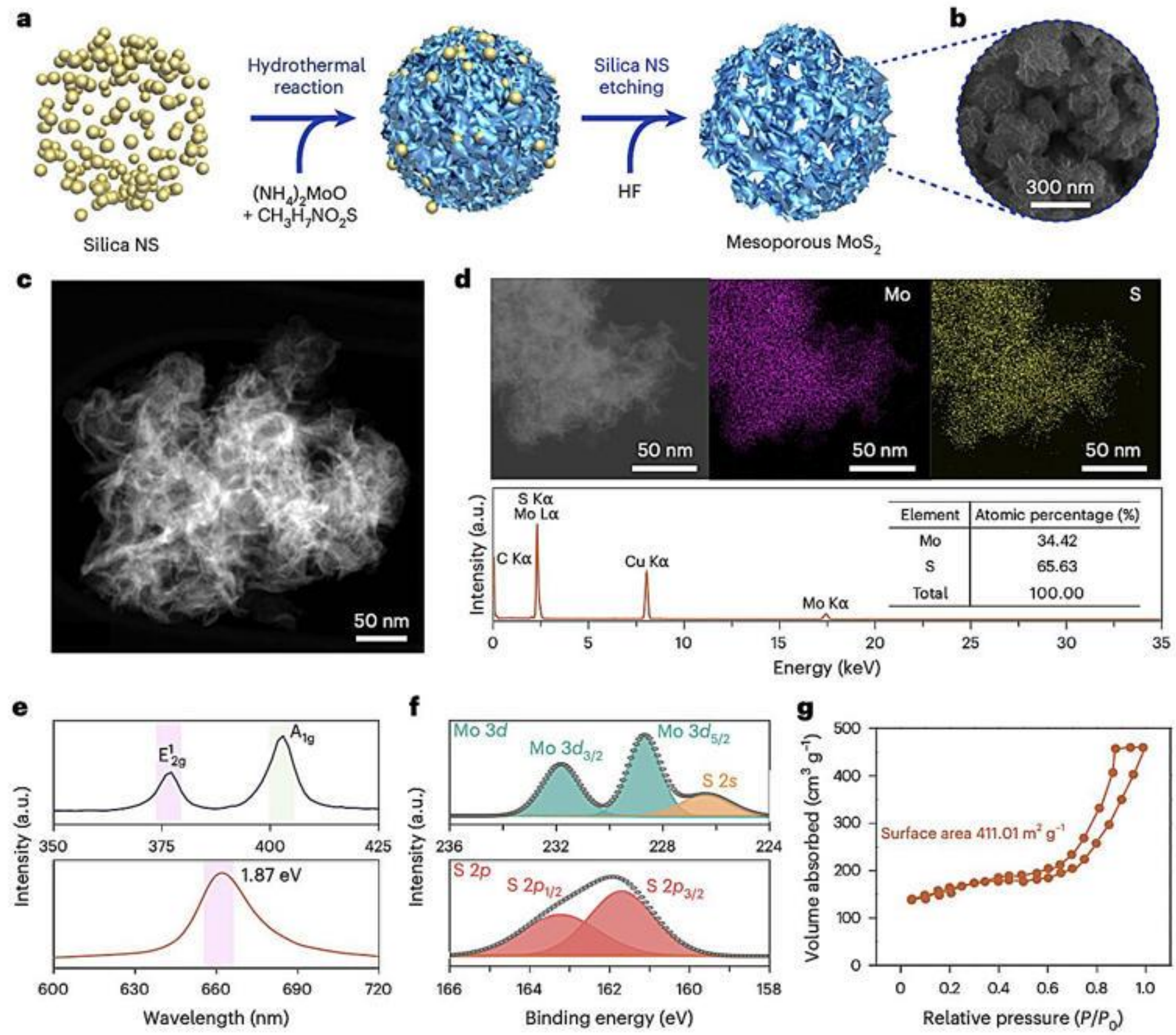
The research team is hopeful that their efforts will eventually have a positive environmental impact by contributing to the field of renewable energy generation. "Our findings have the potential to further accelerate the spread of solar cells, one of the key technologies for environmental energy harvesting and a promising avenue towards a carbon neutral society," concludes Prof. Urakami.

We hope that this study paves the way for further studies to harness the BVP effect and vastly improve the performance of solar cells, as well as enhance the design of sensitive photodetectors.

More information: Noriyuki Urakami et al, Bulk photovoltaic effect of an alpha-phase indium selenide (α-In_2Se_3) crystal along the out-of-plane direction, *Applied Physics Letters* (2024). DOI: 10.1063/5.0222926

Provided by Shinshu University

Mesoporous MoS_2 strategy boosts efficiency and stability of perovskite solar cells



Synthesis and characterization of mesoporous MoS2. Credit: Nature Nanotechnology (2024). DOI: 10.1038/s41565-024-01799-8.

The efficiency and performance of photovoltaics (PVs) have improved significantly over the past decades, which has led to an increase in the adoption of solar technologies. To further enhance the performance of solar cells, energy researchers worldwide have been devising and testing alternative design strategies, leveraging different materials and cell structures.

A class of solar cells that have been found to attain promising results are those based on organic-inorganic hybrid perovskites, materials with various advantageous properties. While these cells have achieved efficiencies of over 25%, they are often unstable and sensitive to various external stimuli (e.g., UV light and oxygen), which hinders their large-scale deployment.

Researchers at the Ulsan National Institute of Science and Technology, Korea University and other institutes recently introduced a new possible strategy to boost the efficiency and stability of perovskite solar cells. This strategy, outlined in a paper published in *Nature Nanotechnology*, entails the use of mesoporous structured molybdenum disulfide (MoS_2) as an electron transport layer (ETL) in perovskite solar cells.

"Mesoporous structured electron transport layers (ETLs) in perovskite solar cells (PSCs) have an increased surface contact with the perovskite layer, enabling effective charge separation and extraction, and high-efficiency devices," Donghwan Koo, Yunseong Choi and their colleagues wrote in their paper.

"However, the most widely used ETL material in PSCs, TiO_2, requires a sintering temperature of more than 500 °C and undergoes photocatalytic reaction under incident illumination that limits operational stability. Recent efforts have focused on finding alternative ETL materials, such as SnO_2."

Building on previous research efforts, Koo, Choi and their colleagues set out to improve the performance of perovskite solar cells using ETLs with a mesoporous structure. This essentially means that the material used for these layers has tiny pores (ranging from 2 to 50 nm in size).

They specifically used mesoporous MoS_2, a versatile material with optoelectronic properties that has previously been used to develop batteries, photodetectors, light-emitting diodes (LEDs) and other technologies. The researchers found that introducing a mesoporous MoS_2 ETL yielded solar cells exhibiting an efficiency above 25% and good stability.

"The MoS_2 interlayer increases the surface contact area with the adjacent perovskite layer, improving charge transfer dynamics between the two layers," wrote Koo, Choi and their colleagues.

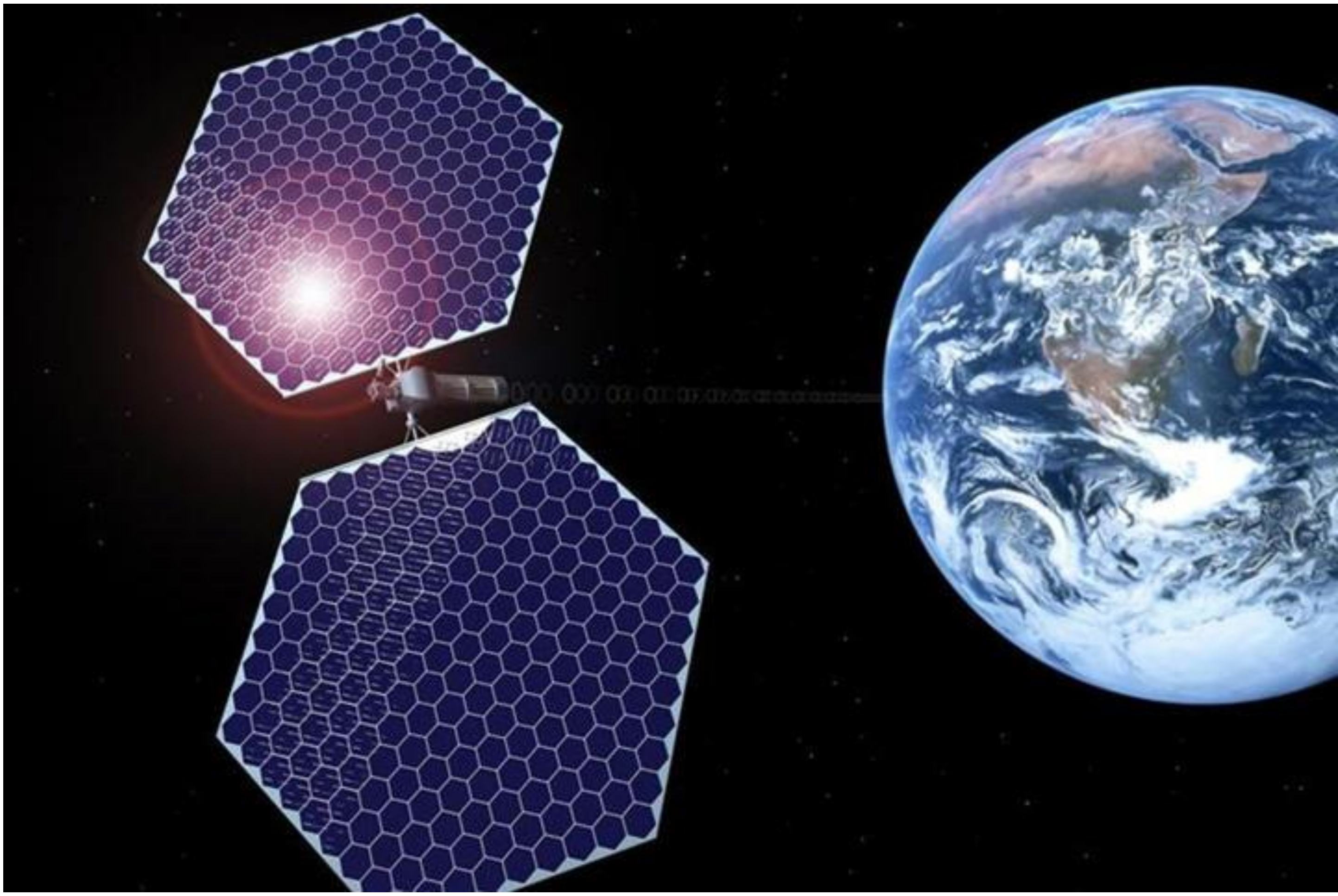
"In addition, the matching between the MoS_2 and the perovskite lattices facilitates preferential growth of perovskite crystals with low residual strain, compared with TiO_2. Using mesoporous structured MoS_2 as ETL, we obtain perovskite solar cells with 25.7% (0.08 cm^2, certified 25.4%) and 22.4% (1.00 cm^2) efficiencies."

In initial tests, the team's solar cells attained highly promising results, comparing favorably to solar cells with a TiO_2 ETL. Notably, the perovskite solar cells with a mesoporous MoS_2 were also found to retain their stability and 90% of their initial power conversion efficiency (PCE) after operating under continuous illumination for over 2,000 hours.

These encouraging findings could inform future efforts aimed at boosting the efficiency and stability of organic-inorganic perovskite solar cells by introducing a mesoporous structured MoS_2 layer. These efforts could help bring perovskite solar cells' performance up to par with silicon-based PVs, contributing to their future widespread deployment.

More information: Donghwan Koo et al, Mesoporous structured MoS_2 as an electron transport layer for efficient and stable perovskite solar cells, *Nature Nanotechnology* (2024). DOI: 10.1038/s41565-024-01799-8.

Iceland Could Become First Nation To Get Solar Power From Space In 2030



ne of the complaints when it comes to solar power is that you usually have to link it to batteries. Even in areas with plenty of sun, you cannot have sunlight 24/7 all year round. At least, not on Earth. In space, however, you can. For decades, people have been considering options and possibilities of space solar power. Now, it might become a commercial reality in just a few years.

UK-based company Space Solar is partnering with Reykjavik Energy and Icelandic sustainability initiative Transition Labs to develop a space-based solar power plant that can deliver about 30 megawatts of electricity – potentially enough to power between 1,500 and 3,000 homes – from 2030. The system will collect sunlight in space through solar panels and then transmit it as radio waves at a specific frequency to a ground station, where it will be converted to electricity for the grid.

The satellite is expected to be scalable and quite big. Even if a full version of their CASSIOPeiA power array is not built, we are talking about the heaviest single object in space that is not a space station, and when all the arrays are splayed out, much larger than the International Space Station.

The company aims to have a scaled-up version of the system in space by 2036, which would supply gigawatts of electricity.

“The collaboration with Reykjavik Energy marks a key milestone in Space Solar’s journey toward full-scale deployment. Their forward-thinking approach to climate technology, combined with expertise in carbon storage through Carbfix and a long-standing partnership with Climeworks, makes Reykjavik Energy the perfect partner for Space Solar’s initial phase,” Kjartan Örn Ólafsson, CEO of Transition Labs, said in a statement.

“Space-based solar power offers unparalleled benefits with competitive energy costs and 24/7 availability. Reykjavik Energy’s recognition of the potential for space-based solar to drive the energy transition is exciting, and we’re thrilled to be working together in partnership toward a sustainable future,” echoed Space Solar co-CEO Martin Soltau.

The plan is certainly bold. So far, the transmission of energy from orbit has nowhere near that kind of power. This year, the Caltech demonstrator for this technology showed that the technology itself is certainly possible, but it beamed only milliwatts of power to Earth. The proposal for Iceland will have to be able to deliver billions of times more power.

There are challenges for sure, so it will be interesting to see if they are met. There’s certainly good humor and hard facts on the Space Solar FAQ page. Our favorite is that the system can’t be turned into a death ray; at most, the beam has a power that is less than a quarter of what the Sun delivers at midday.

The time it takes to break even on solar panels is plummeting — here's how you can get thousands off

The time it takes to break even on solar panels is plummeting — here's how you can get thousands off

Installing solar panels can be expensive up front, but the time it takes you to get your money back has lowered. So, if you are waiting for a sign to take the plunge, this may be it.

According to EnergySage's Solar & Storage Marketplace Report 2024, between the second half of 2023 and the first half of 2024, the payback period for solar dropped from 8.1 years to 7.5 years.

Solar panels are an excellent way to save money on electricity bills. EnergySage reported, "You could save between $28,000 and $120,000 over the lifetime of your solar panel system."

Rooftop solar projects are popping up across America, increasing tenfold between 2012 and 2022 and showing no signs of slowing down. The reasons for this growth are clear: lower bills, more energy independence, and a cleaner environment.

EnergySage has other ways to save money, including free tools to help you calculate your savings on electricity bills and how to get your rebates and tax incentives. The solar company also offers a marketplace where you can search for the best deals on installation, just like you would search for flight deals.

Investing in solar energy can benefit your entire community and even the country. According to a study by the University of Texas at Austin, homeowners and companies who installed solar panels and battery storage or joined community solar reduced the demand on the electricity grid.

The study found that reducing the demand on the grid would save communities $3 million on utility bills.

Switching to solar energy can also have a profound effect on the environment. Per the United Nations, dirty energy sources like gas, oil, and coal are the largest contributors to warming the planet. These sources are used to produce electricity and heat. However, by switching to cleaner and more reliable energy sources, like solar energy, the amount of polluting gases can be cut by almost half by 2030.

You can reap all these benefits by investing in solar energy.

"We're at a pivotal moment for solar pricing, where ongoing cost reductions are enabling more homeowners to make the switch to clean energy," said Spencer Fields, EnergySage's director of insights. "The combination of near-record low prices and more consumer-friendly financing options is creating new opportunities for wider adoption."

New report details the remarkable impact of tripling renewables worldwide by 2030: 'The North Star for what the energy sector needs to do'

Tripling clean energy worldwide by 2030 is doable, according to an encouraging new report from the International Energy Agency.

The ambitious goal was set at last year's major climate conference in Dubai, where nearly 200 countries agreed to boost renewable power like solar and wind dramatically. Now, experts say making this dream a reality could slash harmful pollution by a whopping 10 billion tonnes while putting more money back in your pocket through lower energy costs.

To get there, we'll need some upgrades to our power system, including modernizing electrical grids and adding more battery storage, according to Electrek. Think of it like upgrading your home's electrical system but on a global scale. The improvements would span enough distance to circle the Earth 600 times.

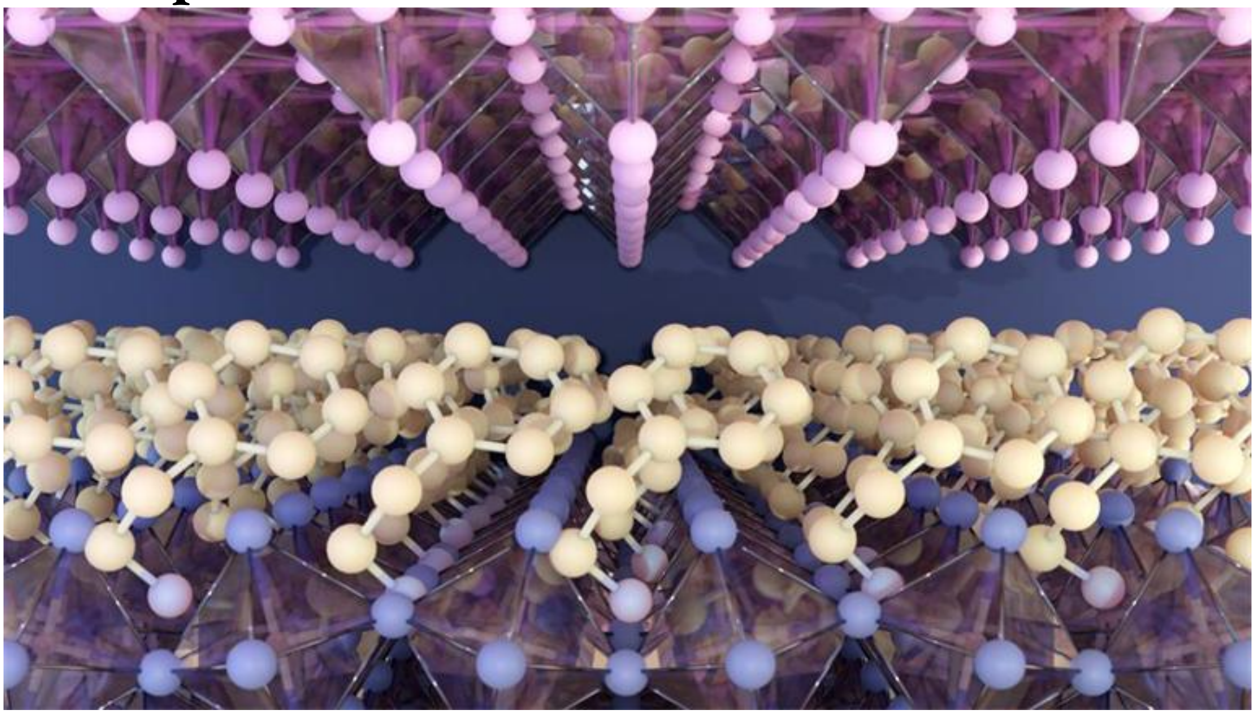
These changes will help your wallet, too. We could cut global energy costs by nearly 10% by doubling energy efficiency alongside the renewable boost. For Americans, that means more affordable electric vehicles and heat pumps, while developing countries will get clean cooking equipment and more efficient cooling systems.

"The COP28 energy goals are the North Star for what the energy sector needs to do," said Fatih Birol, who leads the International Energy Agency. "We need fit-for-purpose grids, energy storage, and faster electrification to ensure the clean energy transition happens quickly and securely."

This massive shift to clean energy isn't just about fighting atmospheric pollution. It's about building a future where energy is cheaper, more reliable, and better for our communities. As these changes roll out over the next several years, renewable power will become the main electricity source worldwide.

The more countries embrace these solutions, the more affordable they become. It's transforming how we power our lives, making clean energy not just the right choice for the planet, but the smart choice for our wallets too.

Computer simulations reveal stability factors in 2D perovskites for better solar cells



More stable and efficient materials for solar cells are needed in the green transition. So-called halide perovskites are highlighted as a promising alternative to today's silicon materials. Researchers at Chalmers University of Technology, in Sweden, have gained new insights into how perovskite materials function, which is an important step forward.

Halide perovskites is the collective name for a group of materials that are considered very promising and cost-effective for flexible and lightweight solar cells and various optical applications, such as LED lighting. This is because many of these materials absorb and emit light in an extremely efficient way. However, perovskite materials may degrade quickly, and in order to know how best to apply these materials, a deeper understanding is required of why this happens and how the material functions.

Computer simulations and machine learning as aids

Within the perovskite group, there are both 3D and 2D materials, the latter often being more stable. Using advanced computer simulations and machine learning, a research team at the Department of Physics at Chalmers University of Technology studied a series of 2D perovskite materials and gained crucial insights into what influences properties.

The research results are presented in an article, titled "Impact of Organic Spacers and Dimensionality on Templating of Halide Perovskites," which was published in *ACS Energy Letters*

"By mapping out the material in computer simulations and subjecting it to different scenarios, we can draw conclusions about how the atoms in the material react when exposed to heat, light, and so on," says Professor Paul Erhart, a member of the research team at Chalmers University of Technology.

"In other words, we now have a microscopic description of the material that is independent of what experiments on the material have shown, but which we can show to lead to the same behavior as the experiments. The difference between simulations and experiments is that we can observe, at a detailed level, exactly what led to the final measurement points in the experiments. This gives us much greater insight into how 2D perovskites work."

Larger systems could be studied over longer time periods

Using machine learning has been an important approach for the researchers. They have been able to study larger systems, over a longer period, than was previously possible with the standard methods used just a few years ago.

"This has given us both a much broader overview than before, but also the ability to study materials in much more detail. We can see that in these very thin layers of material, each layer behaves differently, and that's something that is very, very difficult to detect experimentally," says Associate Professor Julia Wiktor from the research team, which also included researcher Erik Fransson.

Better understanding of the material's composition

2D perovskite materials consist of inorganic layers stacked on top of each other, separated by organic molecules. Understanding the precise mechanisms that influence the interaction between the layers and these molecules is crucial for designing efficient and stable optoelectronic devices based on perovskite materials.

"In 2D perovskites you have perovskite layers that are linked with organic molecules. What we have discovered is that you can directly control how atoms in the surface layers move through the choice of the organic linkers and how this affects the atomic movements deep inside the perovskite layers. Since that movement is so crucial to the optical properties, it's like a domino effect," says Erhart.

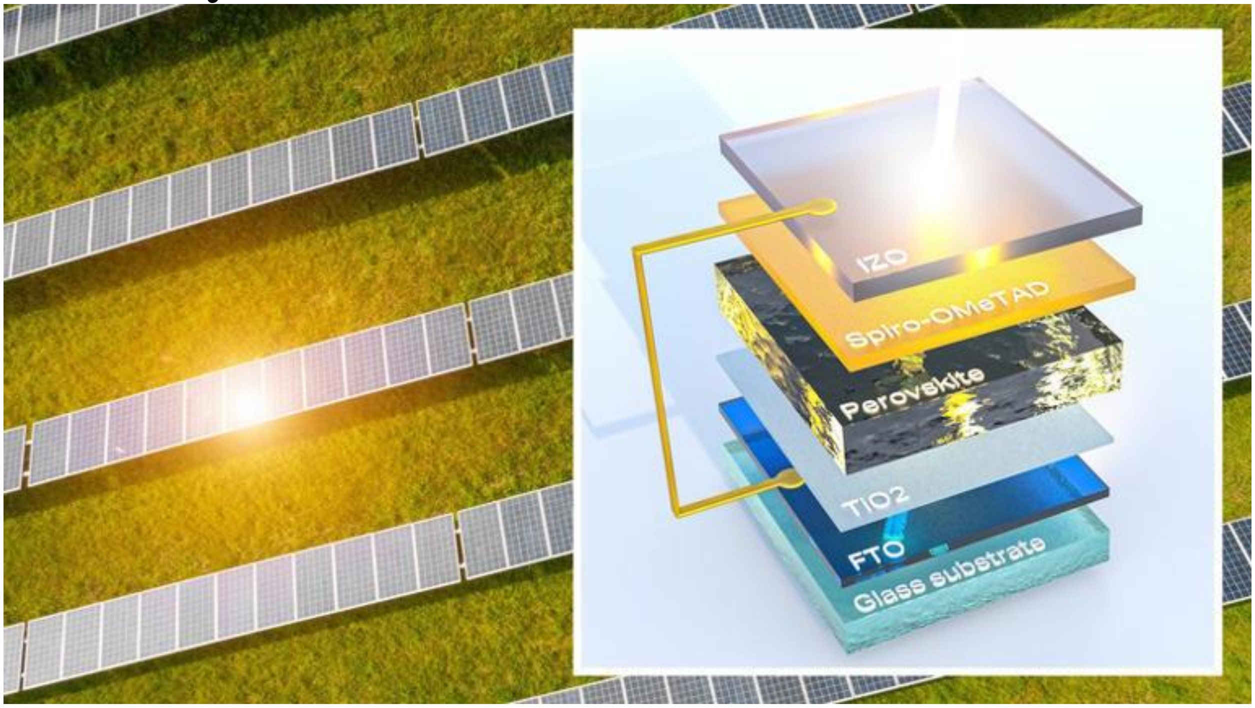
The research results provide greater insight into how 2D perovskite materials can be used to design devices for different applications and temperature variations.

"This really gives us an opportunity to understand where stability can come from in 2D perovskite materials, and thus possibly allows us to predict which linkers and dimensions can make the material both more stable and more efficient at the same time. Our next step is to move to even more complex systems and, in particular, interfaces that are fundamental for the function of devices," says Wiktor.

More information: Erik Fransson et al, Impact of Organic Spacers and Dimensionality on Templating of Halide Perovskites, *ACS Energy Letters* (2024). DOI: 10.1021/acsenergylett.4c01283

Provided by Chalmers University of Technology

Perovskite Solar Cells: What Are They & How Do They Work?



Modern consumer solar technology offers quite a bit of variety, from standard panel designs with silicon materials to thin-film alternatives made of cadmium. So, what's all this about perovskite solar cells? Do we really need another kind of solar to decide on?

Despite sounding like a made-up word that Fenton Crackshell might exclaim before turning into Gizmoduck, perovskite solar cells are real and show a lot of promise. In basic terms, perovskite solar cells are just what they sound like; they are solar cells made using perovskites instead of the more commonly used silicon materials found in most photovoltaic solar energy systems. In this instance, "perovskites" is a blanket term applied to a variety of materials, specifically because of their structural likeness to the mineral perovskite.

Functionally, perovskite solar panels aren't that different from other thin-film solar panels. When incorporated into a solar cell structure, these perovskites convert photons into electricity. That electricity can then be channeled into batteries for storage or directly into certain devices, and so on. Perovskites have been a part of solar research for over a decade, with a wide range of elements and element combinations being explored in order to better refine the technology. The aim is to increase efficiency and reduce potential environmental impacts. With enough time and refinement, perovskite solar panels could theoretically replace current solar technology.

What Makes Perovskite Solar Cells Special?

The reason so many researchers have been trying to refine the perovskite solar cell formula for so long comes down to two main benefits. Specifically effectiveness and affordability.

In lab testing, perovskite solar cells have been able to reach an efficiency rating of over 25 percent, making them arguably the most energy-efficient thin-film panels to date. However, that efficiency is too short-lived to be viable for modern solar panel replacement. According to the U.S. Department of Energy, early perovskite cells would start to degrade in less than a single day -- sometimes within minutes -- while more recent attempts have extended some cells' lifespans up to a few months.

Perovskite solar cells are also expected to be relatively inexpensive to produce, in theory, which would make them even more of a direct competitor to today's common solar panel technologies. The catch is that, so far, the production methods used in testing labs wouldn't really work on an assembly line to mass produce the panels. So, in addition to needing to figure out a way to greatly improve perovskite solar cell lifespans, large-scale manufacturing processes also need to be sorted out.

Can You Buy Perovskite Solar Panels?

In short, no, you can't buy perovskite solar panels. It's probably going to be a while yet before perovskite solar panels become available at the commercial level. Georgia Tech engineers have managed to figure out that the combination of exposure to both water and oxygen is causing rapid degradation — and that eliminating exposure to one would more or less halt the rapid degradation process. However, the methods used to protect the perovskites from one element lead to entirely new hurdles, such as light reducing the effectiveness of the protective barrier.

Ongoing issues of efficiency and relatively low durability have to be addressed before perovskite solar cells have any chance of ending up on store shelves. Extending a cell's overall life expectancy from minutes to months is a great accomplishment, but these cells will need to hold up for decades -- roughly 20 to 30 years -- to have a shot at commercial viability.

While it's unlikely that we'll see perovskite solar technology in Home Depot within the next year or two, that doesn't mean never. A lot of progress has been made since the concept's introduction, so it's reasonable to assume that the right solutions will eventually be found. It's also possible that before standalone perovskite solar cells hit the market, we could see something similar used as part of tandem solar cells that would combine the materials with silicon solar cells to bolster energy production.

Monocrystalline Vs. Polycrystalline Solar Panels: What There Is To Know

solar panels© Jak76/Shutterstock

When opting to use solar panels as a power source for your home or business, the choices tend to revolve around where to place them and how big they should be. But there's at least one more decision to be made: whether to go with monocrystalline solar panels or polycrystalline solar panels. There's really no wrong decision here, as both types perform the basic function of a solar panel by capturing energy from the sun and turning it into electricity. Both are also made of silicon and widely available from solar panel manufacturers, according to Energy Sage. So what's the main difference?

It comes down to the material used and the related efficiency. Monocrystalline solar panels are typically made from a single silicon crystal, contain black-colored solar cells, and usually come with a higher efficiency rating to go along with the higher price. Polycrystalline solar panels are produced with multiple silicon fragments melted together, feature blue-colored cells, and tend to be a little less efficient and more affordable.

Read more: Battery Brands Ranked From Worst To Best

How Each Are Produced And What That Means

solar panels© Nancy Pauwels/Shutterstock

The manner in which they're produced ultimately impacts usage and installment. According to Forbes, monocrystalline solar panels come from a single crystal of silicon grown specifically for solar panel usage, and takes the form of a log-like piece called an ingot, sliced into octagon-shaped sheets that are aligned in a panel, like "like cookies on a baking sheet." This process enables monocrystalline solar panels to have better heat tolerance, require less space and sunlight, and have an efficiency range of between 15% to 20%, and even up to 50% in newer, more advanced models.

In the early stages, the core difference is that polycrystalline solar panels are not taken from a single ingot, but come from cooled fragments of silicon crystals which are melted and sliced for placement in a panel. It's a less drawn out and cheaper process, and the reason these cells become less efficient is because "the melted fragments of silicon afford less room for the electrons to move around," per Forbes. That efficiency rating tends to be between 13% and 16%, and the cells tend to need more space and sunlight.

While these differences can add up over time in terms of costs and electricity harnessed, choosing one over the other often relates to the space available and the amount of sunlight streaming down -- though it could also just come down to which matches the color of your roof.

What Makes Commercial Solar Panels Different, And Can You Use Them On Your Home?

A large building with solar panels on the roof© Chunyip Wong/Getty Images

After you become a homeowner, the costs of regular maintenance and services like power, garbage collection, and water become painfully apparent. So, it's not a mystery why so many homeowners are looking to save money where they can. Humanity has been taking advantage of the sun's rays for millennia, but it wasn't until the early 2000s that people started adding solar panels to their homes.

According to the U.S. Department of Energy, just .02% of available renewable energy was utilized in the U.S. in 2020, meaning solar energy has immense potential. It isn't just homes capturing the sun's power but also portable products like Ryobi's 60W foldable solar panel that lets you charge your tools for free.

With modern residential solar panel systems, homeowners can lower their utility bills, avoid blackouts, and even enhance their homes' value. So, many looking to reap the benefits of solar power wonder if commercial systems are even better and if they can use commercial solar panels for their home. Commercial solar panels are larger, more complicated, and require more extensive permits and approvals. So, installing commercial panels on a residential property would come with several challenges, making it a less-than-ideal choice for homeowners.

Read more: 12 Smart Gadgets You Didn't Know Existed

More Powerful But Larger And Costly

A view of several commercial roofs with solar panels© Asia-pacific Images Studio/Getty Images

Commercial solar panels contain more photovoltaic cells (more power generation capability) than residential equipment, making them a more attractive prospect for homeowners. However, this additional power comes at a cost, with commercial panels being much more extensive than their family neighborhood counterparts. These commercial panels take up vast sections of building and parking structure roofs and even acres of land when installed on the ground.

Even if a homeowner could accommodate commercial solar panels on their property and get all the necessary approvals and permits, is it even affordable? Not really. Unfortunately, commercial units can run into the six- and seven-figure range because of their size and the more complex installation process. If the original goal was to save some money, the prohibitive cost makes commercial solar panels a non-starter for residential homes. These systems are designed for businesses, some of which employ thousands of people working in skyscrapers or large factories with immense power needs that far outpace those of a typical home.

Weight And Installation Are An Issue

Workers installing solar panels on a home© Bloomberg/Getty Images

Putting aside all the other challenges to installing commercial solar panels on a residential structure, you must also contend with added weight. A residential panel is around 40 lbs, give or take, depending on the material used. The larger commercial panels can weigh ten or more pounds than the residential. The added weight may not seem like much until you factor in how many panels will be installed on your house. To generate enough power to make the solar option viable, you'll need upwards of 20 residential panels installed on the roof. Now add ten or more pounds for each panel to account for the larger commercial units, and you're putting a lot of extra weight on your house.

Let's say, for example, you installed 20 commercial panels on your roof, each weighing 60 lbs. Where residential panels (at 40 lbs. each) may weigh around 800 lbs, the commercial panels add another 400 lbs for a whopping 1,200 lbs sitting on top of your home. In addition, with the heavier and more complex commercial panels, you likely couldn't install them yourself to save money. The bottom line is that for homeowners looking to tap into the sun's power, the ideal option continues to be residential solar panels. If you're not ready for the cost of a home solar system but are intrigued by the technology, you can start smaller with Garmin's new smartwatch, which is equipped with solar charging for ultra-long battery life.

What To Know About Portable Solar Panels

E very second, the sun releases 384 yottawatts worth of energy the rough equivalent of 384 hydrogen bombs. With a portable solar panel, you can grab enough of that energy to run everything from laptops to power tools.

My partner and I mostly use our portable solar panels for camping. Our 400 watts of power run the electric cooler, coffeemaker, laptops and phones. We connect the panels to our portable power station to keep its battery charged, but some solar panels come with USB ports for charging electronics directly.

Considerations When Buying Portable Solar Panels

- **Watts:** Panels are measured by the amount of watts they can generate. When calculating how many watts you'll need, plan on panels only giving off about 60% to 70% of their advertised wattage. So under peak conditions, a 100W panel will actually produce about 70 watts per hour. Clouds, ambient temperature and the position of the sun (time of year and time of day) all affect how much draw you'll get.
- **Location:** If you're somewhere with trees or frequent clouds that block the sun for a portion of the day, you'll want more watt capability to recharge your batteries more quickly.
- **Max watts:** If you're using panels with a portable power station, check the station's max solar input. Don't get more panels than your station will accept. But you usually can go over the wattage limit because because, as mentioned above, panels produce less wattage than their rating.

- **Dimensions:** Portable solar panels fold into varying levels of compactness, so check to make sure they're convenient to stow in your vehicle.
- **Composition:** Monocrystalline panels are more efficient than polycrystalline. Most portable solar panels, including all but one of the ones highlighted below, use monocrystalline silicone crystals.
- **Output connections:** If you're skipping the battery box, use a solar charge controller, and make sure you connect it to the battery *before* connecting it to the solar panels. If you don't, you'll likely damage the solar charge controller.
- **Other connections:** Most units come with an array of adapters for use with just about any portable power station. However, some Anderson connectors are configured differently. If the ends don't line up, it's easy to pop them apart and rearrange them to fit.
- **Cable length:** Check the amount of cable the unit comes with. Buy an extension if you want to place your panels farther from your portable power station.

To maximize panel efficiency, regularly wipe off the dust and periodically clean them with mild soap and water. If you need maximum charge, move them throughout the day so they're optimally lined up with the sun.

Two Types of Portable Solar Panels

There are two main styles: **suitcase-style**, which come in a rigid aluminum frame with hinges to fold it in half, or **foldable**, encased in a heavy-duty canvas-like material. Most foldable solar panel faces are also coated with a substrate called ETFE, which protects them from the elements and makes them water-resistant.

Suitcase-style panels are generally heavier and larger, which makes them less portable but more stable in windy conditions and often more durable. They're most commonly used in longer-term RV setups. Note: Neither should be confused with flexible solar or amorphous panels, typically mounted atop curved surfaces like vans and boats.

My partner and I field-tested several portable solar panels. We focused on foldable style panels between 50W and 200W because of their greater portability and packability. Here are some of our favorites, in alphabetical order.

Anker Solar Panel 625 100W

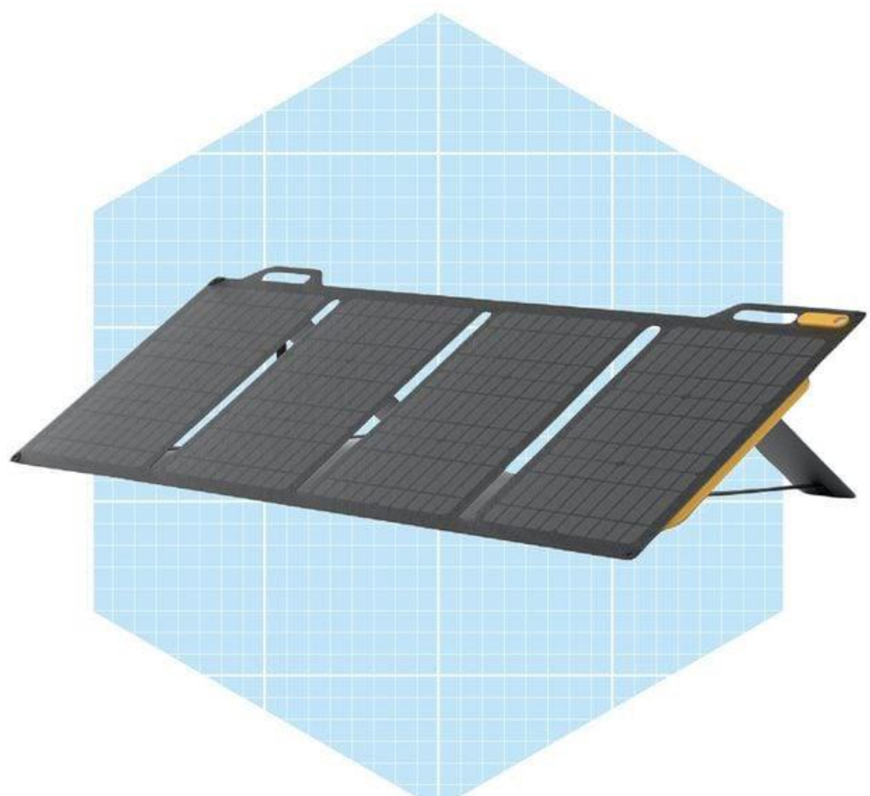
Anker Solar Panel 625 100W

Similar to their portable power stations, Anker's pricing on their 100W portable solar panels is a better deal per watt hour than most other major brands. This panel includes their Suncast technology, which helps you align the panels with the sun for maximum charge.

It also has built-in USB-C and USB-A outputs, so you can charge two devices directly from the panel at the same time.Pair with Anker's 757 PowerHouse or 521 PowerHouse portable power stations.

Specs: 11 pounds, folded dimensions 20.7-in. by 18.5-in. by 3.4 in.

BioLite SolarPanel 100s



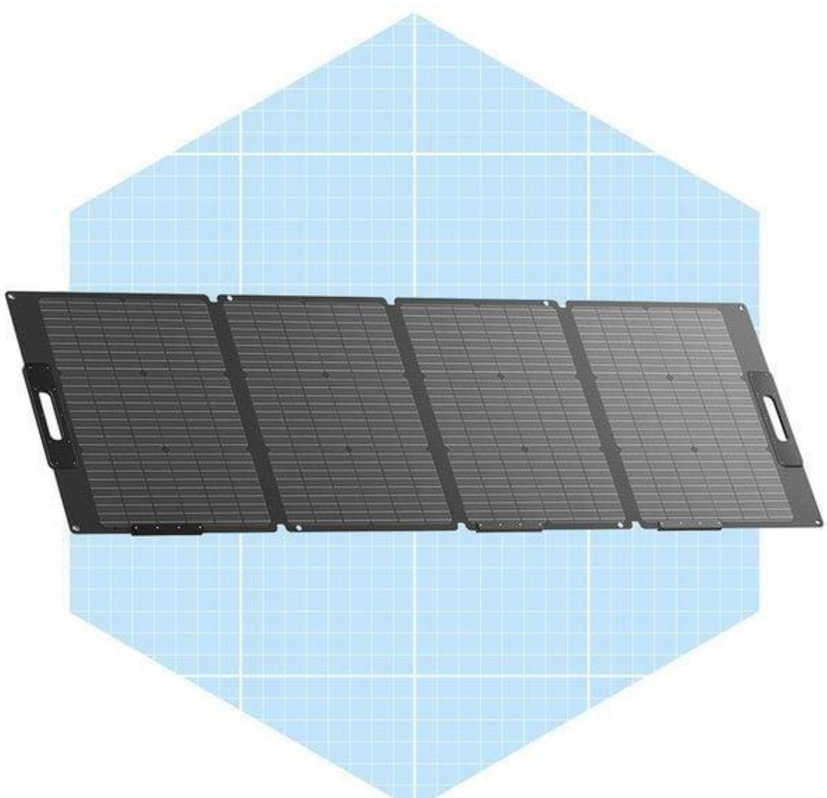
BioLite SolarPanel 100

We toted BioLite's SolarPanel 100s from Colorado all the way down the Baja Peninsula and back. Nice and compact, they also come with an integrated sundial called the Optimal Sun System for best alignment. The panels performed well, with a consistent 70% output.

Other features include USB-A and USB-C ports for direct electronics charging, chain-ability up to four panels with an adaptor cable and an integrated cable storage pouch. Pair with BioLite BaseCharge 1500 or BaseCharge 600. Biolite also makes a nice 10+ solar panel for backpacking.

Specs: 9.5 pounds, folded dimensions 20.1-in. by 14.25-in. by 1.5 in..

Bluetti **PV120 Solar Panel**



Bluetti PV120 Solar Panel

Most solar panels come in 100W or 200W sizes, which puts the 120W Bluetti PV120 Solar Panel in a helpful in-between range. Its still easily packable, only slightly larger than most 100W models. Its extra 20% input is especially helpful in areas where daily sunlight might be limited by obstacles or weather.

It also includes an easy-carry handle and snaps on the kickstands, so you can determine and fix your desired sunlight collection angle. Bluetti also makes a 200W version. Either can be paired with the Bluetti AC200P Portable Power Station.

Specs: 12.57 pounds, folded dimensions 21-in. by 18.5-in. x 1.5-in.

BougeRV Paso 100W CIGS Portable Solar Blanket

BougeRV Paso 100W CIGS Portable Solar Blanket

BougeRV's 100W solar blanket folds down to the size of a laptop thanks to its thin-film CIGS technology, which is different from monocrystalline. Because it's configured with 12 small panels, it can drape over a tent or truck bed. That way, some panels are always getting a charge even if you don't reposition it throughout the day.

Other features include a built-in charge controller and carry case.

Specs: 4.85 pounds, folded dimensions 14.1-in. by 10.6-in. by 1.2-in.

Go Power DuraLite 100-Watt Solar Kit

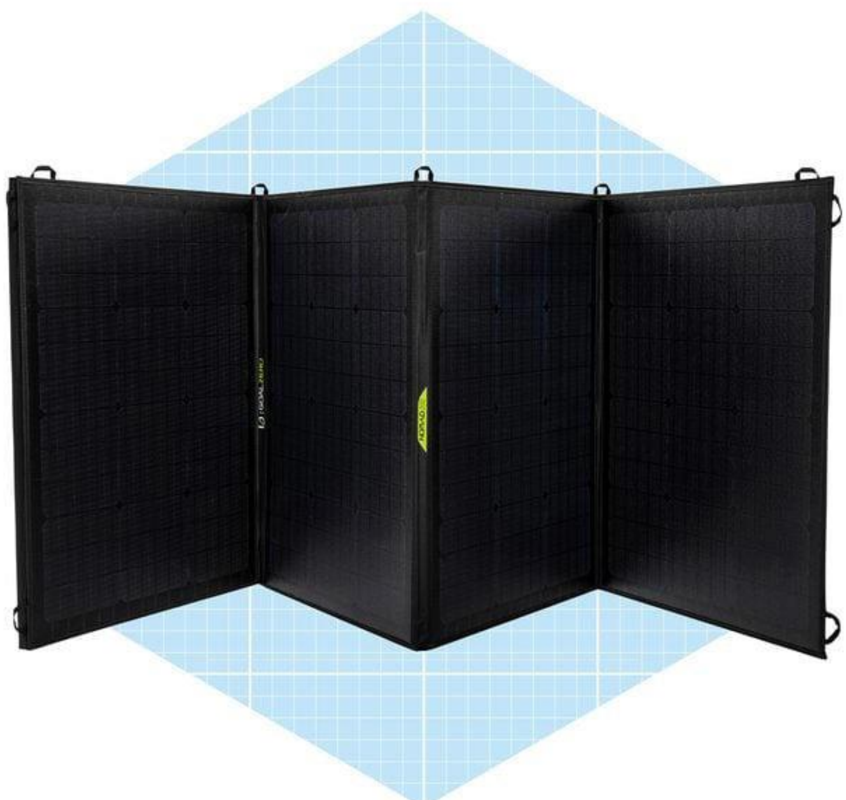
Go Power DuraLite 100-Watt Solar Kit

The Go Power DuraLite 100-Watt Solar Kit comes with a 30-amp charge controller and battery clamps, so you recharge vehicle and other freestanding batteries without a portable power station. It also comes with built-in USB chargers, magnetic closures to keep it together during transit, 12 feet of cable, comfortable plastic handles and a storage bag.

If you're just using it with a portable power station, you can save a little money and get the DuraLite 100W Expansion Solar Panel instead.

Specs: Nine pounds, folded dimensions 21.1-in. by 23.8-in. by 1.8-in.

Goal Zero Nomad 200



Goal Zero Nomad 200

We also used the Goal Zero Nomad 200 during our Baja run. Because it's 200W, you don't need two 100W arrays. That's more convenient as long as you can handle its larger footprint in your vehicle.

This durable panel includes stake-down loops on the foldout legs, a carrying case and a built-in USB-A connector. You can also link it to other panels with a power port combiner. Goal Zero also makes 100W and 50W Nomad foldable panels. Pair with Yeti 500X or Yeti 1500X portable power stations.

Specs: 22 pounds, folded dimensions 28.2-in. by 22.3-in. by two inches.

Lion 50W Foldable Solar Panel

Lion 50W Foldable Solar Panel

The size and weight of Lion's 50W panel make it top of its class. At just three pounds, it's half the weight of competitors' 50W models, so you can easily take it backpacking. It features USB-A and USB-C ports plus a 10-foot barrel-to-barrel cord.

Specs: Three pounds, folded dimensions 11.25-in. by 11.25-in. by 1.63-in.

Nicesolar 100W Foldable Solar Panel

Nicesolar 100W Foldable Solar Panel

For the best price on a decent 100W foldable solar panel, check out this Nicesolar. As compact as the other 100Ws, it features USB-A and USB-C ports for directly charging personal electronics. It also comes with a carrying case and an array of connectors to make it compatible with pretty much any portable power station.

It's got a few quirks the name brands don't have, but overall it's a great value. It also claims to be waterproof, but the connector can actually get wet. Son't leave it in the rain without adequately protecting that. Nicesolar also makes a 200W model.

Specs: 7.3 pounds, folded dimensions 20.7-in. by 14-in. by 1.6-in.

Renogy E.FLEX 80 Portable Solar Panel

Renogy E.FLEX 80 Portable Solar Panel

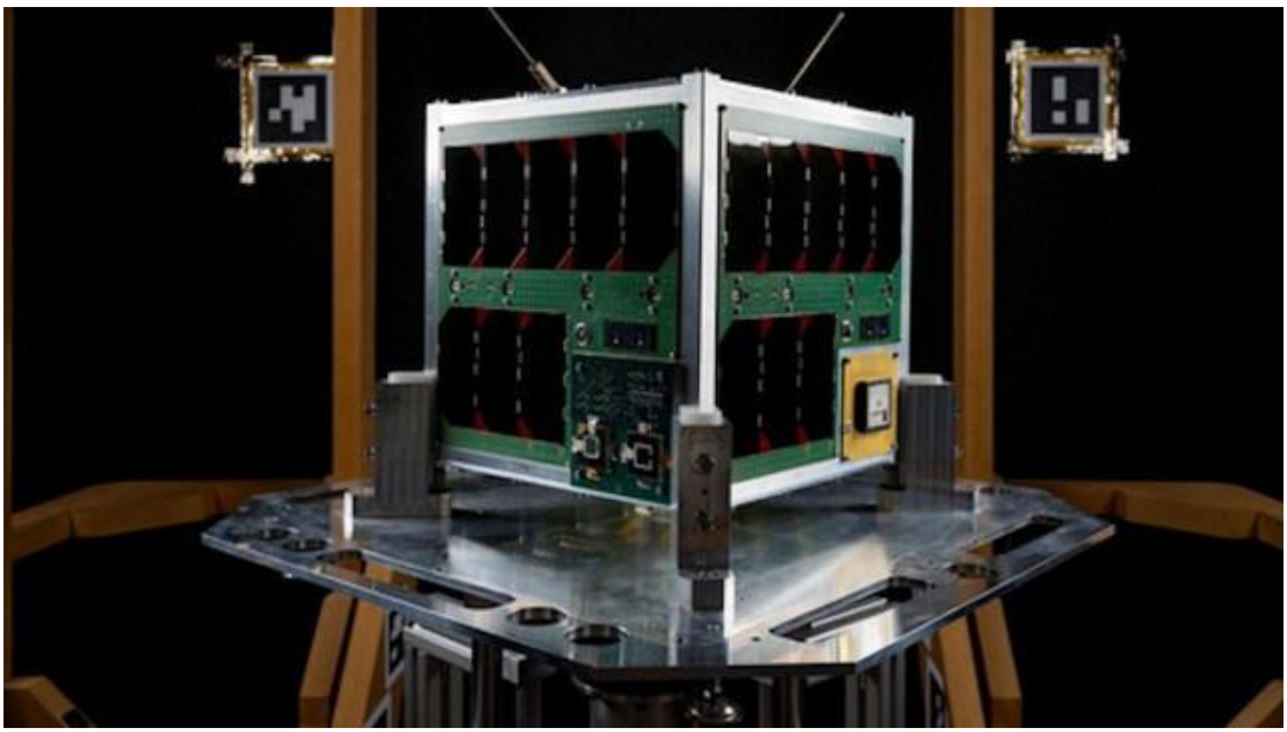
Renogy is best known for its off-grid home and RV solar solutions. We installed one of their systems in our van camper, which we've greatly enjoyed.

But Renogy also makes some terrific portable solar panels, including the E.Flex 80. They're durable, consistently perform well on input tests (around 70%) and can be left in the rain without worry. They also come with comfortable carrying handles, a waterproof storage case, a five-in-one adaptor and eight feet of cable.

Pair with Renogy's Phoenix 500 portable power station.

Specs: 7.3 pounds, folded dimensions 24.8-in. by 17.1-in. by one inch.

Scientists launch first satellite mission to test revolutionary new solar tech — here's how it stacks up



The satellite has already started sending back signals saying the equipment is working.

A new solar panel material called a perovskite tandem solar cell is being tested in space — and the results are looking good, PV Magazine reports.

Thanks to a team led by Dr. Felix Lang from the University of Potsdam, including researchers at Helmholtz-Zentrum Berlin and the Technical University of Berlin, two types of these new perovskite cells have been sent on their first satellite missions into space to test their durability and performance. (They're also being tested at the [International Space Station]().) After a successful launch in July, the early results are in.

The major benefit of perovskite is how much it will improve the efficiency of solar panels. Compared to the current industry standard — which turns 20% to 25% of the sunlight that hits it into electricity — perovskite models boast 35% to 45% efficiency, per PV Magazine.

Click your choice to see results and speak your mind
However, there were concerns that perovskite might gain efficiency at the cost of durability — wearing out sooner than existing solar panels. That's why this mission set out to test how the new tandem solar cells would hold up in the intense environment of space, 580 miles over the surface of the Earth, where they'd be bombarded with radiation and cycle between extreme heat and extreme cold.

PV Magazine explained that there are two types of cells chosen for the test: perovskite/CIGS and perovskite-silicon tandem cells. Perovskite absorbs the part of sunlight that's blue to green, and CIGS or silicon absorbs red and infrared radiation.

According to Dr. Lang, the satellite has already started sending back signals saying the equipment is working, even though the solar panels aren't aligned with the sun yet.

Watch now: How bad is a gas stove for your home's indoor air quality?

Those are already good results. But Dr. Lang doesn't just expect efficiency from the new solar cells. He also hopes that the perovskite will turn out to be self-healing, repairing some of the damage it absorbs from solar radiation. That would make it last even longer, making it a better choice than traditional solar panels.

For now, the team will continue to receive updates from the satellite mission, providing key insights into how this new material performs.

New ultra-thin solar cell could transform energy efficiency


Ordinary photovoltaic panels are a thing of the past.© Getty Images, temis

Chinese researchers have introduced an innovative solar cell that could serve as an alternative to traditional photovoltaic panels. The newly developed thin-film cell boasts high efficiency while using less silicon than standard versions.

A scientific team from Hangzhou Dianzi University created a **monocrystalline cell that matches the efficiency of typical cells**. According to information published in pv magazine, this cell is only 0.0008 inches thick, a significant advancement since it is eight times thinner than popular panels, which have a thickness of about 0.006 inches.

Can the new technique revolutionize photovoltaics?

Researchers employed a layer transfer technique instead of the traditional methods of cutting silicon blocks. This approach involves **transferring a thin semiconductor material layer from the original substrate to the target location.**

This technology uses hydrofluoric acid to create a porous texture on a thick silicon wafer. This substrate then supports the growth of the monocrystalline silicon layer. Once this process is completed, the thin layer is separated from the porous silicon substrate.

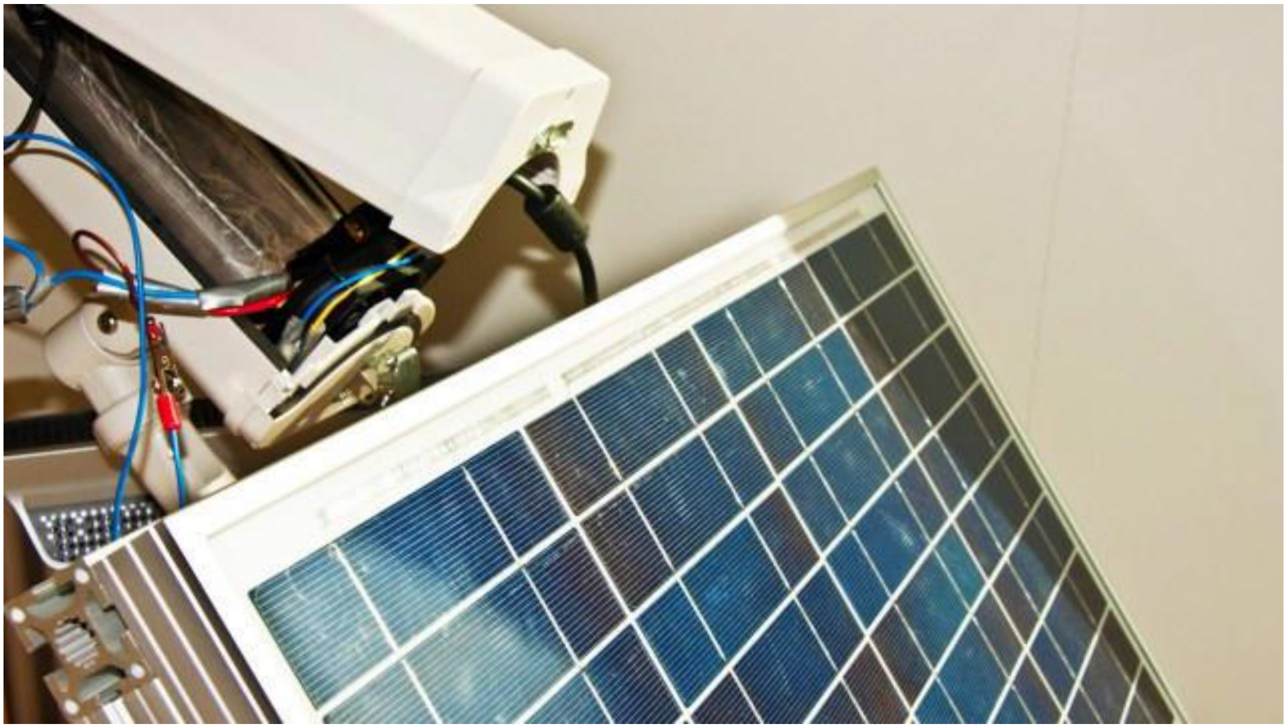
The result is a 0.0008-inch monocrystalline wafer, onto which several passivation layers, such as aluminum oxide, silicon nitride, and silicon oxide, are applied using the PECVD technique.

What characterizes the new solution?

According to scientists, in the newly tested cell, the current density increased from 34.3 mA/cm^2 to 38.2 mA/cm^2. Additionally, the open-circuit voltage **increased from 632 mV to 684 mV.**

Thanks to these modifications, the **fill factor reached 80.8 percent compared to 76.2 percent in standard cells**. Ultimately, the cell's efficiency significantly increased from 16.5 percent to 21.1 percent.

Scientists achieve milestone that could revolutionize growing source of energy worldwide — here's what the next generation could look like



The team was able to reach this level of efficiency through a unique combination of materials.

Researchers in China have reached an exciting milestone in solar energy efficiency, according to a recent report in Interesting Engineering.

Scientists associated with the Institute of Chemistry, Chinese Academy of Sciences have developed the next-generation solar cell, known as the perovskite-organic solar cell.

What makes this breakthrough so impactful is the cell's high efficiency. The perovskite-organic solar cell can reach a record photoelectric conversion efficiency of 26.4%, according to researchers on the team. This means it is able to convert more sunlight into usable energy.

The new findings underscore the potential of perovskite materials in supporting solar energy efficiency, as the conversion rates outperform existing solar cells. According to Sunsave, domestic solar panels have so far reached a top efficiency of 24%, with an average efficiency in the range of 18-24%.

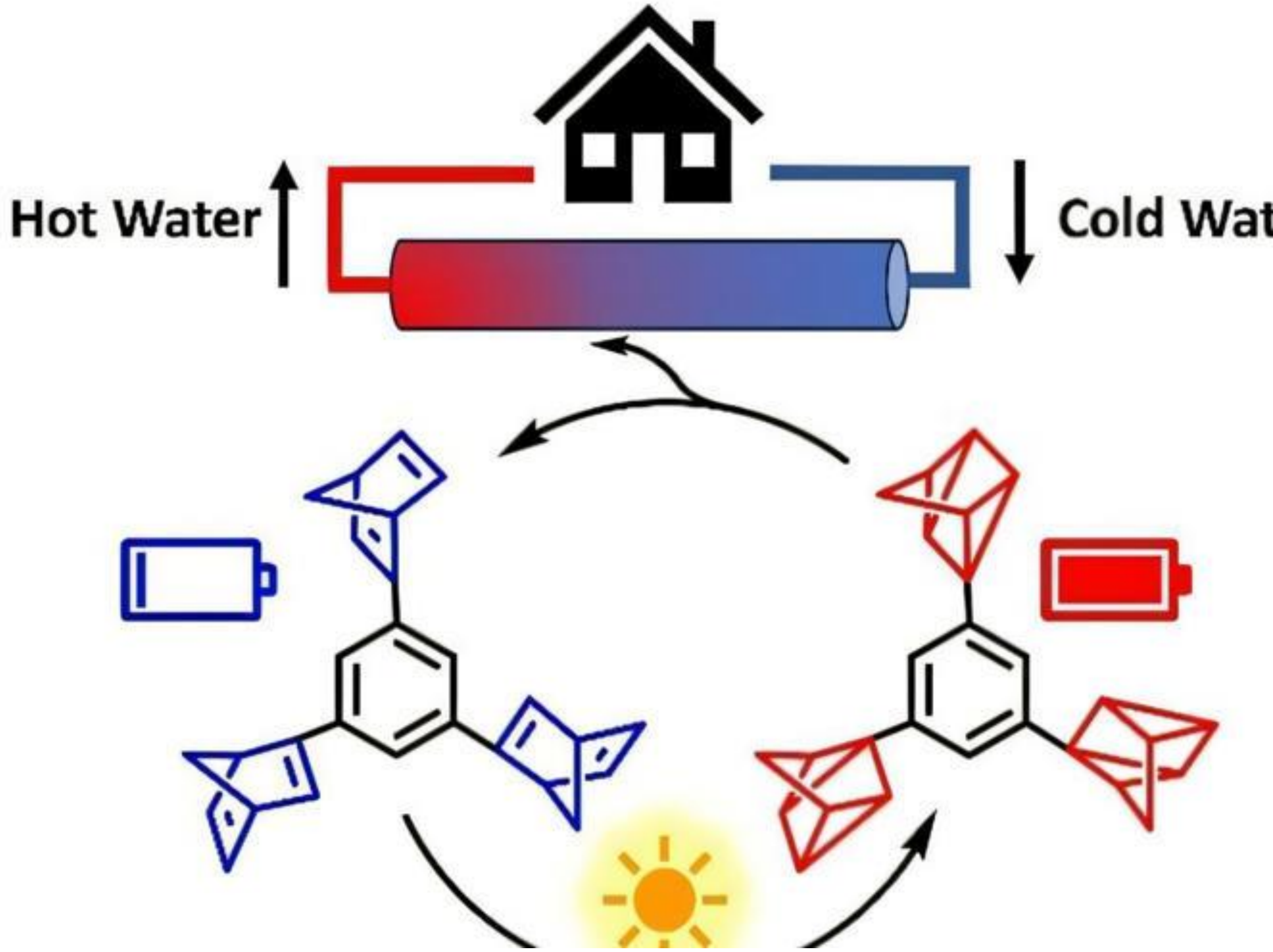
The Chinese team was able to reach this level of efficiency by using wide-bandgap perovskite materials to capture short-wavelength sunlight. They then used a narrow-bandgap organic active layer, which absorbs near-infrared long-wavelength sun rays. Together, this combination significantly expands the usable solar spectrum, improving the device's overall efficiency.

Thanks to its lightweight material and simple preparation, perovskite solar cells offer numerous applications, including portable energy, building-integrated photovoltaics, and indoor photovoltaics, per Interesting Engineering.

In the energy industry, efficiency translates to reduced costs. So by improving solar cell efficiency, the researchers are decreasing the cost of solar energy for commercial and home use.

Switching to solar energy can lead to significant monetary savings down the road. After initial installation costs, you can expect annual savings of up to $1,500.

Photoswitch approach paves the way for harvesting and storing solar energy efficiently



Storing energy in chemical bonds using a large fraction of the solar spectrum. Credit: Till Zähringer / JGU

As stated by the International Energy Agency (IEA), approximately 50% of global final energy consumption is dedicated to heating. Yet, the utilization of solar power in this sector remains relatively low compared to fossil energy sources. An inherent problem limiting the widespread usage of solar energy is the intermittency of its direct availability.

A promising solution comes in the form of molecular solar energy storage systems. Conventional thermal energy storage strategies store the energy for short periods, e.g., in the form of hot water. In contrast, molecular solar energy storage systems store solar energy in the form of chemical bonds, allowing it to be preserved for several weeks or even months.

These specialized molecules—or photoswitches—absorb solar energy and release it later as heat, on demand. However, a key challenge for current photoswitches is the trade-off between energy storage capacity and efficient absorption of solar light, limiting the overall performance. To overcome this issue, research teams at Johannes Gutenberg University Mainz (JGU) and the University of Siegen present a novel approach in a collaborative study.

The results have been published in *Angewandte Chemie International Edition*.

Decoupling the absorption and storing processes of solar energy

The novel class of photoswitches was first introduced by the group of Professor Heiko Ihmels at the University of Siegen, demonstrating exceptional energy storage potential comparable to conventional lithium-ion batteries. However, their functionality was initially limited to activation by UV light, which constitutes only a small portion of the solar spectrum.

The research teams at Mainz and Siegen have now introduced an indirect light harvesting method, comparable to the function of the light-harvesting complex in photosynthesis. This incorporates a second compound, a so-called sensitizer, which exhibits excellent absorption properties of visible light.

"In this approach, the sensitizer absorbs light and subsequently transfers energy to the photoswitch, which cannot be directly excited under these conditions," explained Professor Christoph Kerzig of the JGU Department of Chemistry.

This new strategy has increased solar energy storage efficiency by more than one order of magnitude, representing a major step forward for the energy conversion research community. The potential applications of these systems span from household heating solutions to large-scale energy storage, offering a promising path towards sustainable energy management.

Mechanistic studies essential for reaction discovery and optimization

The Mainz-based team of researchers led by Professor Kerzig and Ph.D. student Till Zähringer conducted detailed spectroscopic analyses to explore the complex system, which were essential for understanding the underlying mechanism. Each reaction step was carefully examined by the paper's first author, Zähringer, resulting in a thorough understanding of how the system operates.

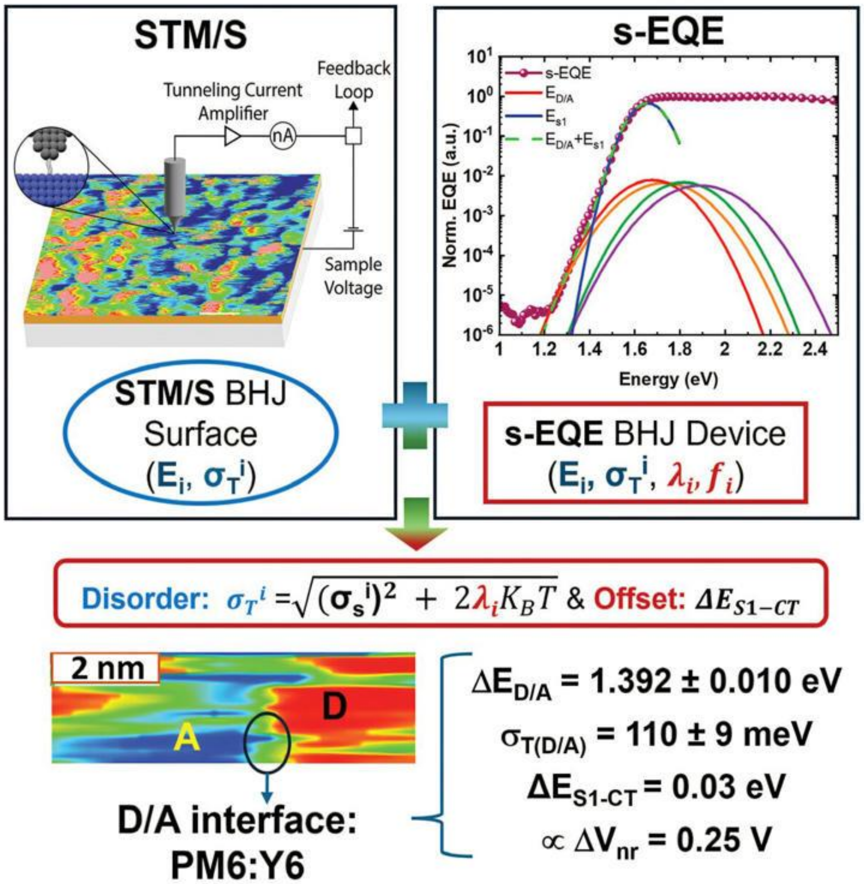
"By doing so, we could not only push the light-harvesting limit substantially but also improve the conversion efficiency of light to stored chemical energy," explained Zähringer.

Under operational conditions, each absorbed photon can trigger a chemical bond formation process, which is rarely observed in photochemical reactions owing to several energy loss channels. The scientists successfully validated the system's robustness and practicality by cycling between the energy storage state and the energy release state multiple times employing solar light, highlighting its potential for real-world applications.

More information: Till J. B. Zähringer et al, Triplet-Sensitized Switching of High-Energy-Density Norbornadienes for Molecular Solar Thermal Energy Storage with Visible Light, *Angewandte Chemie International Edition* (2024). DOI: 10.1002/anie.202414733

Provided by Johannes Gutenberg University Mainz

Linking energy loss to interfaces in organic solar cells could make them much more efficient



Graphical abstract. Credit: Matter (2024). DOI: 10.1016/j.matt.2024.10.007

New research from North Carolina State University provides a deeper understanding of precisely what is happening in organic solar cells as light is converted into electricity. Researchers have developed a new method that visualizes interfaces where sunlight's energy is converted to electrical charges, and they have used the findings to develop a set of design rules that can improve the efficiency of organic solar cells.

The research is published in the journal *Matter*.

Organic solar cells are made with carbon-based polymer materials that have the potential to be low cost, can be made from earth-abundant materials, and have some attractive features—such as the fact that they can be made into semi-transparent or transparent window applications. In addition, as thin film solar cells, they have the potential for lightweight and flexible solar applications amenable to roll-to-roll manufacturing—which could also make them easy to transport and install.

However, organic solar cells have not been as efficient as silicon or perovskite solar technologies at converting light into electricity.

"Organic solar cells are made of a mixture of two materials," says Aram Amassian, co-corresponding author of a paper on the work and a university faculty scholar and professor of materials science and engineering at North Carolina State University.

"Both materials harvest electrons from sunlight. However, one of the materials is a polymer that harvests electrons, but then has to interact with the second material in order to pass those electrons on. The polymer is called a donor material; the other substance, typically a small molecule, is called the acceptor material.

"We knew that interfaces between donor and acceptor materials were responsible for a voltage loss—which is what currently limits the efficiency of organic solar cells. Our goal with this work was to gain a deeper understanding of what aspects of interfaces were responsible for the voltage loss so that we may improve them."

To address this challenge, the researchers developed a scanning-probe microscopy method that allowed them to map not only the topographic characteristics of the donor and acceptor blend, but also the energy characteristics of the donor and acceptor materials at the interfaces—such as the energy gradient at the interface and how disordered the donor and acceptor materials are at the interface.

"This technique allowed us to determine how the degree of disorder of donor and acceptor molecules at the interface impacted the energy disorder," says Daniel Dougherty, co-corresponding author of the paper and a professor of physics at NC State. "Once we had mapped the energetics of all of these interfaces, we were able to compare those findings with the results of conventional methods that characterize the overall performance of an organic solar cell's voltage loss."

The team needed to overcome another key challenge. As the scanning-probe microscopy technique does not directly measure voltage loss, the team could not tell which interface was the main culprit.

"Blends of donor and acceptor materials give rise to many different types of interfaces at once and it is not clear which interfaces are responsible for voltage losses," Amassian says.

"Our study revealed that the functional interface in modern high performance organic solar cells, such as PM6:Y6, is the sharp donor-acceptor interface," Dougherty says. "The findings imply that this type of interface needs to be targeted to further reduce voltage losses."

"Once we identified the functional interface associated with voltage loss, we conducted a series of investigations into which factors influenced voltage loss," Amassian says.

"There has been a longstanding debate in the organic solar cell community between people who argued that voltage loss was driven by energy differential between constituent donor and acceptor materials and people who argued that voltage loss was driven by energetic disorder along interfaces. Our experiments show that both sides are correct—it's a combination of both factors."

The researchers successfully demonstrated that it is possible to "fix" the energy differential and tune the disorder at interfaces by changing the way the donor and acceptor are blended during fabrication in such a way as to reduce the voltage loss as much as possible.

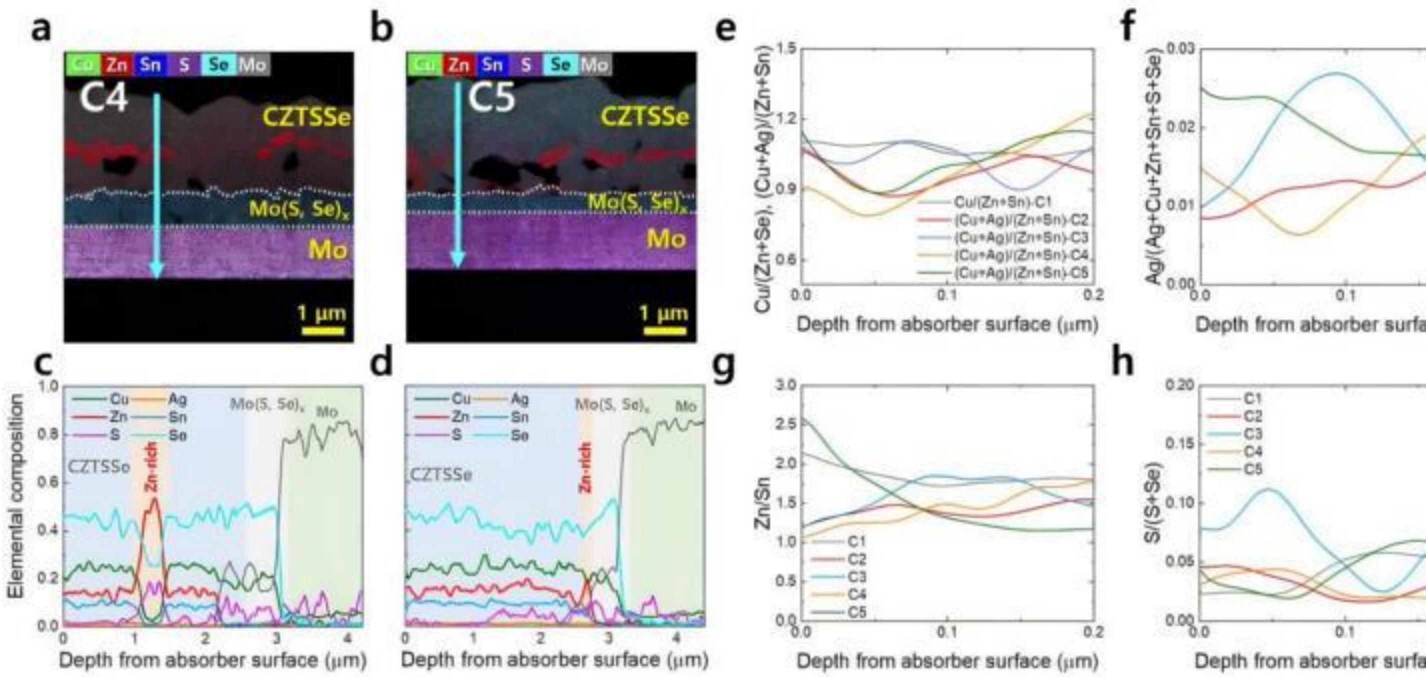
"By controlling for one of the drivers of voltage loss, we were actually able to identify engineering solutions that will help the organic solar cell community minimize the other driver of voltage loss," Amassian says.

"Essentially, voltage losses are reduced by selecting a pair of materials with minimal energy offsets. Practitioners can then further reduce energy losses by identifying a solvent and processing parameters that substantially reduce interfacial disorder. We're optimistic the design rules we developed using this technique can be used to inform organic solar cell research and development moving forward."

More information: Mapping Interfacial Energetic Landscape in Organic Solar Cells Reveals Pathways to Reducing Nonradiative Losses, *Matter* (2024). DOI: 10.1016/j.matt.2024.10.007. www.cell.com/matter/fulltext/S2590-2385(24)00534-4

Provided by North Carolina State University

Next-generation solar cells become more powerful with silver-doping technology



Cross-sectional EDS mapping images of the (a) C4 and (b) C5 absorbers after the sulfo-selenization process. Credit: Energy & Environmental Science (2024). DOI: 10.1039/D4EE02485K

A team of researchers has significantly improved the performance of kesterite (CZTSSe) thin-film solar cells. They developed a new method for doping silver (Ag) in solar cells to suppress defects that hinder cell performance and promote crystal growth, thereby dramatically increasing efficiency and paving the way for commercialization. The work is published in the journal *Energy & Environmental Science*.

CZTSSe solar cells are composed of copper (Cu), zinc (Zn), tin (Sn), sulfur (S), and selenium (Se), and are gaining attention as a resource-abundant, low-cost, and eco-friendly solar cell technology. In particular, they have the advantage of being suitable for large-scale production and highly competitive in price because they use materials that are abundant in resources instead of the scarce metals used in conventional solar cells.

However, conventional CZTSSe solar cells have low efficiency and high current losses due to electron-hole recombination, thus making them difficult to commercialize.

To address these issues, the research team employed a method of doping the solar cell precursor with Ag. Ag inhibits the loss of Sn and helps the materials mix better at low temperatures. This allows the crystals to grow larger and faster, reducing defects and improving the performance of the solar cell.

In this study, they systematically analyzed how the placement of Ag at different locations in the precursor changes the defects and electron-hole recombination properties in the solar cell. The results indicate that Ag can significantly improve the performance of the solar cell by preventing Sn loss and maximizing the defect suppression effect.

Importantly, they also found that doping Ag in the wrong place actually interferes with the formation of Zn and Cu alloy, causing Zn to remain in the bulk and form defect clusters. This can lead to increased electron-hole recombination losses and degraded performance. From this, the research team offered an important insight: solar cell performance varies significantly depending on where Ag doping occurs.

Furthermore, the research team found that the liquid material formed by Ag doping promotes crystal growth, significantly improving the density and crystallinity of the absorber layer. This resulted in an improved energy band structure and fewer defects, ultimately allowing for smoother charge transport in the cell. These findings are expected to contribute significantly to the production of high-performance solar cells at low cost.

The researchers included Kee-jeong Yang, Dae-hwan Kim, and Jin-gyu Kang from the Division of Energy & Environmental Technology, DGIST, who collaborated with Prof. Kim Jun-ho's team from the Department of Physics, Incheon National University and Prof. Koo Sang-mo's team from the Department of Electronic Materials Engineering.

"In this study, we analyzed the effect of Ag doping, which had not been clearly identified before, process by process, and found that silver plays a role in suppressing tin loss and improving defects," said Yang.

"The results provide important insights into the design of silver-doped precursor structures to improve solar cell efficiency and are expected to contribute to the development of various solar cell technologies."

More information: SeongYeon Kim et al, Reducing carrier recombination loss by suppressing Sn loss and defect formation via Ag doping in $Cu_2ZnSn(S,Se)_4$ solar cells, *Energy & Environmental Science* (2024). DOI: 10.1039/D4EE02485K

Provided by DGIST (Daegu Gyeongbuk Institute of Science and Technology)

Solar panels that can generate electricity at night have been developed at Stanford

Solar panels that can generate electricity at night have been developed at Stanford© Jade Small

Solar energy has long been celebrated for its ability to harness the power of the sun, but until recently, it could only generate electricity during the day. A groundbreaking development from a team of engineers at Stanford University has changed that by creating a solar panel capable of producing electricity even at night. This innovation represents a major leap forward in renewable energy, offering a more continuous power source.

Stanford's Revolutionary Solar Cell

A group of engineers at Stanford has unveiled a solar cell that can generate power during both the day and night. Published in *Applied Physics Letters*, their research outlines how this new solar device incorporates a thermoelectric generator. This feature allows the solar cell to capture electricity from the temperature difference between the surrounding air and the solar panel itself, providing energy even in the absence of sunlight.

Expanding Solar's Capabilities

While typical solar panels have only been useful for daytime energy generation, this new technology offers a solution for continuous renewable power. The device could play a key role in providing essential nighttime lighting and power in off-grid and mini-grid applications. These applications are particularly valuable in areas where traditional grid infrastructure is not feasible, helping communities maintain energy independence even in remote locations.

The Rise of Solar Energy and Job Creation

As solar technology becomes more affordable and accessible, its popularity continues to grow. The cost of solar panels has significantly decreased in recent years, driving both residential installations and job creation in the solar industry. This shift is further supported by various state and federal incentives, including those in California, which has actively encouraged the adoption of solar energy.

Solar Energy's Role in Global Energy Independence

In a time of global uncertainty, particularly with the ongoing war in Ukraine, leaders in the solar industry are emphasizing the importance of renewable energy. Abigail Ross Hopper, President and CEO of the Solar Energy Industries Association, highlighted the need to ramp up clean energy production to reduce dependence on foreign energy sources. By investing in alternative energy, the U.S. can secure a more sustainable and reliable energy future.

Conclusion

The development of solar panels that can generate power at night is a significant step forward in the quest for sustainable energy solutions. By expanding solar technology's capabilities, this breakthrough offers a promising future for off-grid communities and helps pave the way for a more energy-independent world. As solar energy continues to evolve, it holds the potential to play an even larger role in the global transition to renewable power.

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The post Solar panels that can generate electricity at night have been developed at Stanford appeared first on Organically Human.

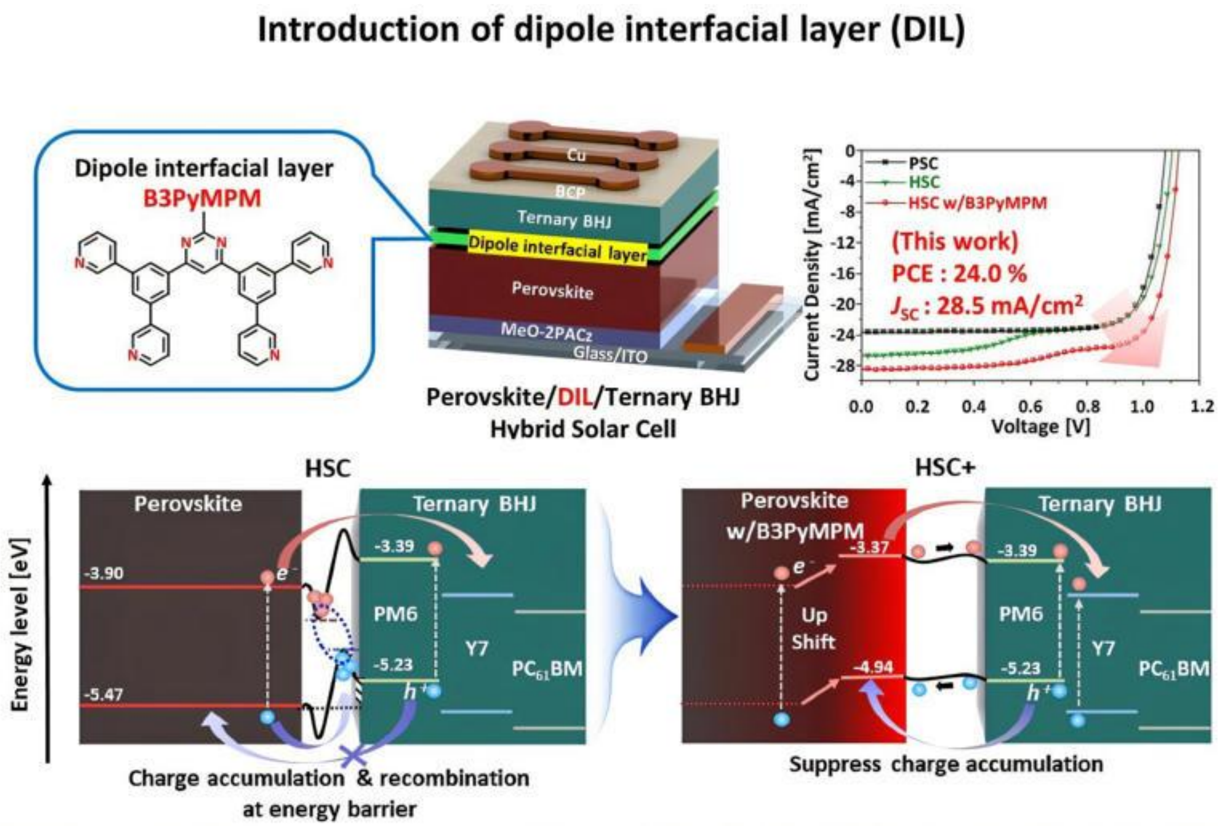
Hybrid near-infrared light capturing solar cell retains 80% performance after 800 hours

Korean researchers have been successful in improving the performance of perovskite solar cells.

They developed a hybrid technology that maximizes near-infrared light capture and power conversion efficiency.

Korea Advanced Institute of Science & Technology (KAIST) researchers state that this innovation paves the way for the commercialization of next-generation solar cells. Moreover, it promises a brighter future for solar energy and global technological progress.

This study broke new ground by significantly boosting the power conversion efficiency of the hybrid device to 24.0%, up from 20.4%.



The illustration of the mechanism of improving the electronic structure and charge transfer capability through Perovskite/organic hybrid device structure and dipole interfacial layers (DILs). KAIST

Hybrid solar cell tech

They've developed a high-efficiency, high-stability hybrid solar cell that can capture near-infrared light.

It's particularly special because it can absorb not only visible light (the kind we can see) but also near-infrared light, which is invisible to the human eye. This expanded light absorption range allows the solar cell to generate more electricity from sunlight.

They've combined two types of materials: perovskite and organic photo-semiconductors.

"The research team suggested and advanced a hybrid next-generation device structure with organic photo-semiconductors to complement perovskite materials limited to visible light absorption and expand the absorption range to near-infrared," the press release noted.

Works in humid conditions

Most perovskite solar cells can only absorb visible light (with 850 nanometers (nm) or less wavelength), limiting their efficiency. This limitation prevents the cells from harnessing roughly 52% of the total solar energy available.

To unlock the full potential of solar energy, they created a hybrid device that merges the strengths of perovskite and organic bulk heterojunction materials.

This innovative approach resulted in a solar cell capable of absorbing light up to the near-infrared region.

Moreover, the researchers identified and addressed electronic structure issues by introducing a dipole layer, resulting in a high-performance solar cell.

By adding a sub-nanometer dipole layer, they improved charge transfer and near-infrared light absorption, boosting the current density to 4.9 mA/cm^2.

In a solar cell, the internal quantum efficiency (IQE) measures how efficiently it converts incoming photons (particles of light) into electrical current.

As per the press release, the device achieved a record-high IQE of 78% in the near-infrared region.

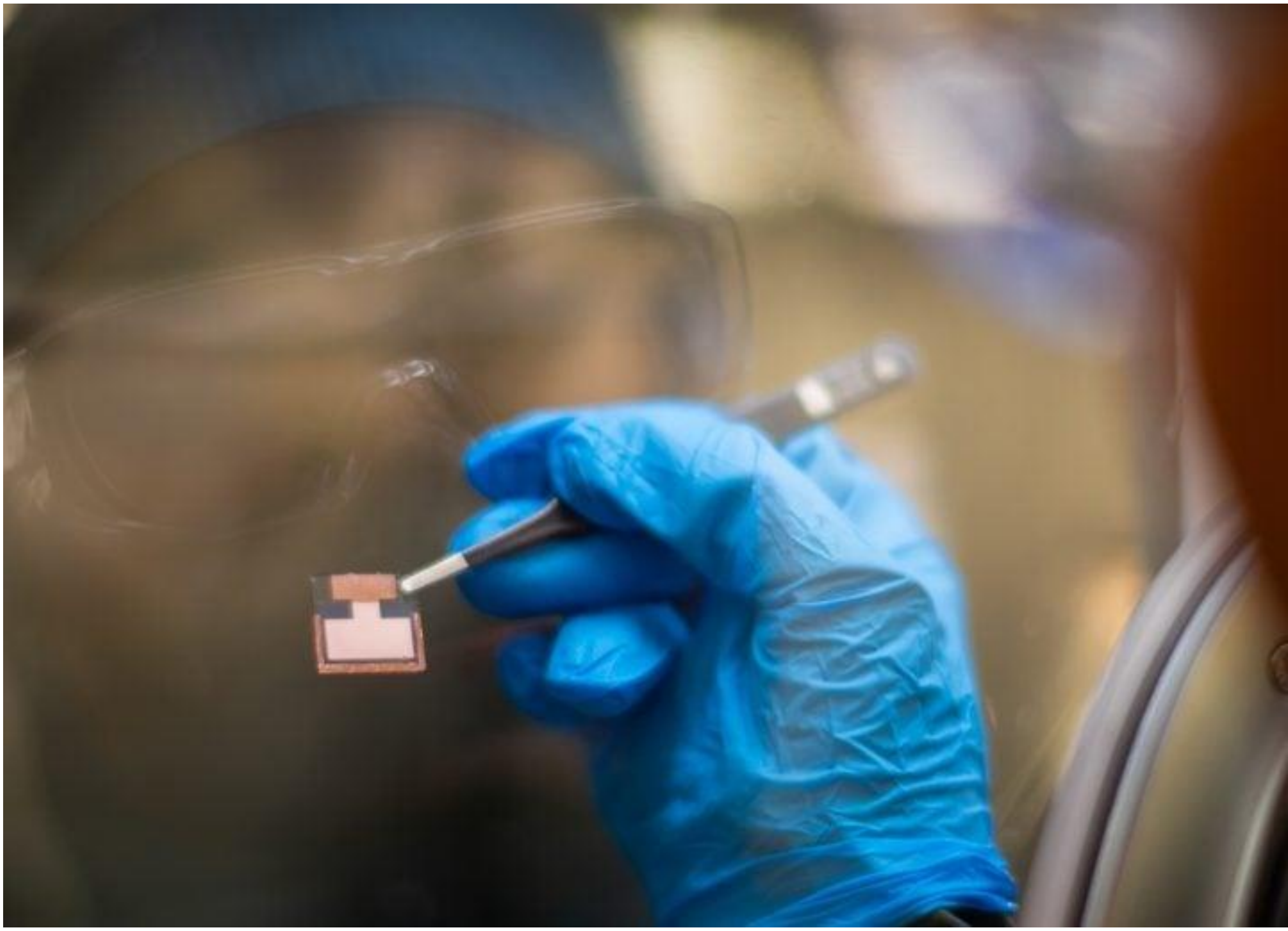
Interestingly, the device proved its durability and reliability by maintaining over 80% of its peak performance for over 800 hours, even in humid environments.

"Through this study, we have effectively solved the charge accumulation and energy band mismatch problems faced by existing perovskite/organic hybrid solar cells, and we will be able to significantly improve the power conversion efficiency while maximizing the near-infrared light capture performance, which will be a new breakthrough that can solve the mechanical-chemical stability problems of existing perovskites and overcome the optical limitations," said Professor Jung-Yong Lee in the press release.

This innovative approach significantly boosts the overall efficiency of solar cells, leading to increased power generation.

The findings were published in the journal *Advanced Materials.*

Solar Cell Breakthrough: Scientists Boost Efficiency and Longevity With Miracle Material



Researchers at the University of Surrey improved perovskite solar cell efficiency to over 23% and extended their lifespan by 66%, advancing clean, sustainable energy technology. Credit: University of Surrey

A research team improved perovskite solar cell efficiency (23% PCE) and lifespan (66% longer) by tackling hidden degradation pathways, advancing affordable and sustainable energy solutions.

An international team, led by the University of Surrey in collaboration with Imperial College London, has developed a strategy to enhance both the performance and stability of perovskite-based solar cells, addressing a previously undiscovered degradation pathway.

In a new study published in *Energy and Environmental Science*, Surrey's Advanced Technology Institute (ATI) details how they, together with their collaborators, were able to produce lead-tin perovskite solar cells that reach more than 23% power conversion efficiency (PCE) – one of the best results achieved with this material and importantly, a design strategy which improves the lifetime of these devices by 66%. PCE refers to the amount of sunlight a cell can convert to usable electricity.

While silicon solar panels are used on many rooftops today, perovskite/silicon solar panels are emerging on the market, with fully "all-perovskite" panels with even higher efficiencies being anticipated to be the next big step with the technology.

Addressing Challenges in Perovskite Solar Cells

However, for this technology to be commercially viable, scientists need to tackle the challenge of improving both the stability and efficiency, especially around the lead-tin perovskite cell used in this design. This collaborative study initiated by the University of Surrey identifies previously hidden mechanisms that contribute to both efficiency and stability losses and addresses these challenges, helping the scientific community to advance this technology.

Hashini Perera, Ph.D. student and lead author of the study from the Advanced Technology Institute at the University of Surrey, said: "The understanding we have developed from this work has allowed us to identify a strategy that improves the efficiency and extends the operational lifetime of these devices when exposed to ambient conditions. This advancement is a major step towards high efficiency, long-lasting solar panels which will give more people access to affordable clean energy while reducing the reliance on fossil fuels and global carbon emissions."

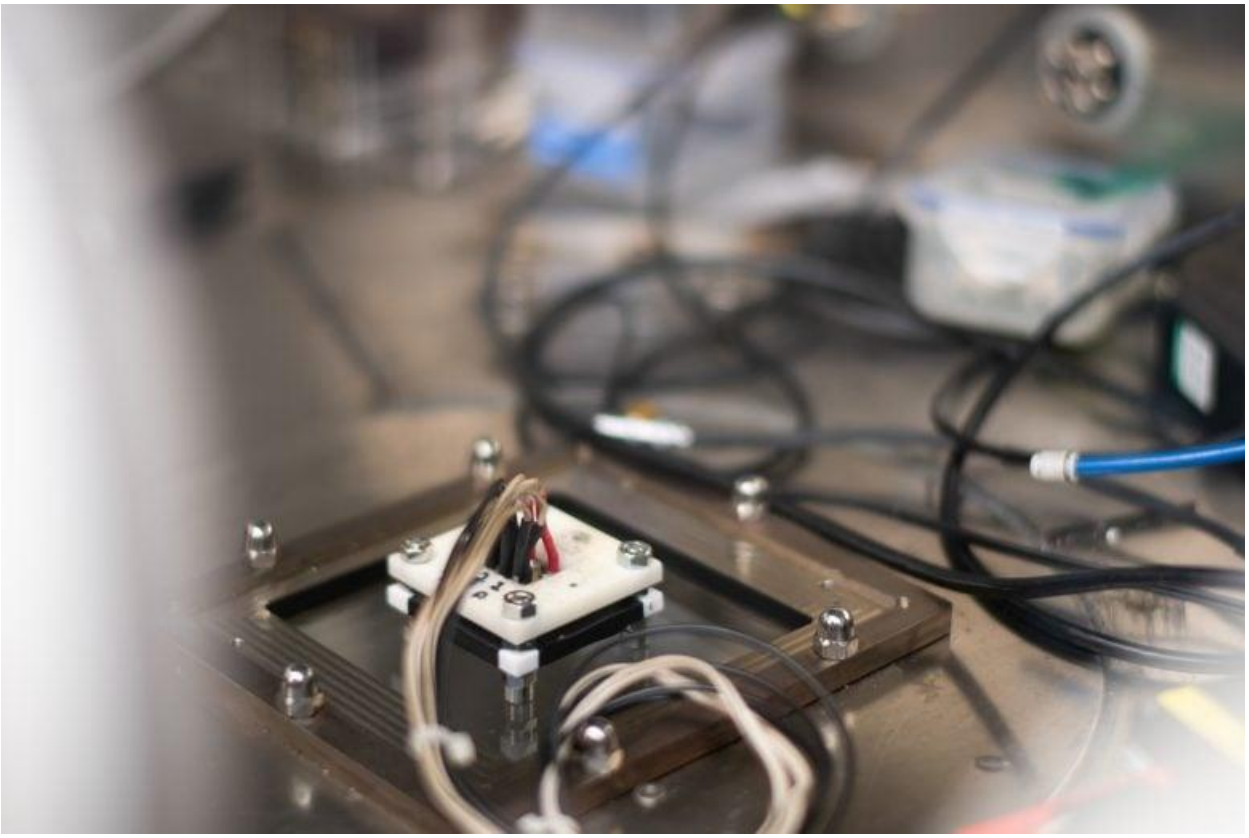


Image of perovskite cell. Credit: University of Surrey

To achieve these improvements, the research team focused on understanding the efficiency and stability losses induced by the hole transport layer which plays an important role in the solar cell performance. They introduced an iodine-reducing agent to inhibit the chemical reactions that cause the cells to degrade over time. This approach not only increased the efficiency of the lead-tin solar cells but also extended their lifespan, making them more practical and cost-effective for long-term use.

Future Prospects for Perovskite Solar Panels

Dr Imalka Jayawardena, co-author of the study from Advanced Technology Institute at the University of Surrey, said: "By significantly enhancing the efficiency of our perovskite-based solar cells, we are moving closer to producing cheaper and more sustainable solar panels. We are already working on refining these materials, processes, and the device architecture to tackle the remaining challenges.

Professor Ravi Silva, Director of the Advanced Technology Institute at the University of Surrey, said: "This research brings us closer to panels that not only generate more power over their lifetime but are also longer lasting. Greater efficiency and fewer replacements mean more green energy with less waste. The University of Surrey are in the process of building a 12.5MW solar farm, where we can test some of these modules. We're confident that our innovative perovskite research will accelerate the widespread commercial adoption of perovskite-based solar panels."

Reference: “23.2% efficient low band gap perovskite solar cells with cyanogen management” by Hashini Perera, Thomas Webb, Yuliang Xu, Jingwei Zhu, Yundong Zhou, Gustavo Trindade, Mateus Gallucci Masteghin, Steven P. Harvey, Sandra Jenatsch, Linjie Dai, Sanjayan Sathasivam, Tom Macdonald, Steven Hinder, Yunlong Zhao, Samuel D Stranks, Dewei Zhao, Wei Zhang, Imalka Jayawardena, Saif Ahmed Haque and S. Ravi P. Silva, 14 November 2024, *Energy & Environmental Science*.
DOI: 10.1039/D4EE03001J

This research helps promote the UN Sustainable Development Goals 7 (affordable and clean energy), 9 (industry, innovation, and infrastructure), and 13 (climate action).
Perovskite Solar CellPhotovoltaicsSolar EnergyUniversity of Surrey

Solar cell efficiency skyrockets to 26.3% power conversion rate with new coating

Solar cell efficiency skyrockets to 26.3% power conversion rate with new coating

A new protective coating has significantly increased the power conversion efficiency of perovskite solar cells.

Developed by Northwestern University scientists, the coating also extends the life of perovskite solar cells. Based on amidinium, the robust layer was 10 times more resistant to decomposition compared to conventional ammonium-based coatings in experiments.

Researchers claimed that the guanidinium-coated cells also tripled the cell's T90 lifetime — the time it takes for a perovskite solar cell's efficiency to drop 90% of its initial value when exposed to harsh conditions.

Protective layer

Northwestern's Bin Chen, who co-led the study, stated that the researchers have been working on the stability of perovskite solar cells for a long time.

Chen highlighted that most reports focus on improving the stability of the perovskite material itself, overlooking the protective layers.

"By improving the protective layer, we were able to enhance the perovskite solar cells' overall performance," added Chen.

Perovskites are a family of materials that have shown potential for high performance and low production costs in solar cells. The name "perovskite" comes from their crystal structure.

These materials are utilized in other energy technologies, such as fuel cells and catalysts. Perovskites commonly used in photovoltaic (PV) solar cells are more specifically called "metal-halide perovskites" since they are made of a combination of organic ions, metals, and halogens; perovskites in other applications may be made of oxygen instead of halogens and are usually entirely inorganic.

Thermal stability of passivation layers

The new study, published in the journal Science, highlights the development of a library of amidinium ligands to increase the thermal stability of passivation layers on perovskite surfaces.

This strategy resulted in a >10-fold reduction in the ligand deprotonation equilibrium constant and a twofold increase in the maintenance of photoluminescence quantum yield after aging at 85°C under illumination in air, according to the study.

Northwestern's Mercouri Kanatzidis, who co-led the study, stated that the new research addresses one of the critical barriers to widespread adoption of perovskite solar cells — stability under real-world conditions.

Significantly advanced durability

"By chemically reinforcing the protective layers, we've significantly advanced the durability of these cells without compromising their exceptional efficiency, bringing us closer to a practical, low-cost alternative to silicon-based photovoltaics," said Kanatzidis.

Researchers also underlined that the state-of-the-art perovskite solar cells typically have ammonium ligands as a passivation layer. However, ammonium tends to break down under thermal stress.

They did some chemistry to convert the unstable ammonium into a more stable amidinium.

"The researchers performed this conversion through a process known as amidination, in which the ammonium group is replaced with a more stable amidinium group. This innovation prevented the perovskite cells from breaking down over time — especially when exposed to extreme heat," said a press release.

Researchers maintained that the resulting solar cell achieved an impressive 26.3% efficiency, which means it successfully converted 26.3% of absorbed sunlight into electricity.

The coated solar cell also retained 90% of its initial efficiency after 1,100 hours of testing under harsh conditions, demonstrating a T90 lifetime three times longer than before when exposed to heat and light, according to study

Elon Musk and Google's CEO want to cover the desert with solar panels. Will Donald Trump agree?

Elon Musk

@elonmusk

Any self-respecting civilization should at least reach Kardashev Type II. In my opinion, we are currently only at <5% of Type I. To get to ~30%, we would need to place solar panels in all desert or highly arid regions.

Elon Musk's foray into right-wing politics hasn't squashed his love for solar power. It's a fandom he shares with Sundar Pichai, the CEO of Google-parent Alphabet, who exchanged friendly messages with the world's richest man after Musk expressed admiration for Willow, Google's breakthrough quantum computing chip. During the exchange, Musk noted humans are not close to harnessing all the energy available on Earth, and said blanketing deserts and arid regions in solar panels could roughly quintuple the globe's power supply.

"Indeed," Pichai replied. "We should scale solar so much more, amazing that we keep looking at alternatives when the most obvious path is staring at our eyes, literally!"

It may have been a theoretical discussion, but the conversation between two of America's most powerful executives bodes well for an industry that investors have largely soured on since Donald Trump's election victory last month. Musk, or America's new "first buddy," is set to lead a so-called Department of Government Efficiency and has become a key part of Trump's inner circle.

Regardless of Musk's sway in the Oval Office, multiple asset managers told *Fortune* they remain optimistic about the industry's fortunes under Trump. The President-elect made clean energy a frequent punching bag on the campaign trail. However, the solar sector's performance during his first term, said Greg Smithies, a partner at venture capital firm Fifth Wall, suggests the industry could still thrive.

Shares of Invesco's solar ETF, which trades as TAN on the NYSE, soared 544% during Trump's presidency, far outpacing the S&P 500's 70% gain. The ETF had dropped 6% between his election night victory over Hillary Clinton and his first inauguration in January 2017.

This time, TAN dropped 18% in the two weeks following Trump's latest win over Vice President Kamala Harris. At the time, Jay Hatfield, the CEO of Infrastructure Capital Advisors, told *Fortune* that the sell-off was “irrational.” Some investors appeared to have agreed as the ETF has regained 5% since.

“During the last Trump administration, people were putting solar into the ground because it was cheaper,” said Smithies, a former finance executive at The Boring Company and then Neuralink, two of Musk’s companies, “and now it's just even cheaper.”

Why solar could thrive under Trump

To many, the economic case for solar is undeniable. It’s no secret the world needs more energy than ever before, especially with advances in AI and computing creating ravenous demand from tech giants like Pichai’s Alphabet. Then there are developments like the rise of electric vehicles, where Musk’s Tesla is the world’s leader.

It makes sense, said Jennifer Boscardin-Ching, who specializes in clean energy and environmental investing at Geneva’s Pictet Asset Management, that companies and countries will consider virtually any and all ways to get more power. Agreements between Big Tech behemoths and nuclear companies have received plenty of press, she noted, despite similarly sized deals being struck with renewable energy providers.

“But those don't make the headlines,” she said, “because that's just kind of the new status quo.”

Solar companies have also been big beneficiaries of The Inflation Reduction Act, which set aside $400 billion in federal funding toward clean energy. While not a single Republican voted for the legislation in 2022, which Trump has called the "Green New Scam," several right-wing lawmakers have a vested interest in the law's survival. A group of 18 House Republicans, for example, recently sent Speaker Mike Johnson a letter cautioning that some of the bill's incentives have created jobs and boosted investment in their districts.

And while tariffs during Trump's first term hit the solar industry hard, companies should be more prepared for protectionist policies this time around. For example, Sunnova CEO John Berger recently told *CNBC* that his company has become immune to tariffs after switching almost entirely to domestic suppliers.

Finally, some believe certain Republican policies might help the industry. A Trump administration could ease permitting requirements for all energy projects, including solar, Smithies said, and increase access to public lands. That includes plenty of desert owned by the Bureau of Land Management, he noted.

Musk has made clear what he thinks should happen to it.

Largest Solar Energy Project in U.S. Reaches Major Milestone

The Sunstone Solar project, a 1.2 gigawatt solar and energy storage facility that would be the largest solar power facility in the U.S., has been approved for construction in Oregon.

Developer Pine Gate Renewables announced that the Oregon Energy Facility Siting Council approved the project for construction in Morrow County, after a hearing on November 14. The whole of Oregon has 1.9 gigawatts of solar power facilities, meaning the new project almost doubles the state's capacity in this energy source.

The project will see the construction of 9.5 miles of transmission lines, paired with advanced battery storage, enabling energy supply even during non-sunny periods. Its size and scope surpass any previous solar installations in the U.S., making it a milestone in the transition toward cleaner energy sources, which Oregon has prioritized with ambitious renewable energy targets.

Construction of the Sunstone Solar project is expected to commence in 2025, with full operation anticipated by 2028. The facility will cover approximately 7,000 acres and is projected to power over 240,000 homes. The addition of battery storage units will also provide resilience against power outages and fluctuations, a crucial feature in stabilizing renewable energy grids.

An array of solar panels, located in a vineyard at Domaine Drouhin in the Dundee Hills, is viewed on July 25, 2012, near McMinnville, Oregon. The state will soon be home to the largest solar power facility in the U.S.. Getty Images© Getty Images

The project is expected to generate significant economic benefits for the state, including job creation during the construction phase and ongoing operations.

Additionally, it will contribute significantly to Oregon's goal of sourcing 100 percent of its electricity from renewable sources by 2040.

According to data from the U.S. Energy Information Administration (EIA), solar energy constituted nearly 16 percent of new electricity generation capacity in the first half of 2024. Currently, the state of Oregon sources around 4 percent of its electricity from solar power, which is enough to power 250,000 homes.

In a statement on the approval, Pine Gate Renewables CEO Ben Catt said: "Oregon's energy facility permitting process is one of the most rigorous in the entire country.

"The recent unanimous permit approval is a testament to the way our team worked with stakeholders to provide a win-win for Oregon and the Morrow County community."

Newsweek contacted Pine Gate Renewables for more information on the next stages of the project via email.

Currently, the largest solar power facility in the U.S. is the DeGiovanni Franklin Solar Plant in New Jersey, which has a capacity of 983 megawatts per hour. Pine Gate Renewables owns and manages 17 other solar power projects in Oregon.

There are now more than five million solar installations in the U.S., according to the Solar Energy Industries Association.

"The missile-drone Peklo has successfully completed its first combat deployment, and just days ago, we delivered the first batch to our defense forces. The new Ruta missile is undergoing successful trials," he said.

The testing of the Ruta missile is only one part of Ukraine's recent weapons developments, which come amid escalating tensions in the Russia-Ukraine war. In August, Zelensky said Ukraine had conducted its first successful test of a domestically developed ballistic missile, but he did not provide further details about the weapon.

He also said at the time that Kyiv could produce 1.5 to 2 million drones this year but did not have enough funding.

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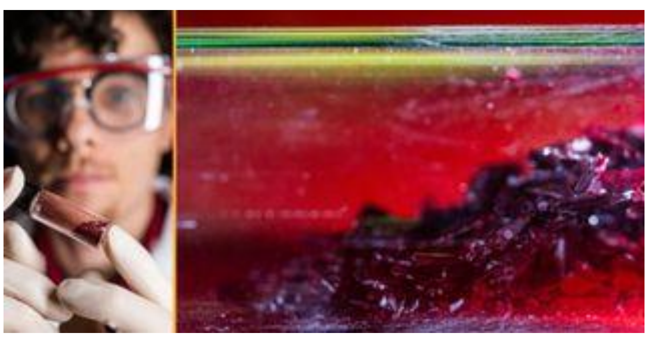
'Holy grail' of solar technology set to consign 'unsustainable silicon' to history



"Seasoning" the FAPbI3 precursor solution with a sprinkling of specially designed two-dimensional (2D) perovskites improved not only the efficiency of FAPbI3 solar cells but also their durability. (Image credit: Photos by Jeff Fitlow/Rice University)

Researchers have synthesized highly durable solar cells made from perovskite — a common crystal structure (in its natural form a calcium titanium oxide mineral) — in a breakthrough that could revolutionize the solar industry.

Solar power is the fastest-growing energy technology and plays a key role in cutting greenhouse gas emissions. Solar power converts sunlight into electricity — and is used in various applications including lighting, heating, cooling, computers, electronics and powering machinery.
Solar panels made from silicon have a lifetime of around 25 years. It is tried and tested, but using silicon is environmentally unsustainable because it is a non-renewable, finite resource. The most durable solar panels, for example, use pure silicon, which is costly and inefficient to produce.

In recent years, perovskites have shown promise as a cheaper, less wasteful material, the scientists said, but have far less durability. Natural perovskites are rare but can be synthesized artificially as an organic-inorganic compound with an ABX3 crystal structure harboring electrically charged ions.

They work as an active light-harvesting layer like those found in solar technologies today. But they are not commercially viable because they have a lifetime measured in just months. They are also prone to chemical and thermal instability, and problems can arise during production (they are susceptible to damage by moisture and oxygen).

Scientists aimed to tackle these stability issues by creating new design strategies, publishing their findings in a study published June 13 in the journal Science. They created a new structure from perovskites that can theoretically last as long as silicon-based solar cells.

"Perovskite solar cells are kind of the holy grail of this new solar cell technology. And that's because perovskites can be made in theory significantly cheaper than inorganic solar cells like silicon or gallium arsenide," said Isaac Metcalf, graduate student of materials science and nanoengineering at Rice University. "The reason why is because they can be solution-processed at low temperatures. Basically, you can take an ink of a perovskite precursor and you can spread it across a piece of glass, and then heat it up, and then you have a perovskite."

Building on past research and other recent studies that sought to improve stability, the team focused on formamidinium iodide, a precursor in the fabrication of perovskite solar cells (known for its enhanced properties of light absorption and thermal stability).
They introduced a soluble form of the precursor to a layer of 2D perovskites and exposed them to heat above 140 degrees Fahrenheit (60 degrees Celsius). This is a temperature at which the stability of formamidinium iodide-based solar cells is known to be limited. Exposure for a long time means the team generated "ultra-stable" 3D perovskites.

Importantly, the new way of designing perovskites renders them amenable to solution-processing methods and means they could be produced on a grander scale. The study marks a major step forward in bringing perovskite solar cells to maturity, the scientists said.

Injecting ‘quantum dots’ into solar panels

New solar industry deal could propel NM startup into mass manufacturing

UbiQD Chief Product Officer Matt Bergren holds a piece of quantum-dot laced luminescent glass that the company makes. Eddie Moore/Journal A new “joint development agreement” that New Mexico-based Ubiquitous Quantum Dots signed in August with global solar-panel maker First Solar Inc. could soon convert the local startup into a mass supplier of quantum-dot technology. Since launching in 2014, the Los Alamos-based company, UbiQD Inc., has worked to turn the nanoscale, three-dimensional structures known as quantum dots into sunlight-harvesting machines. It’s already using them to make solar-generating windows. And, among other things, it’s created plastic row covers for crops that are imbedded with quantum dots to accelerate greenhouse plant growth by manipulating the sun’s rays. Now, First Solar wants UbiQD (pronounced “ubiquity”) to directly integrate its quantum dots into that company’s solar panels to increase the amount of electricity its panels can generate. Through the new agreement, announced Aug. 15, First Solar will help finance the additional engineering and modification work needed to adapt UbiQD’s technology to create a quantum-dot-laced plastic film that could easily be integrated into First Solar’s existing manufacturing process as a “drop-in” component, said UbiQD founder and CEO Hunter McDaniel. Agreement details are proprietary. But McDaniel said it represents at least $1 million in financing from First Solar, making it UbiQD’s “largest deal in company history” in terms of the dollar amount. More importantly, it could create a direct gateway into the mainstream solar industry via a future supply partnership with one of the industry’s global leaders, thrusting UbiQD into mass manufacturing based in New Mexico. “We’re working now to create that drop-in process to integrate our technology with the manufacturing materials that First Solar is already using,” McDaniel told the Journal. “Under the agreement, First Solar is providing support for us to do that work. But when it’s 100% ready to go, First Solar will need a large quantity of material to also be ready, so we’re developing that manufacturing capacity alongside our work to fine-tune our technology.” Assuming the current agreement successfully blossoms into a formal supply partnership, it could propel UbiQD nearly overnight into a major industrial green-tech company, given the immense size of First Solar’s needs. The publicly traded firm has massive manufacturing operations in the U.S. and overseas, and is currently investing billions to expand its domestic capacity under the federal Inflation Reduction Act, which provides substantial tax credits to entice industry to rapidly build out the U.S. manufacturing base for solar and other renewable technologies. Getting a grasp on First Solar’s leading position in global photovoltaic manufacturing helps put the deal in perspective, said Greg Bohannon, managing partner of Greenrock Capital, a private investment advisory firm with offices in San Francisco and Santa Fe that has directly led financing deals for many utility-scale solar projects involving First Solar. “This is the largest U.S. manufacturer of solar panels and one of the top 10 in the world,” Bohannon told the Journal. “We’re talking about a global leader.” First Solar, which already operates sprawling solar panel factories in Ohio, announced a $370 million investment there last fall to build a new research-and-development facility focused on improving its technology and increasing the electric-generating efficiency of its solar panels. First Solar itself is careful to not publicly discuss its strategies, plans and intentions, with strict limitations on what UbiQD can reveal about the joint development agreement. In fact, in the Aug. 15 announcement, the company only said it's interested in the "potential use" of UbiQD's technology. "As we work towards developing the next generation of photovoltaics, we are exploring a range of enhancements that could allow us to convert more sunlight into energy," First Solar Chief Technology Officer Markus Gloeckler said in a statement. "We are interested in the potential use of quantum dots in optimizing the absorption of light and look forward to continuing our work with UbiQD on exploring this possibility." First Solar and UbiQD have been working together in stealth mode since early 2022 to demonstrate that UbiQD's technology can not only enhance First Solar panel efficiency, but that it can be fairly easily integrated into the company's manufacturing base. For First Solar to now move to a higher-level development agreement with UbiQD is very revealing, Bohannon said. "For them to select UbiQD and its quantum dots means a lot," Bohannon said. "It sends an important signal to the marketplace, especially since their collaborative work has been going on for a while. First Solar sees a lot of innovation and has many potential partners, so for them to announce this specifically with UbiQD is a really strong signal." **Quantum dots** First Solar is not the only entity exploring the benefits of quantum dots in solar generation, and UbiQD itself has made significant progress in developing and deploying quantum-dot-laced film for use in solar electric production and other applications. Quantum dots — which measure about 10,000 times smaller than a human hair — manipulate light in unique ways, absorbing it and emitting it back out in specific colors. They're used today in everything from transistors and sunscreens to LCD televisions, tablets, smartphones, lasers and even medical applications. But traditionally, they've been extremely expensive to make, and they're usually composed of toxic materials. UbiQD's product, however, is made through an alternative, inexpensive process that uses low-cost and nontoxic elements. McDaniel helped develop that new process as a post-doc at Los Alamos National Laboratory. He then licensed it from LANL, along with complimentary technology from the Massachusetts Institute of Technology, to make and market next-generation quantum dots for many different applications. That includes plastic crop covers for greenhouses that the company now sells in the U.S. and elsewhere. The dot-laced film shifts sunshine into a red-and-orange light spectrum that mimics late-summer-like sun rays year round. That's considered the most potent time of year for plants, because they sense winter coming and grow faster. Extensive testing and use have shown the row covers can increase greenhouse plant production by 20% or more depending on the crop, and the company is now preparing to roll out a full roof covering for entire greenhouses this fall. It's also deploying quantum-dot films on windows for solar generation, potentially converting windows into self-generating structures where the dots channel photons to solar cells attached to window frames. That technology is now deployed in a number of places in New Mexico and other states, including one building at Ellsworth Air Force Base in South Dakota. And, last year, it signed a partnership with Canadian solar panel manufacturer Heliene Inc. to integrate UbiQD's quantum-dot film into Heliene panels for greenhouses. That could provide double the bang by offering both plant crop growth acceleration plus solar generation. **Thin-film solar panels** Meanwhile, First Solar is a leading supplier of thin-film solar cells, which differ significantly from traditional solar-cell technology. Nearly all solar cells today are made using silicon, an abundant, inexpensive element that's found in sand. The silicon provides the essential semiconductor material needed to turn sunlight into electricity by converting photons into electrons. Manufacturers use a chemical process to refine the material and turn it into crystalline silicon blocks, which they then cut into very thin wafers to make solar cells. Those cells are then strung together to make modules, or panels. In contrast, thin-film technology uses alternative semiconductor materials like cadmium telluride to make solar cells. Rather than creating a crystal wafer, thin-film manufacturers like First Solar coat a thin layer of cadmium telluride directly onto a sheet of glass or plastic to make solar cells and panels. That process is easier than manufacturing crystalline-silicon cells, giving thin-film companies like First Solar a significant cost advantage. In addition, with all silicon cells today made outside the U.S., panel makers must import them, raising costs even more. But despite those advantages, thin-film cells are somewhat less efficient than crystalline-silicon ones in terms of how much sunlight they can convert to electricity. As a result, First Solar is constantly seeking to improve its efficiency, and it's now exploring the use of quantum dots to achieve that. "First Solar is the thin-film technology leader today, but they operate in a very competitive environment with crystalline-silicon manufacturers," Bohannon said. "First Solar has already substantially raised its thin-film efficiency. But if it can integrate quantum dots into its panels, it could increase efficiency even more and potentially close that efficiency gap with crystalline-silicon manufacturers." McDaniel declined to discuss how much additional efficiency UbiQD's quantum-dot technology can add to First Solar panels. But he said it's "very significant" compared with other types of module enhancements First Solar could pursue to improve electric output. **Fine-tuning the dot technology** There's still work to do to fully adapt UbiQD's quantum-dot film for drop-in integration into First Solar's manufacturing process, McDaniel said. But no change in the factory process is required on First Solar's part. "They currently use a polymer film that protects the solar cells and glues it all together in panels," McDaniel said. "They already buy sheets of clear plastic for that. So, rather than buying that, they would instead buy plastic film with quantum dots in it." UbiQD will need to tweak its quantum-dot imbedded plastic to specifically manipulate the spectrum of light it emits to focus on maximum electric generation as compared to, say, the light colors produced by its greenhouse film, which is aimed at accelerating plant growth. It also needs to ensure the long-term stability of the new quantum-dot film while still maintaining a low-cost production process. But UbiQD has already built the manufacturing foundation for all of that since launching in 2014. "This is a new approach, but it's actually a pretty simple, low-cost change with an outsized benefit for improving solar-panel generation," McDaniel said. "All the work we've already done to build our manufacturing process to create stable, low-cost, light and efficient materials for (quantum-dot) films is all largely applicable to this new focus on utility-scale solar generation for First Solar. We can go much faster now in doing this than if we were starting from scratch." The joint development agreement shows that First Solar has developed significant confidence in UbiQD's technology, especially given its scientific base coming out of LANL and MIT and all the additional development work UbiQD has put into it, Bohannon said. "This is now about how to integrate UbiQD's quantum dots into First Solar's existing product," Bohannon said. "It's not about questions regarding the quantum dot-technology itself." **Scaling up** But once UbiQD's drop-in component is ready to deploy, it will require a major scale-up in manufacturing capacity by UbiQD to then produce the amount of quantum dots and film needed to meet First Solar demand. Through its current investment in new factories and expansion of existing ones, First Solar aims to have more than 20 gigawatts of annual global manufacturing capacity in place by 2025. For perspective, that would represent enough potential panel production to power at least 6 million homes, and possibly a lot more, according to local industry experts consulted by the Journal. "We might need to supply up to 1 billion square feet of (quantum-dot) material to meet First Solar demand," McDaniel said. "We have nowhere near that capacity now, so we're immediately working on how to build that out." The company currently produces its quantum-dot technology at a 9,000-square-foot facility in Los Alamos, where 25 of the company's 28 employees currently work. It expects to hire another four or five people this year, and possibly 10 more next year, while also scouting for potential facility sites in New Mexico. "Depending on financing, next year we'll look to build a new manufacturing facility," McDaniel said. "We want to keep everything here in New Mexico, so we're only looking at local sites in Albuquerque and Santa Fe." That would significantly add to New Mexico's manufacturing base for solar and renewable energy, which is growing exponentially, in large part thanks to Inflation Reduction Act incentives that aim to encourage a lot more private investment in domestic manufacturing. Last month, Maxeon Solar Technologies — a global leader in solar cell and panel production — announced a $1 billion investment to build a massive manufacturing plant in Albuquerque that could employ 1,800 people when it comes online in 2025. "The Inflation Reduction Act is driving a domestic clean energy manufacturing boom," Sen. Martin Heinrich, D-N.M., told the Journal in an email. "Nowhere is that clearer than in New Mexico. I applaud UbiQD and First Solar for their work to unlock bold solutions to the climate crisis, support stable careers that New Mexicans can build their families around, grow our economy, and keep our state at the center of an American-made clean energy future." UbiQD is on the verge of breakout growth, said Jordan Clancy, general partner in the New Mexico Vintage Fund, which invested in UbiQD early this year. "This is a big deal," Clancy told the Journal. "It may not be as big as Maxeon, but in the long run, it could be. Over time, UbiQD could become one of New Mexico's larger employers."

Science News
from research organizations

Revolutionary breakthrough in solar energy: Most efficient QD solar cells

Date:

February 21, 2024

Source:

Ulsan National Institute of Science and Technology(UNIST)

Summary:

A research team has unveiled a novel ligand exchange technique that enables the synthesis of organic cation-based perovskite quantum dots (PQDs), ensuring exceptional stability while suppressing internal defects in the photoactive layer of solar cells.

A groundbreaking research breakthrough in solar energy has propelled the development of the world's most efficient quantum dot (QD) solar cell, marking a significant leap towards the commercialization of next-generation solar cells. This cutting-edge QD solution and device have demonstrated exceptional performance, retaining their efficiency even after long-term storage. Led by Professor Sung-Yeon Jang from the School of Energy and Chemical Engineering at UNIST, a team of researchers has unveiled a novel ligand exchange technique. This innovative approach enables the synthesis of organic cation-based perovskite quantum dots (PQDs), ensuring exceptional stability while suppressing internal defects in the photoactive layer of solar cells.

"Our developed technology has achieved an impressive 18.1% efficiency in QD solar cells," stated Professor Jang. "This remarkable achievement represents the highest efficiency among quantum dot solar cells recognized by the National Renewable Energy Laboratory (NREL) in the United States."

The increasing interest in related fields is evident, as last year, three scientists who discovered and developed QDs, as advanced nanotechnology products, were awarded the Nobel Prize in Chemistry. QDs are semiconducting nanocrystals with typical dimensions ranging from several to tens of nanometers, capable of controlling photoelectric properties based on their particle size. PQDs, in particular, have garnered significant attention from researchers due to their outstanding photoelectric properties. Furthermore, their manufacturing process involves simple spraying or application to a solvent, eliminating the need for the growth process on substrates. This streamlined approach allows for high-quality production in various manufacturing environments.

However, the practical use of QDs as solar cells necessitates a technology that reduces the distance between QDs through ligand exchange, a process that binds a large molecule, such as a ligand receptor, to the surface of a QD. Organic PQDs face notable challenges, including defects in their crystals and surfaces during the substitution process. As a result, inorganic PQDs with limited efficiency of up to 16% have been predominantly utilized as materials for solar cells.

In this study, the research team employed an alkyl ammonium iodide-based ligand exchange strategy, effectively substituting ligands for organic PQDs with excellent solar utilization. This breakthrough enables the creation of a photoactive layer of QDs for solar cells with high substitution efficiency and controlled defects.

Consequently, the efficiency of organic PQDs, previously limited to 13% using existing ligand substitution technology, has been significantly improved to 18.1%. Moreover, these solar cells demonstrate exceptional stability, maintaining their performance even after long-term storage for over two years. The newly-developed organic PQD solar cells exhibit both high efficiency and stability simultaneously.

"Previous research on QD solar cells predominantly employed inorganic PQDs," remarked Sang-Hak Lee, the first author of the study. "Through this study, we have demonstrated the potential by addressing the challenges associated with organic PQDs, which have proven difficult to utilize."

"This study presents a new direction for the ligand exchange method in organic PQDs, serving as a catalyst to revolutionize the field of QD solar cell material research in the future," commented Professor Jang.

The findings of this study, co-authored by Dr. Javid Aqoma Khoiruddin and Sang-Hak Lee, have been published online in *Nature Energy* on January 27, 2024. The research was made possible through the support of the 'Basic Research Laboratory (BRL)' and 'Mid-Career Researcher Program,' as well as the 'Nano·Material Technology Development Program,' funded by the National Research Foundation of Korea (NRF) under the Ministry of Science and ICT (MSIT). It has also received support through the 'Global Basic Research Lab Project.'

How Quantum Dots Could Make the Most Efficient Solar Panel

Ever heard of a quantum dot? What about an artificial atom? Though it might sound like technobabble from Star Trek (which of course I'm a fan of), this is a real piece of nano-technology that has the potential to revolutionize fields like medicine, consumer electronics, and especially solar energy. Actually, quantum dot technology has been in TVs for years, so why isn't it already in my solar panels? Well, there are a few challenges… some which might sound familiar to you if you're in-the-know when it comes to cutting edge solar tech. If we can engineer around these challenges, then these little devices could have a BIG impact – breaking the limits of our current solar panels, and ushering in a new and radically more efficient age of solar energy.

What is a Quantum Dot?

What even is a "quantum dot" (QD)? While it sounds like a mcguffin that Stan Lee and Jack Kirby would've thought up in the mid-sixties, it is in fact the real scientific term. But it's also unhelpfully nondescript, so let me explain. Quantum dots are microscopic, crystalline semiconducting particles that could make our solar panels much more efficient. How much more? Well the theoretical maximum conversion efficiency for single-junction solar cells is around 30% efficient. We can add more junctions, like 6 of them, to bump up that theoretical max efficiency to 51.4%.[1] The National Renewable Energy Laboratory (NREL) calculated the theoretical max efficiency of quantum dot solarcells (QDSCs) at a staggering 66%![2] And they're (theoretically) much easier to pull off than multijunction cells. If we can make them work, then quantum dots could change everything.

That might make you wonder, like it did me, how do they do this? Quantum dots are so small that their electrons can only move in very specific ways. They're 'locked in' at very specific band gaps, which means they only produce very specific wavelengths of light (or in other words they emit very specific colors). We call this phenomenon 'quantum confinement.'[2] This is really strange when you think about it: these vials contain exactly the same material,[3] down to an atomic level. Yet, they're glowing vibrantly in extremely different colors. The only thing differentiating them is their size.[3] The biggest and reddest ones tip the scale at 10 nanometers, while the smallest and bluest quantum dots are just 2 nanometers in diameter.[2]

For comparison a human hair is 80,000 to 100,000 nanometers thick. Your blood cells are 10,000 nanometers across. Even a single strand of DNA is about 2.5 nanometers wide.[4,5] Quantum dots are so small that, for almost all intents and purposes, they're considered zero-dimensional. And at this size things start to get weird, and the laws of physics seem to start to break, like with the quantum confinement we mentioned a moment ago. To really understand how quantum dots are breaking these laws to make photovoltaic cells more efficient, we have to brush up on these laws of physics and how they work with solar cells.

How Solar Works

At its core, a solar cell is a crystal with a positive (p) side and a negative (n) side, forming a p-n junction. The sun shoots out photons and eightish minutes later they hit our cell. If that photon has an energy level greater than or equal to the band gap energy of the cell, it'll transfer its energy to an electron, knocking the electron free from its home and creating an electron-hole pair. If not, then that energy is wasted. The 'free' electron and hole want to rejoin and/or settle down, but if they remain free long enough they might pass through the electrode and bam! We got free energy from the sun.[6]

Even though we tried to simplify that, it's still a little complicated. You don't have to be an engineer to notice that there's some big "ifs" and "mights" in that explanation. Solar panels actually aren't all that efficient. Most commercial panels can only convert 15-23% of the light that hits them into usable electricity.[7,8] And solar panels won't get much more efficient, at least not the way we currently understand them. All the way back in 1961, scientists William Shockley and Hans-Joachim Queisser calculated that the maximum possible efficiency for single junction solar cells to be about 30%. Thankfully, with modern advances in materials and engineering, that max efficiency now stands at a mighty… 33.7%. Aw, man.[9]

QDSC: The Shockley-Queisser Limit Breaker

Why is the Shockley-Queisser limit so low? In addition to all the hoops to jump through we mentioned earlier, there's a lot of factors that limit how much juice we can squeeze out of a photon. Luckily there might be a few loopholes. For instance, Shockley and Queisser assumed there's only one p-n junction. However, we could always add more semiconductors to create more band gaps. Remember that band gaps only generate energy from a photon if the photon has the same or greater energy level – they're picky eaters.[10,11] So combining a bunch of them together to form what's called a multi-junction cell is a feasible way to break the Shockley-Queisser limit. It's kind of like making a wider net to catch more energy levels of photons… or maybe it's more like making a net with a bunch of back up nets behind it so less photons slip through? I'm stretching that metaphor … anyway, this works great until you look at the price tag. Multi-junction PVs are expensive and hard to make (at least for now). For reference a typical solar panel costs well less than $1 per watt. For instance, an American made panel typically costs between $0.50 – $0.80 per watt.[12] However, even mere two-junction cells are estimated to cost around $4.85 – $7.17 per watt right now depending on the materials.[13] That cost will drop over time as manufacturing gets perfected, but it's why multi-junction cells aren't really commercially viable at the moment.[14]

And this is where quantum dots come back in. Since quantum dots are teeny-tiny semiconductors, we can use them to cheat something that works just like a multi-junction cell, potentially for less than a $1 per watt.[16,17,18] That's right, quantum dots are relatively cheap and easy to make, we can grow them by just mixing some high temperature solutions, and we can control how big they get with heat or time. Remember that the size of the dots changes how the electrons are confined, which changes their band gap and hue.[1] In a normal cell your absorption layer absorbs the same band gap of light. However, quantum confinement lets us cram a spectrum of different band gaps, even into the infrared spectrum, all precisely tuned to capture different wavelengths of light. At just a few nanometers in size, we can fit more quantum dots in a given space than semiconductors, which further helps to push their efficiency.[15,16]

But wait, there's more! Multiple exciton generation (MEG) is another way quantum dot solar cells can get around the Shockley-Queisser limit. In a normal cell, we get one hole-pair (or exciton) per photon, if we're lucky. But quantum dots can create two or more excitons for each photon. Even though the mechanics of MEG are well understood, there's not yet a consensus on why it works. Anyway, you don't' have to be a quantum physicist to understand that two excitons for the price of one is going to radically increase the efficiency of our solar cell.[17][18] At the very least, it doubles the chance that something is going to make it to the electrode.

Cutting Edge Quantum Dots

So with all the potential of quantum dots, you probably won't be surprised to hear that we're learning new things about them almost every day.

A team of researchers from Korea University and the Ulsan National Institute of Science & Technology are trying to combine quantum dots with perovskites to get the best of both worlds. Perovskites are great, as we've previously covered, but most of them are made primarily of lead and other toxic chemicals, which has raised concerns. That's why researchers have been leaning toward the less toxic tin–lead halide perovskites (TLHP), but they're less powerful than their lead cousins and more prone to defects.[19]

To fix this the researchers added perovskite quantum dots (PQDs) to the cell, which both made the perovskites more stable and upped the maximum voltage of the cell. But now they had a new problem with ligands, which is the material the nano-crystals are suspended in. They were slowing down the charge transport. You can sort of think of it like having a very fast car, but hitting every red light on the way home. Doesn't matter what the speed limit is on the road if you have to stop at every block. The researchers treated their cells with a little isopropyl, which sort of loosened up the ligands and made everything gel together, creating better, smoother highways for the charge to 'drive' though. As a result their perovskite quantum dot cell was more efficient and faster, showcasing improved open-circuit voltage and a record-breaking conversion efficiency for tin–lead halide perovskites.[20]

Meanwhile, a totally different team of scientists from several Korean universities and institutions just developed a flexible quantum dot solar cell based on all-inorganic cesium-lead iodide (CsPbI3) or ‘black’ perovskite. They can deposit a coat of these perovskite quantum dots quickly and at room temperature using a simple layer-by-layer process to create a flexible cell. The “room temperature” thing is particularly important, as you’ll soon see, since quantum dots don’t like too much heat. Ordinarily it takes some heat-treating to connect the perovskite quantum dots to the base layer of your cell, but this also increases the risk of defects. Being able to do this at room temperature should take a lot of the headache out of manufacturing them.[21]

And these cells weren’t slouches either, the team reported power conversion efficiency of 12.70% under standard testing conditions.[22][23] Commercial solar panels right now tend to hit around 20% so the technology has a ways to go, but 12.70% is still a new record for flexible quantum dots PVs.[7]

And this is all just from the last few months of 2024, but it’s not all sunshine and rainbows for quantum dots though. Despite the explosion of innovation, they are still a ways off. Despite their huge potential there’s still some serious issues that need to be dealt with.

The Challenges

I only briefly mentioned what quantum dots are made from, and that’s because most formulations contain harmful metals like lead, cadmium, arsenic and mercury.[24]
This has raised some concerns about toxicity, but the construction and recycling of quantum dots is comparable to standard solar. Where health and safety standards have been well established to deal with contaminants. Again, like standard solar, once in operation quantum dots don’t present issues because they’re locked into the layers of that solar sandwich. What we don’t know is what the package of quantum dots and nanoparticles does to the human body.[25][26]

Due to their small size, quantum dots could be inhaled or otherwise enter the body. An early study suggests that once inside, they can accumulate in organs with a lot of blood flow like the liver and kidneys, where they can cause inflammation and harm.[27] Though these questions are outstanding and more research is needed. For what it’s worth, a team from the Aligarh Muslim University in India has already begun work on making non-metallic, non-toxic quantum dots.[28]

Durability remains the biggest issue for quantum dot solar cells. Much like perovskites, quantum dots are sensitive and can degrade when exposed to air, moisture, and high temperatures (kind of like me). All things that a solar panel is expected to face for at least a decade or two.[3] They also don't like being illuminated too much or getting hit with a lot of ultraviolet light. Needless to say, a solar cell that can get a sunburn is not ideal. Again, I can relate. You also have to be careful about what material you pair with them. A solar panel is basically a sandwich filled with lots of different materials all aiding in the collection of sunlight or the protection of the sunlight-collectors. Quantum dots can react poorly with some materials and degrade even faster.[29]

One of the big advantages of current-gen solar tech, and the reason we see it (at least so far) still in use over less expensive or more efficient technologies, is their longevity. A solar panels' number one job is to change sunlight into electricity, but job number two is to do so reliably for years. While quantum dot solar cells might be radically more efficient, they are super-radically less durable, which means today's more basic solar tech has the edge (at least for now).[3] This isn't a problem when it comes to quantum dots other applications like medicine or high-def television screens. A bit ironic then that solar is the field where quantum dots have the most revolutionary potential, but also face the biggest hurdles.

The potential for quantum dots to revolutionize the energy landscape makes them tantalizing. And the fact that they're already in QLED TVs make it feel like they're right around the corner for solar. And much like perovskites, if researchers can find an affordable way to make quantum dots more durable, then our solar panels are about to double in efficiency … but that's a pretty big 'if.' And if not? Well… quantum dots can still make our TVs, phones and especially medical devices better, and that's still pretty neat.[30]

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US-China crack organic solar cell code to hit toxin-free 20% power efficiency

A new design principle has been identified that could eliminate the use of toxic chemicals in solar cell manufacturing.

The standard manufacturing process of organic cells involves toxic solvents. This environmental concern has hindered the widespread adoption of organic solar cells.

Researchers at Linköping University (LiU) have revealed a new design principle for eco-friendly, high-efficiency organic solar cells.

To unlock this potential, they delved into the molecular shapes and interactions within organic solar cells. This led to the identification of a design principle that allows for the use of environmentally friendly solvents.

“To realize mass production of organic solar cells, with printed technologies for example, on a large scale, we need to find methods that don’t use toxins. Otherwise, it’s not good for the environment or for those working in the factories,” said Feng Gao, professor of optoelectronics at LiU.

Use of toxic chemicals in organic solar cells

Organic solar cells are gaining popularity due to their cost-effectiveness, ease of manufacturing, and flexibility.

As compared to silicon solar cells, they are made from electrically conductive plastics or organic electronics. This allows these flexible, lightweight cells to be integrated into various surfaces, such as windows, walls, and clothing.

Over the years, organic solar cells have significantly improved in efficiency, now converting around 20% of sunlight into electricity.

These organic solar cells are typically manufactured by mixing chemicals and applying them to a surface. The chemicals then evaporate, leaving behind the solar cell material.

Unfortunately, these chemicals often contain harmful substances, raising environmental concerns. Some of the toxic chemicals used are chlorobenzene, chloroform, and dichloroethane.

These solvents are used for dissolving the organic materials that make up the solar cell.

To address this challenge, the LiU team partnered with researchers in China and the US.

They identified a range of non-toxic solvents that could be used to manufacture efficient organic solar cells.

"To choose the right solvent, it's important to understand the entire solar cell manufacturing process. This includes knowing the initial structures of the solution, observing the dynamic processes during evaporation and checking the final structure of the solar cell film," explained Rui Zhang, lead author and researcher at the Department of Physics, Chemistry and Biology at LiU.

Environment-friendly solar cells may soon come up

In the study, advanced techniques like synchrotron X-ray and neutron diffraction were used to examine the behavior of molecules within organic solar cells.

They focused on understanding how the molecules that carry electrical charge (electrons) interact with the solvent used in the manufacturing process.

After this extensive examination, the team developed a design principle that allows for the use of various non-toxic solvents in the manufacturing process.

Their ultimate goal is to use water as a solvent, making the process even more environmentally friendly.

With these molecular-level insights, the researchers believe that the development of environmentally friendly, efficient organic solar cells is now within reach.

"Thanks to a toxin-free manufacturing method, we now have a much greater chance of commercialising the technology on a larger scale," Gao said.

"With electrification and the development of AI, we will probably see a significant increase in the world's energy needs. That electricity needs to come from environmentally sustainable sources if we are to slow down climate change at the same time," he concluded in the press release.

The findings were published in the journal *Nature Energy.*

Scientists achieve major breakthrough with energy storing molecule — here's how it could transform solar power technology

The implications for homeowners and businesses are huge.

Imagine capturing sunshine in the summer and using it to heat your home all winter. Thanks to an exciting breakthrough by German researchers, that sci-fi scenario is becoming reality, according to Interesting Engineering.

A team of scientists has developed a molecule that traps and stores solar energy for months, then releases it as heat whenever needed.
This technology could revolutionize how we use solar power for one of humanity's most basic needs: staying warm.

About half of the world's energy consumption goes toward heating, according to the International Energy Agency. While traditional solar panels are great for generating electricity, they aren't ideal for heating applications. This new molecule stores the sun's energy in chemical bonds that can be "unlocked" to provide heat months later.

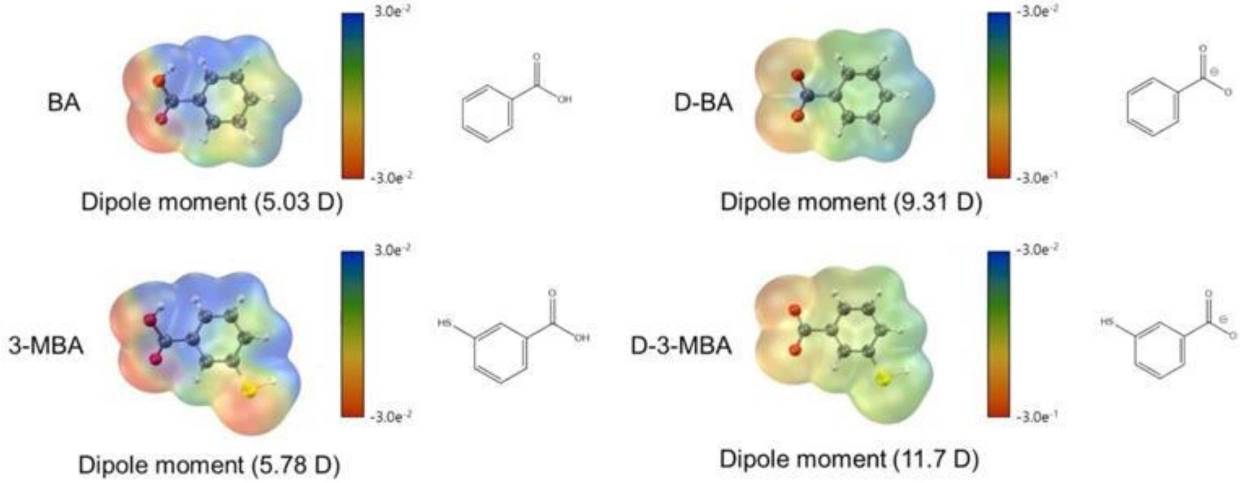
The technology builds on earlier research into molecules called photoswitches. While previous versions could only harness a tiny slice of solar energy from ultraviolet light, the research team found an ingenious solution. By adding a "sensitizer" compound — similar to how plants use chlorophyll in photosynthesis — they increased the molecule's energy storage capacity by more than 10 times.

"We could not only push the light-harvesting limit substantially but also improve the conversion efficiency of light to stored chemical energy," Till Zähringer, a doctoral candidate who helped develop the breakthrough, said. The system proved remarkably efficient, with virtually every particle of light being converted into stored energy.

The implications for homeowners and businesses are huge. Imagine cutting your winter heating bills by storing summer sunshine in an energy-saving molecule. Beyond the financial benefits, this technology could slash the pollution from burning dirty fuels for heat, creating cleaner air and healthier communities.

While this research is still in the laboratory phase, the scientists have already proved the system can work through multiple charge-and-discharge cycles, just like it would need to in the real world. As development continues, this breakthrough brings us one step closer to a future in which clean, stored solar energy keeps our homes cozy through the coldest months of the year.

Hydrogen-bonding additives enhance both performance and stability of solar cells



The chemical structure and corresponding calculated electrostatic potential (ESP) distributions of two passivators and their deprotonated forms. D is the Debye defined as the dipole moment. Credit: Energy & Environmental Science (2024). DOI: 10.1039/D4EE02793K

A recent collaboration has led to the development of a technique to drastically enhance the performance of perovskite solar cells using hydrogen-bonding additives. This research demonstrates that hydrogen bonding can extend the lifespan of solar cell materials while simultaneously achieving improved efficiency and stability.

The research is published in the journal *Energy & Environmental Science*. The team includes Professor Choi Jong-min's team from the Department of Energy Science and Engineering at DGIST and Dr. Moon Byung-joon's team from the Center for Spintronics at the Korea Institute of Science and Technology.

Perovskite is gaining recognition as a promising material for solar cells, offering high efficiency in converting light to electricity and ease of mass production. However, its drawback is that the solution involved in its manufacture gradually decomposes into ions over time, leading to the formation of impurities. Solar cells produced using such solutions may exhibit poor performance, with high temperatures further accelerating ionic changes and hastening performance deterioration.

To address this issue, Professor Choi's research team introduced a hydrogen-bonding additive into the perovskite solution. This additive interacts with organic substances through hydrogen bonds, protecting critical components of solar cells from rapid alteration.

Through computer modeling, the research team demonstrated that these hydrogen bonds can maintain the stability of the components over an extended period. Solar cells produced using solutions stored for 140 days retained nearly the same efficiency (96.7%) as those made with freshly prepared solutions.

In addition, this additive minimizes defects within solar cells, further enhancing their performance. As a result, the power conversion efficiency of the solar cell increased from the previous 22.61% to 24.31%. Experimental results revealed that the solar cell demonstrated outstanding stability, retaining over 98% of its initial performance even after exposure to a high temperature of 85 degrees for 72.5 days.

Professor Choi from DGIST's Department of Energy Engineering stated, "This research has shown that the issue of ions being easily damaged in the traditional perovskite solution–based process can be addressed by using an additive that harnesses hydrogen bonds.

"We believe that this additive will play a crucial role in overcoming the thermal instability challenge that needs to be resolved for the commercialization of solar cells."

More information: Taeyeong Yong et al, Hydrogen bond-mediated pseudo-halide complexation for stable and efficient perovskite precursors and solar cells, *Energy & Environmental Science* (2024). DOI: 10.1039/D4EE02793K

Provided by Daegu Gyeongbuk Institute of Science and Technology

Researchers make nanotechnology breakthrough that could make solar panels more efficient: 'Could open new possibilities'

Researchers make nanotechnology breakthrough that could make solar panels more efficient: 'Could open new possibilities'

Researchers at Curtin University have found they can improve molecule adhesion by optimizing nanocrystal shapes, which could improve the function of solar panels, LEDs, and medical devices.

Associate Professor Guohua Jia from Curtin's School of Molecular and Life Sciences, and lead author of the study, found that molecules known as ligands stick more easily to zinc sulfide nanocrystals in specific shapes, as reported by SciTechDaily.

"In a discovery that could open new possibilities for developing smarter, more advanced devices, our study found flatter, more even particles called nanoplatelets allow more ligands to attach tightly, compared to other shapes like nanodots and nanorods," Jia told SciTechDaily.

"By adjusting the shape of these particles, we were able to control how they interacted with their surroundings and make them more efficient in various applications."

This discovery could lead to enhancements in optoelectronics, which concerns the study and use of devices that are light-emitting or light-detecting.

Solar panels are one of the most important types of optoelectronic devices, given our current climate scenario, although TVs and displays are perhaps the most common.

Advances in solar technology are essential in helping us meet our net-zero 2050 goals, and phasing out dirty fuels like coal and natural gas.

Improving their efficiency has been a continued goal in the green tech sector, especially for NASA's space projects.

Canary Media reported that 428 gigawatts of solar was installed across the globe last year, which is more than both 2021 and 2022 combined. That trend is expected to continue, with an estimated 560 gigawatts of installations expected by the end of 2024, according to the Office of Energy Efficiency & Renewable Energy.

By installing your own rooftop solar array, you can increase your home's value, lower electricity costs for everyone in the area, and support the push towards sustainable energy solutions.

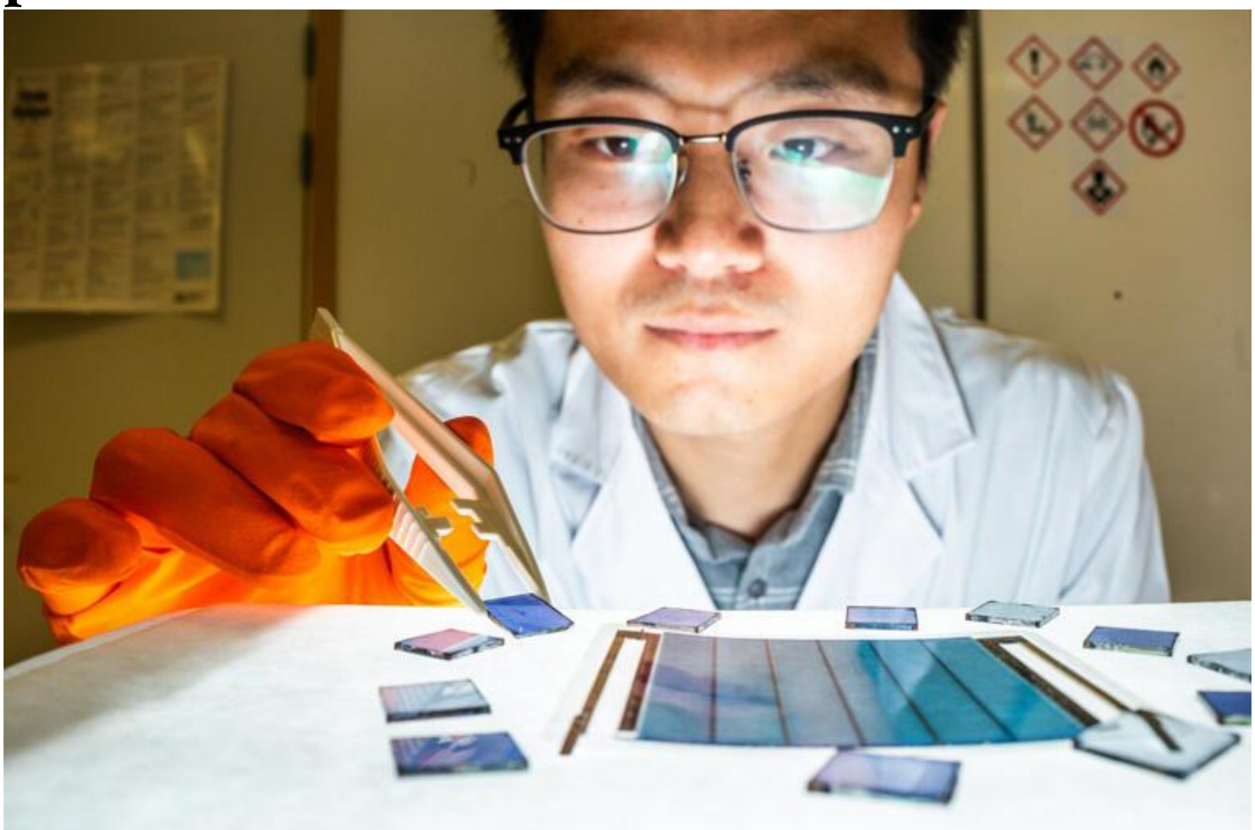
The benefits of this discovery are more far-reaching than just clean solar energy collection, however.

"Optoelectronics are important in many modern technologies, including telecommunications, medical devices, and energy production," as Associate Professor Jia explained in the SciTechDaily report.

"The ability to efficiently manipulate light and electricity is central to the advancement of faster, more efficient, and more compact electronic systems.

"Other devices that could be advanced by this discovery include photodetectors that sense light and convert it into an electrical signal, such as in cameras and sensors, plus laser diodes used in fiber-optic communication that convert electrical signals into light for data transmission."

How non-toxic and efficient solar cells can be produced



Rui Zhang, researcher at the Department of Physics, Chemistry and Biology at LiU. Credit: Thor Balkhed

Large-scale production of organic solar cells with high efficiency and minimal environmental impact. This can now be made possible through a new design principle developed at Linköping University, Sweden. In the study, published in the journal *Nature Energy*, the researchers have studied molecule shape and interaction in organic solar cells.

The researchers from Linköping University have developed a new design principle for non-toxic solvents to be used in the manufacturing of organic solar cells. Credit: Thor Balkhed

The efficiency of organic solar cells is catching up with traditional solar cells and they can convert about 20 percent of the sun's rays into electricity. The high efficiency is the result of several years of intensive materials research and studies of the interaction between the molecules in the material, the so-called morphology.

Organic solar cells are produced in a physical mixture which is then placed on a substrate and the solvent in the mixture evaporates. However, the chemical solution contains toxic and environmentally hazardous substances.

"To realize mass production of organic solar cells, with printed technologies for example, on a large scale, we need to find methods that don't use toxins. Otherwise, it's not good for the environment or for those working in the factories," says Feng Gao.

His research team has now, together with colleagues in China and the United States, managed to crack the code for producing efficient organic solar cells with several different environmentally friendly solvents.

"To choose the right solvent, it's important to understand the entire solar cell manufacturing process. This includes knowing the initial structures of the solution, observing the dynamic processes during evaporation and checking the final structure of the solar cell film," says Rui Zhang, researcher at the Department of Physics, Chemistry and Biology at LiU and lead author of the article published in *Nature Energy*.

According to the researchers, understanding the link between morphology and performance in organic solar cells is a major challenge, as they need to investigate the ultra-fast movement of electrons (the charge transport) from the material that releases electrons to the receiving material.

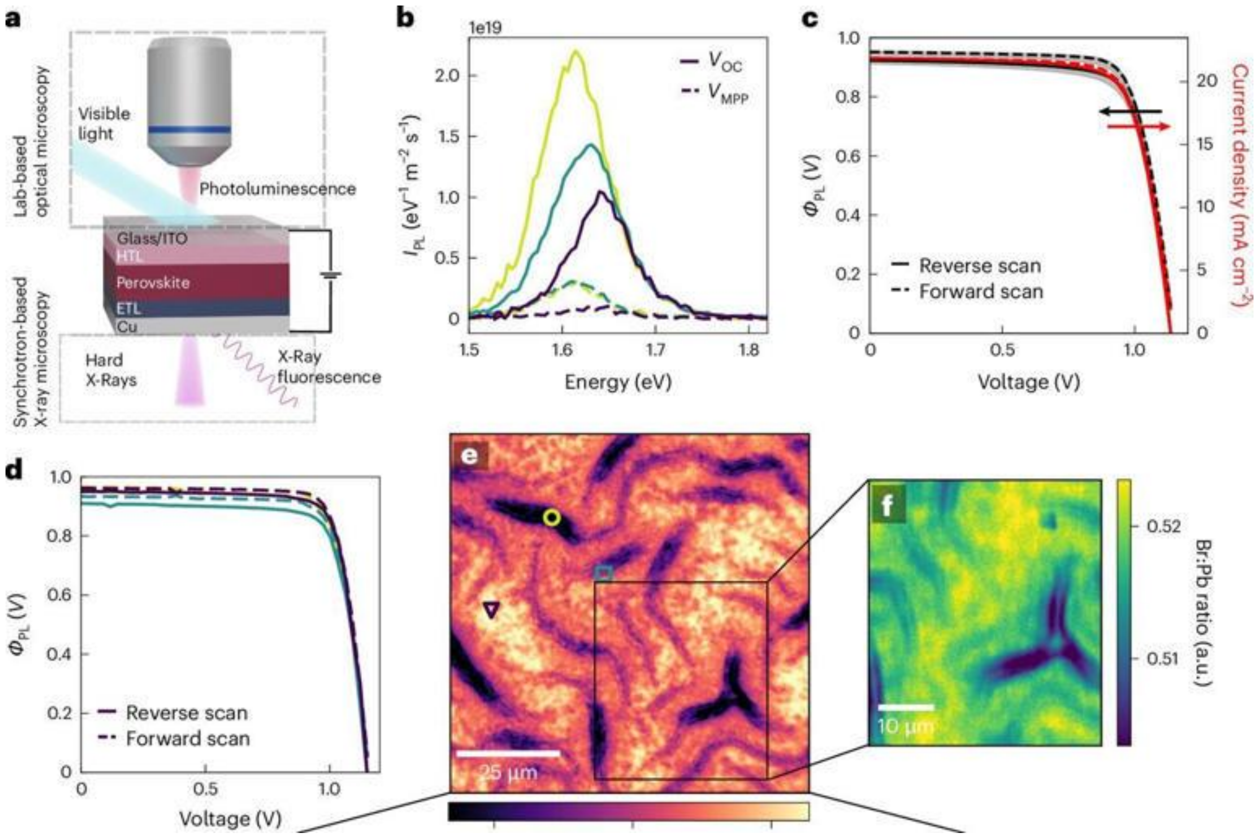
Those processes occur within nanoscale structures and at molecular interfaces. According to Feng Gao, the road to environmentally sustainable organic solar cells is now open.

"Thanks to a toxin-free manufacturing method, we now have a much greater chance of commercializing the technology on a larger scale."

More information: Equally High Efficiencies of Organic Solar Cells Processed from Different Solvents Reveal Key Factors for Morphology Control, *Nature Energy* (2024). [DOI: 10.1038/s41560-024-01678-5](https://dx.doi.org/10.1038/s41560-024-01678-5)

Provided by Linköping University

Study introduces new approaches to engineer stable and robust perovskite solar cells



Device operando microscopy reveals DCDH solar cell performance is tolerant to even dramatic spatial optoelectronic and chemical heterogeneity. Credit: Nature Energy (2024). DOI: 10.1038/s41560-024-01660-1

Perovskites are materials with advantageous optoelectronic properties that could be used to develop more affordable photovoltaics (PVs). While in recent years engineers were able to significantly improve the power-conversion efficiencies of perovskite solar cells, these devices remain less stable and scalable than conventional silicon-based solar cells.

Researchers at University of Cambridge, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH and Diamond Light Source used optical and X-ray microscopy to better understand the nanoscale processes that impact the performance and degradation of solar cells based on halide perovskites.

Their paper, published in *Nature Energy*, demonstrates that microscale variations in composition, recombination and charge transport can impact the performance and stability of these solar cells, while also outlining approaches that could mitigate these effects.

"Our recent work focused on halide perovskite solar cells for applications in next-gen solar cells—these materials are highly disordered on microscopic length scales," Samuel D. Stranks, senior author of the paper, told Tech Xplore. "In our previous works, we showed that microscopic variations in the atomic structure and chemical composition can impact the material properties of perovskite thin-films."

Solar cells made fully of perovskites contain more than just a perovskite film, as they also contain layers of materials that extract and transport electrons and holes. These additional layers add complexity to the solar cells, as they could also contribute to losses in current and voltage, thus adversely impacting a cell's overall performance.

"We wanted to augment our previous expertise by developing a multi-modal microscopy toolkit to probe voltage and current losses, their interactions with structural and chemical variations, in complete, state-of-the-art perovskite solar cells," said Miguel Anaya, another senior author on the paper formerly of Cambridge and now based in Seville.

"Our objective was to understand this microscopic interplay to boost the performance and long-term durability of these devices."

The microscopy toolkit was developed by a research team spearheaded by Kyle Frohna and Cullen Chosy. This toolkit which they used to closely examine perovskite solar cells as part of their recent studies, contains a variety of techniques. This broad range of methods can be roughly categorized into optical microscopy and X-ray microscopy techniques.

"On the optical side, we performed hyperspectral luminescence microscopy, which tracks the color and intensity of light emitted by the perovskite when a light source (e.g., a laser) illuminates the material," explained Frohna.

"Carefully tracking the emitted fluorescence allows us to track microscopic voltage losses in the solar cell. We additionally perform voltage-dependent luminescence microscopy—which allows us to track local charge transport and current losses."

On the other hand, the main X-ray microscopy technique employed by Stranks and his colleagues is known as nano X-ray fluorescence. This is an imaging method that allows researchers to gather more information about the chemical composition of a material.

The team used their comprehensive microscopy toolkit to study a wide range of perovskite solar cells. This allowed them to better understand how these cells' current and voltage losses are influenced by chemical changes and how the parameters they focused on shifted after the cells were operating for long periods of time.

"We showed that perovskite solar cells can tolerate substantial microscopic chemical variations, which is something very different to conventional solar cells like silicon," said Chosy.

"We also showed that they cannot tolerate variations in charge extraction. The messier the current is microscopically, the worse the solar cell performs—and even more strikingly, this messiness also results in the solar cells degrading considerably more quickly over time."

In addition to outlining factors that influence the performance and stability of perovskite-based solar cells at a nanoscale, the researchers outlined approaches that could help to reduce the current losses they observed. As part of their next studies, Stranks and his colleagues plan to continue building on their toolkit, while also trying to use it to improve the long-term performance of perovskite PVs.

"Solar cells experience a wide range of conditions—extremely hot to extremely cold temperatures, forward and reverse bias conditions, intense and weak sunlight—the way that perovskite solar cells handle all of these conditions affects how long they will last," added Stranks.

"We want to understand how these stresses affect perovskite solar cells from the atomic to module level and use this understanding to improve their viability towards commercialization."

More information: Kyle Frohna et al, The impact of interfacial quality and nanoscale performance disorder on the stability of alloyed perovskite solar cells, *Nature Energy* (2024). DOI: 10.1038/s41560-024-01660-1.

One of the largest energy projects in the US just went live — here's how the $2 billion investment will impact California

This move represents a significant evolution in the energy sector.

Mojave, California, is now home to one of the most ambitious solar and battery projects in the United States. In December 2024, Electrek reported that Arevon Energy's Eland 1 Solar-plus-Storage Project, one of the largest solar and battery storage systems in the U.S., went online, delivering clean energy to Southern California.

The project combines a massive 384-megawatt solar farm with a 150-megawatt/600-megawatt-hour battery storage system. And this is just the beginning.

Construction, led by San Diego-based SOLV Energy, is already underway on its second phase, Eland 2, which is slated to go live in early 2025. Together, the two phases will offer 758 megawatts of solar capacity and 300 megawatts/1,200 megawatt hours of energy storage, all backed by an impressive $2 billion investment.

Beyond its impact on the grid, Eland 1 has already benefited the local economy, creating 325 construction jobs and generating millions of dollars for local businesses. Over its lifetime, the project will "disburse more than $18 million to local governments over the project's lifespan, providing revenue for schools, first responders, and other local needs," Arevon said in a statement.

The energy produced by Eland 1 will be delivered under a long-term contract with the Southern California Public Power Authority, benefiting two major utilities: the Los Angeles Department of Water and Power and Glendale Water and Power.

This move toward solar paired with large-scale battery storage represents a significant evolution in the energy sector. A decade ago, solar couldn't compete with dirty energy sources such as oil, coal, petroleum, and natural gas on cost alone.

Today, solar is the cheapest new source of electricity, and when combined with storage, it's ready to outpace natural gas and coal in both price and performance. The batteries add the necessary consistency and resilience to make solar energy a viable alternative, making this transition all the more powerful.

For Arevon Energy, Eland 1 is just one piece of its growing portfolio. With over 4,500 megawatts of solar and storage projects across 17 states and another six gigawatts in the pipeline, the company is helping pave the way for a future powered by renewable energy.