Energy
National Research Programmes 70 and 71

Project

Next generation photovoltaics

Steps towards the energy of the future

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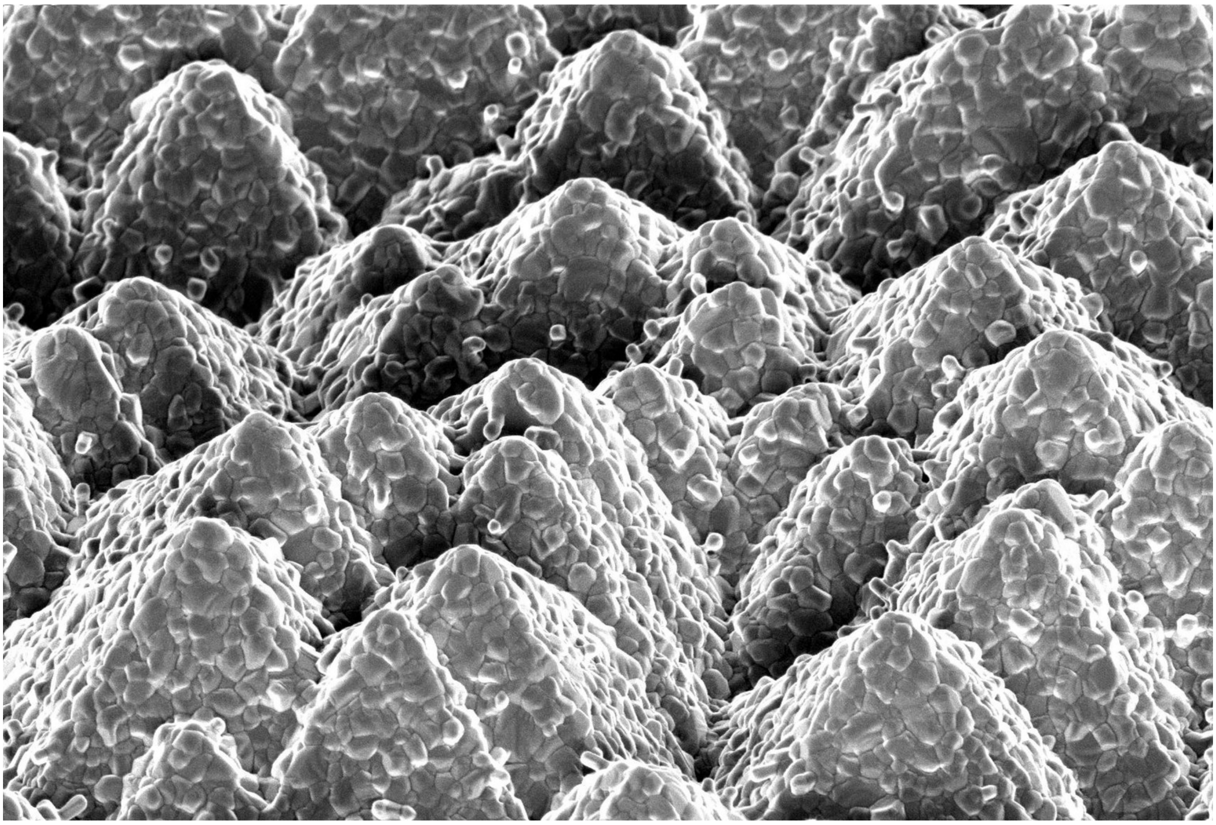
Researchers from leading Swiss research institutions developed a new generation of solar cells in order to support the objectives of Energy Strategy 2050. In six closely linked sub-projects, they also addressed all aspects of the technology, ranging from its energy efficiency to its social acceptance.



Microscopic image of a silicon/perovskite tandem solar cell with an efficiency level of 25.5 % – one of the developments from the photovoltaics joint project. *Source:* EPFL

At a glance

- Swiss research groups have developed building blocks for the implementation of Energy Strategy 2050 in the area of photovoltaics.
- While the new generation of solar cells achieves record-high levels of efficiency, they are not yet sufficiently robust.
- Sustainable and visibly attractive facade modules are creating acceptance for the broad use of solar cells on buildings.

Clean, resource-saving and efficient – this is what the energy supply of the future should be. Photovoltaics will play an important role here. Switzerland wants to generate at least 20 % of the electricity to be consumed in future from sunlight – this is the objective stated under Energy Strategy 2050. This goal can already be achieved with the opportunities currently provided by photovoltaics. However, there are technical developments afoot that could help to manage the upcoming challenges even better.

Promising future technologies

Researchers from leading Swiss research institutions took on the challenge of realising the photovoltaics of the future. The teams from the Swiss Federal Institute of Technology Lausanne (EPFL), the Swiss Federal Laboratories for Materials Science and Technology (Empa) in Dübendorf, the University of Fribourg, the Zurich University of Applied Sciences (ZHAW) in Winterthur and the Swiss Center for Electronics and Microtechnology (CSEM) in Neuchâtel pooled their strengths in six coordinated sub-projects in order to develop a new and better-performing generation of solar cells. In doing so, they utilised innovative materials and functional principles that promise to bring about a quantum leap in the efficiency of the conversion of sunlight into electricity. This would allow for many problems facing solar energy to be mitigated: the required area for the production of a certain quantity of electricity would become smaller – meaning that electricity production costs would also decline. This would also reduce the impact of solar panels on surrounding landscapes and townscapes.

Efficiency as a key factor

Potential for the development of more efficient solar cells can primarily be found in the new material class of perovskites. A sub-project devoted itself fully to this material that stands out thanks to, among other qualities, its high level of light absorption and ease of processing. The main objective was to make perovskite solar cells ready for industrial mass production. To achieve this goal, this meant, in particular, that the solar cells' high level of efficiency would also have to remain stable over extended periods.

In order to get the maximum possible output from the new perovskites, the solar cells' other parts also needed to be optimised, for example the so-called intermediate areas. These layers are important for ensuring loss-free charge transport. Improving them was the subject of a further sub-project. Here, a special challenge lay in making the intermediate areas optically more transparent without having a negative impact on their electrical properties.

Transparent materials also allow for innovative solar cells that comprise several active layers. These so-called tandem solar cells combine solar cells with perovskites with the tried-and-tested technology of the silicon cell or with the thin-film solar cell comprising copper indium gallium selenide (CIGS). With the two-tier principle of the tandem cell, the energy from the sunlight can be better utilised across the entire spectrum. The building blocks for these new, highly efficient solar cells were developed in a third sub-project.

A holistic approach

The researchers were aware that superior efficiency under laboratory conditions alone was not enough. In order for the new solar cells to conquer the market, they also need to be economically viable, sustainable and, last but not least, also attractive – only with these qualities will they have the chance of large-scale use. For this reason, three of the six sub-projects focussed on the practical usage options of the new technology.

A key question here is what the electricity yield will be under real weather and radiation conditions. In order to calculate this, the researchers developed a toolbox comprising computer models that simulate the entire electricity production chain, ranging from the physics of the solar cells to the operation of the system at a specific location. The simulation tools can be used both for research purposes as well as for the planning of solar panels with the new technology.

With the new generation of solar systems, the researchers want to increasingly utilise the potential offered by building surfaces. Here, in addition to the roofs, the facades should also produce electricity – the concept is referred to as building-integrated photovoltaics (BiPV). Advancing this idea was the objective of another sub-project. To this end, the researchers developed electricity-generating facade modules that combine sustainability with aesthetics. With attractive colours and textures, these solar panels offer new design options for the architectural sector.

The unobtrusive solar facades are very well received by the population – according to one of the results from the sixth sub-project. This assessed the sustainability of the new solar cells from an economic, environmental and social perspective. As part of the sub-project, the researchers also investigated strategies for how the electricity grid can in future accept the large share of solar electricity. Overall, this comprehensive analysis gives rise to a positive forecast with respect to the feasibility of the perovskite solar cells – on the condition that they have a sufficient service life.

Making the energy turnaround possible with first-class research

Durability is thus also the biggest remaining challenge facing the perovskite technology. These cells do not yet meet the required standard in this respect. The progress being made is impressive. Thanks to improved materials and protective glazing, the output of the solar cells has already been massively increased in stress tests. The Swiss research groups also recorded major successes in terms of efficiency levels – they set several world records with their tandem cells. Finally, the researchers were able to break new architectural ground for photovoltaics with their facade modules in attractive colours. The challenging cooperation has therefore achieved its goal – providing the building blocks for the implementation of Energy Strategy 2050.

Produkte aus diesem Projekt

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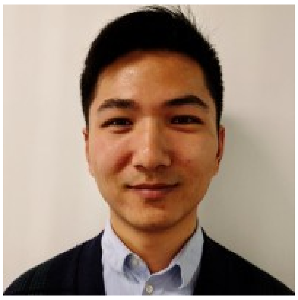

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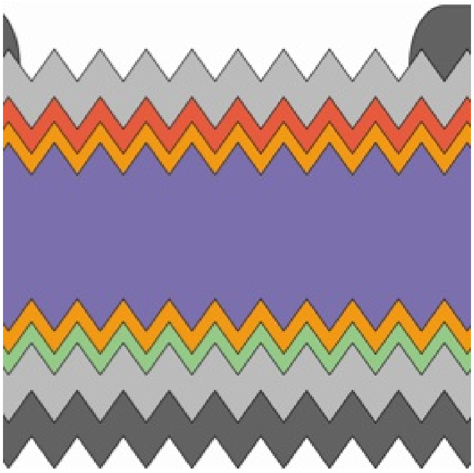
Connected projects



Novel interfaces in solar cells

More Than Just a Gap: Intermediate Layers in Solar Cells

Multi-junction solar cells

Tandem Solar Cells Set New Standards for Efficiency

Novel generation perovskite devices

Perovskite – the future of the solar cell

Highly efficient, integrated PV systems

The aesthetics of sustainability

Simulation of PV systems

Computers contribute to the conception of a new generation of solar cells

Sustainability of PV systems

PV2050: Sustainability, market deployment and interaction to the grid – the impacts of advanced photovoltaic solutions

All information provided on these pages corresponds to the status of knowledge as of 10.05.2019.