**Energy**
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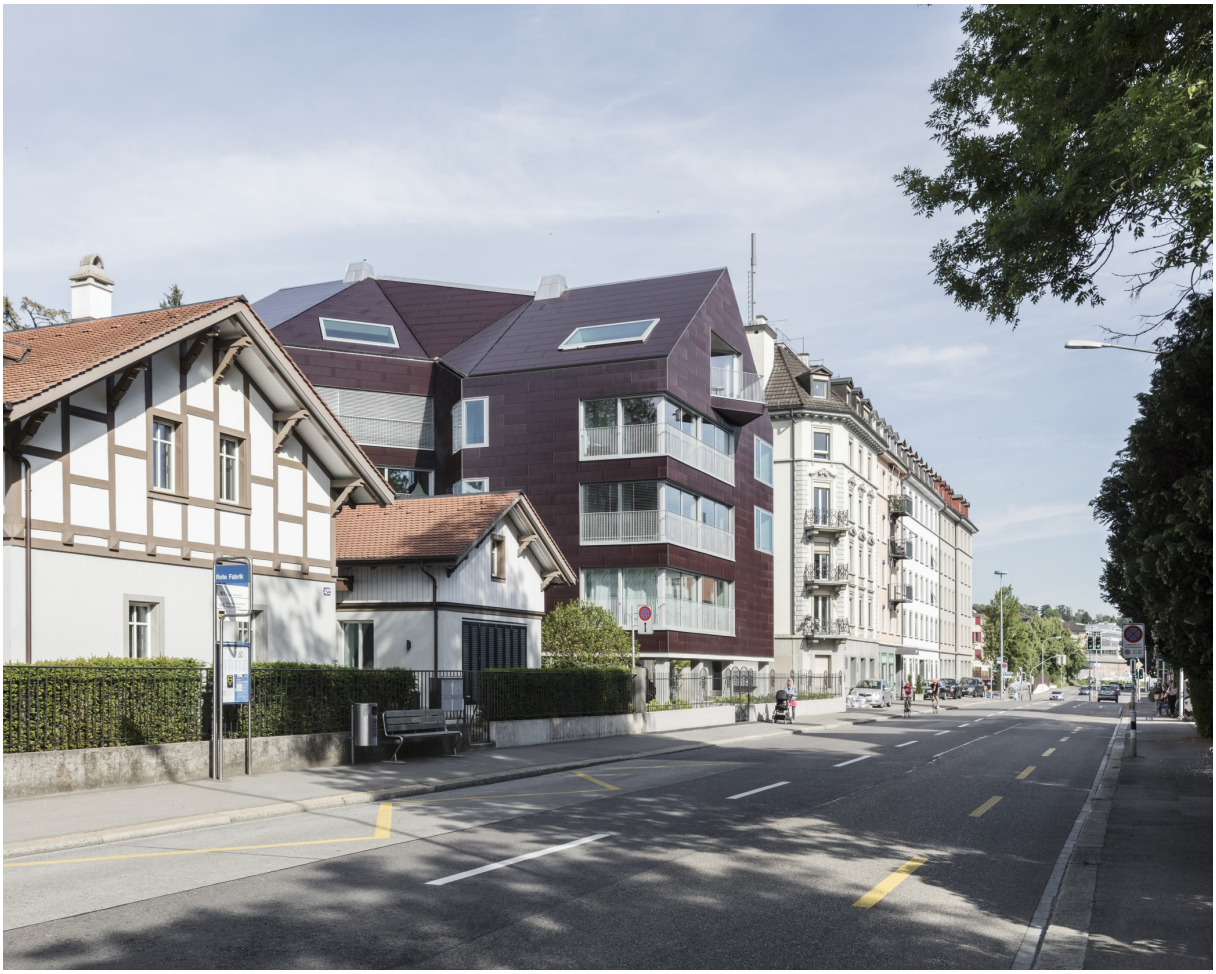
# Project

## Sustainability of PV systems

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

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

Solar cells with a perovskite coating are a new development that promises to allow for the considerably more efficient and cost-effective generation of electricity from sunlight. Researchers from the Zurich University of Applied Sciences (ZHAW) have investigated how sustainable the new solar cells are – from an economic, environmental and social perspective.



Good demonstration projects, such as this building in Zurich with an active facade, are needed in order to enthuse the population about photovoltaic systems on buildings. *Source:* Beat Bühler

## At a glance

- The new technology of perovskite tandem solar cells has good market potential – provided the production costs are low and the perovskite coating is stable over the long term.
- The use of rare minerals in the new solar cells is questionable from both an environmental and social viewpoint. This is because these raw materials are in short supply and their mining in some cases has a considerable environmental impact.
- The Swiss population welcomes the subtle use of solar energy on buildings. However, good examples are important for the technology's image and the increased use of building-integrated photovoltaics.

Solar technology finds itself in a state of transition. In the recent past, a decline in prices for photovoltaic modules has led to strong growth for solar energy on the market. New technological developments now promise to bring additional momentum to the market – with solar cells whose efficiency should surpass the limits of established technologies. These new solar cells contain a special material (methylammonium lead halide) with a perovskite crystal structure that makes ground-breaking solutions possible: for example, the combination of a silicon cell with a perovskite solar cell. A so-called tandem cell such as this has a better light yield and can achieve a higher level of efficiency.

However, whether the new perovskite solar cells are really better is not only a question of their efficiency. From an economic perspective, the electricity production costs are decisive. These are calculated on the basis of the expenditure for materials and production in relation to the return under real operating conditions. From an environmental viewpoint, the environmental impact over the service life of the solar modules is of interest. Here, the positive impact of emission-free electricity generation must be weighed against resource consumption during the modules' production. The service life of the modules is decisive for their environmental added value and economic success. The long-term stability of perovskite cells has yet to be demonstrated. And finally, every technological change also entails social consequences. This is because people are always affected at every stage – from the mining of the raw materials to the production of the modules at factories and their ultimate operation.

## A holistic view

These three aspects – economic viability, the environment and society – were investigated by researchers from the Zurich University of Applied Sciences (ZHAW) in a sustainability analysis of the perovskite/silicon tandem cell. They compared the new solar cells with the current market leader, the silicon cell. They also surveyed a representative section of the Swiss population on their views with respect to the broad use of the new technology on buildings.

One result from the analysis is that tandem cells are not only superior from a technical perspective, but also from an economic standpoint – provided the additional costs do not exceed a few centimes per watt of installed capacity. However, the competitiveness of the new tandem cells will also depend on how the tried-and-tested silicon cells are developed going forward. Should the efficiency of these cells increase further, this would place question marks over the economic viability of the tandem cells.

## $CO_2$ savings predominate

From an environmental perspective, the expectations placed on the new technology are considerable. The electricity generated from the tandem cell should replace fossil energies in an efficient manner and thus reduce $CO_2$ emissions. For example, the energy strategy aims to cover at least 20 % of electricity consumption via solar energy by 2050. For the Swiss electricity grid, such a high share of solar electricity represents a problem. Because the sun does not always shine, voltage fluctuations are to be expected. As the researchers demonstrate, various approaches are expedient. One of the options is a grid expansion – but this would be rather expensive. However, adapted management of the electricity flows or the storage of power with batteries could diffuse the problem. The charging of electric cars, for example, would have a balancing effect on mains voltage.

Irrespective of how the grid integration is accomplished, the additional solar electricity from the tandem cell will make the Swiss electricity mix cleaner. With respect to pollution and land consumption, the tandem cell also fairs similarly or even slightly better than the silicon cell. This is not true, however, when it comes to the consumption of mineral raw materials. This is because the tandem cell contains rare materials which negatively impact its life cycle assessment.

## The social downside of progress

Minerals are also the critical factor from a social perspective. This is because these raw materials are extracted in many countries under difficult working conditions. Tin is one such example. In the worst case scenario, it is sourced from regions where mining is conducted on an uncontrolled basis, with the income being misappropriated for the financing of armed conflicts – the term “conflict materials” is used in such cases. While the researchers write in their report that the social impact of the new solar technology is difficult to assess as in most cases it is not known where the used materials originate from, the social risk will remain high as long as the rare materials cannot be replaced.

A further social factor that can be decisive for the destiny of a technology is acceptance. Where large-scale solar panels are installed for the achievement of energy objectives, resistance from the population is predictable. Here, the development of less obtrusive alternatives should help: for example, building-integrated photovoltaics (BiPV) for which, where possible, the solar cells are installed so that they do not visually stand out from the normal building. A survey conducted by the ZHAW researchers confirmed that this type of solar energy is well received. Nevertheless, the result should be viewed with caution to the extent that those surveyed hardly had any personal experience of BiPV. The researchers believe that in order to gain acceptance, pilot projects are therefore important that demonstrate the design options of BiPV with good architecture.

## Good marks – but with reservations

Viewed across all aspects of sustainability, the ZHAW researchers give good marks to the new tandem solar cells. On a self-critical note, however, they also explain that assessing future technologies of this kind is difficult. This is because the tandem cells are not yet marketable. The industrial production process is thus still unclear, as is the situation with respect to the precise raw material requirements. These results are therefore subject to considerable uncertainty. The analysis did, however, show one thing clearly: the fact that a new technology will win through should not be taken for granted – even if it is superior to the old solution. It is therefore worthwhile to contemplate the economic, environmental and social sustainability at an early stage.

## Produkte aus diesem Projekt

- Highly Efficient 3rd Generation Multi-Junction Solar Cells Using Silicon Heterojunction and Perovskite Tandem: Prospective Life Cycle Environmental Impacts
  Date of publication: 25.09.19
- Social Life Cycle Assessment: Specific Approach and Case Study for Switzerland
  Date of publication: 25.09.19
- Energiewende mit unregelmässiger Stromproduktion aus Fotovoltaik
  Date of publication: 25.09.19
- Solarenergie vermindert Stromimporte
  Date of publication: 25.09.19
- Fotovoltaik auf Holz – ein ökologisches Duo
  Date of publication: 25.09.19
- Stromzukunft mit mehr oder weniger Solar?
  Date of publication: 25.09.19

# Contact & Team

Evelyn Lobsiger-Kägi
Institut für Nachhaltige Entwicklung
ZHAW Winterthur
Technoparkstrasse 2
8400 Winterthur

+41 58 934 70 21
evelyn.lobsiger-kaegi@zhaw.ch

Prof. Vicente Carabias
Institut für Nachhaltige Entwicklung
ZHAW Winterthur
Technoparkstrasse 2
8400 Winterthur

+41 (0) 58 934 70 15vicente.carabias@zhaw.ch

Bettina Furrer
Projektleiterin

Thomas Baumann

Franz Baumgartner

Vicente Carabias

René Itten

Raphael Knecht

Evelyn Lobsiger-Kägi

Hartmut Nussbaumer

Matthias Schmid

Harry Spiess

Matthias Stucki

Uros Tomic

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