Energy
National Research Programmes 70 and 71

Project

Highly efficient, integrated PV systems

The aesthetics of sustainability

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Until now, aesthetics have not been one of the primary criteria during the development of better solar modules. And when coming up with their designs, solar energy has not been at the forefront of architects' minds. Researchers from the Swiss Center for Electronics and Microtechnology (CSEM) in Neuchâtel and the EPFL Lausanne want to change this in order to fully exploit the potential of buildings for electricity generation.

The demonstration cube shows the aesthetic and technical possibilities of new facade elements with integrated photovoltaics in their original scale. *Source:* Final report Perret-Aebi

At a glance

- Building facades can make a major contribution to the expansion of solar energy.
- Solar panels that are integrated in facade modules with aesthetically pleasing surfaces are becoming attractive for modern architecture.
- The development of new and more efficient solar cells is essential in order to reduce both costs and the spatial requirements of building-integrated photovoltaics.

Finding suitable areas for the installation of solar panels is not easy in a small country like Switzerland. So, what could make more sense than making use of energetically dormant building surfaces? Installations on just 40 % of sun-facing building roof areas would be enough for the timely achievement of the production objective stated under Energy Strategy 2050 of 11 terawatt hours of solar electricity by the halfway point of the century. Building facades could also take on 30 % of the planned capacity.

Building envelopes that convert sunlight into electricity already exist. However, so-called “building-integrated photovoltaics” (BiPV for short) are still only used in rare instances. This is because architects have little interest in covering their projects with unattractive solar modules.

Researchers from the CSEM in Neuchâtel and the EPF Lausanne are working on making BiPV more popular. They are aiming to achieve nothing short of a paradigm shift: photovoltaics should not only be understood as an energy-technology issue, but rather as an aspect of architectural freedom. First and foremost, the aesthetic possibilities of BiPV must be expanded to this end.

Reference for attractive solar architecture

The objective of the researchers was to create an architectural reference that demonstrates how the efficient generation of electricity can be combined with contemporary aesthetics. They developed a facade module that is compatible with common solar cells and hides them out of view behind an attractive envelope. This is ensured by a partially area-wide, colourful and opaque fabric between two glass layers.

The new facade module also uses forward-looking solutions in terms of building ecology. It is constructed from the renewable raw material wood and contains efficient thermal insulation comprising the natural materials cellulose and wood fibres. This saves energy over the building's entire life cycle – from its construction (grey energy) to its use (heating energy). And following their removal, the modules can be easily dismantled and recycled.

The installation of solar cells in the facade elements initially increases the level of resource consumption. And the BiPV facade is also around one-third more expensive relative to an average facade. However, the emission-free generation of solar electricity overcompensates the environmental impact of the manufacturing process by a factor of ten and recoups the investment costs again in just a few years.

Efficiency is key

From an energetic and financial viewpoint, the figures could be even better if the efficiency of the solar modules was higher. Lower spatial requirements would reduce the costs per kilowatt hour and provide greater architectural freedom – giving a further boost to BiPV technology. This could soon become a reality as a new generation of solar cells with a markedly better level of efficiency is under development. With the tandem solar cells comprising two layers, 25 % of the suitable roof areas would theoretically suffice in order to achieve the expansion objectives stated under Energy Strategy 2050.

However, the tandem solar cells are still not suited for practical use as, among other factors, they are generally not yet sufficiently stable. In order to change this, the researchers developed a more efficient encapsulation method. More stable tandem cells are also being developed. The solar cells enclosed in this way passed the endurance test with flying colours: in a hot and humid environment and under irradiation without UV protection, they delivered electricity on a constant and reliable basis.

Rethinking buildings

However, the requirements of Energy Strategy 2050 do not provide time to wait until the new solar cells are ready for series production. The new BiPV modules with common solar cells should be put into practical use as quickly as possible. Architecture, as the first instance in building planning, plays a key role here. In order to convince the architectural world of the concept of building-integrated photovoltaics and obtain feedback from the relevant players, the researchers built a demonstrator – a cube-shaped mini building that allows for the appearance and function of the BiPV modules to be inspected in their original scale. The demonstration object was well received by architects – 90 % of visitors at a national architecture forum expressed an interest in themselves working with BiPV in their design process in future.

With the new BiPV modules, facades can be realised with very different appearances. Depending on their design, the energy balance is also different.

In order to implement the new opportunities offered by photovoltaics in architecture, a competition given the name “Active Housing” was organised with 39 participants. Under this motto, the EPFL architecture students explored the design scope provided by the new facade elements. The competition showed that when the next generation of architecture specialists meets the next generation of building facades, the concepts of buildings can be rethought.

Produkte aus diesem Projekt

- Integrated thinking for photovoltaics in buildings
  Date of publication: 25.09.19
- Fully textured monolithic perovskite/silicon tandem solar cells with 25.2 % power conversion efficiency
  Date of publication: 25.09.19
- Un démonstrateur de façade active bas carbone
  Date of publication: 25.09.19
- 9° édition du forum ecoparc. Potentiel solaire des territoires urbains: vers de nouveaux paradigmes?
  Date of publication: 25.09.19
- Concevoir des façades actives bas carbone
  Date of publication: 25.09.19

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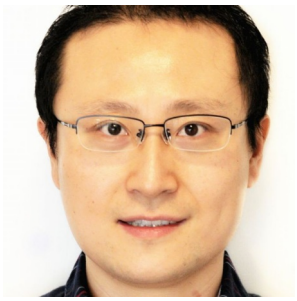

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All information provided on these pages corresponds to the status of knowledge as of 18.06.2019.