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National Research Programmes 70 and 71

Project

Standards for photovoltaics

Aesthetic Power Production: Colourful Photovoltaic Systems to Promote the Development of Solar Energy

Aesthetic Power Production: Colourful Photovoltaic Systems to Promote the Development of Solar Energy

By 2050, solar power should have replaced nuclear power, but the development of photovoltaics is currently very slowly, partly due to the fact that blue-black paved roofs and facades are perceived as ugly. Researchers at the Lucerne University of Applied Sciences and Arts have now found a way to print bright colours and patterns on photovoltaic modules. These modules are somewhat less efficient than the conventional ones, but much more attractive for large-scale use.

The colour-printed photovoltaic cells on the face of the "Solaris" residential building in Zurich cover the tenants' electricity needs. *Source:* Beat Bühler

At a glance

- The Swiss government's Energy Strategy 2050 stipulates that the share of electricity from photovoltaics (PV) must increase from the present 2 % to 20 %. However, progression is very slow.
- This is due to the fact that photovoltaic systems are usually of a uniform blue-black colour. As a result, architects are reluctant to use them on a large scale.
- Now colourful and patterned PV cells should help solve this conundrum: they look attractive while still producing electricity. First buildings are already equipped with such systems.

On the shores of Lake Zurich, not far from the city centre, the Solaris residential building's terracotta-coloured facade glistens in the sunlight. This is not only an attractive style element intended to remind passers-by of the light reflections on the lake: the facade also produces electricity thanks to 1,300 individual photovoltaic cells, hidden behind printed glass, that convert solar energy into electricity. The building produces 40,000 kilowatt hours of electricity per year, thus completely meeting the energy requirements of its tenants. Stephen Wittkopf and his team at the Lucerne University of Applied Sciences and Arts have participated in the development of these innovative PV modules. The colours and patterns are printed on the glass surface of these elements using a digital ceramic printing process.

Patterns printed on PV modules. Stephen Wittkopf

The final appearance results from the transparent colour of the printed glass and the dark colour of the underlying solar cell. As the printing ink differs from the intended final colour, the researchers at the Lucerne University of Applied Sciences and Arts had to optimise the colour settings, so as to obtain the desired electrical output. This was far too low in the first conventionally produced PV modules.

Decreased efficiency

One of the problems encountered by the scientists was that the printed glass obscures the solar cells, causing them to convert less sunlight into electricity and decreasing their efficiency. Additionally, the dark surface absorbs more light. On average, the printed PV modules therefore produce approximately 20 % less power than their conventional counterparts.

However, what is lost in efficiency is gained in aesthetics. Because of the blue-black techno-look of facades covered in solar cells, architects, historic building preservation authorities and residents are reluctant to accept and install them. The Energy Strategy 2050 stipulates that 20 % of Switzerland's electricity requirements must be covered by photovoltaics. However, only 2 % of the country's power is currently produced by solar systems. As the Spatial Planning Act prohibits the construction of large-scale photovoltaic power plants, solar cells must be installed on buildings. Yet, rooftop installations alone are not sufficient, and typically produce a power peak only around noon, whereas most buildings also require electricity in the morning and evening. This power can be produced by installations on unshaded east and west facades. The purpose of the printed PV modules is to encourage architects to design solar facades similar to that of the Solaris building.

Almost ready for the market

PV modules with the cantonal coats of arms on the stair tower of the Umwelt Arena Schweiz in Spreitenbach.
Stephen Wittkopf

Not only have Stephen Wittkopf and his team produced prototypes of the printed PV modules. Their invention is almost ready for the market. They have applied for three patents, have had the printed PV cells extensively certified according to industry standards with the help of the Scuola universitaria professionale della Svizzera italiana (SUPSI) and, in collaboration with the technology transfer company Üserhuus, have set up pilot and test systems such as the "Swissness" solar facade displaying the Swiss cantonal coats of arms on the stair tower of the Umwelt Arena Schweiz in Spreitenbach. Glas Trösch already sells the multicoloured printed glass under the name "Swisspanel Solar".

In addition to developing the prototype, the researchers have also devised methods to measure the visual effect of photovoltaic systems on facades as objectively as possible. This is an important step when PV modules are to be installed on the facade of a listed building. For the historic Villa Seerose on the shores of Lake Zurich in Horgen, for example, the investigators carried out computer simulations with and without PV modules. Using a special image processing method, they analysed the two facade options and were thus able to assess how each one attracts the human eye. This method makes it possible to objectively determine how photovoltaic systems must be installed or printed in order to preserve the appearance of valuable buildings.

Preventing glare

But it's not just about looks. Walls covered in conventional PV modules present another problem: they are sources of glare, an additional reason why they are not readily accepted by residents and builders. In this context, the researchers involved in this project developed another computer simulation: they created a 3D model of the surroundings of a church in Lucerne and calculated how glare caused by solar panels installed on the large roofs would affect the neighbourhood. Using meteorological data and measurements of the reflective properties of different types of glass used in PV modules, Wittkopf and his team simulated the refraction of sunlight on the photovoltaic facade throughout the year to find out where bothersome reflections would appear. This model too should help decide whether and how solar cells can be integrated into existing buildings.

Installing PV modules on facades of new buildings such as the Solaris house does not automatically make these buildings "green". Erecting a building costs energy, and recovering this energy costs PV modules a portion of their 30-year lifespan. The investigators, in collaboration with scientists from the University of Applied Sciences Northwestern Switzerland (FHNW), have calculated this expense: eight years for coloured PV modules installed on a south-facing wall; five years for PV modules replacing existing elements. Hence, in the best-case scenario, the colourful photovoltaic systems can generate an energy surplus over 25 years.

The coloured PV modules have already reached the highest technology readiness level, which means that they could soon be introduced on an industrial scale and become established on the market. However, their success equally depends on the political and legal framework conditions, which the researchers also examined as part of their project. They concluded that the "Model Regulations of the Cantons in the Energy Sector" encourage the use of building-integrated photovoltaic systems. In addition, installation of such systems on facades is supported by labels such as "Minergie-A" and "Plusenergy". However, these standards being optional, they cannot mediate increased use of PV modules on facades, as would be necessary to achieve the goals of the Energy Strategy 2050.

Produkte aus diesem Projekt

- Pressemitteilung Glas Troesch
  Date of publication: 16.10.19
- Live-Monitoring der Fassade "Swissness"
  Date of publication: 16.10.19
- Knowledge and Technology Transfer
  Date of publication: 01.01.18
- Pilot- and Demonstration (P&D) Project
  Date of publication: 01.01.18
- Visual Assessment
  Date of publication: 01.01.18
- Policy Analyses
  Date of publication: 01.01.18
- Technical Standards
  Date of publication: 01.01.18
- Testing and Certification experience to qualify a family of colored BIPV modules
  Date of publication: 01.01.18
- Life Cycle Assessment
  Date of publication: 01.01.18
- Frame conditions and testing processes for the implementation of PV-products in BIPV projects
  Date of publication: 01.01.17
- Significance of prevailing regulations, standards and labels for the deployment of BIPV
  Date of publication: 14.12.17
- Common methodological framework to assess energy, climate and economic impacts of BIPV
  Date of publication: 30.06.16
- Energy-Policy analysis
  Date of publication: 01.01.16
- Fire Safety of BIPV Facades
  Date of publication: 01.01.18
- Farbige Photovoltaik-Module
  Date of publication: 16.09.20

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