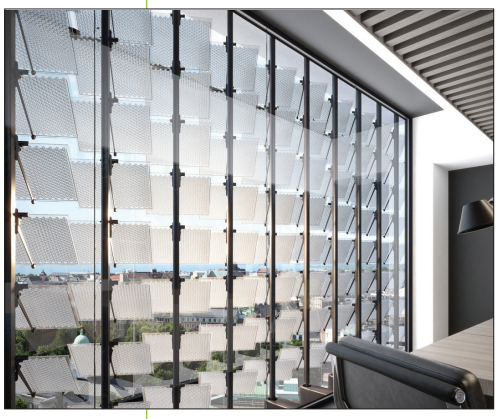
Building Integrated Solar Envelopes: Current Status and Actions Needed

The objective of our Task on Building Integrated Solar Envelope Systems for HVAC and Lighting was to answer how solar envelope systems can become common practice in building construction. The SHC team that tackled this challenge was a group of experts from eight countries representing seven companies, six universities, and four research institutes. How they went about it was to tackle the issue from different angles – simulation of multifunctional envelope systems, review of laboratory tests and norms, and market assessments. The following is what they concluded needs to be done and by whom to push this technology further into the building market.



▲ **Figure 1. Examples of solar envelope systems described in SHC Task 56 report, State-of-the-art and SWOT analysis of building integrated solar envelope systems. On the left, Kromatix BIPV panels (photovoltaics, Swissinso). On the right, Lumiduct (photovoltaics and shading system, TUe).**

Decarbonization of the heating and cooling sector in buildings is one of the main challenges to reduce greenhouse gas emissions and achieve the Paris Agreement objectives. The transformation of the current building stock into net-zero or positive energy buildings requires investing in energy efficiency to lower buildings' overall energy demand and to replace fossil fuel energy sources with renewables. The exploitation of a locally available renewable source, such as solar energy, is not only desirable to reduce the import of high primary-energy carriers on-site but also needed for the reliable and resilient operation of electric grids.

Building integrated solar envelope systems for HVAC and lighting offer a promising solution to this challenge. On the one hand, they can improve daylighting and control solar gains, hence reducing the building's electrical and thermal energy needs. On the other hand, a share of the building's residual energy demand can be covered by harvesting, storing, and distributing the solar radiation reaching the building façade.

Current Status

Solar envelope solutions cover a rather broad range of technologies, but there are two main market segments. The first relates to solutions that control incoming solar radiation. Innovative solutions, such as motorized shadings or electrochromic glass, have a place beside traditional shading devices, such as shutters, blinds, and curtains, which already have a well-established market in the residential and tertiary building sectors.

The second market segment relates to solar harvesting technologies – building integrated photovoltaic panels, solar thermal collectors, and PVT collectors. These systems are a niche market, despite the large number of building integrated photovoltaic products reaching the market in the last years.

Several challenges hindering the penetration of innovative solar envelope systems in the construction market are:

- The design, manufacture, and installation of these systems are usually more complex and time-consuming compared to conventional cladding solutions.

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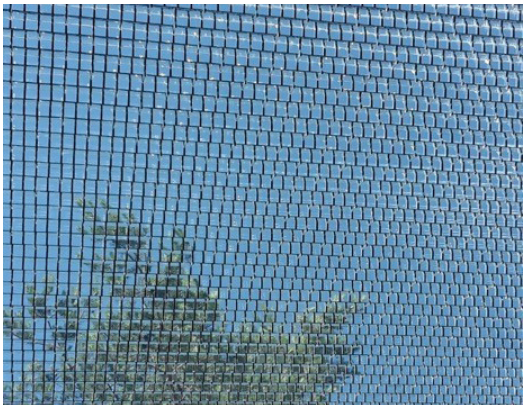

▲ **Figure 2. Examples of solar envelope systems described in IEA-SHC Task 56 Deliverable DA1+2. From left to right, Okalux Okasolar 3D (shading system, Bartenbach), Kindow (shading system, Kindow & TUe), and SunRise façade (solar thermal system, Eurac Research).**

- The legal liability for correct installation and operation, warranties, and maintenance must be cleared and planned before installation.
- The compliance with both construction codes and energy-related norms is required; the lack of consolidated international standards and test methods devised for building integrated components may deter planners, investors, and clients from adopting these technologies.
- The need for adequate design tools to estimate energy performance and architectural impact during the initial concept design.

Actions Needed

Manufacturers

To overcome such barriers and better promote the use of solar energy in buildings, manufacturers and policymakers need to take action. Industry should work in the direction of offering **systemic design and construction packages**, which would support the adoption of solar envelope systems in the building design phase. Also, this action could generate new business opportunities based on innovative partnerships, business models, and financing schemes. Prefabrication and plug-and-play design could also simplify the manufacturing and installation stages.

The **value propositions of solar envelope systems** should be reframed to avoid single-selling point market strategies (e.g., based on energy savings only). Instead, a broader, systemic perspective should be adopted that takes into account the impact of the solutions on sustainability protocols (e.g., LEED and BREEAM), higher property values, reduced impact on the grid and user comfort and wellbeing. User and human-centric solutions can be strong "go to market" strategies.

Manufacturers should provide **life-cycle cost and risk assessments** that are adapted to their markets and customer needs and account for commodities prices, incentives, norms, and legal frameworks.

Another important lesson is that a **customizable architectural appearance** is key to enter the construction market. There is no general rule of what is preferred by architects, public authorities, building owners, or occupants; thus, manufacturers should offer aesthetically flexible solar envelope systems to comply with specific architect requirements.

Policymakers

For policymakers, they should work to **harmonize regulations for building integrated products**, which may require higher level or country-specific legal approvals, thus creating a significant market-entry barrier for manufacturers. Policymakers should

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CHALLENGE	ACTION NEEDED
A large number of actors are involved in manufacturing, planning and installing solar envelope systems	To offer systemic design and construction packages
The construction market is often unaware of the potential of solar envelope systems	To promote professionals training To elaborate on new "user-centric" value propositions: • to provide LCC and risk assessment • to provide information for sustainability protocols • to provide information on user comfort and wellbeing
Architectural integration is not easy, but it is key for acceptance	To offer customizable architectural appearance
The regulatory framework is often unclear with respect to building integrated technologies.	To implement a normative framework facilitating the integration of solar technologies in the construction sector, as uniform and international as possible
Current regulations can be a barrier to the foundation of energy-sharing economies	Improve the regulations to ease the implementation of energy communities
Early-stage assessment of solar envelope technologies is crucial, but there is a lack of tools	To support the development of tools, like 3D solar cadasters, to evaluate the solar availability on façades
The construction sector is conservative and innovative solutions can hardly penetrate the market unless a proven record of installations is available	To promote pre-commercial-procurement demonstration projects in public buildings To devise administrative and legal procedures promoting private-public investment initiatives

address this obstacle by defining and enforcing a regulatory framework that is as uniform and international as possible.

At the same time, current regulations on energy communities can be an obstacle to sharing locally produced energy among neighboring buildings, thus devising legal frameworks that allow the **practical implementation of energy communities** can make the needed difference.

Moreover, **public support of solar envelope systems** should not be limited to the mere deployment of incentives supporting specific technologies. Instead, public support should be considered the elaboration of an integrated framework of measures that creates a level playing field with conventional solutions. This could include developing practical tools like 3D solar cadasters to assess the solar source availability on building façades, devising pre-commercial procurement demonstration projects, or using administrative and legal procedures to promote public-private joint investment initiatives.

This article was contributed by Roberto Fedrizzi of Eurac Research and the Operating Agent of SHC Task 56. You can learn more about this work and download the free reports, tools and Technology Position Paper from the Task webpage, https://task56.iea-shc.org/.