Task 56

Building Integrated Solar Envelopes: Common Challenges and Trends for the Future

Integrating solar systems into the envelope of buildings is receiving rising attention from stakeholders in the construction sector, like architects and façade systems manufacturers. Even though several barriers prevent a quick penetration of these solutions into the common practice of building design, a progressively increasing number of concepts and solutions is being developed, and several products have already reached the market.

IEA SHC Task 56: Building Integrated Solar Envelope Systems for HVAC and Lighting has gathered the experiences of both industry and research institutions on the challenges they are encountering and the trends that will characterize this market in the coming years. This has been a challenging task due to the variety of technologies embraced, which include any multifunctional envelope system that uses and/or controls solar energy that impact thermal energy demand, thermal energy consumption and comfort of the building. As such, these include building integrated solar thermal and photovoltaic solutions as well as sunlight control technologies. The analysis performed by the experts in SHC Task 56 takes into consideration the aesthetical and architectural aspects while tackling integration in building HVAC plants and socio-economic questions.

As the activities of SHC Task 56 are in the final phase (the project ends the beginning of 2020), it is time to sum up the main outcomes.

Starting with a review of solar envelope systems on the market, it has been possible to identify common threats and opportunities as perceived by manufacturers and researchers developing multifunctional façade systems:

▼ **GAP:skin in a building complex in Graz, Austria.** (Source: GAP Solutions)

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SHC Solar Award *from page 1*

market similar to the one in Denmark developing in France. The largest solar thermal plant in France, and the largest solar industrial process heat plant in Europe, is under construction and KYOTHERM's Heat Purchase Agreement will provide solar thermal heat for a set € or $ per MWh price. This means that KYOTHERM, and not the customer, bear 100% of the performance risk. Financing has become a commodity for the photovoltaic sector, and KYOTHERM's goal is to do the same for solar thermal with the help of their ESCO third-party financing solution.

"The 2019 SHC Solar Award spotlights successful financing mechanisms for solar thermal projects. The recipient, KYOTHERM, understands solar thermal's potential to decarbonize the energy sector, and using its novel ESCO solution will no doubt be a game-changer for the industry."

DANIEL MUGNIER, IEA SHC Chairman

KYOTHERM
investing in clean energy

About KYOTHERM

KYOTHERM provides third-party finance for renewable heat production and energy efficiency projects. The company partners with project developers (energy service companies, EPC contractors, etc.) to finance their projects with an optimal capital cost. This partnership allows KYOTHERM to supply the heat or energy saving to the end-user over contract periods of 5 to 25 years so that they can realize savings from year 1 without having to invest.

- **Building codes and building integration:** Solar technologies integrated into the envelope of buildings must comply with building codes and standards, which in most cases were developed for conventional envelope elements. The lack of adequate test methods and references, as well as the presence of regulatory gaps, is hindering the spread of innovative integrated products. Nevertheless, the efforts of the scientific community and the lobbying action of façade manufacturing companies can lead to a standardization process and the development of new norms, as was done for Building Integrated PV (BIPV) solutions.

- **Conservative construction sector:** The construction market is, in general, conservative compared to other sectors. While light-shading elements are nowadays consolidated praxis in new-built tertiary buildings, envelope integrated PV and solar thermal products are still a niche market. Solar innovations can hardly find a place in building practices to show an established history of successful installations. Support by decision-makers to make public buildings available to these technologies could play an important role in promoting the adoption of solar envelope solutions in both the public and private sectors.

- **Building construction process:** Achieving optimal building-integration of solar components requires adjusting the conventional design processes and roles, which may, in turn, alter 'well-oiled' procedures and be met with suspicion at first. Depending on the type of solar envelope product, the traditional roles of the façade manufacturer, HVAC installer, interior designer, etc. can overlap during the building design process as well as in the manufacturing and installation of solar envelope elements. Roles and responsibilities, information and material fluxes, liabilities and warranties, and maintenance become relevant multifaceted issues that must be cleared and planned. Although this may seem to create additional burdens on the companies involved in the construction process, the upside is that new opportunities can be generated based on innovative business models and partnerships between companies.

Upward view of the demonstration facade of the lumiduct BIPV system (Source: Wellsun).

- **Government policies:** The policies adopted by national or supranational institutions are perceived to be determinant for promoting the adoption of Building Integrated Solar Envelope Systems. However, because this sector is highly diversified, with solutions ranging from PV and solar thermal systems to advanced shading solutions and daylighting management, it cannot be easily targeted with a single scheme or policy action. Possible action includes policies that support solar energy production, energy efficiency, daylight and visual comfort.

- **Increased awareness:** Over the last few years, rising interest for life-cycle sustainability and human comfort in buildings has spread in the construction sector and among the general public. These movements are drivers for the adoption of solar envelopes and are often rewarded when it comes to decentralized green energy production, energy savings, blackout security and user comfort. Simultaneously, the building construction industry, especially building designers, are gradually becoming more aware of the possibilities offered by solar envelope solutions and more informed on the options viable for new constructions and retrofitted buildings.

A few significant trends identified, thanks in particular to the Task's review of products being developed and tested in laboratories and that will be reaching the market in the coming years are:

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- **New materials and applications:** New materials entering the market are driving product innovation. For example, high-efficiency polymers used as absorbers in building-integrated collectors and the development of new light shifting species in luminescent BIPV windows. The progress in solar façade technology, however, doesn't stop with innovative materials; it also is pushing advances in the manufacturing and assembling of existing materials resulting in the development of new concepts, improvement of existing technologies and design of new applications from old concepts. An example is the use of solar envelope technologies for daylight management and electricity or thermal energy generation in residential to commercial sectors.

- **Adaptivity:** Many solar envelope solutions can adapt their behavior or characteristics to the local climate conditions. The adaption process can occur at very different timescales, e.g., from seasonal processes to instantaneous processes, as in electrochromic glasses used in transparent surfaces to shade from daylight. In doing so, they create a balance between offering opportunities for energy savings and improvements of indoor environmental quality.

- **Multifunctionality:** A prevailing trend in façade technology is multifunctionality, where the envelope element is designed to be more than the barrier from external weather and includes additional functions. Most of the solar envelope concepts analyzed in SHC Task 56 integrate RES generation or advanced daylight control and solar protection. In some solutions, this is pushed even further by replacing (part of) the building's central services, such as the artificial lighting system or entire parts of the HVAC system.

- **Prefabrication:** The practice of assembling a variety of components on a structure at the manufacturing site is one of the most common practices in the analyzed solar envelope solutions. Compared to traditional construction methods, prefabrication offers many advantages, such as the reduction of the construction/renovation time, the decrease in manufacturing process costs and the increase in product quality. These aspects are particularly relevant for solar envelope solutions since installing solar components in the envelope structure on-site would require multiple professionals (i.e., façade installers, plumbers and electricians) to cooperate. Thanks to prefabrication, this can be carried out by trained technicians in controlled industrial conditions.

- **Automation vs. passive approach:** The operation of several elements in a Solar Envelope System is performed by automatic control logic based on a variety of inputs (e.g., indoor air temperature, solar irradiation, occupation) integrated at the component level for a room, floor, building or multi-buildings. In some cases, the envelope component becomes a data source for smart building technology.

  At the same time, in the exact opposite way, there is the trend toward **completely passive components**, that is once installed, they require no type of active control. Such solutions are usually advertised as low-tech, self-regulating and low/free maintenance. Being completely passive, they are generally durable and not subject to users' possible misuse.

- **Architectural integration:** As highlighted by many producers, architectural integration (appearance and design flexibility) is vital for acceptance in the building sector. To appeal to architects and building designers, many solar envelope producers are investing in products that offer a range of colors, installation options and sizes (or even textures, transparency levels and materials) to allow for both seamless integrations and stand-out installations. In this sense, BIPV is an excellent example of how the industry is evolving to meet the demand of architects and building designers for architecturally integrated solutions.

There is a lot to look forward to in the next years as more innovative products enter the market and the existing solar envelope solutions progressively become part of the building construction practice. **Overall,** as the construction sector experiences a drift towards industrialization, it is likely that Building Integrated Solar Envelope Systems will gain a larger share of the market thanks to joint ventures between innovative companies and to new business models covering the whole construction process with one-stop-shop installations.

This article was contributed by Paolo Bonato of Eurac Research and Roberto Fedrizzi of Eurac Research and the project leader of SHC Task 56: Building Integrated Solar Envelope Systems for HVAC and Lighting. To learn more about this project and its results visit, http://task56.iea-shc.org.