

Smart windows today and tomorrow

By Frank Koos, Secretary General of EuroWindow AISBL and Deputy General Manager of the German Window and Facade Manufacturers' Association (VFF) (pictured)

SMART WINDOWS TODAY

Windows have developed at stunning speed over the last few decades. Few components have been the object of as much innovation as the trusty window - especially when one considers what it replaced: Neolithic cave entrances, and empty semicircular openings in Ancient Roman buildings. Even in the 1970s, virtually all buildings were still single-glazed. But soon - prompted by rising energy prices, the spectre of climate change, and building users' demands for greater comfort in their homes and workplaces - "smart" windows began to emerge. Suddenly there was a call for better energy efficiency, more daylight, and greater comfort and convenience - and manufacturers

needed to think how windows could help in achieving these goals.

Insulating glass units, more energy-efficient installation techniques, new types of coated glass, smart glass configurations, and innovative ventilation and solar shading concepts all had their part to play in the success

story that followed. Then came windows that could actually generate their own power, thanks to solar heat and photovoltaics. However, a truly "smart" window today must also be part of a modern building automation system - for example enabling ventilation and solar shading to be controlled automatically - and be integrated into the building





services network of the building as a whole. In today's smart houses, smart windows need to "communicate", via the building services network, with users and other technical installations and devices, in order to respond automatically to the users' lighting, ventilation, temperature, sound insulation and privacy needs.

A remarkable new apartment building called the "Aktiv-Stadthaus" was recently inaugurated in Frankfurt. It is an example of an "active house plus", meaning that it not only uses energy extremely efficiently, but its state-of-the-art windows and photovoltaics actually produce an excess of energy that can be stored in e.g. electric cars¹.

Windows have become hugely more energy-efficient in recent decades, as demonstrated by the following: 40 years ago, the U_w -value of a typical single-glazed window (i.e. the thermal transmittance of the entire window) was $5 \text{ W}/(\text{m}^2\text{K})$, compared to less than $0.8 \text{ W}/(\text{m}^2\text{K})$ for a state-of-the-art triple insulating glass unit today. In

Frankfurt, inaugurated in summer 2015, is the largest energy-plus residential building in Europe. Designed by HHS Planer + Architekten from Kassel, Germany, it perfectly combines high-efficiency passive insulating materials (north side) with active energy generation (south side).



other words, windows today lose 5 times less heat than they did 4 decades years ago. However, to determine the real energy performance of a window, the solar gain needs to be credited against the heat loss (U-value) to give an "equivalent U-value" (or "energy performance value"). Obviously this figure varies greatly depending on the orientation of the facade in which the window is installed: windows on a south-facing facade will generally be more energy-efficient than even a well-insulated wall.

CURRENT SMART WINDOW PROJECTS

It is against this background that the first "European Smart Windows Conference" (an initiative of the European Commission and part of the "World Sustainable Energy Days") took place in February 2015 in Wels, Austria. As Secretary General of EuroWindow, I gave a talk at the conference entitled "LCEA from an industrial point of view - challenges & benefits" (LCEA = "Life Cycle Energy Analysis"), in which I looked at the problems of using life cycle analyses (as demanded today by EU research projects) for comparing different products. Often the datasets used in LCEA calculations do not allow meaningful comparison, due to differences in boundary conditions or in the products' technical performance. If project decisions are taken on the basis of misleading LCEAs, the project can produce flawed products. In addition, the product's entire life cycle needs to be considered; current approaches for assessing sustainability take account not

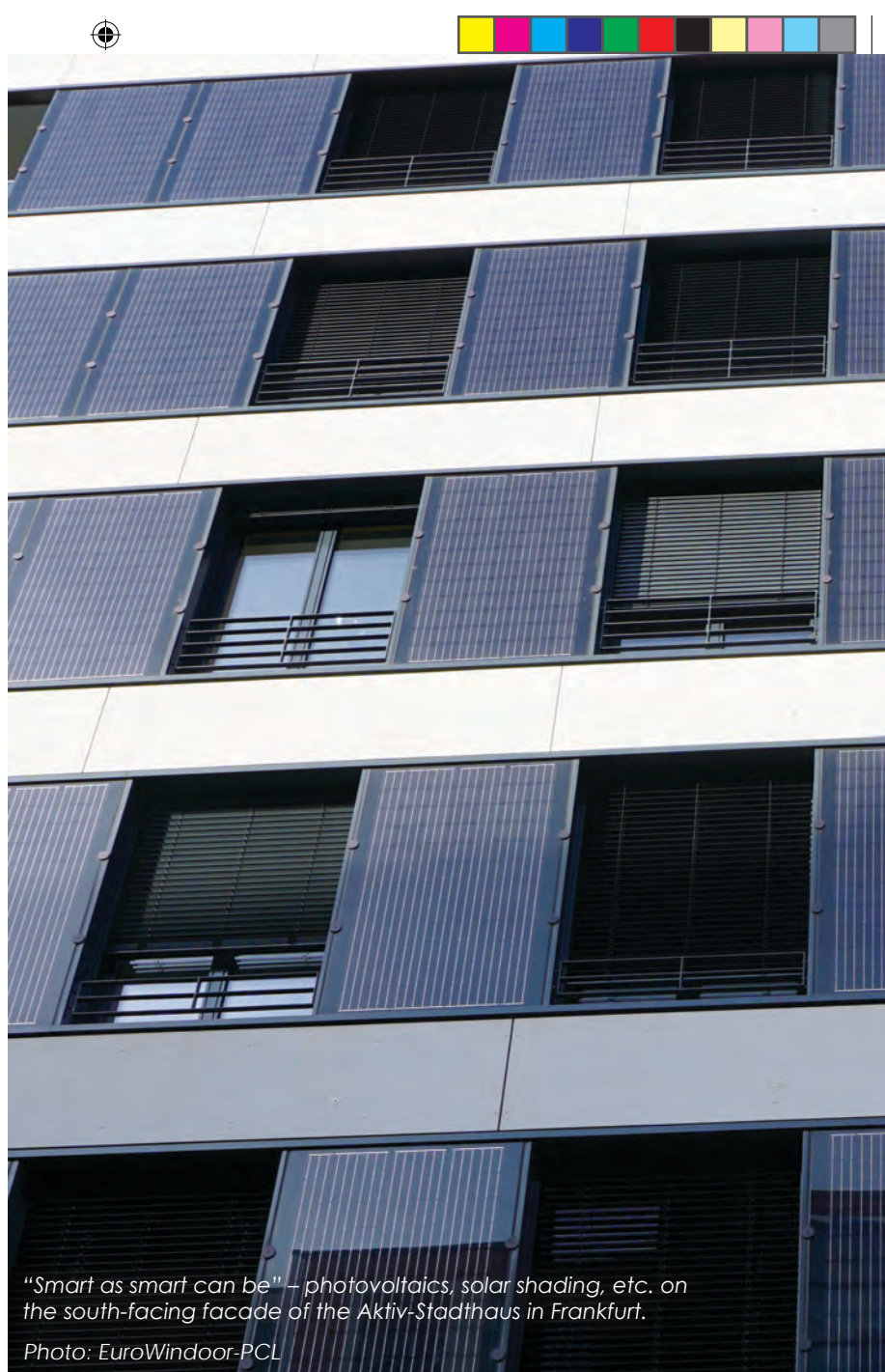
just of environmental quality at the building level, but also socio-cultural and economic quality.

A major part of the European Smart Windows Conference was devoted to presentations on a range of current EU research projects in the field of smart windows. One such project was "HarWin" ("Harvesting solar energy with multifunctional glass-polymer windows"), for whom EuroWindow is the "Industry Advisory Board". The following is an excerpt from the official project description²:

In HarWin new materials will be developed with the aim of constructing next-generation windows that will significantly

improve the energy efficiency of windows and buildings. They will enable window functionality to be extended beyond the current European state of the art. The improvements will be achieved through reduced weights, reduced thermal conductivities and energy consumption, reduced material usage, and monitoring of the windows' life cycle environmental performance. New additional functionalities, e.g. window-integrated functional coatings, will be combined with intelligent phase-change materials and novel glass-polymer composites with wavelength management capabilities.

The new materials will combine heat and moisture control



"Smart as smart can be" – photovoltaics, solar shading, etc. on the south-facing facade of the Aktiv-Stadthaus in Frankfurt.

Photo: EuroWindow-PCL



• **Mem4win:** The goal of MEM4WIN is to introduce a novel Integrated Glazing Unit (IG Unit) for quadruple glazing containing ultra-thin glass membranes for use as frameless openable windows for direct application in facades. New, tempered ultra-thin glass membranes (thickness attained so far: 1.3 mm) are employed. Thanks to this approach U-values of 0.3 W/m²K can be achieved, reducing weight by more than 50% and costs by 20%.³

A BRIGHT FUTURE FOR SMART WINDOWS

These projects give some indication of what the future might hold for smart windows. Certainly, virtually all windows in the future will offer high energy efficiency and energy gain as the absolute minimum.

On top of that come technologies that will allow windows to respond automatically to the needs of the building occupants. As mentioned above, only once that is achieved will smart windows truly become an integral part of the "smart house". Today's "intelligent" cars are perhaps the best indicator of the direction in which smart technologies are moving. They adapt to the road surface, the lighting conditions, the traffic flow, the person sitting in the driver's seat, and the weather - to name but a few of their already well-established functions. Based on this, it is safe to assume that plenty of exciting new developments still lie ahead for the "smart window". ●

thanks to new laminate and fibre-reinforced structures for the glazing, and integrated lightweight framing for windows. In the long term, the windows developed in HarWin will enable the creation of a new type of building in which the merging of functionalities currently assigned separately to windows and architectural glass will result in a new definition of the multifunctional facade, adjustable according to geographic and cultural needs."

Apart from HarWin a number of other smart window projects are also underway in Europe, including:

• **Winsmart:** This goal [i.e. the

building industry's 2020 energy efficiency targets] will be achieved through a new vacuum-insulated glazing (VIG) solution combined with new, robust, switchable glazing systems mounted in a durable and energy-efficient sash and frame.

• **Smartblind:** The SMARTBLIND project aims to develop an Energy-Efficient Smart Window including a hybrid film consisting of an electrochromic LC film and a photovoltaic film both printed on the same long-lasting flexible substrate.

1. More information on the Aktiv-Stadthaus in Frankfurt is available on the website www.abg-fh.com/bauen/aktuelle-projekte/aktiv-stadthaus.html, including various downloads (German language only)
2. www.harwin-fp7.eu/
3. The project descriptions are taken from <http://amanac.eu/thematic-areas/smart-windows/>

