Energy-Efficient Architecture with Glass

High-performance functional glazing has a significant impact on the energy efficiency of buildings and their level of usability or life quality. Experts agree that increased demands will lead to improved functionality of the glass products used in facades.

Gleaming glass facades have become a key element of today's cityscapes in most of the world. With their smooth surfaces and coordinated designs, these glass claddings are a symbol of modernity and architectural elegance. Glass creates transparency and allows daylight to reach far into the inner spaces, thus forming a basis for a pleasant living and working atmosphere – in residential spaces as well as in commercial buildings. For years we have been able to observe a trend to larger windows and glass surfaces in this field.

The performance parameters of the employed functional glass and the dimensions of the glazed portion of the façade are critical factors in the energetic efficiency of the buildings, whether commercial or residential. The careful fine-tuning of construction and functionality ensures a maximally positive effect.

Functional Glass: The Basis of Modern Architecture

The field of potential applications for high-performance glass products is huge. François Dubuis, Director of Corporate Development for the Glas Trösch Group, was quoted in a German trade magazine[1] in autumn of 2013 as stating, "The ratio of windows to walls in European buildings is currently 40:60 for walls." The goal of the Swiss glass group is to reverse that ratio. In order to achieve that, according to Dubuis, glass must fulfil even more functions and become a multifunctional structural component

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in the standard version.

Next to the currently major functions – thermal insulation, solar protection and noise insulation, performance characteristics such as light control and energy production via the glass surfaces in the building envelope will be increasingly important in the future. "Solar insulating glass" serves as a collective term for this concept. Already today, modern energy-saving glass has the ability to transform windows – traditionally a weak spot – into heat-producing surfaces. This was verified by a study using, among other products, the triple-insulating SGG Climatop Lux glass ($U=0.7W/m^2K$, g=0.62) and SGG Climatop Max ($U=0.5W/m^2K$, 6=0.60), conducted by the Austrian ClimaPlusSecurit partner, Eckelt Glas, in collaboration with Saint Gobain Glass Germany and Dr. Peter Holzer from the Danube University Krems[2]. This already high level of performance can be further maximized by integrating additional functions.

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Heightening of Energetic Demands

The future will see a continuous heightening of energetic standards on an international level, and with them, of the performance level of building envelopes. This is, of course, especially true for newly constructed buildings. With its 2010/31/EU policy, for example, the European Union formulated extremely ambitious goals regarding the overall energy efficiency of buildings already in 2010. The implementation of the policy in the national states is targeted to produce a 20% increase in the energy efficiency of buildings by the year 2020. For newly constructed buildings, the policy stipulates the demanding "almost zero-energy building" specifications for government buildings beginning in 2019, and in 2021 for all other buildings.

Now it's up to the national states to implement these objectives. With the amended Energy Saving Act, enacted in October 2013 (EnEV 2014), the German government has already set an example. Beginning 1 January 2016, all newly constructed buildings are to use 25% less energy, while the standards for the thermal insulation of building envelopes will increase by an average of 20%[3].

No Reduction of Window Area

EnEV 2014 specifies maximum values for transmission heat loss in building envelopes, including values via "H'_T" (specific transmission heat loss based on the heat-transmitting enveloping surface). Although the values specified here were not modified, a heightening of the corresponding standards beginning in 2016 is created by the 25% reduction in annual primary energy consumption. What's new is that the building envelope of a planned building is not allowed to have a worse specific transmission heat loss value based on the heat-transmitting enveloping surface than the reference building. This relative relationship to the reference building will prevent the limitation of the window area that is dreaded by the glass and window industry.

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The background: When strictly observing the heat transmission coefficient responsible for heat loss, the solar gains made possible by glass surfaces are not taken into consideration, in spite of the fact that they lead to a significant reduction in annual energy consumption on all sides of the building with the exception of the north side[4].

As explained by the German Institute for Window Technology (IFT) of Rosenheim in a trade article on the amendments in EnEV 2014, "In the case that a 25% reduction in annual energy consumption is not achieved through more extensive use of regenerative modules

(e.g. PV modules), this will naturally lead to lower heat transmission coefficient values for all parts of the building envelope. Here we should not disregard the solar gains, and look for high total solar energy transmittance (g-value) and light transmittance (τ), which contribute significantly to a reduction in annual energy consumption[5]."

Given the new maximum heat transmission coefficient for the heat-transmitting enveloping surface effective beginning in 2016, only energetically optimized facade systems will be acceptable for use in newly constructed buildings according to the IFT. It will still be possible, however, to employ double-glazing units when using profile systems with a Uf-value of 1.4 W/m2K[6].

Heat Insulation in Summer

EnEV 2014 also dictates higher standards for thermal insulation in summer for residential buildings. Corresponding calculations can only be avoided if the window surface area relative to the floor area is under 35% and a specified external sun shelter system, such as roller shutters, is installed. Evidence of such a system is not required if the window surface area is under 10% or 15% depending on the orientation of the windows.

The highly effective solar protective coatings available today for insulating glass provide a significant contribution to the sustainment of a pleasant building climate in summer. The same applies to sunshade and anti-glare systems that are integrated in insulating glazing or mounted externally, as well as functional electrochromic, thermochromic or gasochromic glazing with adaptable transparency. Ideally, intelligent control systems will always provide the ideal incidence of light or solar protection.

Solar Gains

Next to transparency and light incidence, the available solar gains are an elementary advantage of integrating glass in the building envelope. This energetic contribution is especially welcome in the winter months. In an interview published by the Institute for Window Technology on the topic of the Energy Saving Ordinance 2014, Professor Ulrich Sieberath, Director of the IFT Rosenheim, states, "The solar gains through windows and glazing have been taken into consideration since the EnEV 2002, in the context of a building-related verification – insofar as such a verification is prepared by the architect or building energy consultant. This is required with newly constructed buildings, and optional with current properties. In this process, however, solar gains are not attributed to windows or glass as building components. Thus there are still contractors who are not aware of these advantages.[7]"

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Glass as an Energy Producer

The integration of solar glass (photovoltaic and solar thermal) is a proven method for complying with the heightened annual energy consumption standards. According to the manufacturers of relevant products, however, the lack of knowledge among architects and planners regarding the technical possibilities and performance of available systems remains a significant obstacle. The integral planning of the various work areas is an additional challenge – here there are still deficits to overcome. Moreover, contractors often shy away from the high costs, in spite of the fact that manufacturers tirelessly point out that the integration of photovoltaic elements eliminates the need for traditional façade components and the related costs.

Another aspect that speaks for the integration of photovoltaic elements in the façade is sustainability (certifications i.e. according to LEED, BREEAM or the German BNB and BGNB methods). In

this context, brand-new façade concepts are also interesting, such as the algae façade shown at the special show "glass technology live" at glasstec 2012. Thanks to the sunlight, micro-algae grow in the specially developed glass hull (photo-bioreactors). This process produces biomass and biogas as intermediates, which in turn are used to produce electricity. The current "FluidGlass" research project conducted by the University of Liechtenstein, in which a new concept for multifunctional solar-thermal glass façade systems is being developed, is also extremely innovative. FluidGlass transforms passive glass façades into active, transparent solar collectors, while simultaneously regulating the energy flow in the building envelope.[8]

The Future of Construction with Glass

The increased necessity to save even more energy in the building sector in the not-too-distant future will naturally cause an increase in the demands made on the performance of building envelopes. In turn, the suppliers of functional glass for windows and façades will see themselves forced to do their part by developing new, more efficient multifunctional glass products that contribute to an overall increase in efficiency. Integral planning plays an especially integral role in the establishment of multifunctional glass façades. It is the key to the optimal interplay between façade technology, automation, and ventilation and air-conditioning systems, and ensures maximum energy efficiency.

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At glasstec 2014 in Düsseldorf we will get a glimpse of where things are headed in the area of multifunctional glass and glass façades. From 21 to 24 October, the world's largest trade fair for glass products, glass production and glass processing will once again be the hot spot for glass professionals from around the globe. From glass manufacturing to handling to application, glasstec 2014 shows the industry's solutions for the future of

construction with glass. For architects, planners and façade builders, the trade fair – with its special show "glass technology live" and the Façade Centre, as well as the Architecture Congress – an eldorado for new ideas and a gateway to new concepts for energy-efficient, multifunctional façades of the future.

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Captions

Photo 1
Large-area glass façades such as "Sign" in the Düsseldorf Media Harbour, designed by star architect Helmut Jahn, are symbols of modern construction. Under its glass domes, the 76-metre high, 20-story building offers premium event rooms with a guaranteed view of the state capital on its uppermost floor.

Photo 2
The Capricorn House in Düsseldorf was finished in 2006 and has been awarded the Innovation Prize for Architecture and Office, and the label "best architects 2008". One design highlight of the building is the i-module facade. Integrated modules cool, ventilate and reclaim heat. In addition, lighting, sound absorption and room acoustic elements are integrated in the façade panels.
Image: Messe Düsseldorf

Photo 3
Large-area glass façades do not preclude manual ventilation. Effective solar and anti-glare protection is available via the integrated blinds, even when open.

Photo 4
According to industry experts, triple glazing units with warm edge protector will become standard. Toughened thin glass makes insulated glass lighter than with conventional construction. Pictured here is glass with the following construction: 3mm white glass ESG, 12mm SZR, 2mm white glass TVG, 12mm SZR, and 3mm white glass ESG.
Image: Messe Düsseldorf

Photo 5
Conventional downstream sunshade systems are never the first choice, since they can allow more heat into the room in this position. Ideally the sunshade will be mounted on the façade or in the insulating glass.
Image: Messe Düsseldorf

Photo 6
Honeycomb panels that act as solar protection and anti-glare systems can also be integrated in the space between glass panels in insulating glazing. Depending on the mounting angle, the panels can completely block out direct sunlight and offer good transparency and light dispersion.
Image: Messe Düsseldorf

Photo 7
One solution for building-integrated photovoltaic: Dye cells are produced using simple silkscreen printing and sealed in a thermal fusing step.
Image: Messe Düsseldorf

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