An external sunscreen protected against the wind can be inserted into the cavity between the inner and outer building skin in order to avoid overheating in summer. The cavity with windows that can open in the inner shell allows natural ventilation even in high-rise buildings. In this way the building can be cooled down via the supply of fresh air, and the air quality indoors can be improved. The ventilation can also be used for night cooling. In winter the fresh outer air, heated by the sun, can be supplied to the rooms. This curtain wall system allows large glass areas for the better use of natural light by means of light manipulation. The requirement for artificial light can be reduced by 60 to 70 percent. With improved utilization of solar radiation and solar heat the heating requirement decreases by 40 to 60 percent, and the cooling loads and air-exchange rates can be reduced by 70 to 80 percent.

**Commerzbank-Hochhaus in Frankfurt**

For a long time Commerzbank-Hochhaus in Frankfurt was the highest building in Europe with 259m. The building was designed by Lord Norman Foster and has got a double skin façade. In front of the internal façade lies the naturally ventilated, mainly single-glazed external skin partly with innovating radar glazing. The external skin includes for openings and is constructed to avoid any eaves to allow from the outside to enter the façade corridor. Internal skin with double glazed inner operable spanable side bottom hung windows. Sunscreen situated within the façade corridor 80 mm thick mineral insulation for the opaque spandrel areas of the internal skin and white enamelled glass for the external skin.

**BBC Scotland New Headquarters in Glasgow**

The new headquarters of BBC Scotland was built on the Pacific Quay in Glasgow, only meters away from the River Clyde. Occupying a 120 x 55 m footprint, the rectangular building is some 28 m tall with a total façade area of 9,800 m². The major part of the envelope (approx. 3,000 m²) takes the form of a double-skin façade, with ventilation slits in the transoms and along the mullions. Partially perforated lower sunshades are located in the cavity. Ceiling-high opening lights are provided internally for ventilation and maintenance.

Air-conditioned facades and double skin facades have considerable economic advantages as they use natural light and heating properties. They also improve the satisfaction and productivity of employees, as natural daylight has a beneficial effect on the human state of mind. The employees can control temperature and air supply individually, which means the costs for the operation of an air conditioning system - the major energy consumption in high-rise buildings - are omitted or can be reduced by a smaller dimensioned system. Disturbances of comfort and health by the aptly named sick building syndrome, caused by artificial air conditioning, can be avoided, too. These facades lower the energy consumption of artificial light, heating, cooling and ventilation (supply and return air). All technical systems of the building can be carried out with smaller dimensions, so that the investment costs for the building are lower. The same building size offers more room for other use, and the operating expenses can also be lowered. For example, some years ago the “Stadtodor in Duesseldorf” with a double-skin façade, was awarded as the best ecological office building in Europe.

Part 2 of this article will be published in the next issue of IGS (scheduled for publication in March 2008) and is dealing with integrated facades for heating and cooling, functions like protection from heating, blinding, sound and bombardment and photovoltaic facades.
Intelligent Glass Solutions

Energy Efficient Glazing

Manchester Civil Justice Centre in Manchester
The 16-storey courthouse building is situated in the centre of Manchester in area of “Spinningfields.” The building has an area of approximately 80 m high by 30 m wide and 130 m long. The curtain wall area covers 31,824 m². The building shell consists of two different curtain wall systems. The curtain wall is designed as a suspended, double-skin all-glass façade. The façade with this system consists of aluminum units. Sheets and profiles are powder coated in different colour shades, the glass provided with a high performance coating. The outer skin is provided with a clear, laminated double glazing, the same as the curtain wall.

Glass façades have developed from a simple building closure to a high-tech building component fulfilling multiple functions. However, as a rule, the latest developments are not considered sufficiently in standard tendering.

What about the efficiency of modern high-rise-building and office façades? How can ventilation, heating, cooling or daylight systems be improved for example? And what should planners and builders bear in mind if they would like to save energy and costs, or even generate energy by means of the façade?

The outer shell is mainly responsible for the energy balance of a building, also for the interior climate and comfort of the buildings occupants. Glass façades open a building towards the environment and extend the view. Their major function is to protect occupants from the climate outside, like hot and cold temperature, wind, sun and rain. During the last few years thermal insulation has advanced considerably by improved glass and construction types. The integration of additional functions is progressing, like heating and cooling, ventilation and daylight projection into the façade. With new glass types, coatings and LEDs the façade turns into an area of communication. Amongst glass, aluminium and steel also the use of natural stone, sheet and other materials has increased in connection to the façade. With double-skin or photovoltaic façades, the energy of the external climate is going to be considered with ESD 2008 in order to determine the average u-value of the building shell for reference purposes.

The latest ESD is a step forward to an integrated view. However, studies and tests are decisive to find out how this individual factors co-operate in a complex building and what is their effect in reality. It is therefore not sufficient to consider only the individual effects. It also makes sense to take a look at the energy balance and the costs during the whole life cycle of a building when deciding on a certain development, as investments in energy saving or energy generating façades partly only pay after several years of utilization.

Energy saving air-conditioned façades
Just Renckens defines the glass façade as a “non-load bearing, the internal room climate controlling and external climate anticipating, energetic partition construction made of compact and transparent components.” He makes a difference between functional, architectural, structural, building physical and building technical performances of the façade. The façade does not only affect the visual appearance of a building. It is also purposefully used by architects to show the branding of an enterprise. The most important building physical performances are low air tightness, controllable ventilation, energy generating insulation and daylighting, ventilation, adequate thermal and sound insulation. The building physical qualities are stability, water tightness under heavy rain or fire prevention. The following summary is mainly dealing with functions and curtain wall systems substantially influencing the energy balance of a building.

Air-conditioned and ventilated façades for example, use the solar heat recovery for heating the building in winter. By means of solar control double glazing and air circulation, overheating of a building in summer can be avoided. This curtain wall system, known since the seventies, has a thermally insulated external glass pane and a non-insulated internal glass pane. Both panes are separated from each other by a wide ventilated cavity. In winter the dispatated room air is heating the temperature of the inner shell as well as the solar energy gained. The air in the cavity of both panes is heated by the sun and can be carried off together with the exhaust room air and is conducted by means of a heat exchanger. This way a part of the conducted internal heat is recovered. In summer the solar heat stored in the cavity can be conducted to the outside in order to reduce heating of the building. Air conditioning systems can partly be omitted or executed in smaller dimensions.

Solar heat recovery by glass façades
In these times of high energy costs and climatic temperature rise by excessive use of fossil fuel, energy consumption has become a central criteria for real estate. The Federal Government of Germany has subsidised this development by introducing an energy licence and Energy Saving Decrease. With the ESD (Energy Saving Decrease) in 2002 the allowable primary energy requirement of the complete building became the guideline of energetic planning ESD 2007, which becomes effective the 1st October. It is focusing the total energy balance of the building, i.e. the combined evaluation of heating, cooling and artificial light. For calculating the total energy requirement of non-residential buildings a reference building procedure will be introduced in order to determine the allowable annual energy requirement. The previous standard orientation on u-values however, did not consider the enormous passive solar heat recovery and the lighting energy saved with natural light. With so-called balance- u-value the solar heat recovery, depending on cardinal point and solar radiation, could be included in the calculations. According to the Building Ministry, solar heat recovery by glass façades can also be used actively. These façades are able to lower energy and operating expenses enormously not only in skyscrapers. Thus curtain wall construction has developed into a key technology that can improve the energy efficiency of a building and turn buildings into power plants for energy generation.

Stadttor Düsseldorf
Stadttor in Dusseldorf, awarded as the best ecological office building in Europe, is provided with a double-skin façade. The Bavarian company Josef Gartner GmbH, consists of an internal double glazing construction with a deep insulated cavity and external single glazing. The additional glazing in front of the original room closure improves the sound proofing even with open windows.

Sunscreen louvres or special daylight systems can be integrated in the cavity between external and internal pane. The first ones protect from overheating in summer and save cooling energy the second ones direct natural daylight deep into the rooms and save energy from artificial lighting. These intelligent curtain wall systems can also be furnished with solar modules for active energy generation.

The double-skin façades, invented by the Bavarian company Josef Gartner GmbH, consist of an internal double glazing construction with a deep insulated cavity and external single glazing. The additional glazing in front of the original room closure improves the sound proofing even with open windows.

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In Europe alone 19 countries have established promotional programmes in order to advance the development of renewable energies. The key industrial nations of Japan and the United States, as well as the core countries of the European Union, are promoting solar power and other energy sources.

All the latest developments in this sector will be central themes at glasstec 2008. In Düsseldorf next year the latest products and possible applications for solar-powered heating, cooling and power generation will be on show, complemented by the entire spectrum of innovative glass products for energy-efficient construction.

In the 1960s – had become a fest of the block housing with its huge denting type housing and that wall ultimately a function of an architectural nature, a significant factor in the design of building envelopes in the 1970s and 1980s. From the 1990s onwards, the growing awareness of the energy crisis led to a renaissance of the window concept, with the development of intelligent glass systems.

In intelligent glass systems, it is possible to integrate various functions into the glass itself. For example, it is possible to engineer glass that automatically changes its transparency, regulates the amount of heat, or even produces electrical energy. These functions are achieved through various technologies such as polymer gels, magnetic fluids, and electrochromic coatings.

High-tech facades of today fulfil multiple functions. Part 1.

Dr. Jochen Mignat