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Automatically controlled natural ventilation and solar shading

The intelligent control of these passive strategies is a low carbon option for reducing energy consumption and improving the indoor climate for building occupants

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Why solar shading?

Simply put, because it helps building occupants to be more productive and feel better while in the built environment, at least according to the research.

According to the Center for Building Performance and Diagnostics at Carnegie Mellon, providing access to a view of the natural environment via windows has measurable benefits on energy and productivity. Studies in their research show that the introduction of daylight in the workplace could increase individual productivity by up to 18% and increase sales by up to 40%.[1]

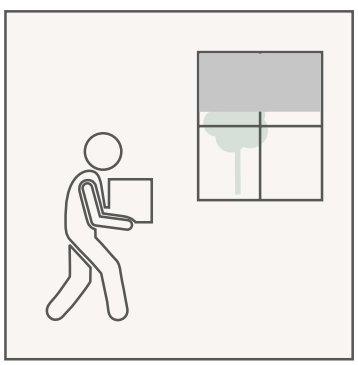
In 2010, the European Solar Shading Organization (ES-SO) and The Federation of European Heating, Ventilation and Air Conditioning (REHVA) released a guidebook on solar shading. In it, they also provide a detailed summary of the body of research available about the influence daylight has on the health and productivity of workers and students.

One study from Carnegie Mellon University found that maximizing the use of daylight without glare provided a median productivity benefit of 3.75%.[2] Another study cited in the guidebook found that major health complaints are lowered by 20 – 25% for occupants that sit closer to an exterior window, compared to those who have no access to daylight or an exterior view.

With regards to student and classroom productivity, the guidebook highlights findings that point to the importance of controlled access to natural daylight. It

> “Buildings with well-functioning solar protection can cut the investment cost for cooling and ventilation installations, reduce energy use and create the conditions for good thermal and visual comfort.”
>
> Helena Bülow-Hübe
> Research Assistant et al., University Lund

shows that negative student performance is associated with direct sun into classrooms. On the other hand, students with adequate natural daylight in their classrooms showed 20% faster progress in math tests and 26% in reading tests during the course of a year.[3]



Combining solar shading with intelligent natural ventilation

Natural ventilation on its own, when automated intelligently, has also been shown to provide very promising benefits to occupant health. In buildings where high-performance ventilation strategies included automated natural ventilation, respiratory illness such as asthma and allergies were reduced by as much as 90%![4] When combined with controlled solar shading, HVAC and lighting expenses can be reduced by 50 – 80%.

With the combination of improved health and reduced operating expenses, using intelligent natural ventilation and solar shading as a joint strategy is a no-brainer for providing the best indoor climate possible.

Read about control strategies and solar shading solutions

Integration of solar shading within natural ventilation systems

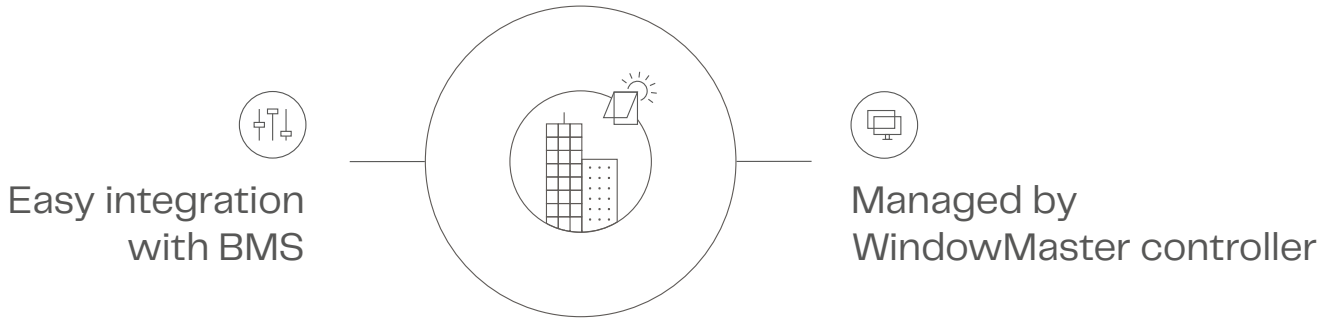
Integrating sun screening functions into your indoor climate control system allows venetian blinds, awnings etc. to be controlled automatically, both in summer and winter, so that the position of the sunscreens can be continually adapted to the prevailing lighting and heating situation in a room. This allows an optimal use and exploitation of the sun screening product as well as optimizing the use of solar thermal energy. The actual control is based on measurements of lux and temperature.

WindowMaster control systems, for natural or mixed mode ventilation solutions, can also include a built–in solar shading controller. The controller includes functions that allow the shades to open, close, and tilt depending on lux levels, indoor temperature, and the option of manual override by users.

There are various control strategies for the solar shading solution depending on the type of shading as well as the actual building and its needs. WindowMaster systems have the ability to control the shade positions for a very precise level of daylight, ensuring the optimum position is reached for indoor comfort.

As previously mentioned, there is a synergy between natural ventilation and solar shading because both are key to maintaining a comfortable indoor climate. Because of this, controlling them in one coordinated system can reduce complexity in the overall building management strategy and maximize energy saving benefits.

How WindowMaster can manage solar shading controls



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Different kinds of solar shading solutions

Solar shading can be fixed or flexible. Fixed measures cannot be varied according to the season or the time of day. These measures can include window size and orientation, shading by other buildings or surroundings, or a reduction of total solar energy transmission of the glazing. In some cases, these measures can result in disadvantages compared to flexible systems.

Flexible measures (venetian or roller blinds etc.) allow the user and control system to have influence on how much solar radiation enters the room. Accordingly, the heating energy demand in winter can be reduced, while overheating (and cooling energy demand) can be avoided during the summer.

Venetian blinds have the potential of providing shading while also giving building occupants a view to the outside since the blades in many cases can be angled. Flexible systems are therefore often preferred to fixed systems.

Photo: Schmidt Hammer Lassen Architects

Read a case study with solar shading

Conclusions

There is a clear case for the benefits that access to natural daylight provides, though the research also points to the fact that the amount of direct sun into the built space must be controlled.

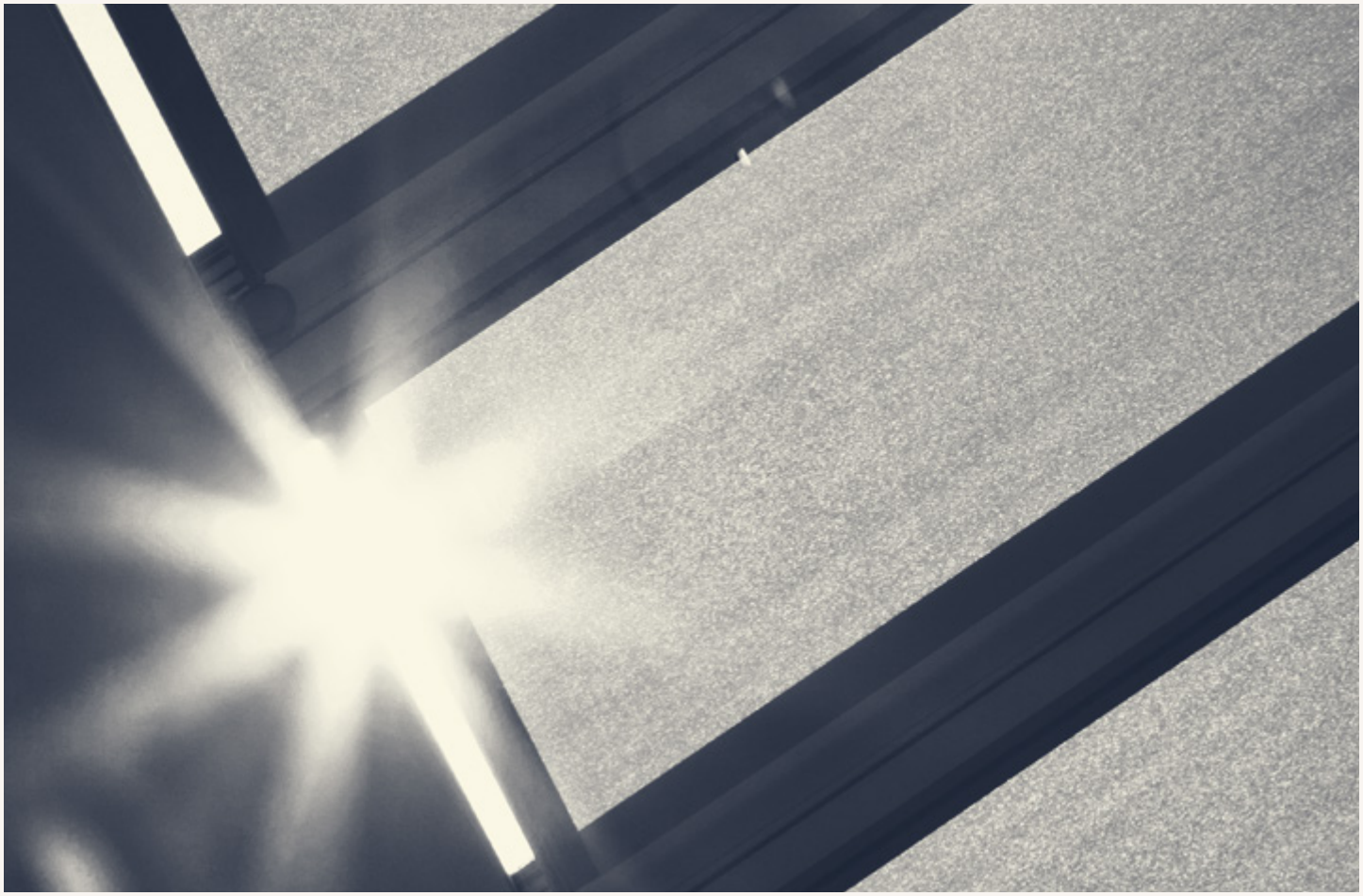
Perhaps one of the best ways to achieve this is through adaptive control of daylight, where movable solar shading is used to guarantee the conditions of good visual comfort and indoor temperature.

Effective control of sun screening is an important contributor for maintaining a comfortable indoor climate as it can be used as both a shield against extreme overheating and as additional insulation in the winter.

Many buildings these days have large glazed windows which are chosen because of the transparent and cleaner facade they provide. The high-performance glazing ensures plenty of daylight, increased comfort, good insulation, and optimal energy consumption when designed correctly.

However, the exposure to too much direct sun can also cause overheating, disruptive reflections on screens and discoloration of furniture and décor, which in turn can lead to a poor indoor climate.

An effective solar shading solution can prevent a poor indoor climate through well-designed and controlled solutions.



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Project examples

Numerous WindowMaster projects control both the natural ventilation and the solar shading. Read about some of these projects on the next pages

Ørestad High School

Ørestad high school's main building was constructed in 2007 and is located in Ørestad City at Amager in Copenhagen, Denmark. The five-story building is known for its innovative architecture without traditional corridors and classrooms. Instead, there are open, flexible rooms adapted to the high school's digital profile, where all teaching is web-based.

The open structure of the high school makes the building particularly suitable for natural ventilation

of all open areas. The open areas include learning environments for both individual studies and group-oriented work, canteen, library and the big main staircase that takes you all the way up to the roof terrace. The staircase is at the heart of school's social and educational life and is the primary connection between the floors.

Ventilation is achieved through automatically controlled windows in the facades, evenly distributed on the five planes and through skylights. The windows are opened depending on the different areas' need for fresh air. The skylights are also used for heat and smoke ventilation. In addition to controlling natural ventilation and smoke ventilation, WindowMaster also controls the solar shades as well as the heating in the building.

The external solar shades are composed of vertical slats with 230V motors supplied by COLT. Some slats are fixed, others can be rotated to 0, 45 and 90 degree positions. The regulation is automatic via WindowMasters system and is primarily based on indoor temperature and heat radiation from the sun. However, it is possible to override the automation manually.

Ørestad high school has won the Copenhagen Cultural Fund Prize in 2007 (Københavns Kulturfonds Pris) and Forum AID in 2008 as the best Scandinavian building.

Type of shading
External screens in the façade

Building type
University

Control solution
NV Advance®

Ventilation
Natural ventilation

Architect
3XN A/S

Consultant
Søren Jensen A/S

Country
Denmark

Moesgård


Photo: Moesgaard

The new Moesgaard opened the doors to the public for the first time in 2014 and is one of the world's most sustainable museums with its unique green initiatives.

The museum's foyer and restaurant are connected in an open space area, which is jointly ventilated via automatically controlled windows in the facade and roof (natural ventilation).

The museum's offices and meeting rooms are ventilated via automatically controlled windows in the facade combined with mechanical ventilation (hybrid ventilation).

Type of shading
External screens in the façade

Building type
Museum

Control solution
NV Advance®

Ventilation
Natural- and mixed mode ventilation

Architect
Henning Larsen Architects

Consultant
COWI A/S

Country
Denmark

"In relation to building costs, natural and hybrid ventilation is advantageous at Moesgaard. If these energy efficient ventilation systems were replaced with traditional mechanical ventilation, alternative measures such as solar panels on the roof would be necessary to meet the energy requirements. But if looking at the lifecycle cost of the building, natural and hybrid ventilation is a solid solution compared to solar panels. The lifespan of solar cells is limited to around 30 years, while natural ventilation is building integrated, meaning that it reduces energy consumption and improves the indoor climate for as long as the building stands."

Alice Andersen
Engineer with specialty in indoor climate and energy from COWI A/S

"With such an impressive building it is important that we are able to provide the visitors with a holistic experience. It's not enough to give them that 'wow moment' when they see the building from the outside. We needed to bring the positive experience inside as well. The indoor climate plays a central role here, which is why I am also thrilled that the comfort level provided by the automated natural ventilation is so high. There is always fresh air inside, which naturally affects both the staff and our visitors."

Mikkel Berg Thorsager
Technical Manager at Moesgaard

Photo: Moesgaard

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HouseZero, Harvard University – Center for Green Buildings and Cities

Built in 1924, this residential building is situated on Harvard University's campus. It has been renovated to inspire others by how older, existing structures can be altered to become ultra-efficient facilities with ambitious performance targets. The building houses research dealing with global climate change and sustainable building design strategies.

HouseZero consist of the original structure and an extension of the existing building in the basement called ‚The Vault". The current conventional heating and cooling systems in the house include a gas-powered boiler, hot water heater, steam-driven radiators, forced-air ventilation, and window-mounted air conditioning units. These will be fully replaced with a new paradigm which relies on the addition of thermal mass and radiant surfaces. Natural ventilation inside both the existing house and The Vault will adress the heating and cooling needs of the structure. Rather than approaching the project as a hermetically-controlled

Type of shading
Internal blinds in the skylights

Building type
Office

Control solution
NV Advance®

Ventilation
Natural ventilation

Architect
Snøhetta

Country
USA

box, the envelope and materials of HouseZero are designed to interact with the seasons and the exterior environment in a more natural way. Much like a layered approach to clothing, the house is meant to adjust seasonally.

All glazing systems in the house will be replaced with triple-glazed, low-E windows and skylights, which will be fully operable through WindowMaster's automated system, NV Advance®. WindowMaster's control system will allow the building to fully monitor the temperature, humidity, and air quality through internal and external sensors. Manual overrides of the automated system are also incorporated.

The almost zero-energy natural ventilation strategy is attuned to seasonal and climatic variables through adaptive installations; some passive and some with algorithm-based control technologies. Ventilation is controlled via WindowMaster actuated windows on all floors, while a passive solar chimney contributes to critical ventilation of The Vault and the event space in the basement. Operable skylights are added to the roof plane to allow for a robust ventilation of level 2 and 3 as well as the stairwell. Furthermore, windows will let air in at select times to manage the indoor air quality during the winter. In the summer, the higher level windows will be utilized to keep the temperature in the building at the required level throughout the day. NV Advance® also controls the sun screening in the building.
All openings are programmed for daily night purging to help stabilize indoor air quality throughout the seasons.

Photography by Michael Grimm©

1. Loftness V. Hartkopf V. and Gurtekin B. (2003) "Linking Energy to Health and Productivity in the Built Environment: Evaluating the Cost-Benefits of High Performance Building and Community Design for Sustainability, Health and Productivity," USGBC Green Build Conference, 2003.
2. Carnegie Mellon (2004) Guidelines for High Performance Buildings – Ventilation and Productivity.
3. Heschong Mahone Group (2003) Windows and Offices: a Study of Worker Performance and the Indoor Environment (Technical Report) for California Energy Commission, 2003, pp 2–4.
4. Loftness, Vivian, et al. Sustainability and Health are Integral Goals for the Built Environment

WindowMaster aspires to protect people and the environment by creating a healthy and safe indoor climate, automatically ventilating spaces with fresh air through facade and roof windows in commercial buildings. We offer the construction industry foresighted, flexible and intelligent window actuators and control systems for natural ventilation, mixed mode ventilation and smoke ventilation – of the highest quality.

WindowMaster employs highly experienced cleantech specialists in Denmark, Norway, Germany, United Kingdom, Ireland, Switzerland and United States of America. In addition, we work with a vast network of certified partners. With our extensive expertise built up since 1990, WindowMaster is ready to help the construction industry meet its green obligations and achieve their architectural and technical ambitions.

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