VELUX China Office / Langfang

Light Years Ahead Introducing a New Model for Healthy Budildings

Today's architects should be able to successfully integrate sustainable design into their practice. However, simply resolving issues relating to thermal comfort and energy reduction is no longer sufficient. Sustainable innovations that may have exceeded a client's expectations a decade ago are likely to fall short in meeting the demands of contemporary office design. We can no longer afford to separate the physical and mental wellbeing of an individual employee from their workplace environment.

The new era of office buildings depends upon thoughtful architectural strategies that produce environments conducive to pride and complete wellbeing for those who work in busy, competitive work environments. In addition to thermal comfort and low-energy applications, these design strategies should include natural full-spectrum daylight and clean fresh air. Since these priorities comprise the factors that contribute to overall human comfort and productivity, it is not surprising why a new model for healthy buildings has emerged.

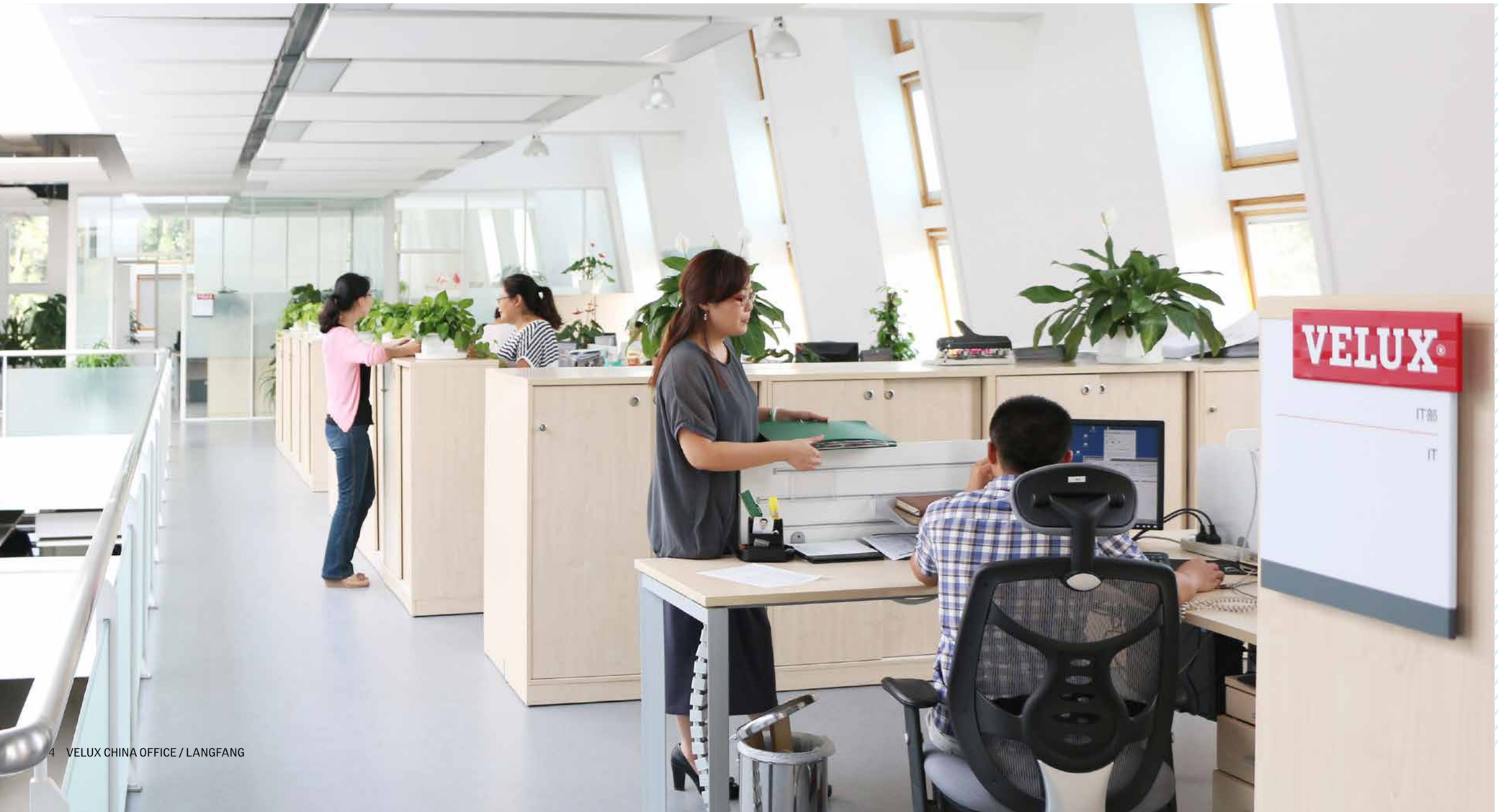
One such example is the new Chinese headquarters for VELUX where considerable research was invested on behalf of the company's design team to leverage increased natural daylight and fresh air as key drivers for improving the quality of life for its occupants. This multi-facetted design strategy overcame challenges, misconceptions, and doubts relating to a new paradigm for holistic architectural design and resulted in a building that serves as a model for VELUX to inspire its employees and customers of the benefits of healthy design.

Physical and mental wellbeing of employees cannot be seperated from work environment

The multi-facetted design strategy serves as model for VELUX to inspire its employees and customers of the benefits of healthy design

Designing for Many Types of Occupants Under One Roof

With a presence in the Chinese market since 1985, VELUX has been based in Langfang since 1993. Located midway between Beijing and Tianjin, this operations and manufacturing facility is also responsible for numerous parts and accessories destined for the European market. The designers from VELUX's Building Industry division saw an opportunity to create a new headquarters that optimizes the comfort and productivity of its management, marketing, sales, and technical staff. Each of these departments have their own distinct requirements for daylight, acoustical privacy, and even electricity needed to power equipment. Understanding this design challenge as an opportunity, VELUX's design team began a collaborative process involving various consultants and stakeholders that yielded detailed studies of energy use, airflow, ambient and appropriate task-oriented daylighting factors. The results of this work can be experienced in the building that we have today.



over 1000 m²
office area

58,500 m²
land area including factory

296
roof windows

10
departments

Working Together: Building a Globally Competitive VELUX Community

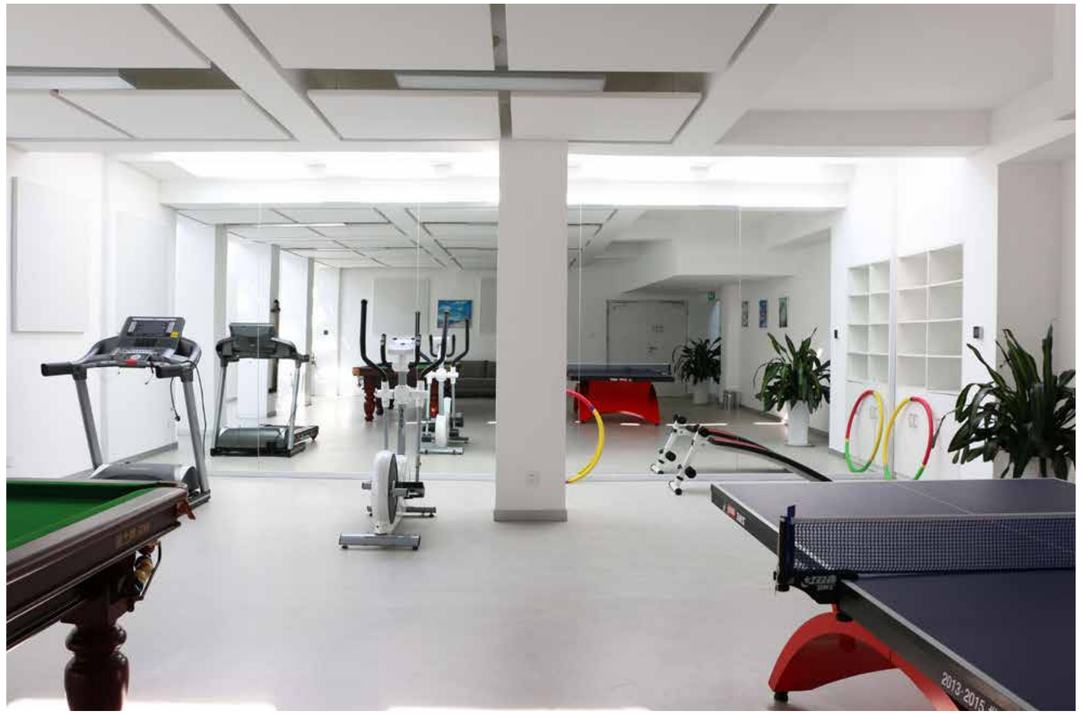
As the era of globalization continues, so does the Chinese economy, its expanded construction market, and its growing number of consumers. This dynamic economic environment means that global companies such as VELUX must continue to invest in the well-being of its Chinese employees to sustain innovation and competitiveness.

To ensure this challenge is met, the open floor plan encourages dialogue and greater collaboration and both floors have touchdown zones where employees can gather for informal meetings. A fitness centre, table tennis and a pool table in the basement fosters a greater sense of camaraderie amongst the staff. Furthering the sense of community and belonging, outdoor recreational facilities include football, volleyball, and most significantly: a vegetable garden. Referred to as the "Happy Farm", Managing Director: Christian Olsen delights in the fact that employees "finish their lunch quite quickly and spend the rest of the lunch break tending the gardens." Collecting the week's harvest every Friday a mix of corn, peas, chilies, potatoes, watermelon and other produce employees are not only cultivating a garden, but growing an important social dimension to their workplace that employees enthusiastically refer to as a "lifestyle."

With its manufacturing facility located about 20 metres from the office building, VELUX has ostensibly built a campus-like atmosphere. This proximity between sales, marketing, and manufacturing is a reflection of company founder Villum Kann Rasmussen's philosophy which places a high value on the importance of working with suppliers, installers and end-users. Entrenching this philosophy into VELUX's 21st-century Chinese headquarters represents an achievement of establishing a deeper connectivity within the company, contributing to an organization that is both competitive and responsive in today's global economy.

"One of my favorite time is to take harvest from our Happy Farm! Potatoes, beans, cucumbers and even watermelons

Ms. Sunny Shi,
Secretary of CEO



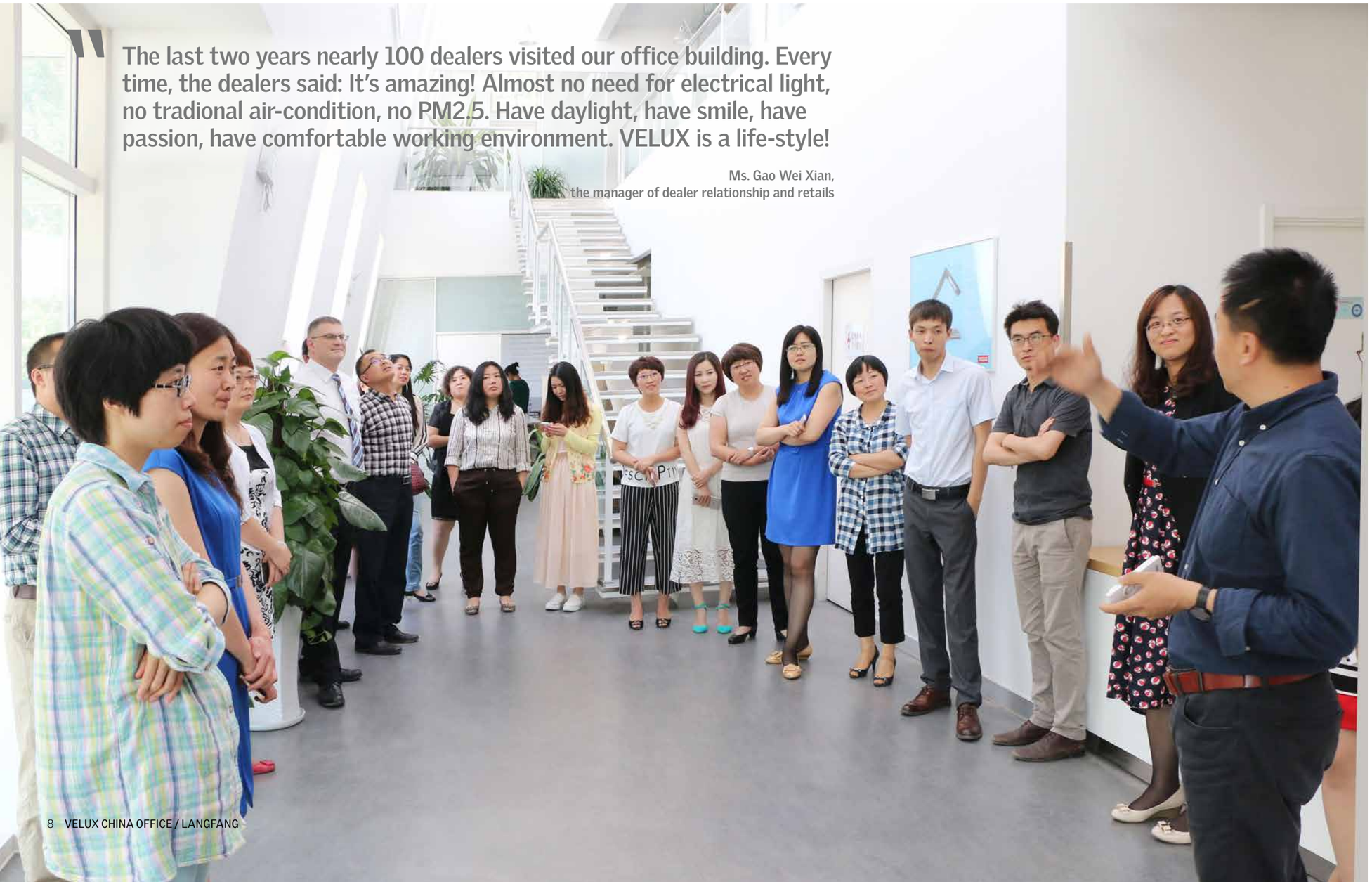
Changing Attitudes, Inspiring People

Jan Engberg, the former Manager of Manufacturing and Purchase who supervised the construction of the building acknowledged the "challenge to create a Nordic indoor environment and design in China, considering the materials and craftsmanship available."

But it may have been the attitudinal changes rather than the technical issues that ultimately proved the most challenging. Operational since May 2013, the building has been successful in shifting the mindset of its employees, evolving into an effective teaching aid for visitors who come to experience and understand why the future of architecture is not just about energy-efficiency, but is defined by optimizing daylight and natural ventilation that promotes a healthy, collaborative and productive office environment. Convincing the many stakeholders and construction trades to adopt the design and technical solutions used in Langfang required tremendous patience as the VELUX design team's strategies were not immediately apparent to the many disciplines involved in the building's design process. The design process ultimately required a behavioural shift amongst the users to appreciate how a holistically designed low-energy building can boost productivity through greater physical and mental health, resulting in a more collaborative, socially positive workplace.

Since the building became operational, the manager of human resources reports with pride how the rates of sick leave have dropped eight times when compared to the old VELUX offices. And with an expected 10-year payback due to reduced energy costs, the financial and intellectual investments needed to make the new headquarters have been validated. The Langfang office continues to receive approximately 200 visitors every month who include architects, engineers, researchers, professors and most importantly customers and clients who are inspired by what they experience. The constant flow of visitors helps reinforce the building's significance to staff, many of whom are not trained in building science but who have been motivated to become ambassadors of healthy indoor environments.

> "The last two years nearly 100 dealers visited our office building. Every time, the dealers said: It's amazing! Almost no need for electrical light, no tradional air-condition, no PM2.5. Have daylight, have smile, have passion, have comfortable working environment. VELUX is a life-style!
>
> Ms. Gao Wei Xian,
> the manager of dealer relationship and retails



8 times less
sick leave than in old building

About
200
visitors every month

About
5000
visitors in first 2 years

Visitors
architects
dealers
building
engineers
professors
students
customers

"The building is great! Architects and engineers should be encouraged to create buildings like this. The balance of comfort, energy and environment should be put in the centre of the building design.

Mr. Zhanghua,
the president of Xian Dai Design group

A Showcase of Ideas: A Convergence of Strategies

VELUX's Chinese headquarters represents a showcase for its products and a shift in preconceived ideas about the optimal potential of natural daylight, indoor air quality and thermal comfort. The creation of large, bright interior spaces achieved two major benefits: a reduction of energy required for electrical lighting; and an increase in natural light to boost alertness and improve mood amongst employees.

Building upon a strategy of designing open spaces to increase light penetration to as many work areas as possible, interior surfaces were selected by VELUX managing architect Agnieszka Szwarczewska, to reflect rather than absorb light such as the white-painted walls or the three-dimensional woven-patterned sound-attenuating wall acting as a central spine along the length of the atrium. Light-coloured wooden tables and casework add warmth while highlighting VELUX's commitment to the use of sustainable materials. Glass partition dividing walls, an opentread central staircase, and a reduction in the number of load-bearing walls further contribute to maximum light penetration.

"By using very light colours for interior surfaces, you can minimize the lighting power density,"
notes Aymeric Novel, a French green building engineer who collaborated with the VELUX design team.

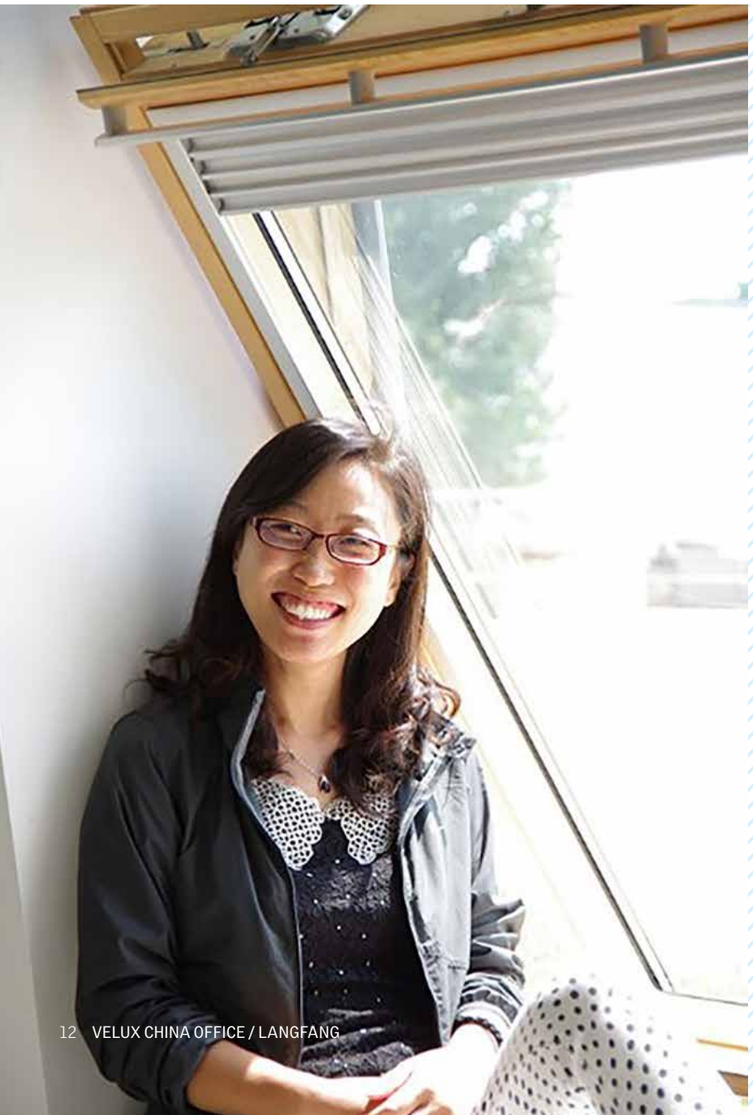
The use of wood in the circulation and reception areas also improve acoustics, surprising many visitors with an unusually quiet environment.

While not only reducing demands on electricity, optimizing the full colour spectrum of natural daylight wherever possible remains the best solution for a healthier workplace. ChengLin Guo, Market Development Manager sees the physical as well as psychological benefits of natural daylight, noting how much he likes the reception area which "is almost always bright, full of high-quality difused light. I feel much more comfortable under the sunlight."

Beyond the positive feedback from employees like Guo, the VELUX design team has been measuring daylight on various work surfaces throughout the building to make minor adjustments to interior configurations, even though most of the office spaces already require little to no artificial lighting.

Because the building's dynamic façade has such a high percentage of glazing, architects and engineers from Building Industry in VELUX A/S developed solar shading systems on the exterior and interior surfaces of the glazing to prevent overheating in summer, excessive heat loss in the winter, and distracting glare for the occupants. To optimize the performance of the shading devices, a pre-programmed operation system responds to changing weather conditions throughout the day and seasons. Individual occupants only control the blinds on the lower row of windows. If required, special remote controls can manually override the system and allow the windows to open, but this is avoided, especially during the heating and cooling seasons, or during the winter when air pollution is particularly problematic. To keep the indoor air quality pollution-free, the HVAC system is equipped with a highly effective air filter system to maintain indoor air quality—a huge benefit in Langfang, an industrial city battling smog-related air-quality issues.

50
happy and healty employees



Using Light to Shape Form

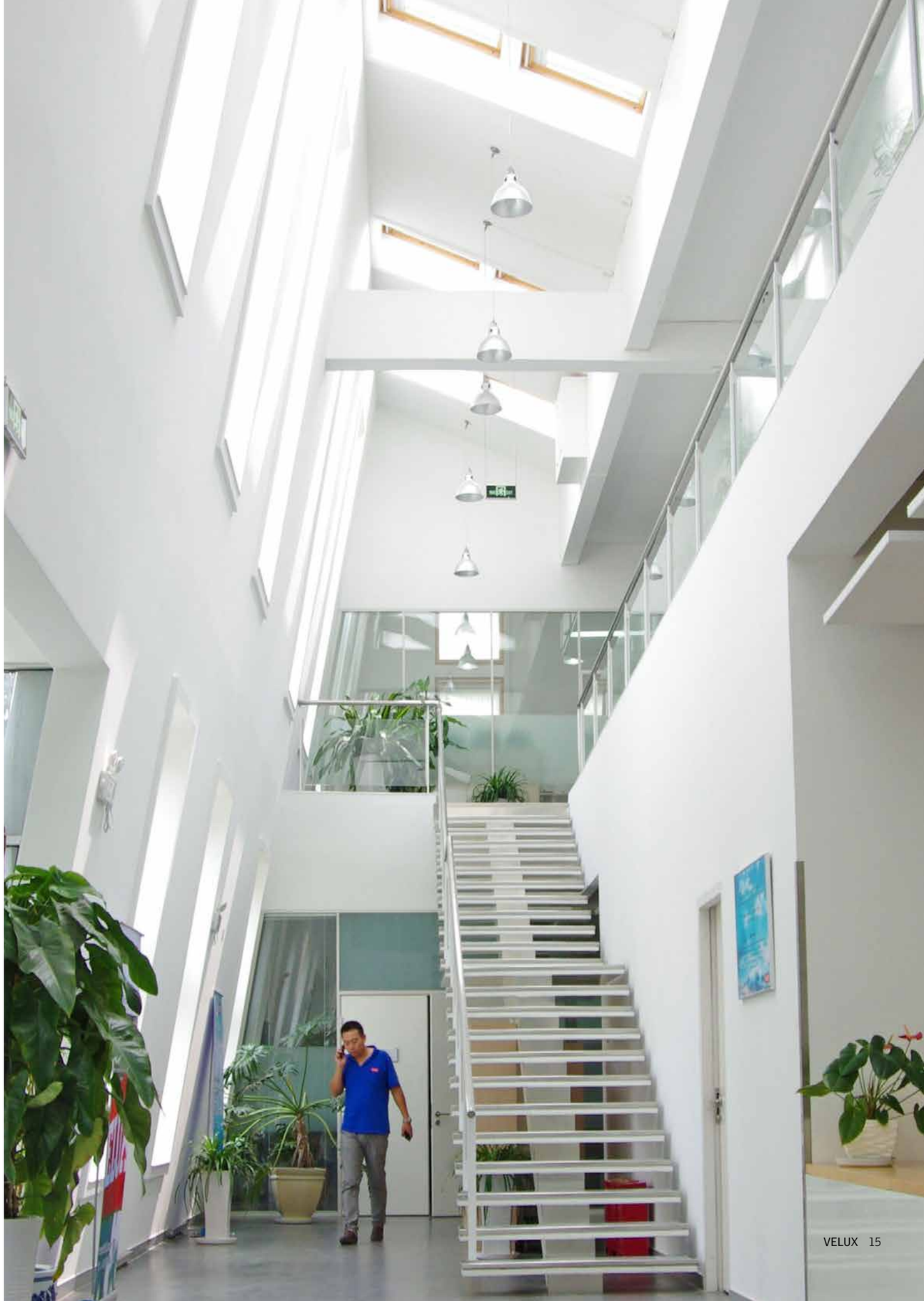
Visitors are immediately impressed by the amount of natural daylight flooding through an array of windows complemented with exterior and interior shading devices. "The façade design is critical for low energy buildings," notes Aymeric Novel. With a total office staff of approximately 50 employees, the two-storey office building has an elegant rectangular plan with a double-height atrium space running length-wise through the centre. The sloped walls dramatically increase the ability to reflect light into the building, thereby diminishing the need for artificial lighting. The result is a building that offers an open, highly functional and collaborative work environment. "Early in the design process, we decided to create a compact building mass centred on an atrium," explains Architect MAA Henrik Nolander Smith who led the VELUX design team. "The trapezoid shape offers a more dynamic look than most offices towers, and it creates a better inflow of light through the roof windows." The trapezoid shape also helps the effectiveness of the many operable skylights incorporated into the flat roof which are programmed to open and close at specific times to optimize the indoor air quality and temperature, thereby keeping the interior spaces cool-a-welcomed feature during Langfang's hot and humid summer months.

2 times more
air change than required minimum

32,14
kWh/m²/year

The building uses
1/4
of the average building energy consumption in China

10 years
payback time



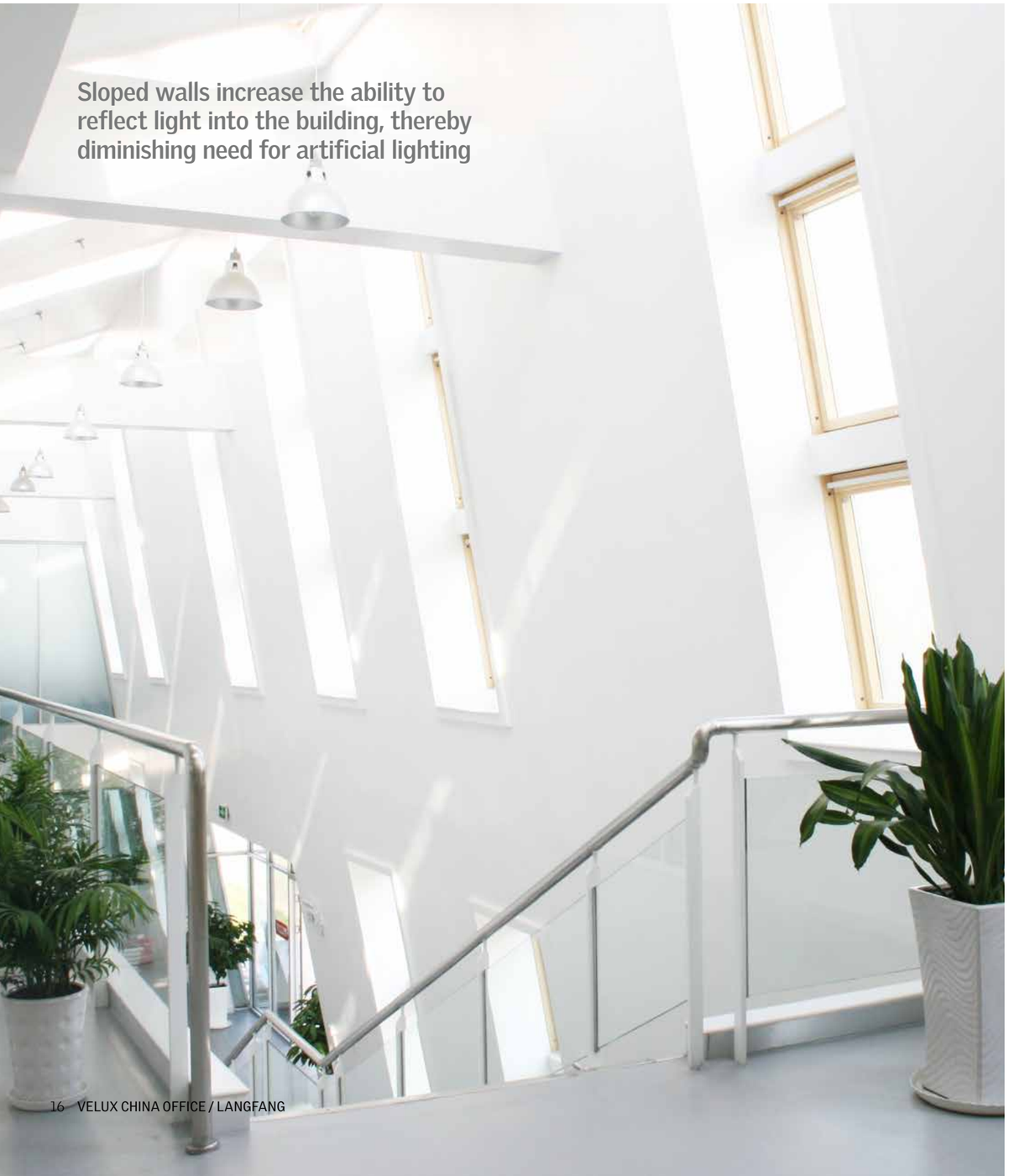
Daylight Factor

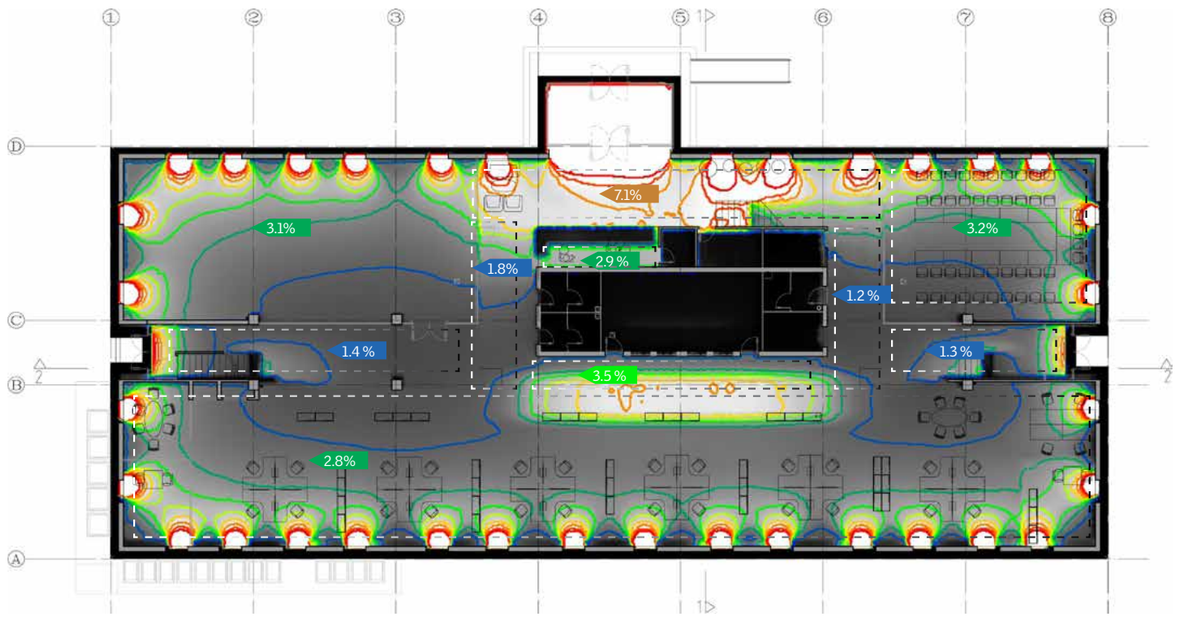
Facts:
The daylighting performance of VELUX China Office has been specified using the daylight factor (DF) as performance indicator.

The daylight factor is a common and easy-to-use measure for the available amount of daylight in a room.

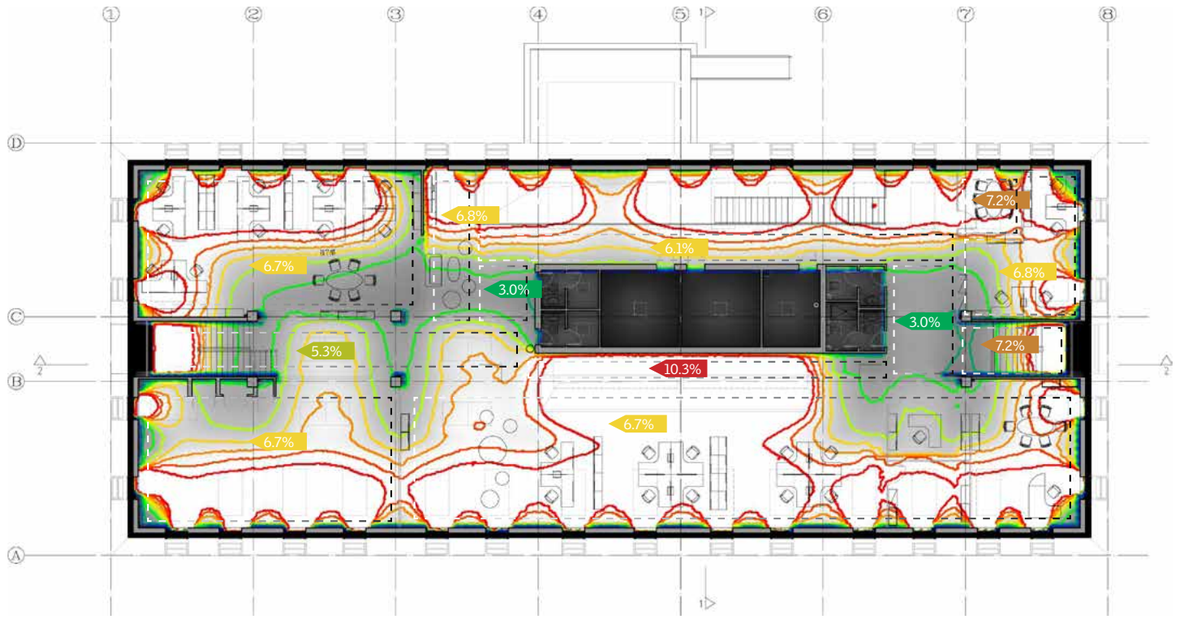
It expresses the percentage of daylight available inside, on a work plane, compared to the amount of daylight available outside the building under known overcast sky conditions. The higher the DF, the more daylight is available in the room. Rooms with an average DF of 2% or more are considered daylit. A room will appear strongly daylit when the average DF is above 5%.

The daylight factor analysis has been performed using computer simulations of radiance. The figures below are showing the daylight factor levels on each floor and the impact of the installed roof windows.





Daylight analysis ground floor



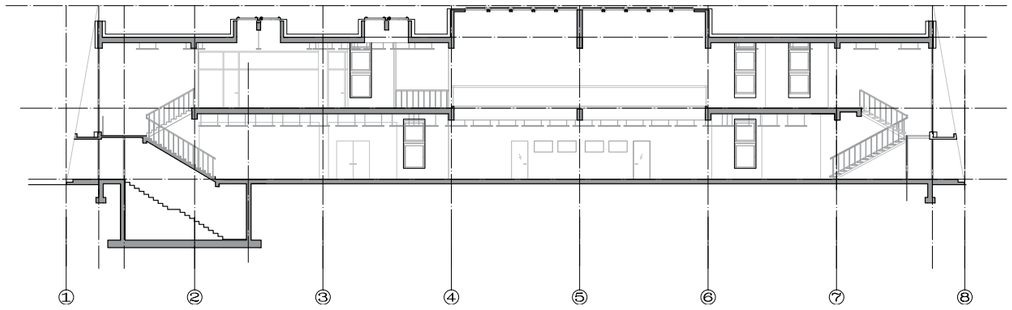
Daylight Factor %
10.0
8.8
7.8
6.8
5.5
4.4
3.2
2.0

Daylight analysis upper floor

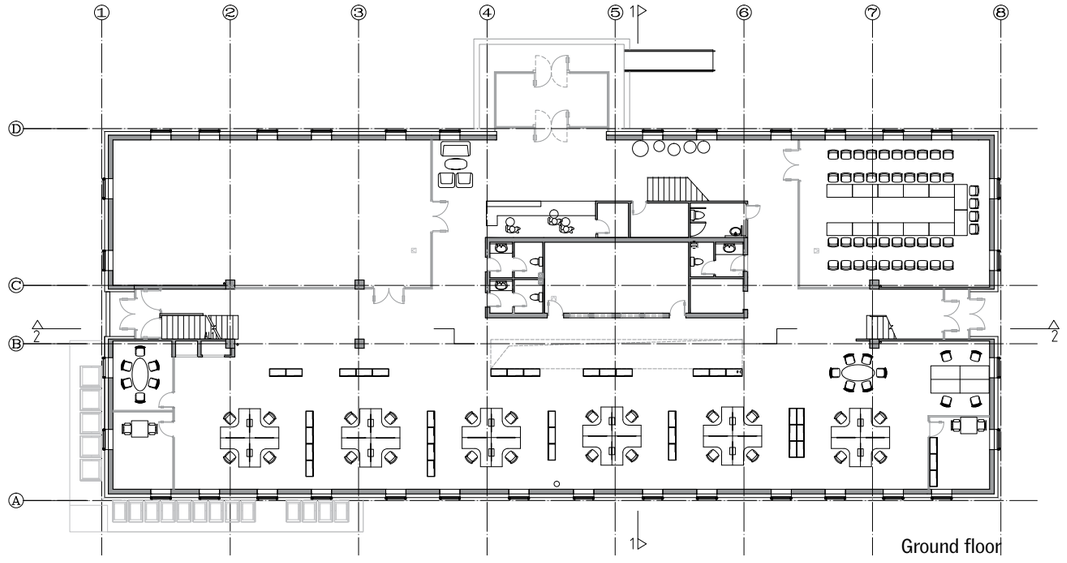
Teaching Healthy Values

VELUX's Langfang headquarters teaches us the value of collaboration and working across many disciplines, not just many cultures. It necessitated the input of engineers, architects, various technical specialists, and employees to develop a comfortable and healthy workplace requiring minimal energy use. The building continues to provide insight through its ability to be measured, modified and maintained for optimum energy efficiency.

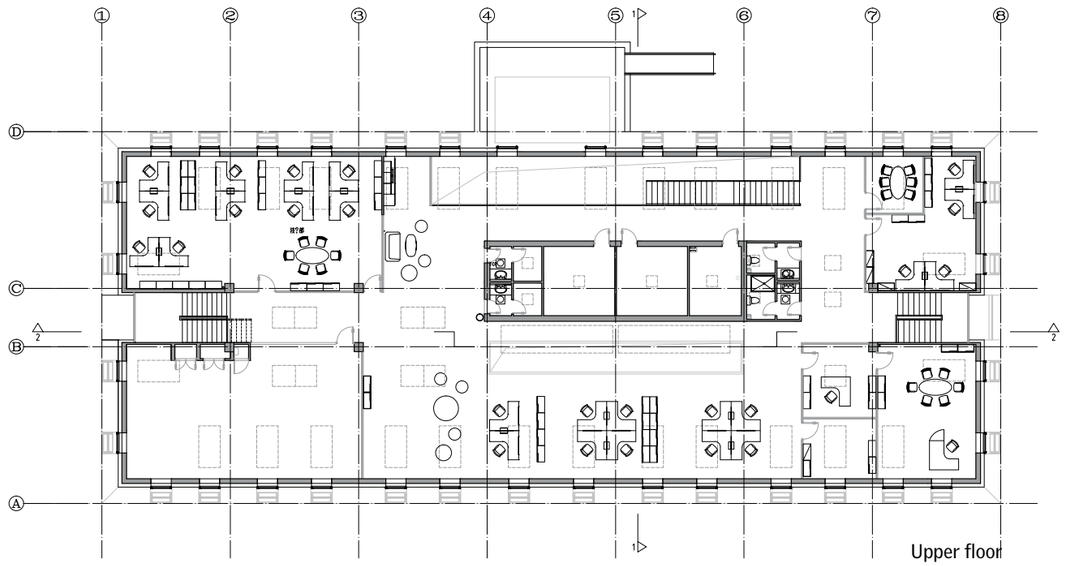
"The technologies implemented in the building teaches that everyone has to collaborate to create a good indoor climate where the whole building similar to the human organism has to be well balanced and regulated," notes managing architect Agnieszka Szwarczewska. This philosophy helps the building to act upon the priorities of our new era of globalization: An age that requires the world's economies to cooperate in reducing carbon emissions and energy consumption for a healthier, sustainable future.



Longitudinal section



Ground floor



Upper floor

A Collaborative Process Yields a Collaborative Building

Just like a team of people, a building's mechanical system must work together. No matter how effective the VELUX products may be on their own, other climate-control systems need to be designed in conjunction with VELUX technology to ensure a building's complete success once in full operational mode. Of critical importance to the occupants' comfort, a Thermal Active Building System (TABS) was designed to deliver both radiant heating and cooling. The TABS design is a closed-loop system of water pipes embedded in the concrete slabs to help reduce peak cooling or heating requirements during the day by storing cold or hot energy at night. As Novel explains,

"Because the TABS principle works in conjunction with the operable skylights to encourage the stack effect and natural ventilation, a smaller air-handling system is required for the building to achieve optimal human comfort."

Pumping all that water through the closed-loop system requires a lot of energy, so a strategy was developed to combine the use of a ground-source heat pump with an outdoor air unit that takes advantage of cheaper electrical rates during off-peak hours.

A number of decisions were made to enhance the overall sustainable design strategy which would invariably boost human comfort. Examples include a suspended Rockfon ceiling panel system to reduce noise from the overhead equipment, and a natural linoleum flooring installed over the TABS design to improve acoustics and help minimize the levels of volatile organic compounds (VOCs) to improve indoor air quality. Sub-metering is used throughout to accurately monitor the use of energy consumption and

"allows for a regular analysis to fine tune and detect possible disfunction,"

says Novel who adds that

"No building design delivers its promises without proper control. This is especially true of low-energy buildings because their need for energy varies a lot more in time than inefficient buildings."

Other systems include a CO_2-based control system that constantly adapts the fresh-air flow rate based on changing occupant loads throughout the day, and a continuous energy consumption feedback shown on a VELUX display screen in the reception area allows employees to continuously monitor the building's energy performance. This technology provides a bit of gamesmanship by challenging them to look for ways to further reduce their energy consumption. The ultimate goal has been achieved: the building's various operating systems collaborate with each other to benefit occupant health and wellbeing.

Main features to reduce energy consumption:

Active Thermal Mass (TABS)

Natural light

Solar heat gain through windows (winter)

Solar panels for domestic water

Natural ventilation in spring/autumn season

Insulation

Ground Source technology for heating and cooling

Heat recovery system on ventilation equipment

A Collaborative Building System

Obtaining the good results of VELUX Langfang Office has required a conscientious effort.

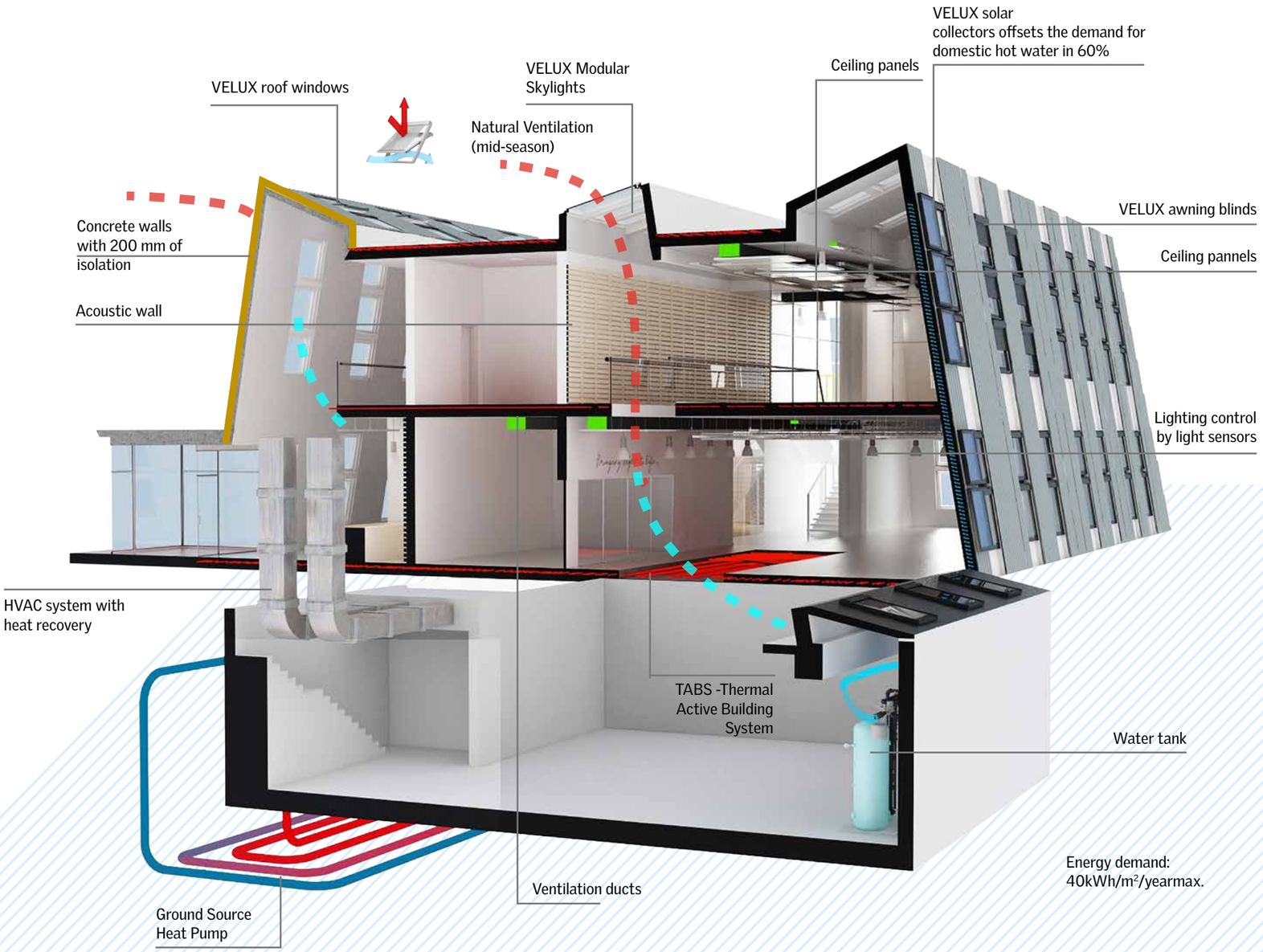
"The Langfang climate is very cold and dry. It is a tough climate in which to achieve low energy consumption," points out Asymeric Novel, consulting engineer during the planning and construction of the building.

The challenges he faced were not only caused by the surroundings.

"The building is an office space. This means that internal heat gains play a major role in defining the heating and cooling loads. In order to reach our targets, VELUX Langfang Office was equipped with a range of energy-saving technologies."

These include:

- A TABS system: An embedded network of water pipes in the mid-plane of all concrete slabs. Combined with a ground source heat pump and an outdoor air unit with variable volume, the TABS system provides pleasant and energy-efficient heating.
- A highly-insulated and airtight envelope to limit heat losses in winter. Thickness of Rockwool insulation in floor, 250 mm; roof, 200 mm; walls, 150 mm.
- A CO_2 based control of ventilation
- Extensive use of roof windows and facade windows
- Solar thermal collectors heating domestic water.
- Awning blinds that prevent overheating, thereby reducing the need for cooling on hot days.
- Heat pump – supplying the building with energy extracted from the ground under the building.



While the TABS system is largely invisible to users of the offices, it plays a crucial role in terms of energy efficiency.

"The principle is to load the building structure during the night time with thermal energy carried by water,"
explains engineer Aymeric Novel.

"This has several advantages. Firstly, storing cold energy in the concrete slabs at night, during hot seasons, will have the effect of levelling the peak cooling load during the daytime. In this case, the concrete slabs act as a radiant cooling system. This is not enough to reach the comfort zone during the peak summer time, but the remaining load can be met only with the conditioned fresh air brought by the ventilation system. In this way, the TABS principle and the fresh air required by the indoor environment standard work together well.
Novel explains. He adds:
As a consequence, the ventilation syste can be much smaller than the conventional air condition system."

To achieve the best results in energy efficiency, attention has to be paid to small details.

"A lot of work went into being able to use as low fan and pump power as possible,"
says Aymeric Novel. "

"In terms of energy performance, they represent a significant part of the final energy bill."

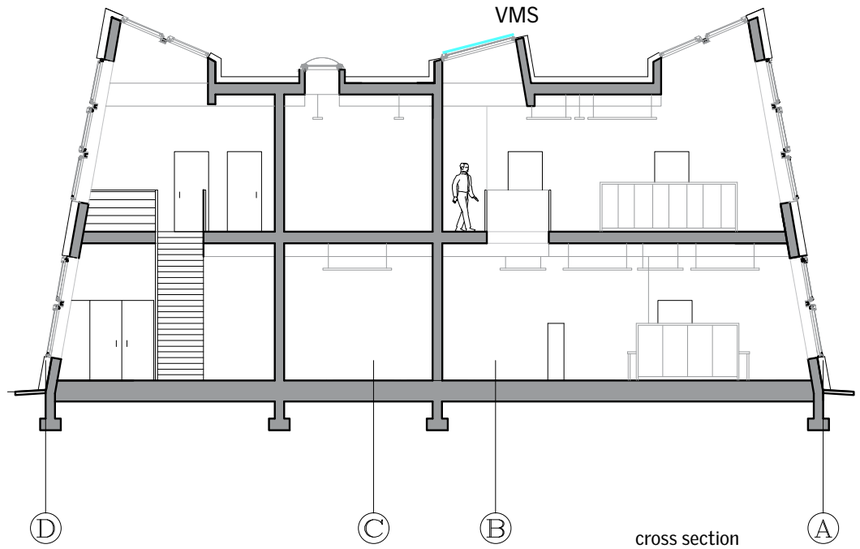
China's First Active House Office Building: Part of a Global Trend in Holistic Sustainability

In recent years, VELUX has been working closely with an alliance known as Active House. The organization is comprised of academics, researchers, and product manufacturers. Originating out of Europe, Active House is an important source for leading-edge sustainable design strategies to improve the design of residential, commercial and office buildings. Comfort, energy and the environment encompass the three key Active House principles but it is the use of natural daylighting and ventilation with an overarching concern for human comfort that helped guide the VELUX design team to succeed in achieving China's very first Active House office building.

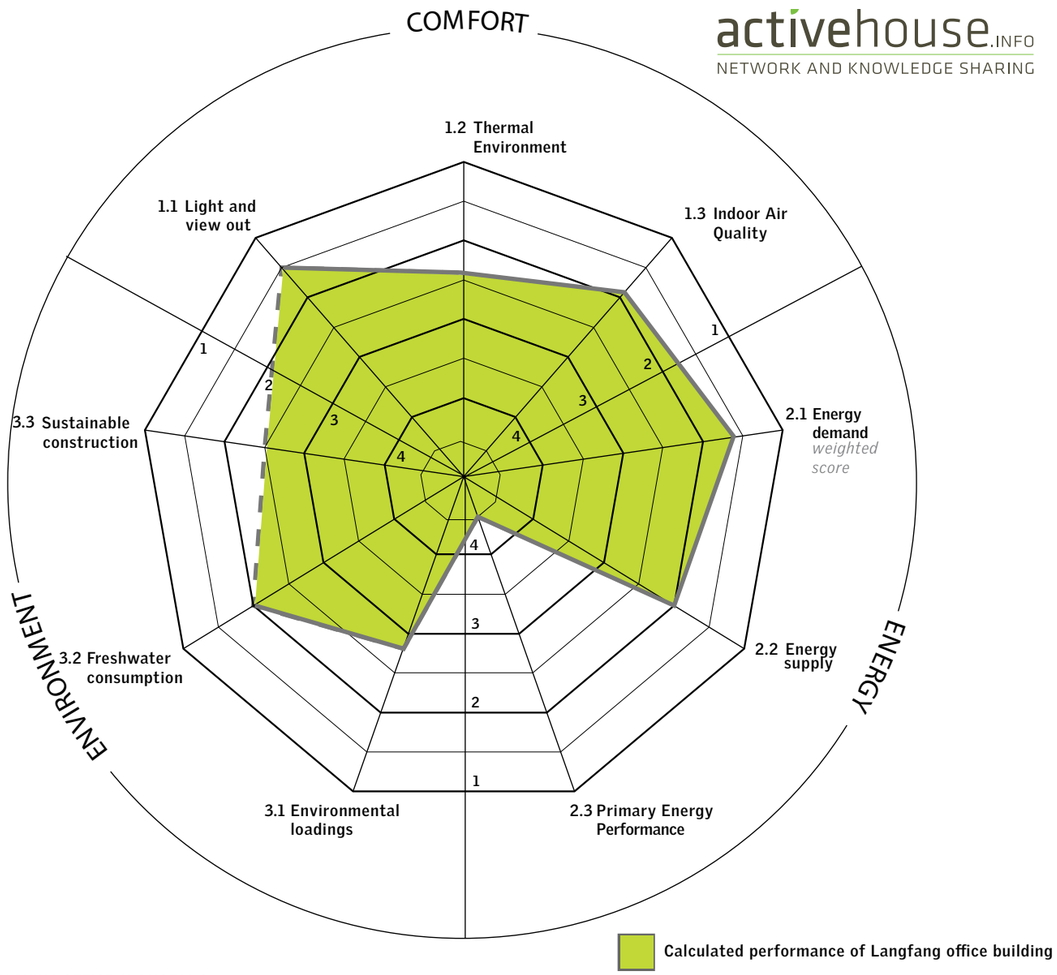
"Whenever possible, new VELUX buildings are designed to Active House specifications, which make well-balanced daylight conditions essential" says Henrik Norlander Smith.

Achieving the Active House sustainable design principles necessitated achieving a primary and secondary energy consumption rate between of 30-50 kWh/m²/year within a reasonable construction budget.

"What surprises most people is that we can achieve the low energy consumption of 32.14 kWh/m²/year while still having 296 windows in the building," notes Christian Olsen, the CEO for VELUX's Chinese operations, adding "This is of course the message we are trying to convey – that windows are important because they are essential in providing a healthy indoor climate."



cross section



The radar shows the results of the Active House rating of the VELUX Langfang office. However, a number of things must be borne in mind in the analysis: this guideline is intended for use in residential buildings; the criteria adopted apply to European standards and not Chinese, as data is not as readily available in China as it is in Europe. The presented score is calculated, not based on measured data. The highest score in the rating system is 1, the lowest 4.

1.1 Daylight and view out: one of the objectives of the design was to harvest as much daylight as possible. At 1.5, the project scores well in this category.

1.2 Thermal environment: the building scores 2.4. As it was designed to the high European standards for indoor environment quality (class B, PPD<10%, DR<20%), the building provides comfortable temperatures. The only reason for not achieving the best score is slow response of the heating system in the morning. The radiant temperature takes longer to rise due to the heavy thermal mass of the building.

1.3 Indoor air quality: the project scores 1.9. The Air Handling Unit delivers 100% fresh air and is controlled by CO_2 sensors.

2.1 Energy demand: thanks to the efficiency of the heating, cooling and ventilation systems, and the high degree of insulation, the building has a low energy requirement. The high score of 1.6 is particularly impressive given the fact that the target figures were scaled for homes, where energy intensity is lower than in office buildings.

2.2 Energy supply: the high score for energy supply of 2 is due, primarily, to the heat harvested by the heat pump units and solar thermal collectors.

2.3 Primary energy performance: The score for this parameter, defined for homes and not offices, is out of range for two main reasons:

a. Active House principles require the use of renewable electricity, which was never part of the design of this project; and, generally speaking, most office buildings do not get enough renewable energy to offset their electricity use. It is, however, believed that cogeneration using waste wood from production could lead to an improvement in this score.
b. The requirements do not take into account the variation in primary energy coefficient for different world location.The average primary energy coefficient in China is currently 3.28, which is much higher than the average in Europe (around 2.5), which significantly worsens the score. Although out of range, the score is better than most buildings in China.

3.1 Environmental loadings: the score is 2.8. This was not an initial objective of the project and the LCA (Life Cycle Analysis) was based on data from the European database. The score does not, therefore necessarily reflect conditions in the construction industry in China.

3.2 Fresh water consumption: another high score of 2. Had the building used rainwater and grey water recovery, the score might even have approached 1. But water-saving fixtures are in place and the flooring was chosen to ensure that maintenance and cleaning of surfaces required a minimum of water.

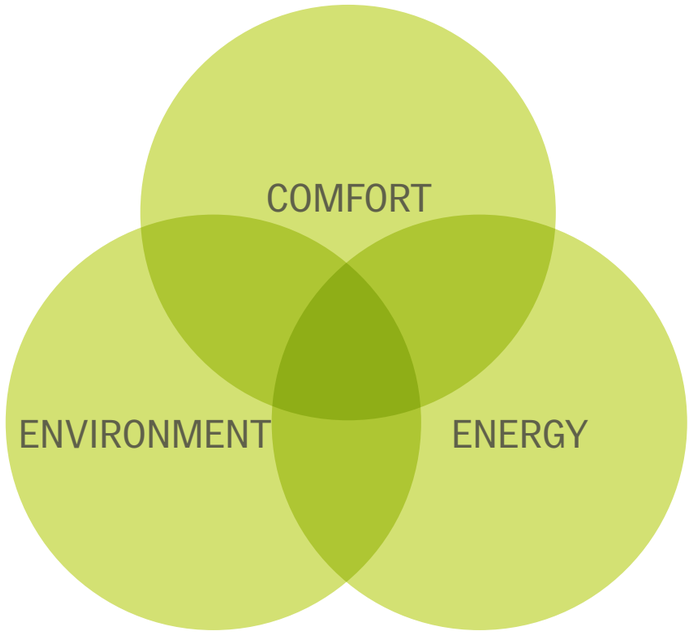
activehouse

Buildings that give more than they take

Active House is a vision of buildings that create healthier and more comfortable lives for their occupants without impacting negatively on the climate – moving us towards a cleaner, healthier and safer world.

The Active House vision defines highly ambitious long-term goals for the future building stock. The purpose of the vision is to unite interested parties based on a balanced and holistic approach to building design and performance, and to facilitate cooperation on such activities as building projects, product development, research initiatives and performance targets that can move us further towards the vision.

The Active House principles propose a target framework for how to design and renovate buildings that contribute positively to human health and well-being by focusing on the indoor and outdoor environment and the use of renewable energy. An Active House is evaluated on the basis of the interaction between energy consumption, indoor climate conditions and impact on the environment.



The Active House key principles are as follows:

COMFORT

- a building that provides an indoor climate that promotes health, comfort and sense of well-being
- a building that ensures good indoor air quality, satisfactory thermal climate and appropriate visual and acoustical comfort
- a building that provides an indoor climate that is easy for occupants to control and at the same time encourages responsible environmental behaviour.

ENERGY

- a building that is energy efficient and easy to operate
- a building that substantially exceeds the statutory minimum in terms of energy efficiency
- a building that exploits a variety of energy sources integrated in the overall design.

ENVIRONMENT

- a building that exerts the minimum impact on environmental and cultural resources
- a building that avoids ecological damage
- a building that is constructed of materials that can be recycled.

Active House is an initiative supported by the VELUX Group

Conclusions:
Responding to Future Needs

Over the course of its 75-year history, VELUX has built a reputation that depends upon its ability to bring natural daylight and fresh air indoors. This is an evolving challenge. Just as society's awareness has changed with respect to designing healthy and productive work environments, VELUX has responded with developing increasingly sophisticated products and measurement tools that are incorporated into the designs of its own office buildings around the world. The design of the VELUX headquarters in Langfang presents a convincing argument about the need for healthy living spaces – and suggests that the future of healthy living spaces requires the cooperation of many people to ensure that natural daylight and fresh air continues to be a major component to our daily lives.

VELUX Products

1

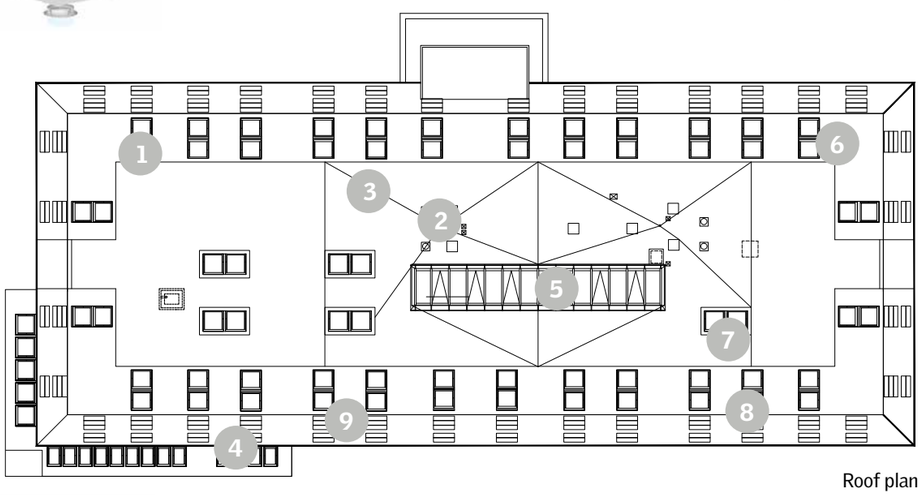
VELUX INTEGRA® is an innovative system of remote controlled windows, blinds and shutters. It lets you open and close with just one touch of the control pad. Use the predefined programmes, or create your own based on your needs. VELUX INTEGRA® roof windows come with a rain sensor that closes your windows automatically if it starts to rain.

2

The VELUX vented flat roof window provides ventilation and fresh air through the roof. Available electrically operated with hidden motor, rain sensor and control pad. The clear or opaque dome is designed to protect the double-glazed unit below from rain and snow.
Suitable for roof pitches between 5° and 15°
Available in nine sizes.

3

VELUX sun tunnels for flat roofs are designed to provide natural light into corridors, stairwells, bathrooms and cupboards, under flat roofs, where installation of a VELUX roof window is not possible.

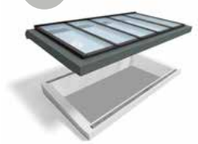


Roof plan

4

VELUX Electric "Fresh Air" skylight is the perfect daylighting solution for overhead applications. It allows for abundant natural light, and with the touch of a button, opens to let in fresh air.

5



VELUX Modular Skylights is a fully prefabricated skylight concept. Made from a composite material that ensures excellent energy performance, thermal stability and high strength, the product was elegantly designed in collaboration with Foster + Partners. This solution can be opened automatically for ventilation and the addition of electrically operated roller blinds offers greater light and energy control.

6

The exterior VELUX awning blind blocks the sun's rays before they hit your window pane and reduces passive heating by up to 72%*. It helps keep your room comfortable on a warm, sunny day. Awning blinds are transparent, so it is still possible to enjoy view out.

7

The VELUX blackout blind offers a light-proof seal for total darkness anytime. It is ideal in rooms, where there is complete light control needed.

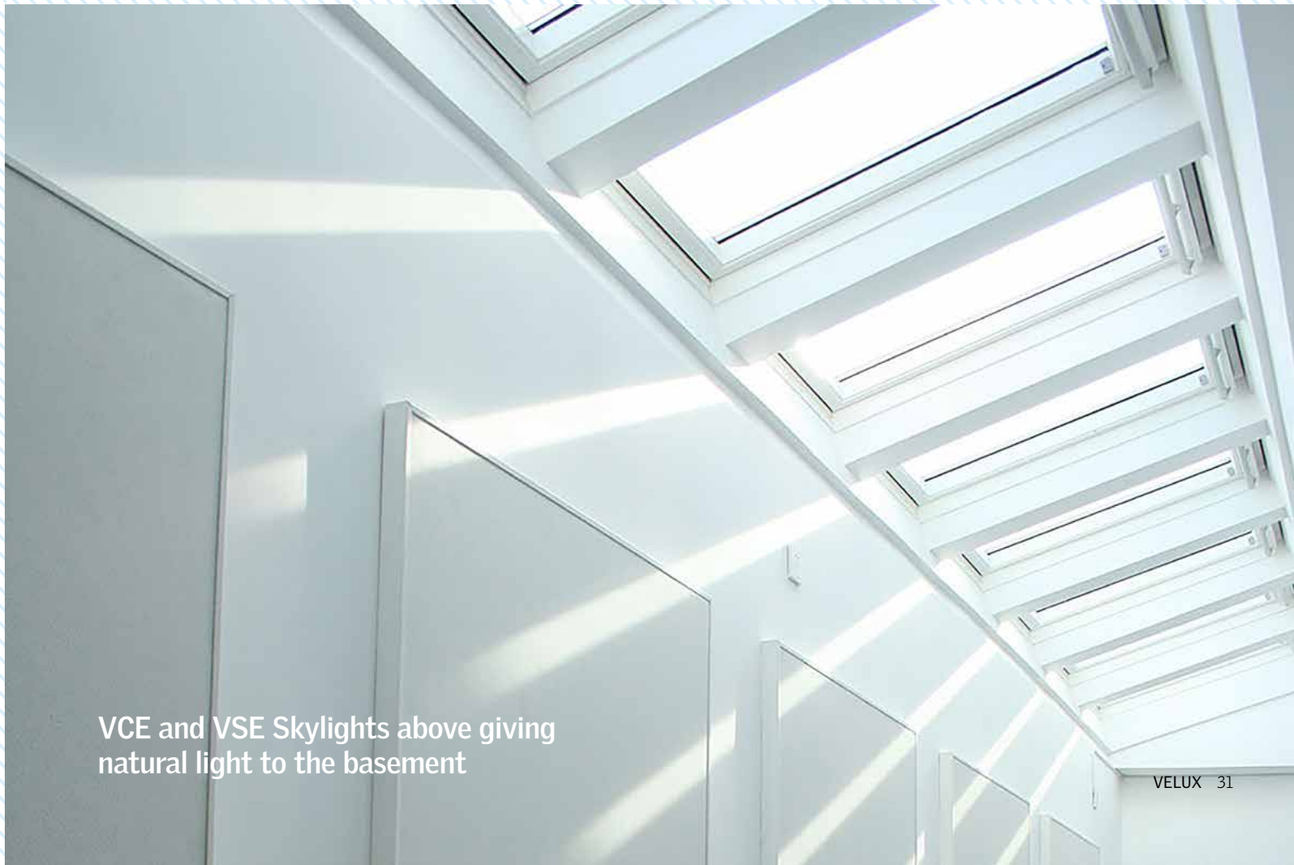
8

The VELUX pleated blind makes it easy for you to adjust the incoming daylight, as it can be positioned anywhere in the window seeing that it's not fixed either at the top or at the bottom (manual only). This provides basic privacy and greater control of sunlight.

9

The VELUX roller blinds provide basic privacy whilst still allowing natural light in. The roller blind runs in aluminium side channels and can be positioned anywhere in the window. A roller blind is an effective and practical solution that offers protection and good looks.

VELUX modular skylights



VCE and VSE Skylights above giving natural light to the basement

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