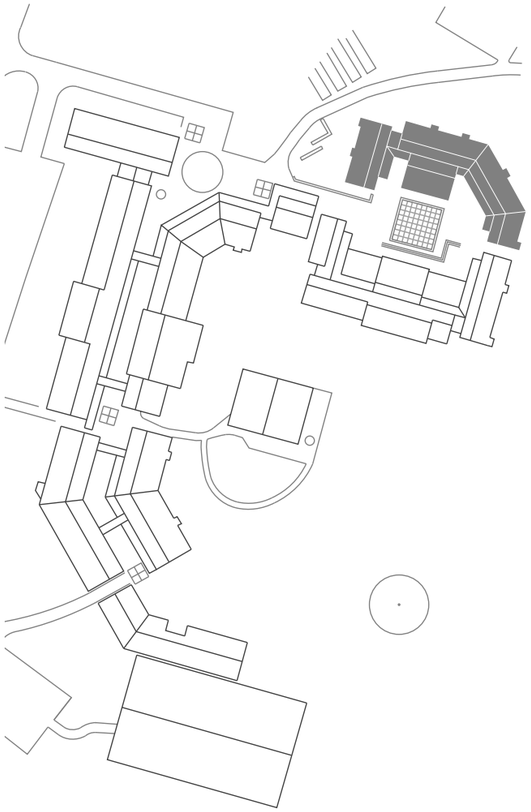
VELUX®

Langebjerg School

Adapting classrooms to future demands on education

Langebjerg School

Humlebæk, Denmark



Facts

Langebjerg School is located in the municipality of Fredensborg, around 40 kilometers north of the Danish capital of Copenhagen.

In 2014, the school and municipality administration embarked on a renovation of six classrooms, a hall, toilets and a common room in the North house. The renovation focused on replacing the old roof, adding extra insulation and installing new roof windows. The renovated area is now equipped with a total of 59 roof windows.

The Challenge

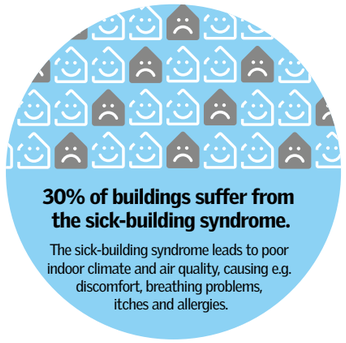
Preparing old school buildings for the future

Compared to the general building mass in Europe, Langebjerg School is quite new. Built in the 1980s, the low-rise wings and whitewashed walls still look modern and fresh. But in terms of functionality, the school buildings have long been ready for an update.

When constructed, the roof was fitted with the short generation of fibre cement roof plates that was produced after asbestos were forbidden. But the material became infamous for its porosity - and, in 2013, the roof was literally cracking.

The inside of the school has felt the passage of time too. Increased focus on academic achievement had led to longer school days, which resulted in poor air quality in the classrooms. Lene Mossin, who teaches history, Danish and music at Langebjerg School, was one of the users who was concerned about the dry and stuffy air.

She tried to cope with it by opening the facade windows, but:
"The pupils often complained that they were cold and that there was a draft".
In her teaching, new tools like tablets and smartboards also provided a challenge in the classrooms with inadeqaute daylight control.
"It is difficult to use a smartboard when the room is too bright," says Lene Mossin.
"Sometimes we were forced to cover the windows with black garbage bags in order to be able to read the screen. " She is also confident that the internal VELUX remote controlled black-out blinds will solve the problem of overexposed smartboards:
"I will definitely use the sun screening in the windows" she says.



30% of buildings suffer from the sick-building syndrome.

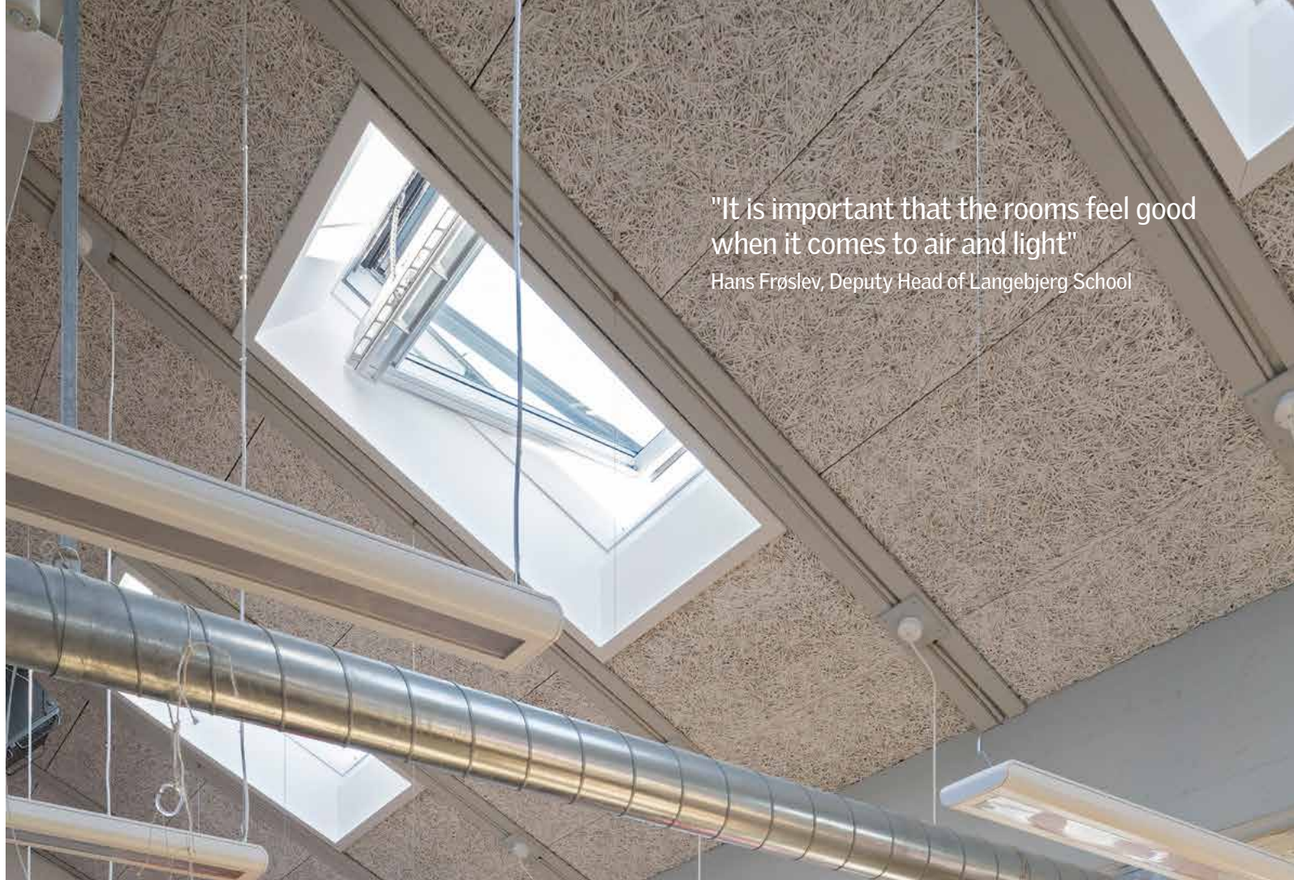
The sick-building syndrome leads to poor indoor climate and air quality, causing e.g. discomfort, breathing problems, itches and allergies.

Inspired by daylight

The need for improvements was obvious. But a renovation would have to address a range of problems at the same time. School management and municipality officials looked to nearby Endrup School for inspiration. Here, a renovation with new roof windows had not only improved the air quality, but also job satisfaction among teachers.

Deputy Head of Langebjerg School, Hans Frøslev, visited Endrup School and one of its renovated pre-school buildings: "It was clearly an improved room in terms of light and air quality. These things matter the most to me, especially because of the extended school days. It is important that the rooms feel good when it comes to air and light," says Deputy Head Frøslev.

Visit to the climate renovated Endrup School inspired the Deputy Head of Langebjerg School.

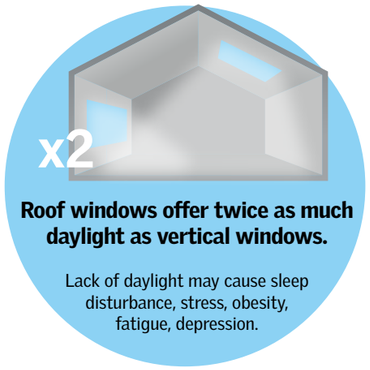


"It is important that the rooms feel good when it comes to air and light"

Hans Frøslev, Deputy Head of Langebjerg School

A Solution

In the light of the future



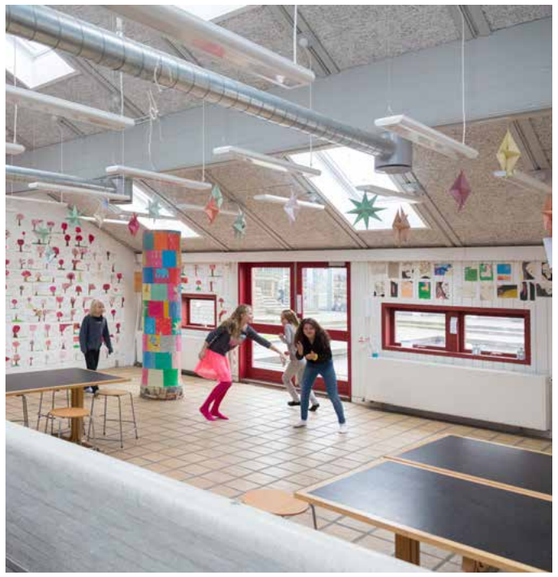
Roof windows offer twice as much daylight as vertical windows.

Lack of daylight may cause sleep disturbance, stress, obesity, fatigue, depression.

The renovation of Langebjerg School was designed to solve the immediate problems of the roof as well as to prepare for demands on education in the future.

"In the refurbishment of the roof, we chose a holistic, long-term approach," says Fredensborg municipality architect Peter Sommerfeld, project manager of the Langebjerg renovation. It involved removal of old concrete features with non-openable windows.
But visually and functionally, the most remarkable change was the addition of new roof windows in each room to create optimal daylight and natural ventilation with VELUX INTEGRA® windows. "It makes the building much easier to live with," says Peter Sommerfeld, adding that the roof windows have made a considerable improvement to the indoor climate. The VELUX INTEGRA® windows will be controlled automatically, based on CO_2 levels in the room, or operated with a remote control unit, a feature valued by teacher Lena Mossin. "I believe things will be much better with a continual change of air." She explains that the introduction of ventilation to the upper part of the classrooms will prevent the uncomfortable draft that occurs when facade windows are opened to air out the rooms.

Deputy Head Hans Frøslev believes the indoor climate technology will not just be beneficial to the teaching process; data from CO_2 sensors and monitoring system could become an active part of the learning process: "It would be an obvious step to use it in science lessons," he says.



Langebjerg School before and after renovation

Daylight factor

The daylighting performance of Langebjerg School has been specified using the daylight factor (DF) as performance indicator.

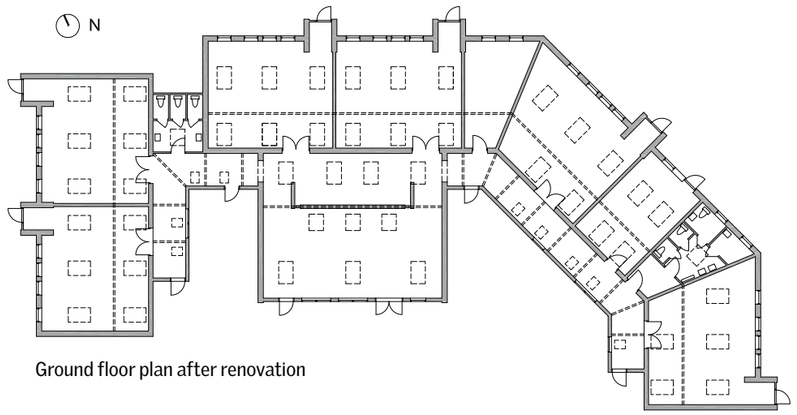
The daylight factor is a common and easy-to-use parameter for the available daylight in a room. It expresses the percentage of daylight available inside on a work surface compared to the amount of daylight available outside the building under known overcast sky conditions. The higher the DF, the more daylight is available in the room. An average DF below 2% generally makes a room look dull and electrical lighting is likely to be frequently used, whereas an interior will look substantially daylit when the average DF is above 5%.

The figures on the right show the daylight factor levels obtained for two different variants evaluating the impact of the installed roof windows on the final design.

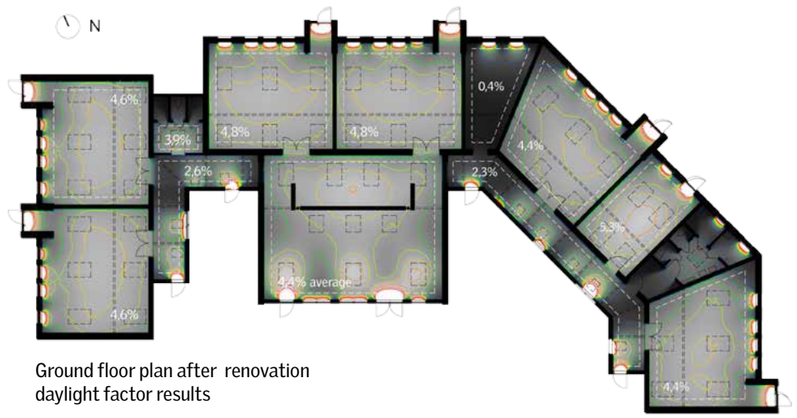
The comparison of results shows the positive effects of adding roof windows on the daylight conditions in the building. It shows that the roof windows deliver high levels of daylight in the centre part of the classrooms.

Daylight Factor [%]
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0

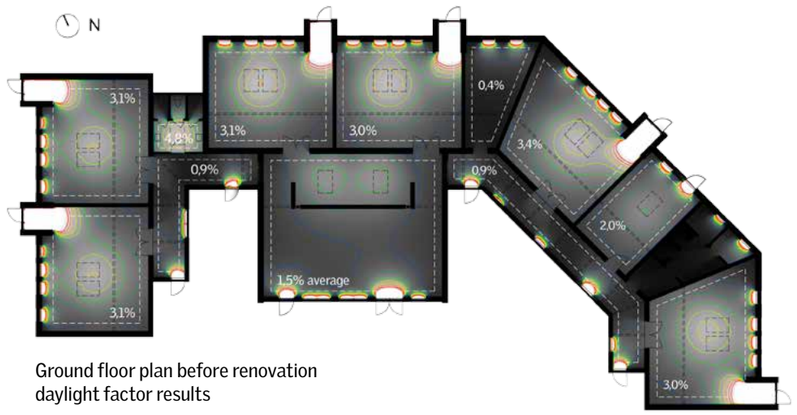
Daylight is vital for our circadian rhythm and has a positive impact on our well-being and performance, and provides the pupils and teachers with a better learning environment. In addition, optimized and controlled use of daylight reduces the need for artificial lighting and provides useful solar gains during the winter period. In this respect, intelligent use of daylight can significantly help to reduce a building's energy consumption.



Ground floor plan after renovation



Ground floor plan after renovation
daylight factor results



Ground floor plan before renovation
daylight factor results

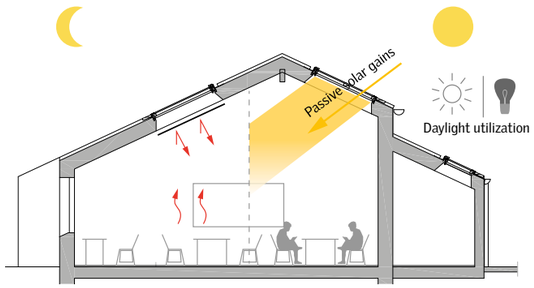
Simulations were made by the VELUX Daylight Visualizer 2, a software tool dedicated to daylighting design and analysis. For more details and download, visit http://viz.velux.com.

Old rooms, new feeling

The renovation of Langebjerg School began in June 2014 and was completed in October the same year. During first phase, pupils were temporarily relocated to other classrooms, but they were able to use their usual rooms while the final adjustment of the roof took place.

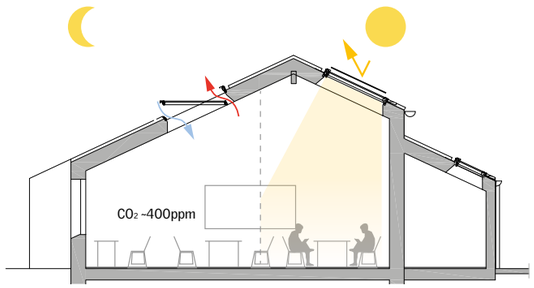
After taking the rooms into use, the improved lighting was the most valued feature among the pupils:
"Previously, when the room was darker, it sometimes felt enclosed" 10-year-old Erik explains, while his classmate Nasrin adds:
"Now, it is easier to find a good spot when you need to work."
Teacher Lena Mossin express a more general satisfaction with the renovation:
"The first time we entered the new rooms, I was simply thinking: Wow, this is great!"

Winter



Automatically controlled interior sunscreening help to minimise heat losses at night during winter.

Summer

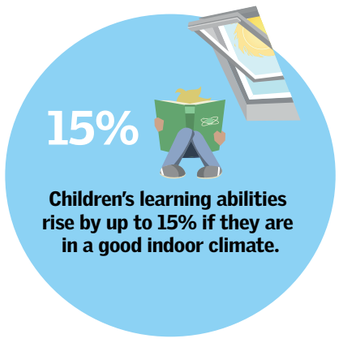


In summer, automatically controled exterior sunscreening helps to control solar heat gains. While manual control of interior blinds provides the possibility of adjusting daylight levels according to the need of teacher and pupils.

Indoor climate

A good indoor climate, with generous daylight levels and provision of fresh air from outside, is the key to making schools healthy.

The air that we breathe and the daylight we are exposed to have a great impact on our health, well-being and performance. Investigations into mental performance of children in schools have shown that poor air quality reduces mental performance, while good air quality improves it. In other words pupils learn faster and work more accurately when fresh air supplied.



Children's learning abilities rise by up to 15% if they are in a good indoor climate.

Schools and kindergartens are characterised by having relatively few square metres per person in classrooms and activity rooms, and use of the rooms based on predefined schedules.

To ensure a well-performing natural ventilation system for a classroom, the window opening area in relation to the number of pupils and the floor area are the key design parameters. As much opening area as possible should be achieved.

Single-sided ventilation by facade windows alone can be challenging, whereas much better performance can be achieved in combination with roof windows on both sides.
The following considerations were made in optimising the design of Langebjerg School:
- The breaks between lessons can be used for airings. In that case, the maximum window opening area should be used to minimise CO_2 concentration before next lessons.
- Automatic control achieves the full potential of natural ventilation. CO_2-sensor control of ventilation is the best answer to providing good air quality.
- A schedule-based control of ventilation may be sufficient, if the schedule of lessons and breaks is repetitive and rarely changed.

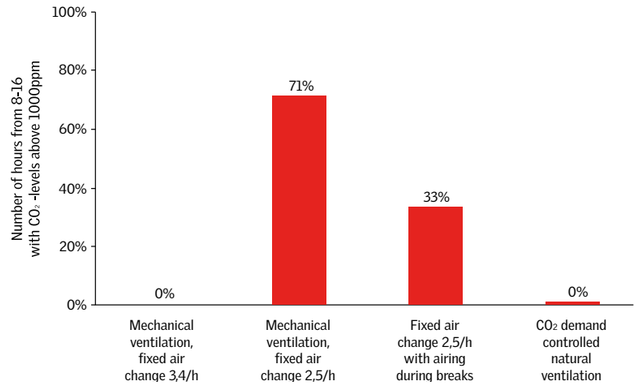
Fresh air

The ventilation performance of a typical classroom in Langebjerg School has been studied using the number of hours when CO_2 level exceeds the recommended level of 1000ppm.

Parts per million (ppm) is the common way of expressing dilute concentrations of substances such as CO_2 in the air. CO_2 is a good indicator of the indoor air quality in classrooms, where the pupils and their activities are the main source of pollution. Outdoor air contains approximately 400 ppm. Breathing generates CO_2, so the indoor CO_2 concentration will always be at least 400 ppm and usually higher. An indoor CO_2 level lower than or equal to 1,000 ppm indicates a good indoor air quality in most situations.

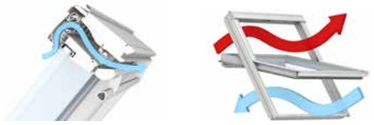
The figure on the right shows the number of hours with CO_2 levels above 1,000 ppm obtained for four different variants of ventilation in the room. The compared ventilation strategies are as follows:
- Mechanical ventilation of 3.4 air changes per hour
- BR2010 requirement - mechanical ventilation of 2.5 air changes per hour (BR2010 stands for Danish Building Regulation 2010)
- BR2010 requirement + opening of windows during breaks
- Demand controlled natural ventilation with CO_2 setpoint for window opening.

VELUX Energy and Indoor Climate Visualizer is used to evaluate the performance of a classroom in terms of ventilation and indoor climate.

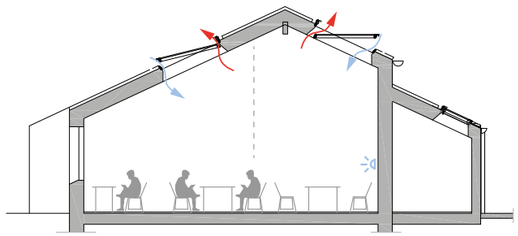


The comparison of the results shows that demand-controlled natural ventilation with CO_2 sensors provides much better air quality to the room than the fixed air change of 2.5 (calculated according to BR 2010). Demand-controlled natural ventilation is operated by CO_2 sensors installed in each classroom. The opening of the windows is controlled by two setpoints:
- Open window, approxamitely 1000ppm
- Close window, approxamitely 650ppm

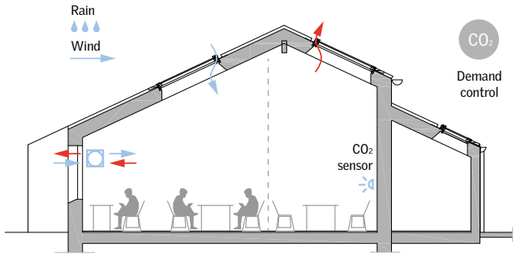
When the CO_2 level reaches the first setpoint, the window is fully opened until the next setpoint is reached.



The monitoring system used for collecting indoor air quality and thermal comfort data (Netatmo) is installed in each individual classroom. Children can easily analyse the measurments on tablets or smartphones and create simple diagrams of monthly or annual results. They can observe and analyse data about indoorand outdoor air temperatures, CO_2 levels, humidity and noise levels.



CO_2 sensors control the air quality in the classroom. The roof windows open automatically and close again when minimum CO_2 setpoint is achieved or if it rains.



In the event of rain and high CO_2 levels, fresh air is supplied through the flaps in upper part of roof windows or additional mechanical ventilation if needed.

VELUX Products

Langebjerg School

VELUX INTEGRA® roof windows

If you want ultimate comfort, VELUX INTEGRA® is the answer. This innovative system of remote controlled windows, blinds and shutters lets you open and close with just one touch of the control pad. VELUX INTEGRA® is the ultimate choice for fresh air and a better indoor comfort.

Exterior sunscreening
- electrically operated awning blinds.

Offers great heat protection, view out and light in due to the transparent cloth.

Model MML.

Linings

Standard lining for pitched walls. VELUX linings optimize the finish in your room. The unique design creates space for extra insulation material to prevent thermal bridges.

Model LSC (roof thickness up to 400 mm)

Interior sunscreening
- electrically operated blackout blinds.

Elegantly designed VELUX blinds for easy control offers a lightproof seal for total darkness anytime. It is ideal, where you need complete light control to ensure a restful nap during the day.

Model DML

The Langebjerg School
Humlebæk, Denmark

Building owner
Fredensborg Municipality

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