Green Lighthouse

VELUX®
MODEL HOME 2020

Renderings of Green Lighthouse
Christensen & Co Architects

Photos of Green Lighthouse
Adam Mørk

Other photos and illustrations
VELUX Group

Denmarks first public CO_2-neutral building

The University of Copenhagen, The Danish University and Property Agency, the Municipality of Copenhagen, VELFAC and the VELUX Group have entered a strategic alliance to construct a new sustainable office building with optimal balance between energy efficiency, architectural quality, healthy indoor climate and good daylight conditions. The building has facilities for the Dean, professors and students of the Faculty of Science at the University of Copenhagen.

The building was designed by Christensen and Co Architects A/S, with COWI as engineers.

The partners want Green lighthouse to be a beacon for sustainable building in Copenhagen, Denmark and the rest of Europe.

The house is a lighthouse in more than one sense. It is a green lighthouse for CO_2-neutral buildings up to the UN Climate Conference (COP15); It is a lighthouse of efficient public-private cooperation; and last, but not least, it is a lighthouse for the Faculty of Science at the University of Copenhagen, which will see its student services consolidated under one roof.

Universitets- og Bygningsstyrelsen
Ministeriet for Videnskab Teknologi og Udvikling

KØBENHAVNS KOMMUNE

KØBENHAVNS UNIVERSITET

VELFAC®

VELUX®

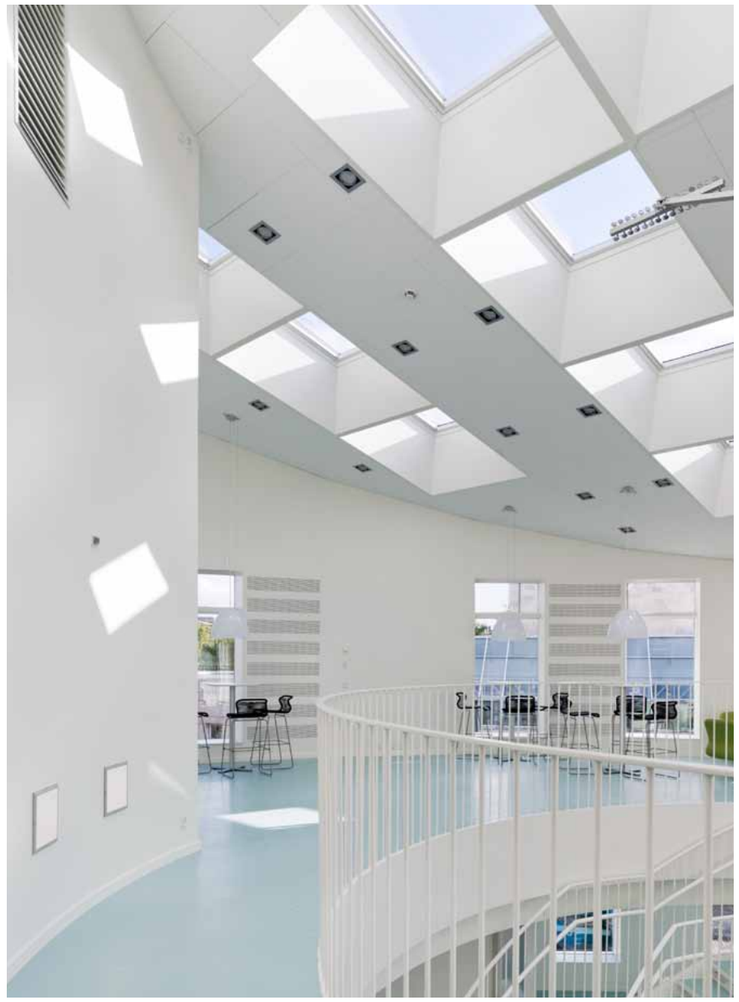
Daylight, energy and indoor climate

The benefits of VELUX products today are more important than ever before. Daylight and fresh air have been at the core of our business since the company started in 1942.

Model Home 2020 is an experiment launched by VELUX as part of our strategy to contribute actively to the development of future sustainable buildings. This is our vision for how daylight and fresh air can render buildings of the future climate-neutral while providing a good indoor climate and being attractive to reside in. The project supports the ideas of the coming generation within building design – often called "active houses". The purpose is to create a balance between energy efficiency and an optimum indoor climate by means of a building that dynamically adapts to its surroundings whilst being climate-neutral. Green Light-house is the second of six experiments in the Model Home 2020 project.

From an architectural point of view the house was inspired by the sundial and the movement of the sun around the house. The design underlines the fact that the sun is an important topic in science and one of the most significant energy sources in Green Lighthouse.

The VELUX Group works to supply products that help reduce CO_2 emissions from buildings without compromising on the highest standards of daylight and indoor comfort. With our products and the way they are used, we wish to contribute to more sustainable buildings.



Daylight in Green Lighthouse

Green Lighthouse is not only a lighthouse when it comes to sustainability. Vital daylight has been thought into all details.

Daylight is the primary light source in Green Lighthouse and daylight has been thought into the very architectonic principal idea itself. The house is circular and has an internal core, which simultaneously holds the central staircase, provides ventilation through the natural stack effect and draws a lot of daylight down through the house from the roof windows. When you are going to energy optimize a building as it is the case for Green Lighthouse it is decisive to integrate architecture, materials and light into an overall plan to obtain an extremely low energy consumption.

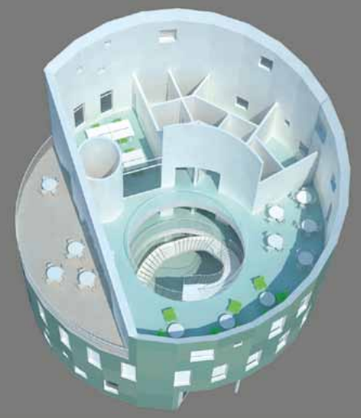
Green Lighthouse has been designed as a deep circular house with an internal passage of light, which fetches light down into the building from a huge glass covered hole at the top. It provides lots of daylight, creates natural ventilation and lets the hot air out. The stairs utilize the room to its full extent and creates a good, open and clear flow in the house. In that way the architectonic and sustainable solutions will be combined.

The daylighting performance of Green Lighthouse has been specified using the daylight factor (DF) as performance indicator. In technical terms, the daylight factor should be at least 3 % in all working stations and minimum 2 % in hall ways. This means that daylight is evident in all rooms. Due to the construction of the automatic window shades, sunlight is reflected deeply into the building.

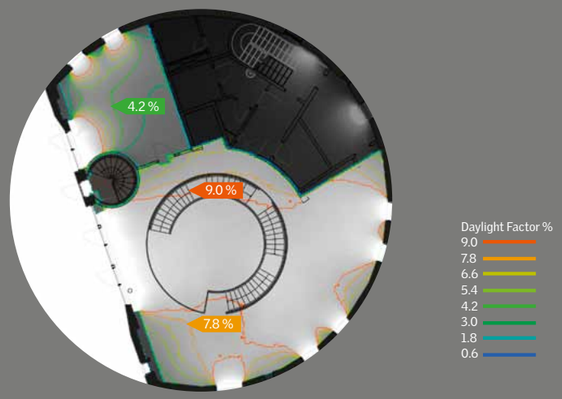
"Working in daylit environments results in higher productivity."
Visher 1989

In Green Lighthouse, daylight is used as an active energy-saving strategy. The building has the ability to function as a daylight lamp, at all times and in all weather conditions, transporting maximum exterior daylight into the interior through windows in the facade and the roof. Together with lux sensors and dimmer controls, the result is an efficient balance between available daylight and the need for artificial light, which results in minimum use of electricity. If the roof windows were removed and the same light levels were to be reached with artificial light, the need for electricity would be more than four times higher.

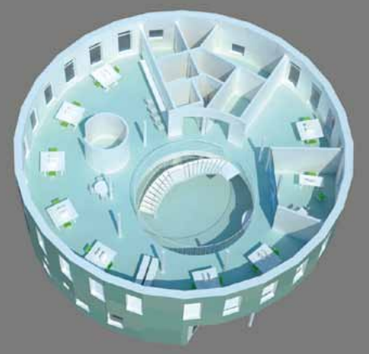
Second floor



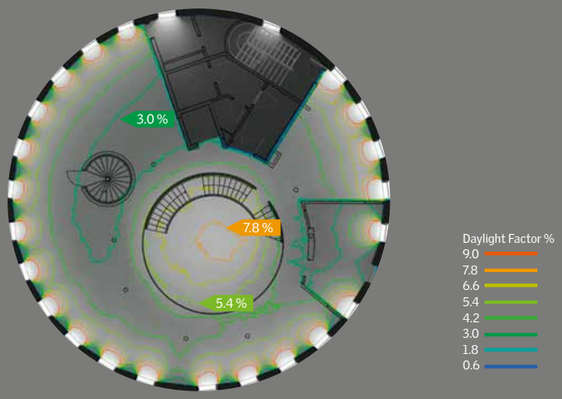
Daylight performance, second floor



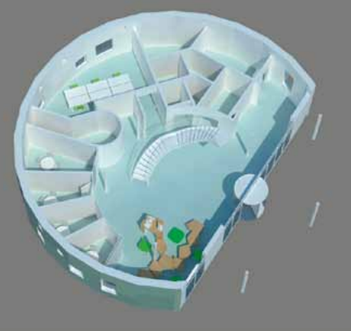
First floor



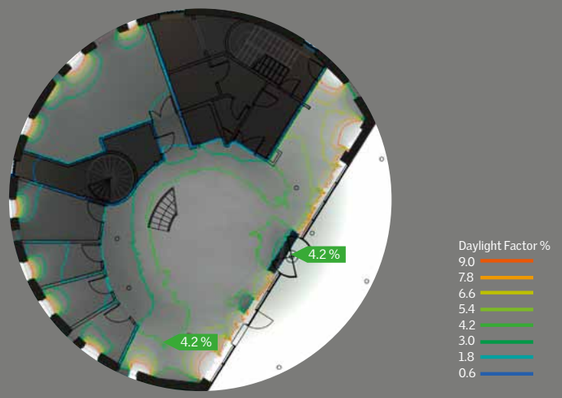
Daylight performance, first floor



Ground floor



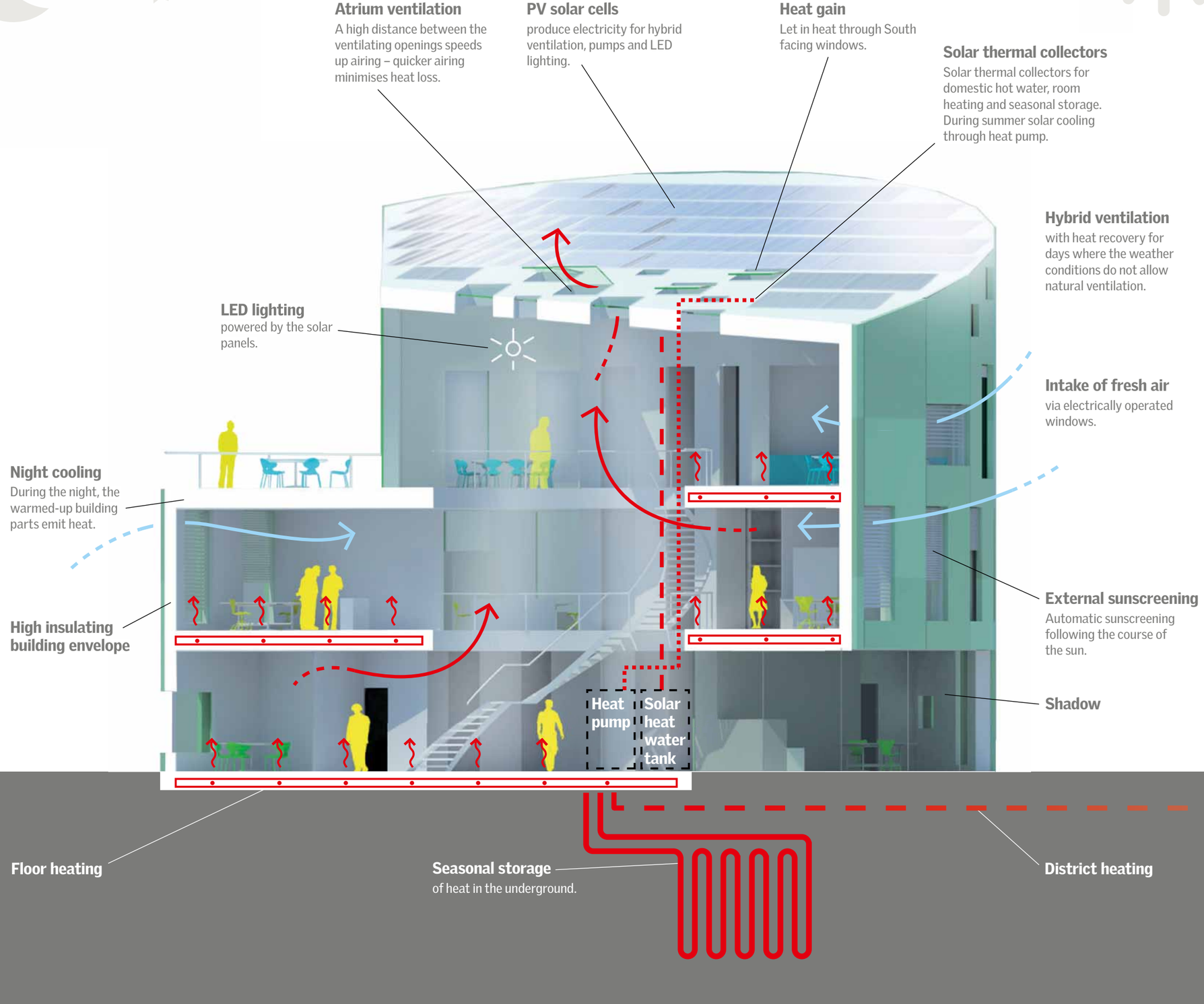
Daylight performance, ground floor

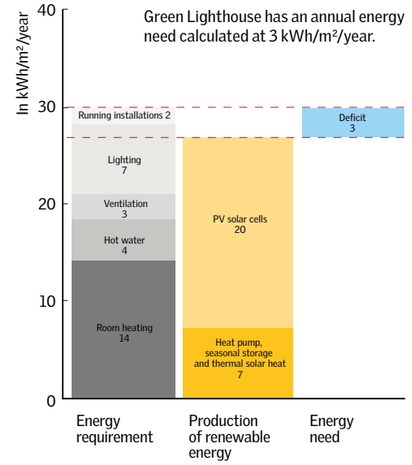


Energy concept

The sun constitutes the central point and primary energy source of Green Lighthouse. The house is 950 m² and it has been built in accordance with the "active house" principle, which means that it generates energy. The house has its own energy supply consisting of an unprecedented combination of thermal solar heat, heat pumps, seasonal storage, PV solar cells and district heating. Green Lighthouse is an energy-efficient construction work of high architectural quality and with a large intake of daylight. The house is filled with plenty of fresh air deriving from natural ventilation, which ensures a healthy indoor climate.

By means of the building's energy design, the building has cut down ¾ of its energy consumption in relation to Danish building standards. This means that the building is better than other buildings in Low Energy Class 1 under the EU standards applicable since 2006. These standards are expected to apply across the EU for all new construction work by 2020.





The primary energy is accounted according to the Danish Energy Calculation tool BE 06.

Thermal solar energy

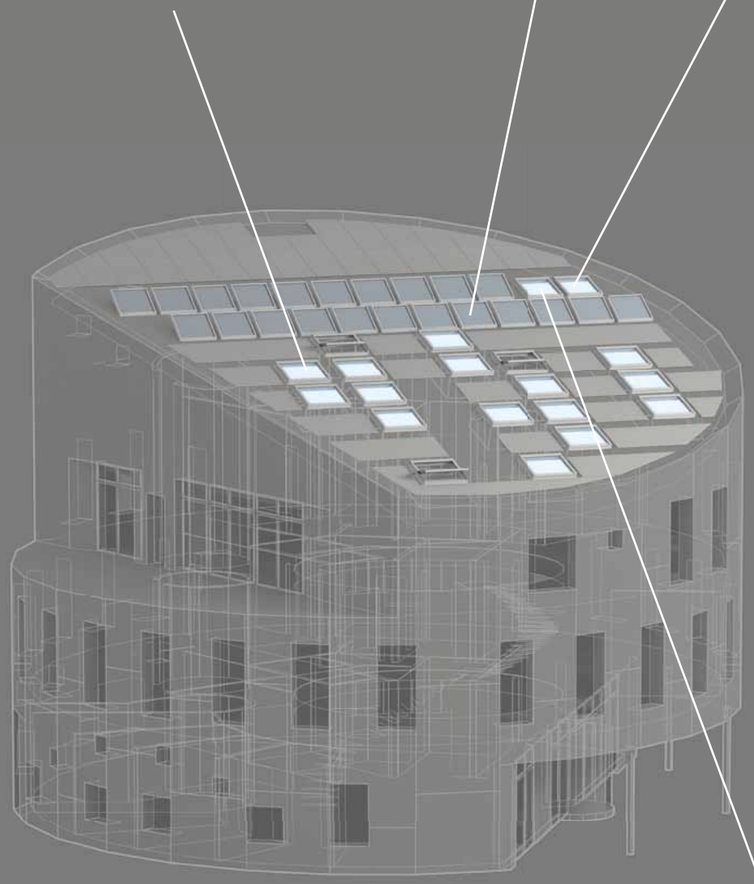
22 solar collectors (CLI S08 4000), flextubes for solar collectors (ZFR EFO and ZFM 015)
2 modified combi flashings for solar collectors (special FLA ECX)

Roof windows

18 safety-laminated triple-glazed centre-pivot roof windows with white polyurethane finish and solar window operators (GGU U08 006530)
18 flashings for roof windows (EDL U08 0000)
18 installation sets (BDX U08 2000)
18 vapour barrier collars (BBX U08 0000L)
18 solar awning blinds (MSL U08 5060E)
18 solar roller blinds (RSL U08 4070E)

Workman's access roof window

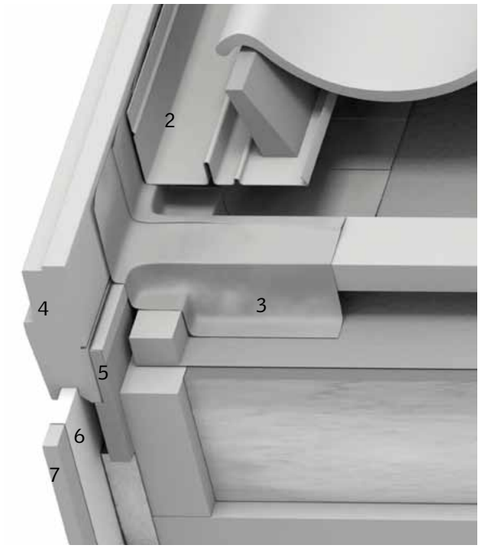
1 safety-laminated triple-glazed top-hung roof window with white polyurethane finish (GTU S08 0073GK)
1 combi flashing for roof window (EKL S08 0021E)
1 installation set (BDX S08 2000)
1 vapour barrier collar (BBX S08 0000L)

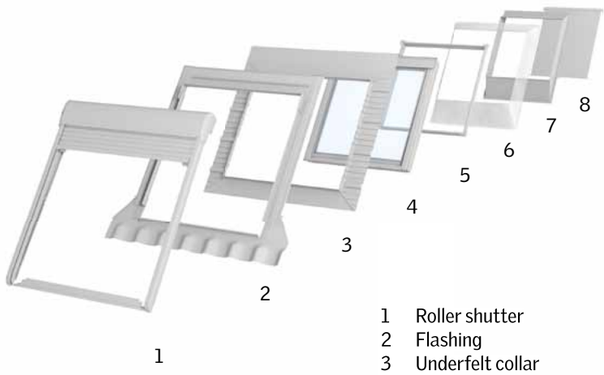


Sun tunnel

1 sun tunnel with rigid tunnel (TLR 014 0124)
1 rigid extension tunnel (ZTR 014 0124)
1 double-glazed roof window with white polyurethane finish (GGU S08 0059) installed over the sun tunnel
1 combi flashing for roof window (EKL S08 0021E)

System solution





1 Roller shutter
2 Flashing
3 Underfelt collar
4 Roof window
5 Insulation collar
6 Vapour barrier
7 Lining
8 Interior sunscreening

Figures
The chart shows the technical characteristics of the VELUX roof windows in relation to heat loss, passive heat gain and daylight. The heat loss (Uw) of the roof windows is influenced by the roof pitch. The heat gain (g-value) and light transmittance (Tau) are not affected by the orientation or roof pitch.

Roof windows with pane --65

Roof pitch	90°	15° (South)
U_w (Heat loss U-value window)	1.0 W/m²K	1.1 W/m²K
U_g (Heat loss U-value pane)	0.5 W/m²K	0.7 W/m²K
g (Heat gain g-value)	0.45	0.45
Tau (Light transmittance)	0.67	0.67

External awning blinds MSL 5060
The performance of the window is improved when the blind is rolled down.

Roof pitch	15° (South)
U_w (Heat loss U-value)	1.1 W/m²K
g (Heat gain g-value)	0.1
Tau (Light transmittance)	0.12

VELFAC facade windows	90°
U_w (Heat loss U-value window)	0.93 W/m²K
U_g (Heat loss U-value pane)	0.72 W/m²K
g (Heat gain g-value)	0.5

Outer walls	
U (Heat loss U-value)	0.095 W/m²K

Roof	
U (Heat loss U-value)	0.084 W/m²K

Floor slab	
U (Heat loss U-value)	0.085 W/m²K

Facts
The primary energy consumption for heating Green Lighthouse has been calculated to 30 kWh/m²/year.

A combination of the following energy sources is expected to supply heating for Green Lighthouse:

35 % solar energy from thermal solar collectors on the roof and storage of solar heat in the ground via a heat pump.

65 % eco-friendly district heating with an approx. 35 % share of renewable energy.

The heat pump increases the utilisation of the district heating by some 30 %.

76 m² of PV solar cells on the roof will cover the need for base lighting, ventilation and pumps.

The house is CO_2 neutral as to the primary energy need.

Building owner:	The Danish University and Property Agency
Strategic partners:	The Municipality of Copenhagen, the University of Copenhagen, the Danish University and Property Agency, VELFAC and the VELUX Group
Architects:	Christensen & Co Architects
Energy design:	COWI
Turn-key contractor:	Hellerup Byg

VELUX A/S
Ådalsvej 99
DK-2970 Hørsholm
Tel. +45 45 16 40 00

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Follow the project, visit
www.velux.com/modelhome2020