

Monday, 23 September 2013

Retrofitting buildings – what about daylight?

IEA SHC Task 50: “Advanced Lighting Solutions for Retrofitting Buildings”

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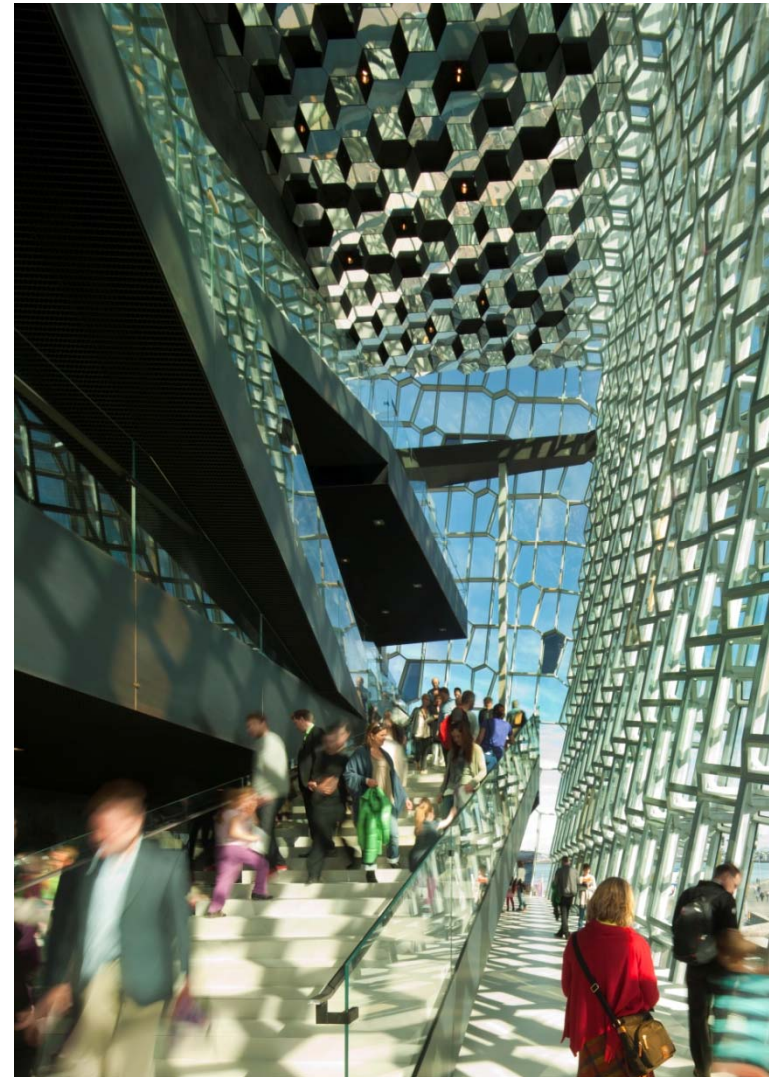
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SUSTAINABILITY DEPARTMENT

The sustainability department
employs 12 engineers and architects

Strong engagement in research
Projects

New scientific knowledge on
sustainability is applied in the **early**
design phases

Sustainable by design



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SUSTAINABILITY DEPARTMENT

RESEARCH

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The urban canyon and building energy use: Urban density versus daylight and passive solar gains

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ABSTRACT

The gap between urban density and building energy use is a complex relation between climate, urban and spatial material and use patterns of urban space and the buildings that constitute them. This study uses the concept of the urban canyon to investigate the effect that the energy performance of low-rise buildings in a north-European context is affected by their context.

This study uses a comprehensive suite of climate-based simulation methods and building simulation methods to describe how their primary factors could guide energy performance of buildings affected by urban density.

It was found that the geometry of urban valleys has significant impact on energy consumption in the range of up to 10% for office and +10% for housing, which shows that the geometry of urban valleys is a key factor in energy use in buildings. It was demonstrated how the reflectivity of urban valleys plays an important, previously under-estimated role, which needs to be taken into account when designing low-energy buildings in dense urban energy environments of urban and building design responses. A detailed understanding of the complex interplay between the temporal and spatial phenomena taking place, ranging from day and night to other variables.

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1. Introduction

One of the most basic and fundamental questions in urban planning and building regulation is how to ensure optimum access to sun, light and fresh air, but for the welfare of individual properties. It is a question of getting the most out of a valuable space. There is potential for negatively impacting conflict between public and private interests. Solar access and the right to light remains connected to the city's social, cultural and health, comfort and quality.

Traditional urban planning has sought to control the proportions of the streets, because the basic priority of building height to add distance between buildings regulates access to light and solar heat. This has led to building regulations usually set at 20:1 height-to-distance ratio that limit the overshadowing that buildings may cause for public spaces and other buildings. A similar geometric relationship of urban space – the urban canyon – has been used in urban planning, to describe the way that urban spaces create special microclimatic conditions. It is a spatial archetype that allows us to link urban knowledge to the concept of energy regulation.

Fields of research, in particular terms, the urban canyon is identified as the length/width ratio of the space between adjacent buildings. Cities develop over time, and the proportions of urban canyons have long lasting impacts on the future energy consequences for the heating, cooling and lighting of the buildings that define them and the environmental quality of the streets, squares, courtyards or gardens that comprise them. Urban development in a urban environment is not building energy use multiply over the years – more than other environmental effect (buildings performance over its lifetime). So, considering that one of the main challenges to architects and engineers in the last decades will be how to improve the energy performance of our buildings and cities, we need to improve our knowledge of both urban and building design through research in the dynamic interplay between climate, urban and building energy use. The passive properties of buildings are likely to play a much more important role in the total energy consumption, as when heat losses are reduced with better insulation, glazing and air tightness.

Urban design can also have a strong effect on building development, forcing an energy savings through efficient transport systems, shared infrastructure and increasing local green and blue that decrease energy footprint. It is an issue on which it is difficult to find a balancing act between those opportunities on the one hand, and ensuring solar access for low-energy buildings and urban

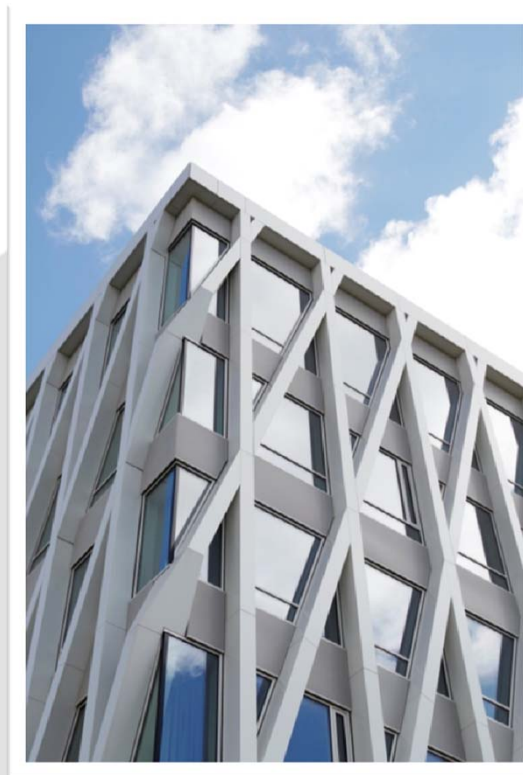
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DESIGN WITH KNOWLEDGE

New research in sustainable building
Published by Henning Larsen Architects

PROJECTS



*“Sustainability is more than
technology and daylight is
more than architecture”*



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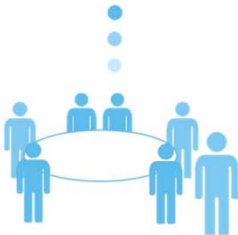
Algreen Arkitekter v. Charlotte Algreen



RETROFITTING WITH DAYLIGHT

WHO BENEFITS AND INFLUENCES?

Authorities



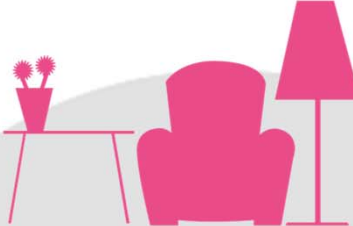
Environment
Social capital

Owners



Market value

Residents

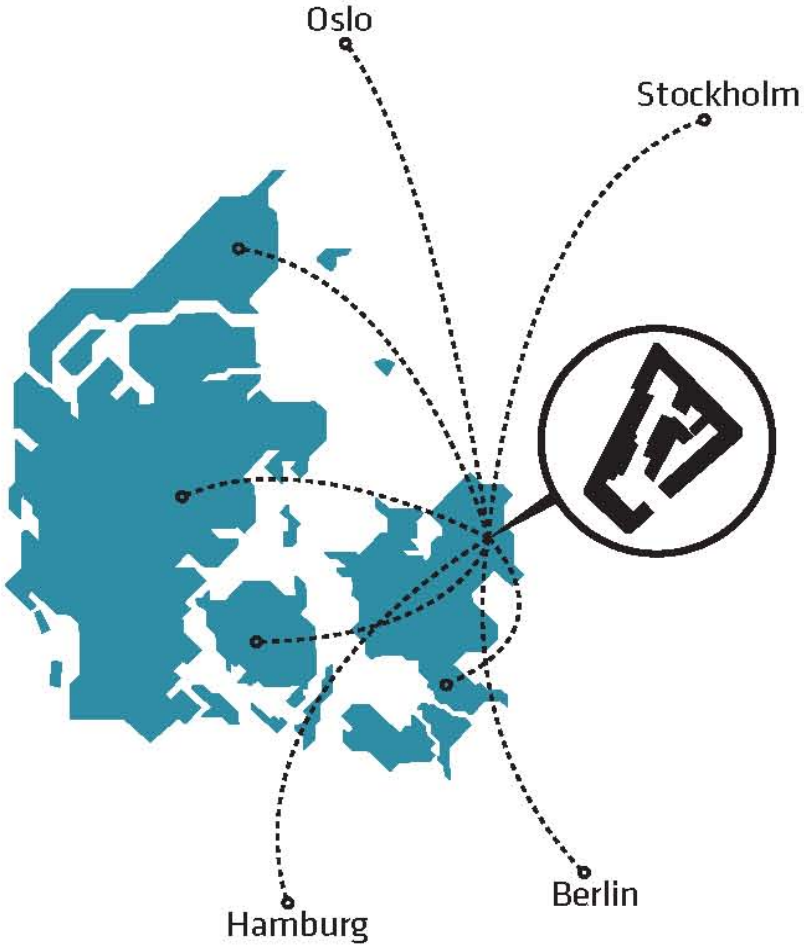


Quality of life



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RETROFITTING WITH DAYLIGHT



URBAN SPACE



RETROFITTING WITH DAYLIGHT

3 implementation levels

1. Urban space
2. Buildings
3. Housing



RETROFITTING WITH DAYLIGHT

URBAN SPACE



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RETROFITTING WITH DAYLIGHT

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“High-density cities and daylight are not necessarily conflicting entities”



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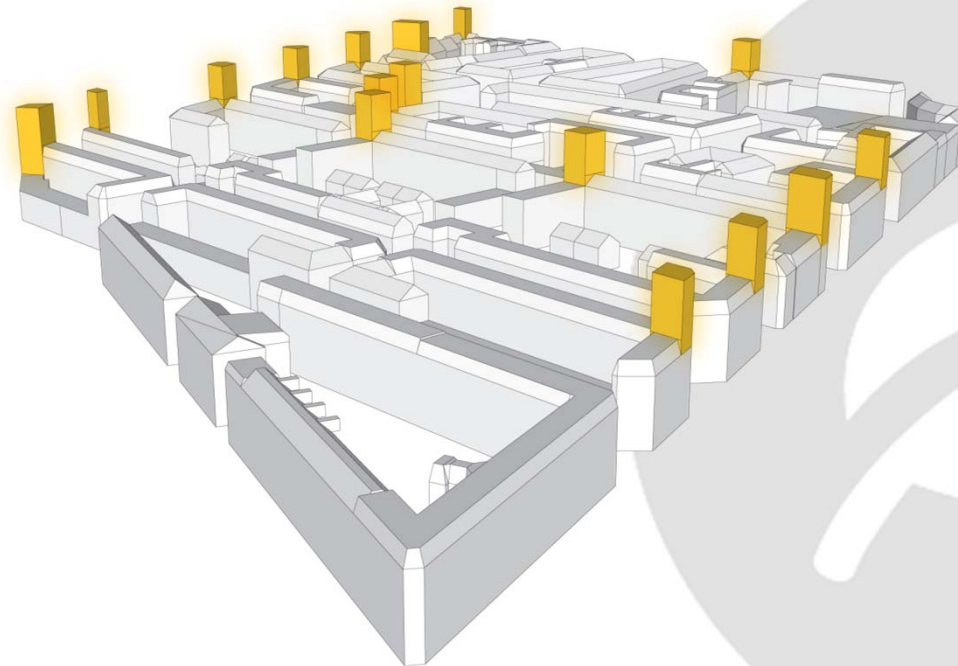


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New building volumes **increase** square meters



RETROFITTING WITH DAYLIGHT

URBAN SPACE



Demolitions increase daylight levels and create new routes and passages

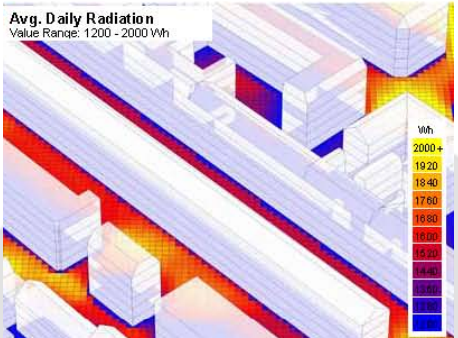
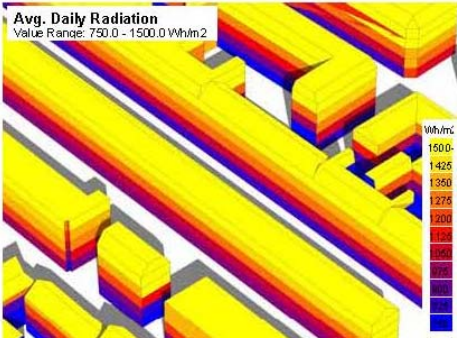
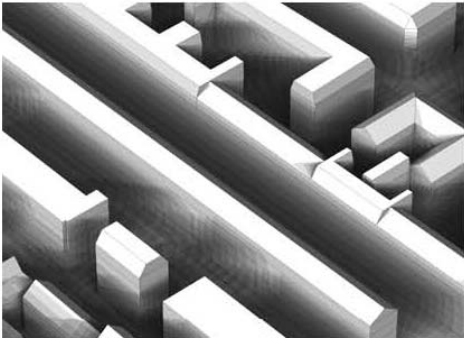


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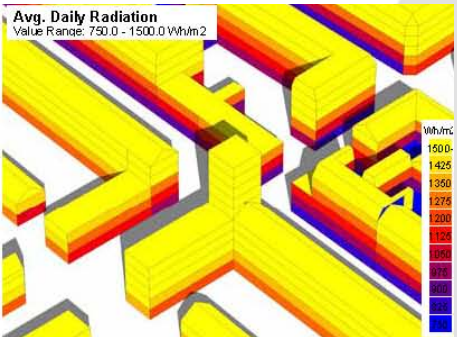
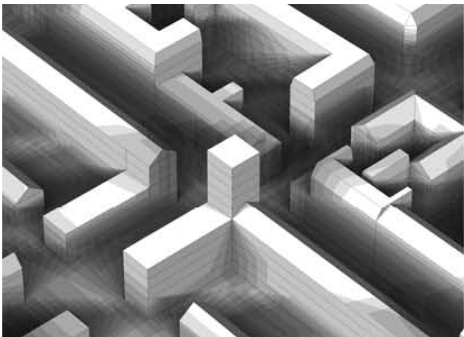
URBAN SPACE



Before



After



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RETROFITTING WITH DAYLIGHT

URBAN SPACE



More m² can increase the sunlight level in urban areas and improve urban spaces

RETROFITTING WITH DAYLIGHT

URBAN SPACES



RESULT

- + 20% increase in square meters
- + 10-15% more sun on the facades
- + 15-20% more sun at ground level
- + Higher quality outdoor areas and green spaces



RETROFITTING WITH DAYLIGHT

BUILDINGS



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RETROFITTING WITH DAYLIGHT BUILDINGS

*“Variation is the key word.
Tall and low buildings distribute
daylight and attract different
residents, stimulating urban life.”*



RETROFITTING WITH DAYLIGHT BUILDINGS

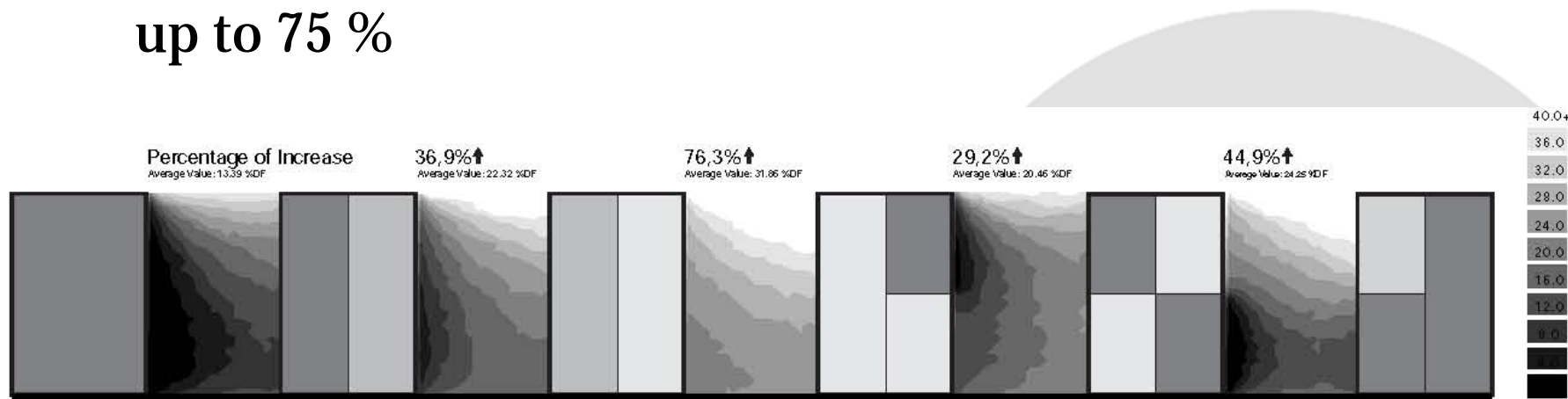


Light-coloured **facade materials** increase the daylight level in urban areas and backyards by up to 75 %



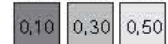
RETROFITTING WITH DAYLIGHT BUILDINGS

Light-coloured **facade materials** increase the daylight level in urban areas and backyards by up to 75 %



Annual illuminance > 10,000 lx in street canyon. Calculated in RADIANCE/DAYSIM (working hours 08-18, contour range 0-40% in steps of 4%). Weatherdata, Copenhagen (*epw).

Facade reflectances

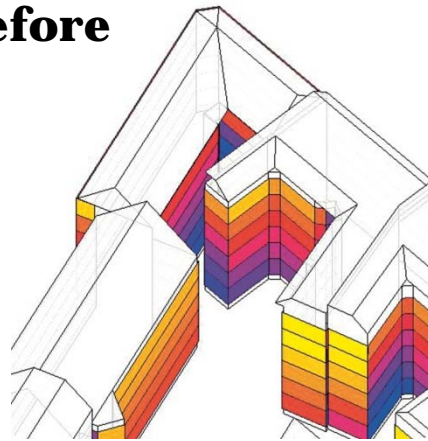


RETROFITTING WITH DAYLIGHT BUILDINGS



Sunlight design increases sunlight and daylight levels in backyards and residences

Before



After



RETROFITTING WITH DAYLIGHT BUILDINGS



RESULT

+ 10-20 % increase in daylight
levels in urban areas and backyards



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RETROFITTING WITH DAYLIGHT

HOUSING



RETROFITTING WITH DAYLIGHT

HOUSING

“The market value of an 80 m² apartment in Copenhagen increases with 20.000 €, with every floor above ground level, simply due to increased daylight”



RETROFITTING WITH DAYLIGHT

HOUSING



6 strategies

1. Insulation and ventilation
2. Installing double glazing windows
3. Installing new windows
4. Increasing window size
5. Insulation, ventilation and increasing window size
6. Insulation, ventilation, increasing window size, and installing a French window



RETROFITTING WITH DAYLIGHT

HOUSING



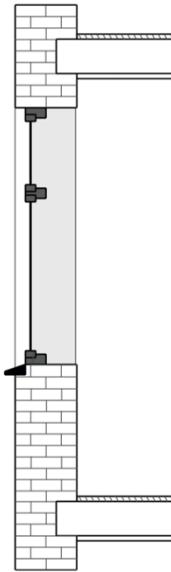
6 strategies

1. **Insulation and ventilation**
2. Installing double glazing windows
3. Installing new windows
4. **Increasing window size**
5. Insulation, ventilation and increasing window size
6. Insulation, ventilation, increasing window size, and installing a French window

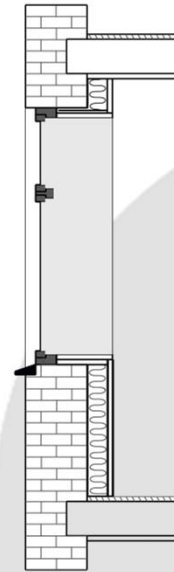
RETROFITTING WITH DAYLIGHT

HOUSING

Strategy 1: means



No insulation
U-value : 1,2 W/m²K
Natural ventilation



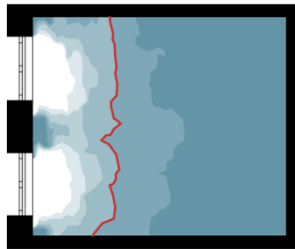
New insulation: 100mm
U-value : 0,27 W/m²K
Mechanical ventilation



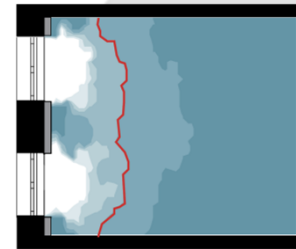
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HOUSING

Strategy 1: results



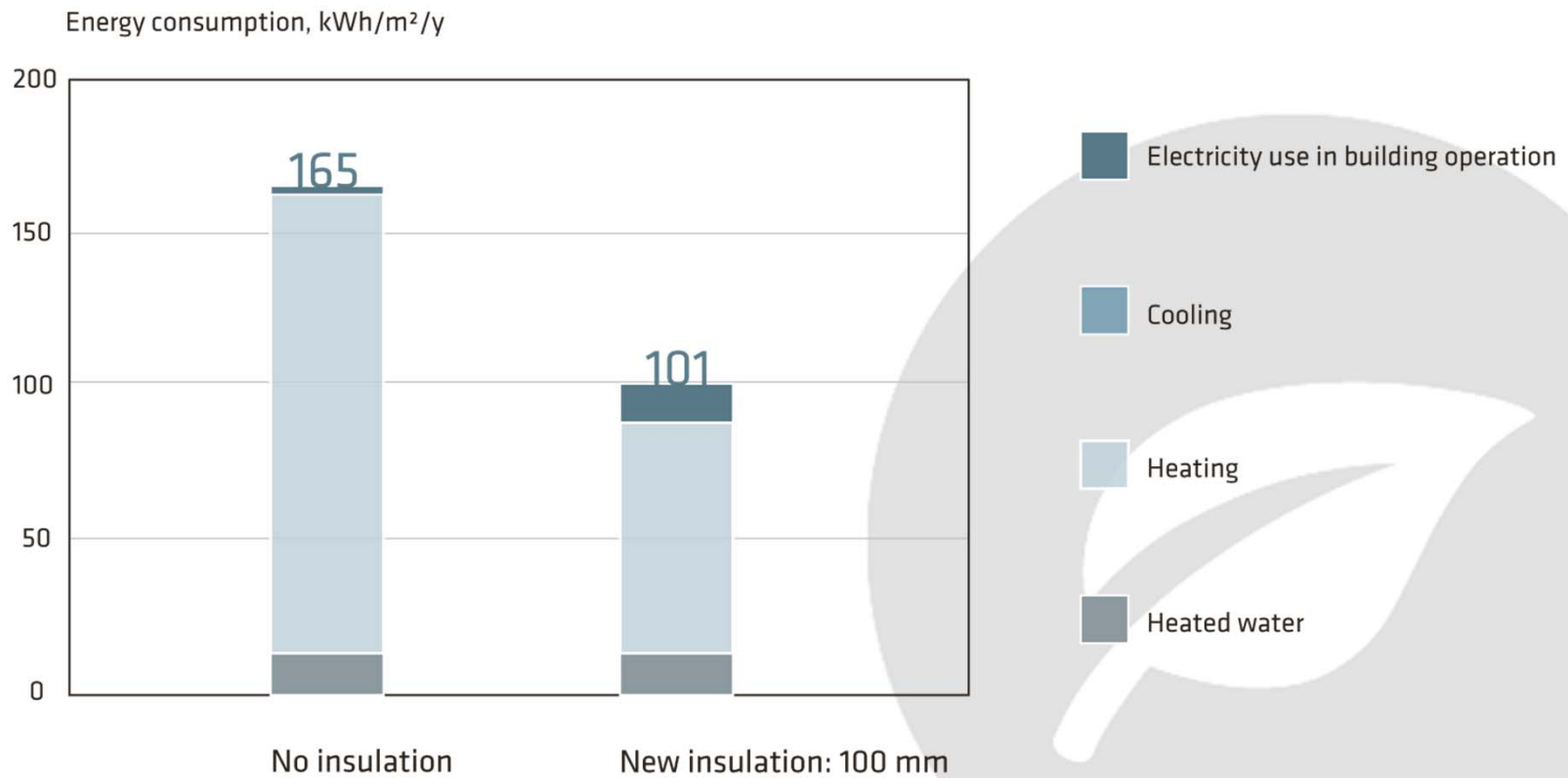
No insulation
DF=1,92%



New insulation: 100mm
DF=1,73%

RETROFITTING WITH DAYLIGHT HOUSING

Strategy 1: results



RETROFITTING WITH DAYLIGHT HOUSING

Strategy 1: results



RESULT

-40% decrease in energy consumption

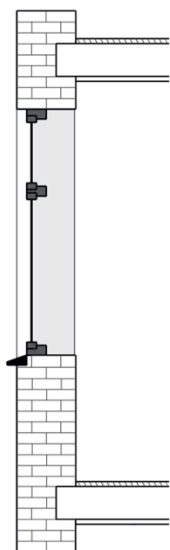
-10% decrease of daylight



RETROFITTING WITH DAYLIGHT

HOUSING

Strategy 4: means



Window

1 layer

Window percentage: 33%

U-value: 4,2 Wm²K

LT: 89%

G-value: 0,85

Proportions of glass: 0,60%



French window

2 layer

Window percentage: 49%

U-value: 1,7 Wm²K

LT: 78%

G-value: 0,68

Proportions of glass: 0,70%



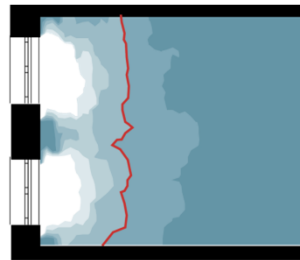
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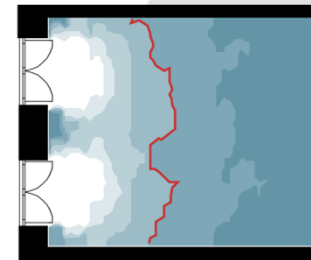
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HOUSING

Strategy 4: results



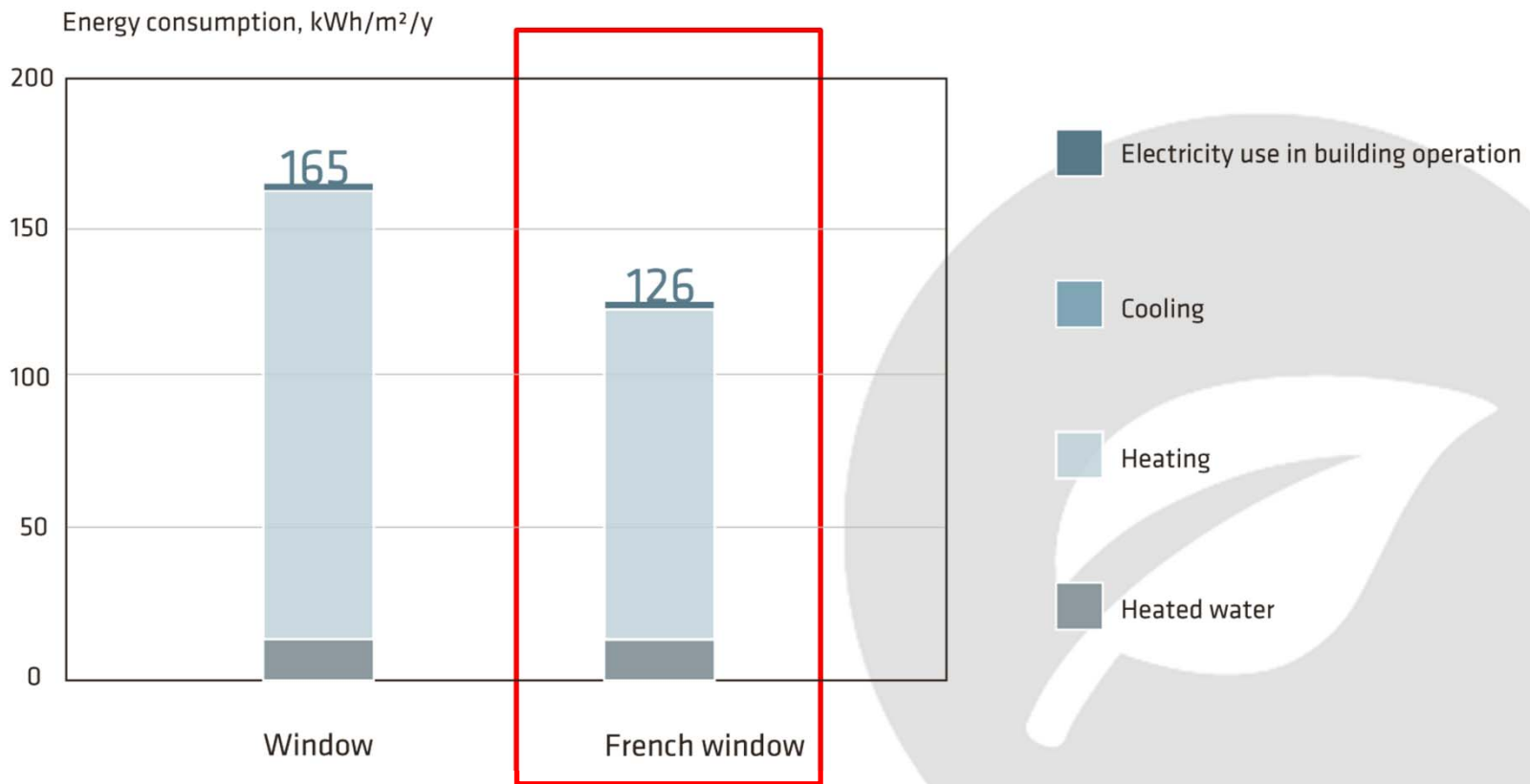
Window
DF=1,92%



French window
DF=2,48%

RETROFITTING WITH DAYLIGHT HOUSING

Strategy 4: results



RETROFITTING WITH DAYLIGHT

HOUSING

Strategy 4: results



RESULT

- **25%** decrease in energy consumption
- + **30%** increase of daylight



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SUSTAINABILITY

“Performance-based architecture addresses the importance of outdoor climate, as well as indoor climate. We need new knowledge and methods to substantiate this”



Thanks

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