Optimal solution for an office development compliant with nZEB IRL in Dublin city centre

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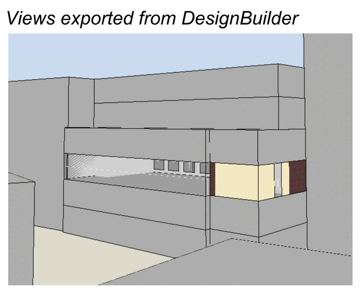
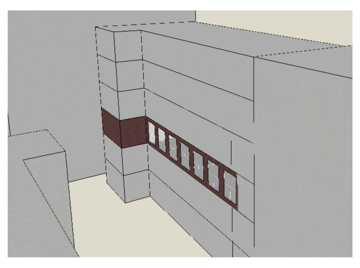
Case Study Introduction

Existing Building - Kildress House - Baseline

Render of existing office development

Views exported from DesignBuilder





Current situation

Kildress House is an ongoing office development located in Dublin City Centre. The building is six storeys high and a total of 2065 m² area. Most of the external walls are made of brick except the stone tiles facade in the North-East side. One of the main characteristics of the project is the two partially or fully glazed facade facing North-East and South-West.

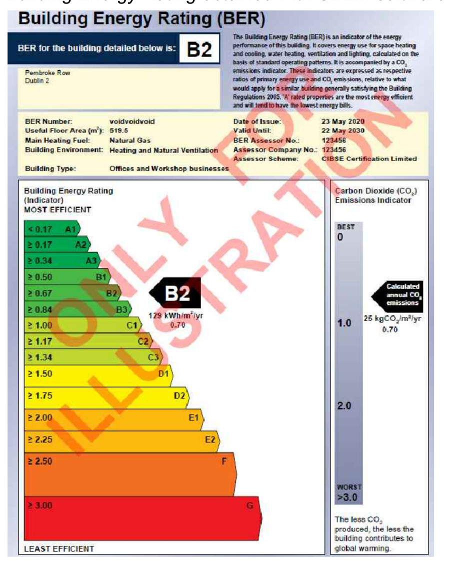
The building requires to be compliant with the Irish Building Regulations, in particular, with Part L 2018 and, with nZEB Standards for Non-Residential buildings. To achieve these requisites it is necessary to reduce the energy consumption of the building without worsening the indoor environmental quality of the office.

The aim of this project is to find the optimal strategy to comply with the two aspects named above. For this reason, an initial analysis has been performed taking Building Regulation - Part L 2008 as a baseline.

Once the issues were identified, different approaches have been pursued to find the optimal solution. This academic poster explains the final strategy obtained after the analysis.

Issues

Building Energy Rating obtained with SBEM software



CPC, EPC & RER provided by SBEM software

Primary Energy Consumption, CO2 Emissions, and Renewable Energy Ratio

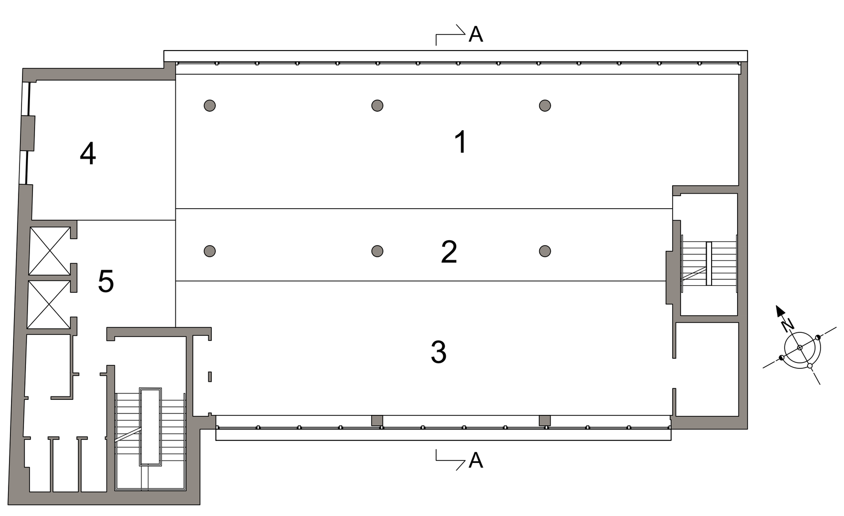
The compliance criteria in the TGD-L have not been met.

Calculated CO2 emission rate from Reference building	10.6 kgCO2/m2.annum
Calculated CO2 emission rate from Actual building	25 kgCO2/m2.annum
Carbon Performance Coefficient (CPC)	2.35
Maximum Permitted Carbon Performance Coefficient (MPCPC)	1.15
Calculated primary energy consumption rate from Reference building	55.5 kWh/m2.annum
Calculated primary energy consumption rate from Actual building	129.2 kWh/m2.annum
Energy Performance Coefficient (EPC)	2.33
Maximum Permitted Energy Performance Coefficient (MPEPC)	1
Renewable Energy Ratio (RER)	0
Minimum Renewable Energy Ratio	0.2

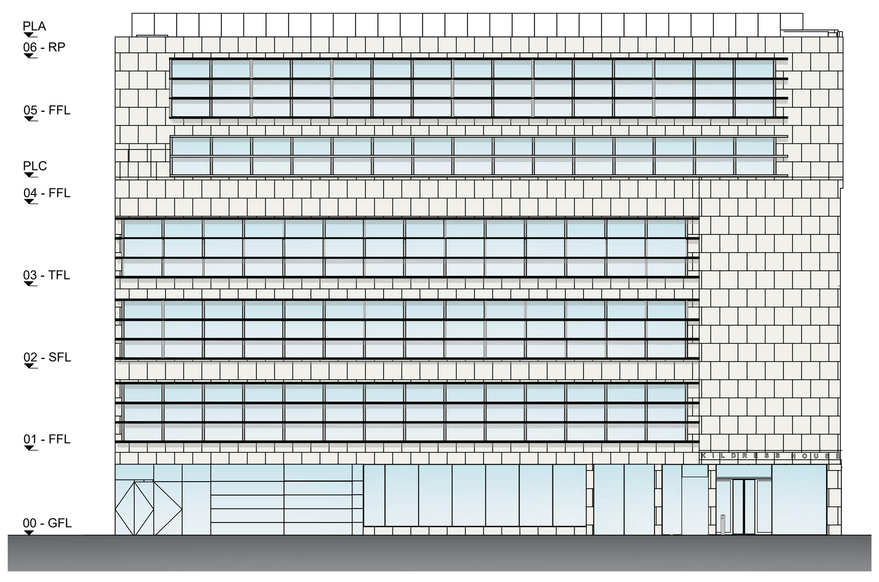
DesignBuilder is the software used to undertake the analysis. It offers two interfaces: SBEM and EnergyPlus. They analyse different energy aspects of a building.
The study reveals that initially the building doesn't comply with Part L 2018 and the BER is B2.
In addition, because it was decided to use only passive cooling systems, it has been observed that there is an exceed of solar gains and overheating what means a bad thermal performance.

Optimal Strategy

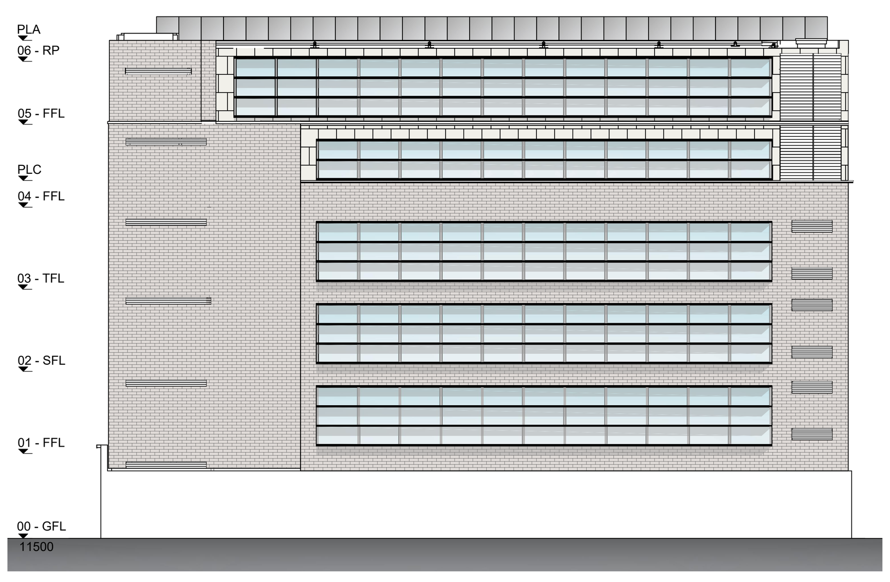
Proposed second floor plan and zones (s. 1:200)



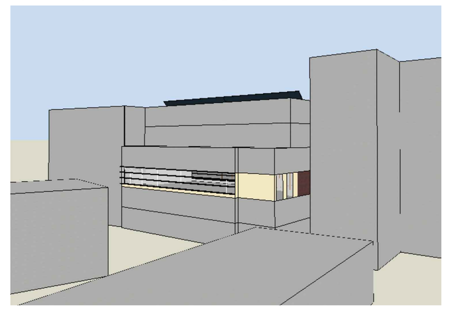
Proposed front elevation treatment (s. 1:200)

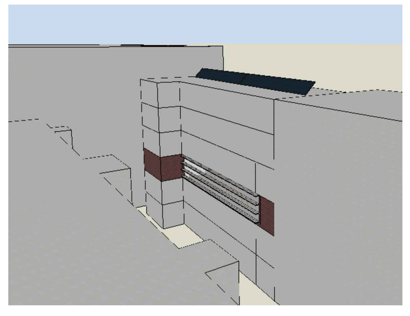


Proposed rear elevation treatment (s. 1:200)



Views exported from DesignBuilder

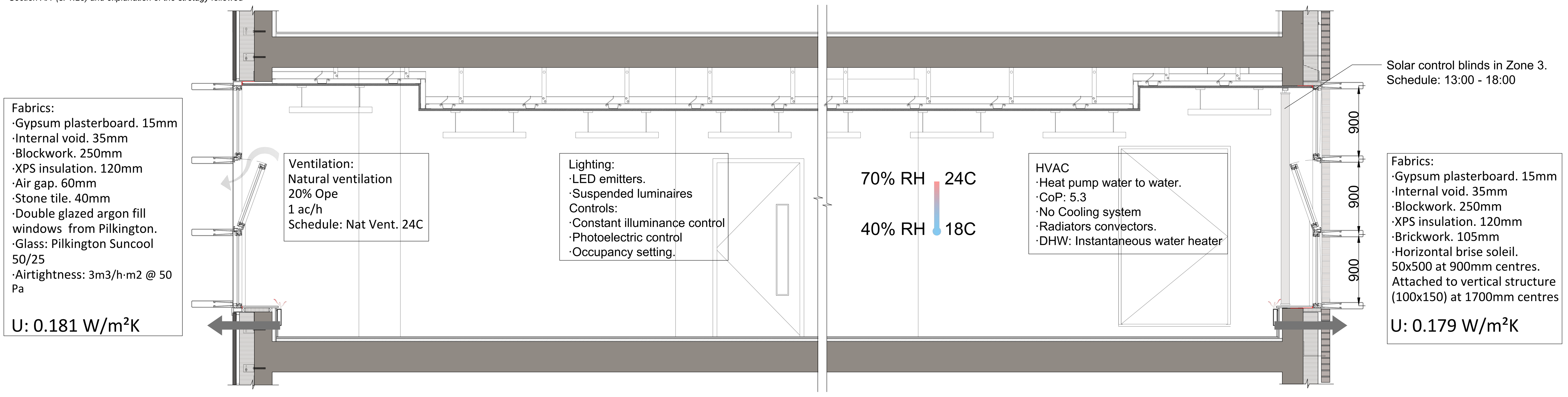




The proposed elevation treatment involves the introduction of horizontal brise soleils to reduce the solar gains and a proportion of 80% glass and 20% wall in zones 1 and 3.

60m² of photovoltaic panels have been placed on the roof, South west facing, at 45º

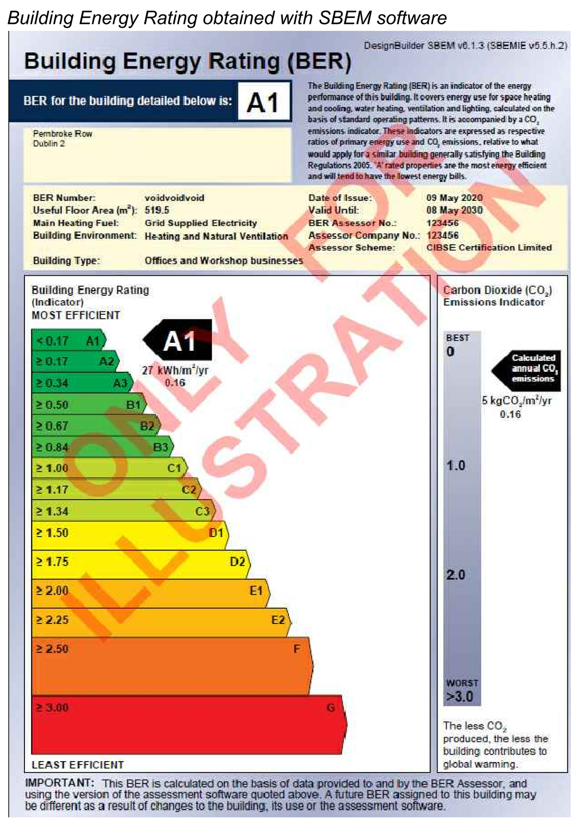
Section AA' (s. 1:25) and explanation of the stretagy followed



Research Findings

BR PART L Compliant

Building Energy Rating obtained with SBEM software



CPC, EPC & RER provided by SBEM software

Primary Energy Consumption, CO2 Emissions, and Renewable Energy Ratio

The compliance criteria in the TGD-L have been met.

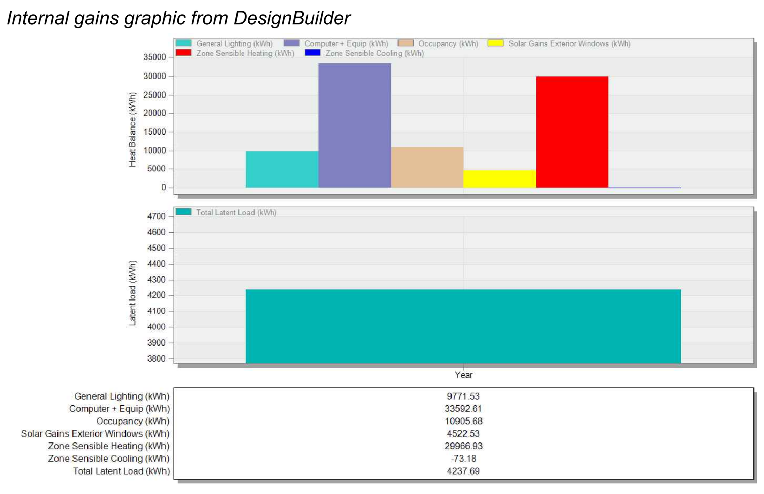
Calculated CO2 emission rate from Reference building	9.9 kgCO2/m2.annum
Calculated CO2 emission rate from Actual building	5.3 kgCO2/m2.annum
Carbon Performance Coefficient (CPC)	0.53
Maximum Permitted Carbon Performance Coefficient (MPCPC)	1.15
Calculated primary energy consumption rate from Reference building	51.9 kWh/m2.annum
Calculated primary energy consumption rate from Actual building	26.8 kWh/m2.annum
Energy Performance Coefficient (EPC)	0.52
Maximum Permitted Energy Performance Coefficient (MPEPC)	1
Renewable Energy Ratio (RER)	0.51
Minimum Renewable Energy Ratio	0.1

The strategy followed has achieved an A1 in the BER. and a CO_2 of 5 $kgCO_2/m^2/yr$.

In terms of energy and carbon performance coefficient and renewables energy ratio, the solution has suceeded considerably the expectations, obtaining an CPC of 0.53<1.15, a EPC of 0.52<1 and an RER of 0.51<0.1. Therefore, the optimal strategy complies with the Building Regulations Part L 2018.

Solar Gains

Internal gains graphic from DesignBuilder



Solar gains analysis from SBEM

Solar Gain in Summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
02_Second floor - Staircase 1	N/A	N/A
02_Second floor - Office 5	N/A	N/A
02_Second floor - Office 3	NO (-42.5%)	YES
02_Second floor - Office 2	N/A	N/A
02_Second floor - Office 1	NO (-52.9%)	NO
02_Second floor - Toilets	N/A	N/A
02_Second floor - Lifts	N/A	N/A
02_Second floor - Office 4	NO (-61.9%)	NO
02_Second floor - Comms Room	N/A	N/A
02_Second floor - Staircase 2	N/A	N/A

The graphic on the left shows that solar gains is the area contributing the least to the energy consumption.

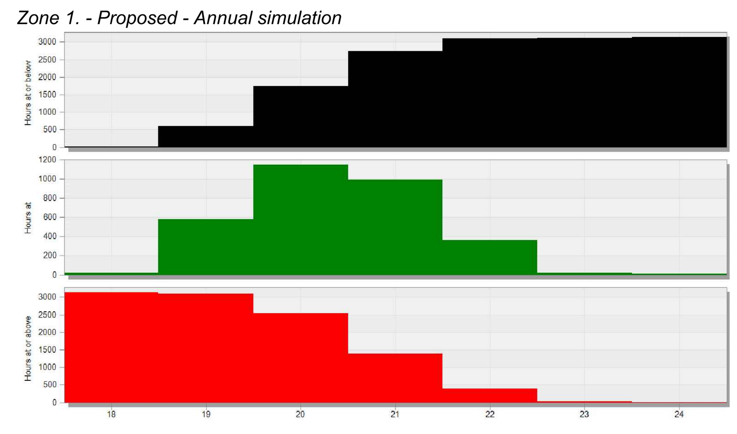
A window glass with a low solar transmittance & light factor and the addiction of a brise soleils in the main facades have permitted this reduction.

This fact has implied the decrease of daylight. To comply with the minimum Dalylight Factor, the main facades have been designed with the following glaze proportion: 80% of glazing and 20% of wall.

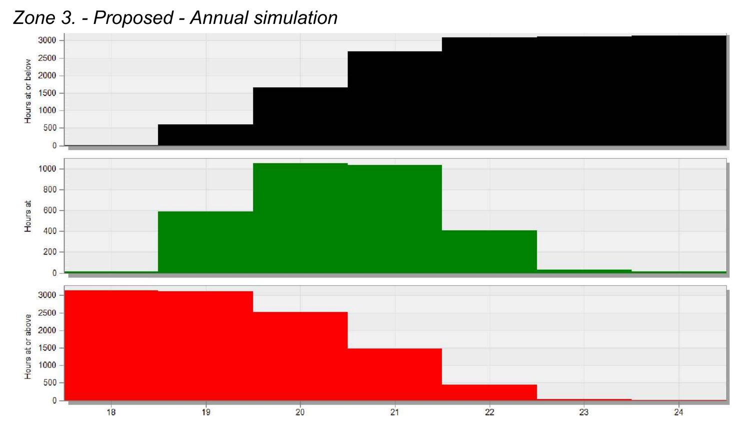
SBEM also has calculated the solar gains of the zones with windows. All of them are positive.

Overheating

Zone 1. - Proposed - Annual simulation



Zone 3. - Proposed - Annual simulation



ASHRAE sets up a maximum of 5% of working hours above 25ºC and a 1% of working hours above 28ºC in order to avoid overheating.

The following graphics reflect the final results obtained after applying the optimal strategy.

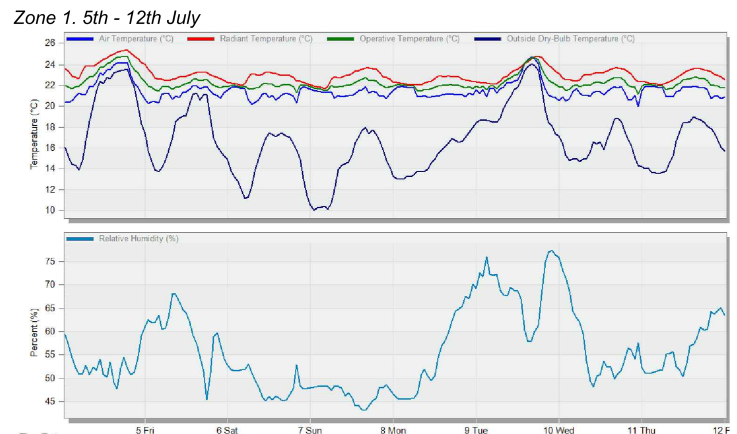
Zone 1:
The minimum temperature this zone will reach is 18ºC.

During 11.5 working hours, the office will achieve a temperature above 24ºC

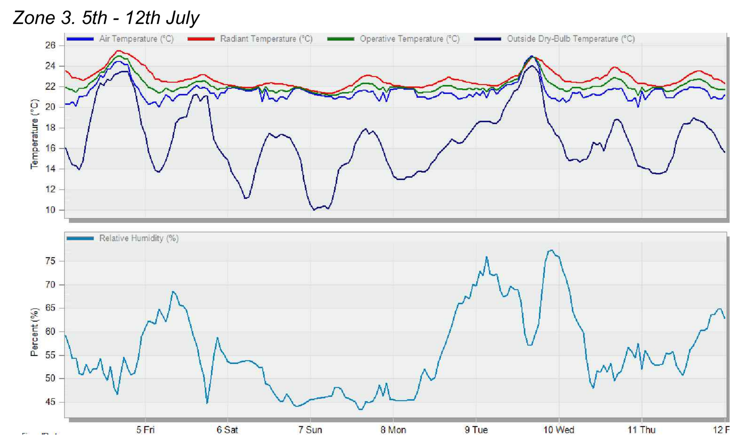
Zone 3:
The minimum temperature this zone will reach is 18ºC.

During 12.5 working hours, the office will achieve a temperature above 24ºC

Zone 1. 5th - 12th July



Zone 3. 5th - 12th July



A closest analysis has been carried out to check if the strategy doesn't overstep the 25ºC. For that, it has been studied the worst-case scenario. This would be during the week 5th to 12th July.

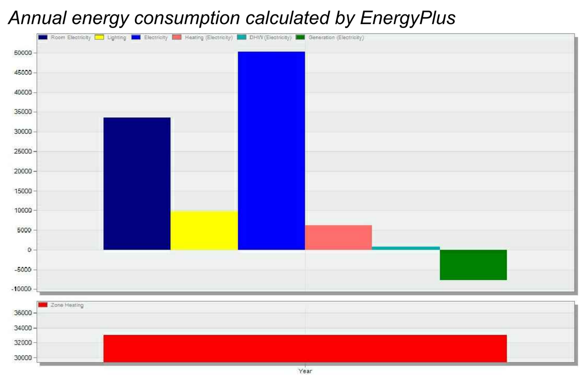
In zone 1, the highest temperature reached would be 24.72ºC the 5th July.

In zone 3, the highest temperature reached would be 24.98ºC also the 5th July.

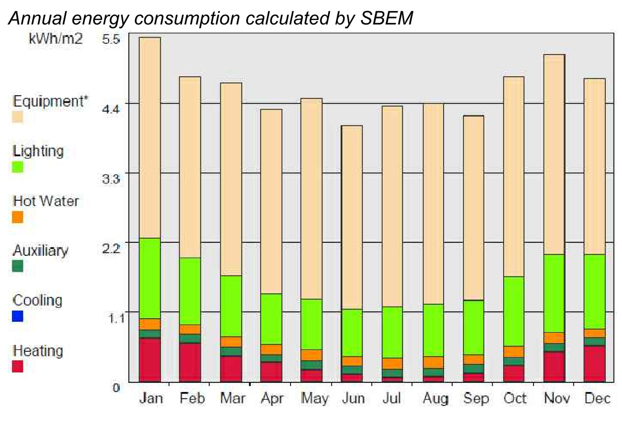
None of the zones would achieve a temperature above 25ºC

Energy Consumption

Annual energy consumption calculated by EnergyPlus



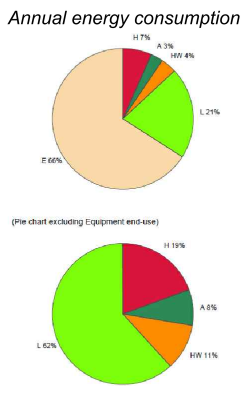
Annual energy consumption calculated by SBEM



Both graphics on the very left hand side show similarities in relation to area proportions. Most of the energy is consumed by computers and equipment or its equivalence in EnergyPlus: Room electricity and general electricity. EnergyPlus graphic indicates as well the contribution of the photovoltaic panels.

There is only heating load. The absence of cooling load is due to the decision of using natural procedures to cool the office such as natural ventilation, no active cooling or a reduction of internal gains.

Annual energy consumption

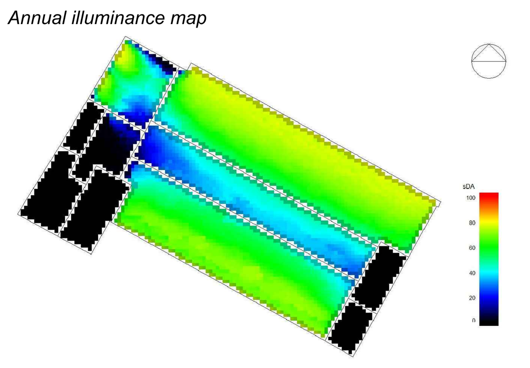


Charts on the centre reflect the proportion of energy used by each area.

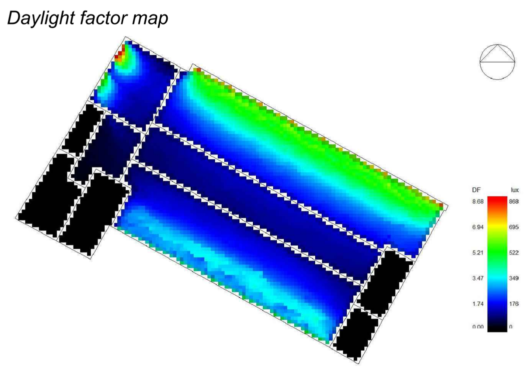
When excluding the equipment, the area consuming the most energy is lighting, then heating and finally hot water.

Daylighting

Annual illuminance map



Daylight factor map



BREEAM Health and Wellbeing Credit HEA 01

Block	Zone	Floor area (m2)	Min DF (%)	Uniformity ratio (Min / Avg)	Average Daylight Factor (%)	Area Adequately Daylit (m2)
02_Second floor	Staircase 1	24.6	0.00	0.00	0.0	0.0
02_Second floor	Office 5	22.1	0.09	0.20	0.5	0.0
02_Second floor	Office 3	132.7	0.60	0.27	2.2	0.0
02_Second floor	Office 2	81.9	0.66	0.62	1.1	0.0
02_Second floor	Office 1	158.7	1.21	0.34	3.5	158.7
02_Second floor	Toilets	24.4	0.00	0.00	0.0	0.0
02_Second floor	Lifts	9.5	0.00	0.00	0.0	0.0
02_Second floor	Office 4	36.8	0.64	0.30	2.1	36.8
02_Second floor	Comms Room	12.4	0.00	0.00	0.0	0.0
02_Second floor	Staircase 2	16.4	0.00	0.00	0.0	0.0
Total		**519.6**				**195.5**