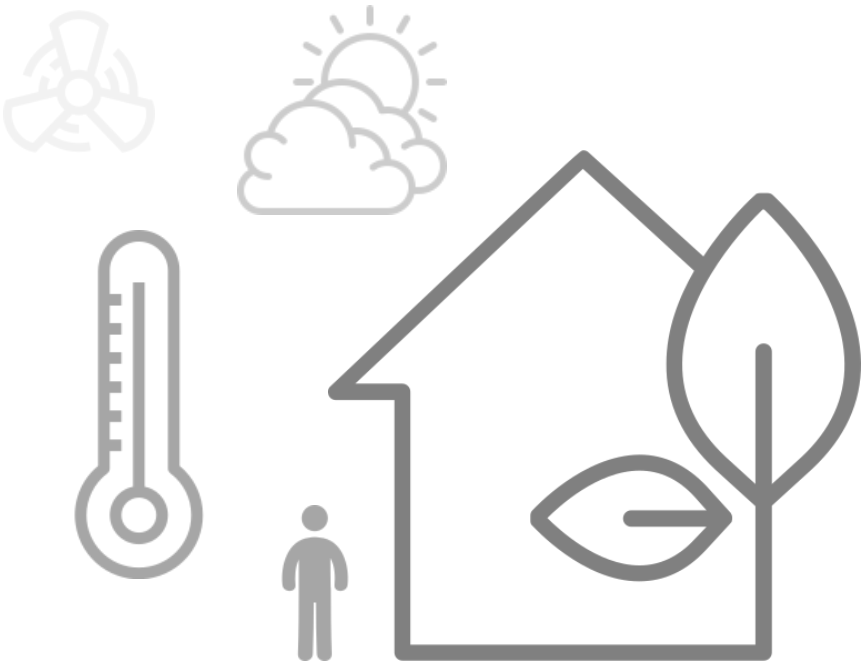
TECHNICAL ENVIRONEMENT SYSTEM

Politecnico di Milano, 2018



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Summary

Illustrations

1. Project Description

In this project we will try to study a commercial building using Sketchup and OpenStudio to calculate the yearly heating and cooling consumption of the building. We will first study a base case as a referential. Next, a parametric study, should be conducted in order to investigate the effect of changing the position and wall characteristics on the building's yearly energy consumption.

We will perform the simulation for three different cities and three different walls, and the result that we will compare will be the yearly energy consumption.

2. Building Description

Spaces

We decided to draw a two-storey building, with a L shape. With 2 open spaces, 2 conference room and one big open space with an open staircase.

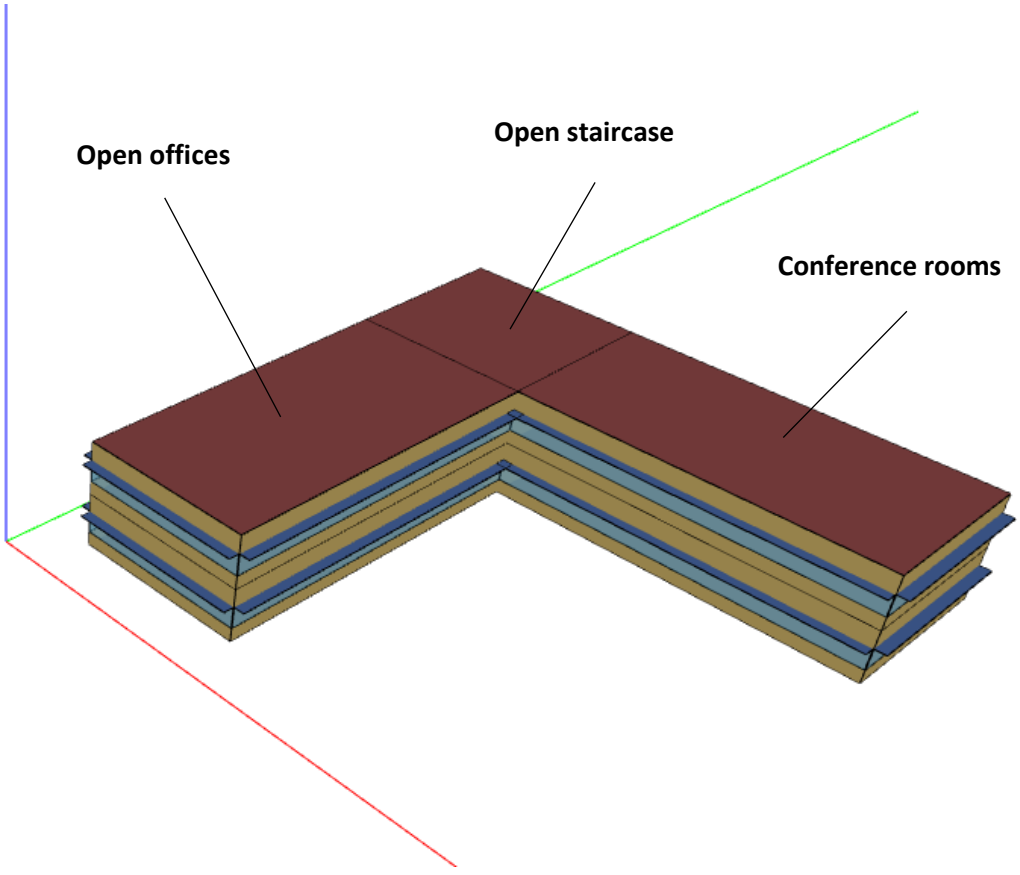


Figure 1 - 3D Model of the buidling

Transparency and shading

We choose to put 40% of transparency for the façades, except on the north with 20%. We put shading on surfaces that are not facing north, and we used the default value.

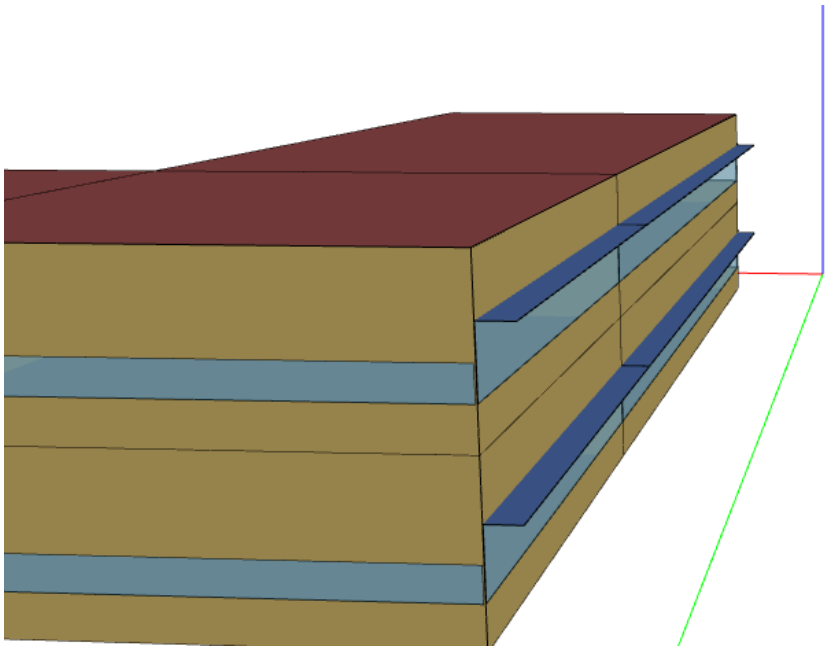


Figure 2 - Difference of transparency ratio and shading beetween the North facade and the other facades of the building

Thermal zones

We decided to define 3 thermal zones, one for each use. The spaces, even if they are on 2 different levels, will be connected for the heating and cooling system.

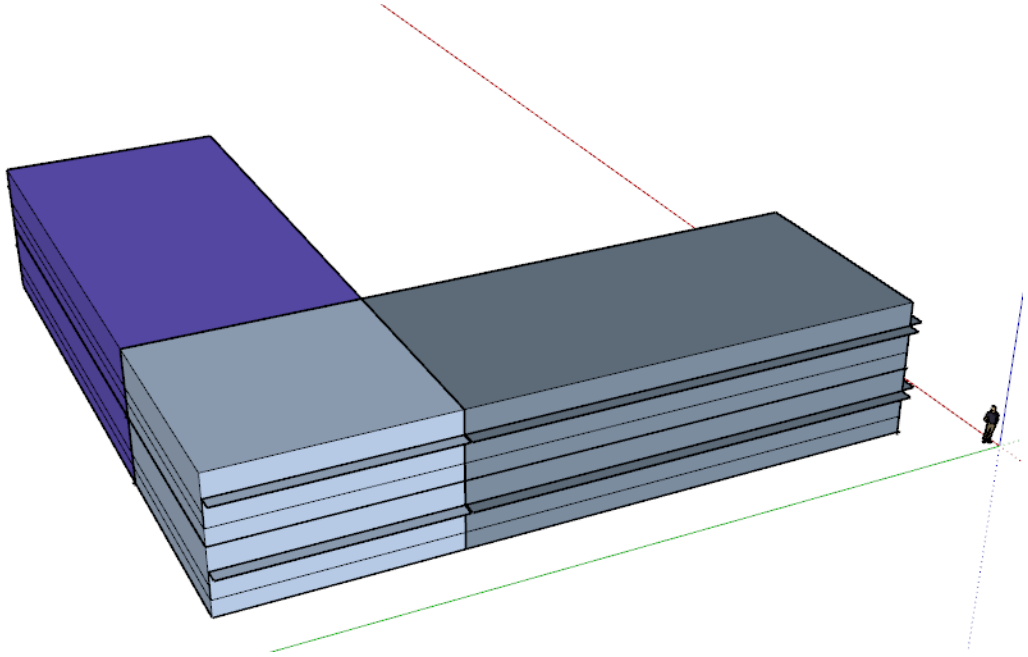


Figure 3 - Thermal zones of the project

3. Basic Scenario

The basic scenario will be the default one, with the construction set “CZ1 – Office” and the exterior wall “ASHRAE 189.1 2009 ExtWall Mass ClimateZone 1”. The city choosed for this basic scenario is Piacenza (Italy).

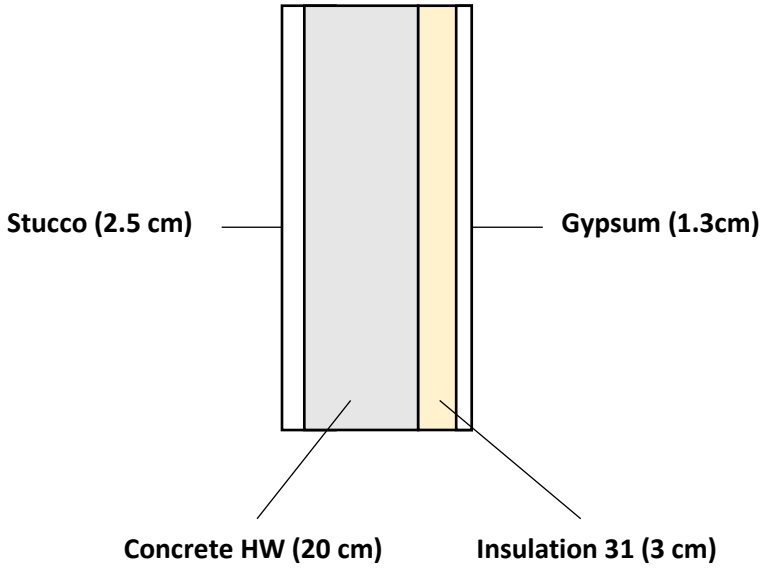


Figure 4 - Exterior Wall composition for the basic Scenario

4. Walls variations

To study the role and the impact of the different materials of the walls we decided to design 2 other walls and the compare the results of the simulation with the basic scenario.

We decided to use bricks and a biosourced insulation material from France called “Biofid Trio” composed of a mix of cotton, flax and hemp fibers.

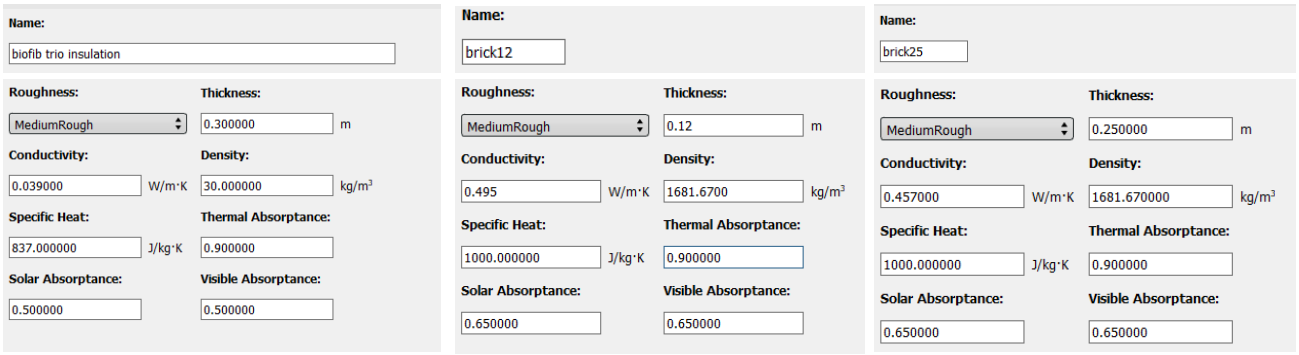


Figure 5 - Definition of new materials in OpenStudio

Caratteristiche generali	
Lunghezza	25 cm
Larghezza	12 cm
Altezza	6 cm
Pezzi per pacco	176
Peso dell'elemento	3 Kg
Peso pacco	532 Kg

Spessore muratura	12 cm	25 cm
Pezzi al m²	58	118

Figure 6 - Technical caracteristics of bricks

CARACTÉRISTIQUES TECHNIQUES

Composition	92 % Fibres de chanvre Fibres de coton Fibres de lin, 8 % Liant PE								
Densité	30 kg/m³								
Epaisseur	45 mm	60 mm	80 mm	100 mm	120 mm	145 mm	160 mm	180 mm	200 mm
Résistance thermique (R)	1,15	1,50	2,05	2,55	3,05	3,70	4,10	4,60	5,10
Perméabilité à la vapeur d'eau (Sd)	0,07	0,09	0,12	0,15	0,18	0,21	0,24	0,27	0,30
Capacité thermique	1800 Cp								
Conductivité thermique massique	λ 0,039 (ACERMI)								
Coefficient de résistance à la diffusion de la vapeur d'eau	≤2 µ								
Réaction au feu	F / Non testé								
Température maxi d'utilisation	120 °C								

Figure 7 - Technical caracteristics of "Biofib Trio"

For the first wall (Wall 1) we decided to put the bricks in the length, so the thickness is 12 cm, and we used 30 cm of insulation (100+200 mm rolls).

For the second wall (Wall 2) we decided to put the bricks in the shortest lenght, so the thickness is 25cm, and we used 15 cm of insulation.

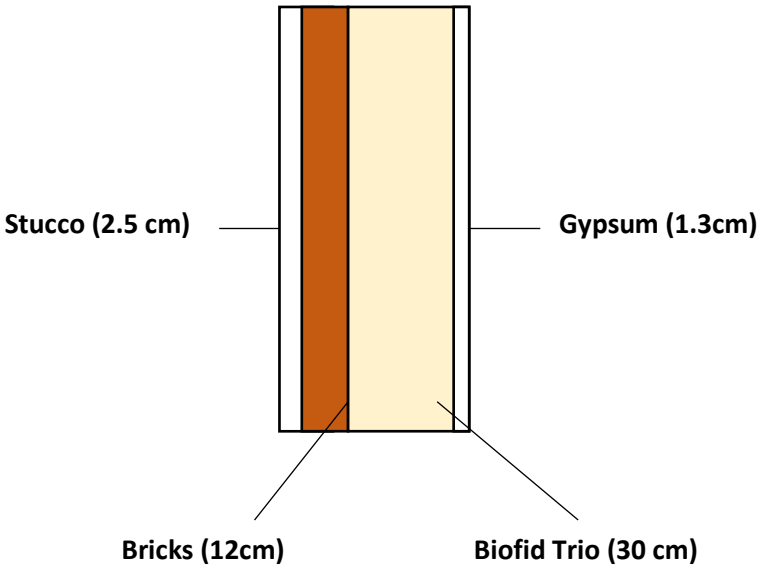


Figure 8 - Exterior Wall 1 composition

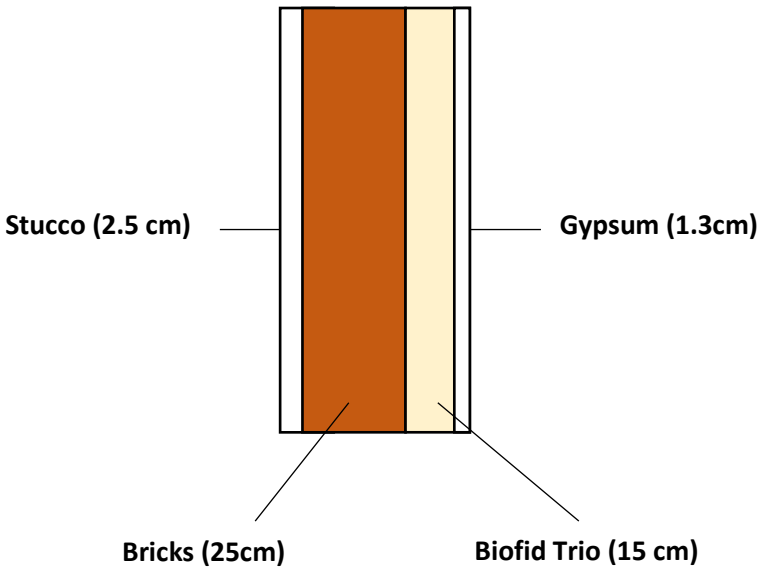


Figure 9 - Extorior Wall 2 composition

Choice of the different geographical situations

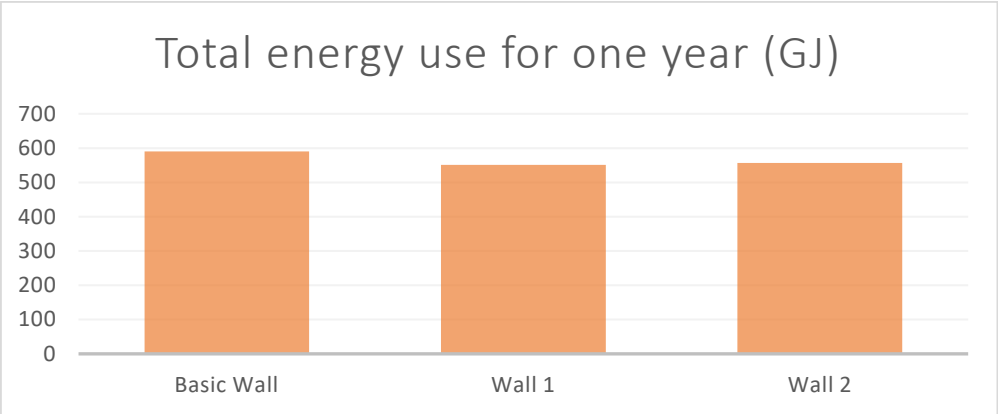
To study the effect of the location of the building on its yearly energy consumption, we decided to run a simulation for the Wall 1 in the tree cities of: Piacenza (Italy), Catania (South of Italy) and Amsterdam (Netherlands).

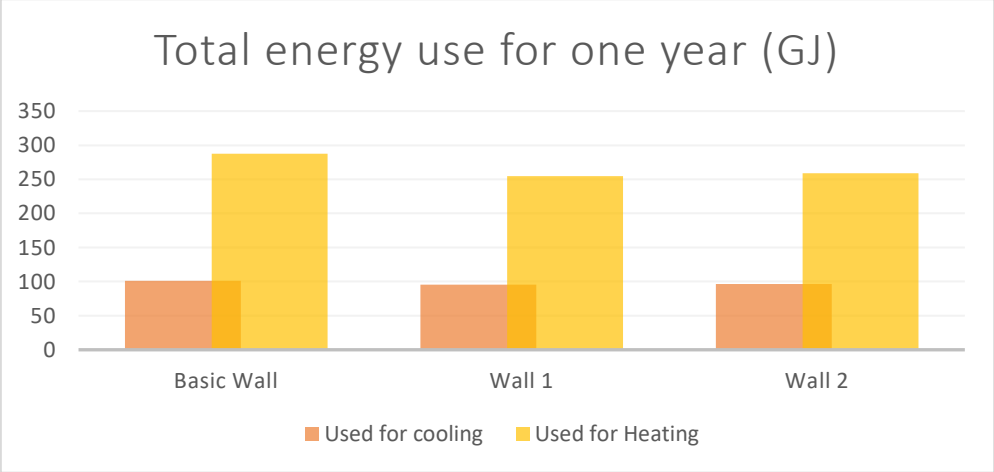
5. Results:

Wall study

First, let's look at what the impact of the change of wall composition. We calculated the consumption of the building for the 3 different walls, for the city of Piacenza.

Wall	Total site energy use (GJ)	Energy used for cooling (GJ)	Energy sed for Heating (GJ)
Basic Wall	589,87	101,32	287,77
Wall 1	550,84	95,4	254,67
Wall 2	556,23	96,39	259,07



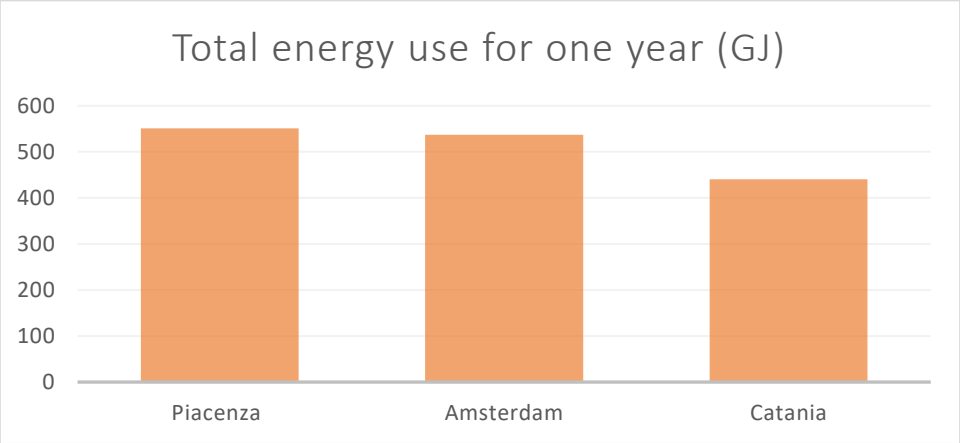


As we can see the difference is not big (from 590 GJ to 550 GJ for the more efficient wall (Wall 1). It can maybe explain by the fact that glass as a major impact on the conductivity of the all façade, and that the effect of the change of composition of the opaque part as a minor effect when the transparent part is put in the calculation.

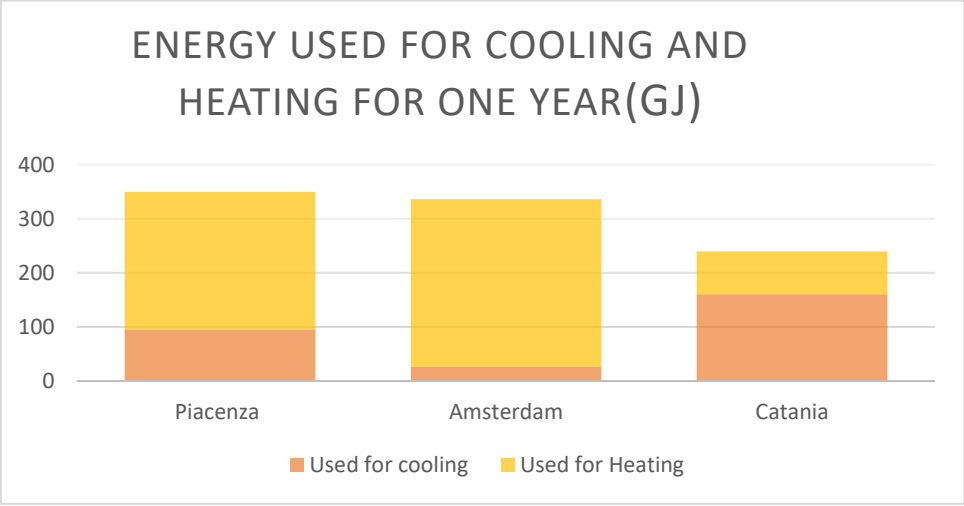
But still we can see a difference from the basic case and the wall propositions. The first solution is the best. And it's interesting to see that the difference between the wall 1 and the wall 2 is not that big. Just changing the direction of the bricks and reducing by 2 the quantity of insulation doesn't modify the consumption that much. To choose wich solution is better we could for example analyse the price of each solution or the structural solutions that are choosed to design the building. But if we look only at the thermic parameter, the 2 solutions are almost equivalent, with solution 1 a little bit better.

Geographical Study

In this part we analyse the results for the energy consumption in 3 different cities. Piacenza, Amsterdam and Catania (South of Italy)



As we could imagine, when the building is in Catania, in the south of Italy, the energy consumption is smaller. But what can seem surprising is the fact that the energy consumption is higher for Piacenza than for Amsterdam. To understand this, we need to look at the repartition on the energy use between cooling and heating.



What is interesting in these results is to see that the energy consumption of the building in Piacenza is higher than in Amsterdam. It's because during the summer we have to cool more the building in Piacenza than in Amsterdam, and this quantity is more than the difference of energy used to heat the building in Winter.

For Catania it's clear that the quantity of energy to cool the building will be bigger than the quantity of energy to heat the building during Winter. It shows that Catania is not

6. Impact of the Schedule

To see the impact of the Schedule and the use of spaces, we decided to simulate the closure of the 2 conference rooms. To do so, we simulate the fact that the 2 spaces are completely closed, with 0 persons and no light.

We created a new Space Type called “CONFERENCE CLOSE” with inside a Schedule set called “CONFERENCE ROOMS CLOSED”. We then changed the number of people, the people activity and the lighting.

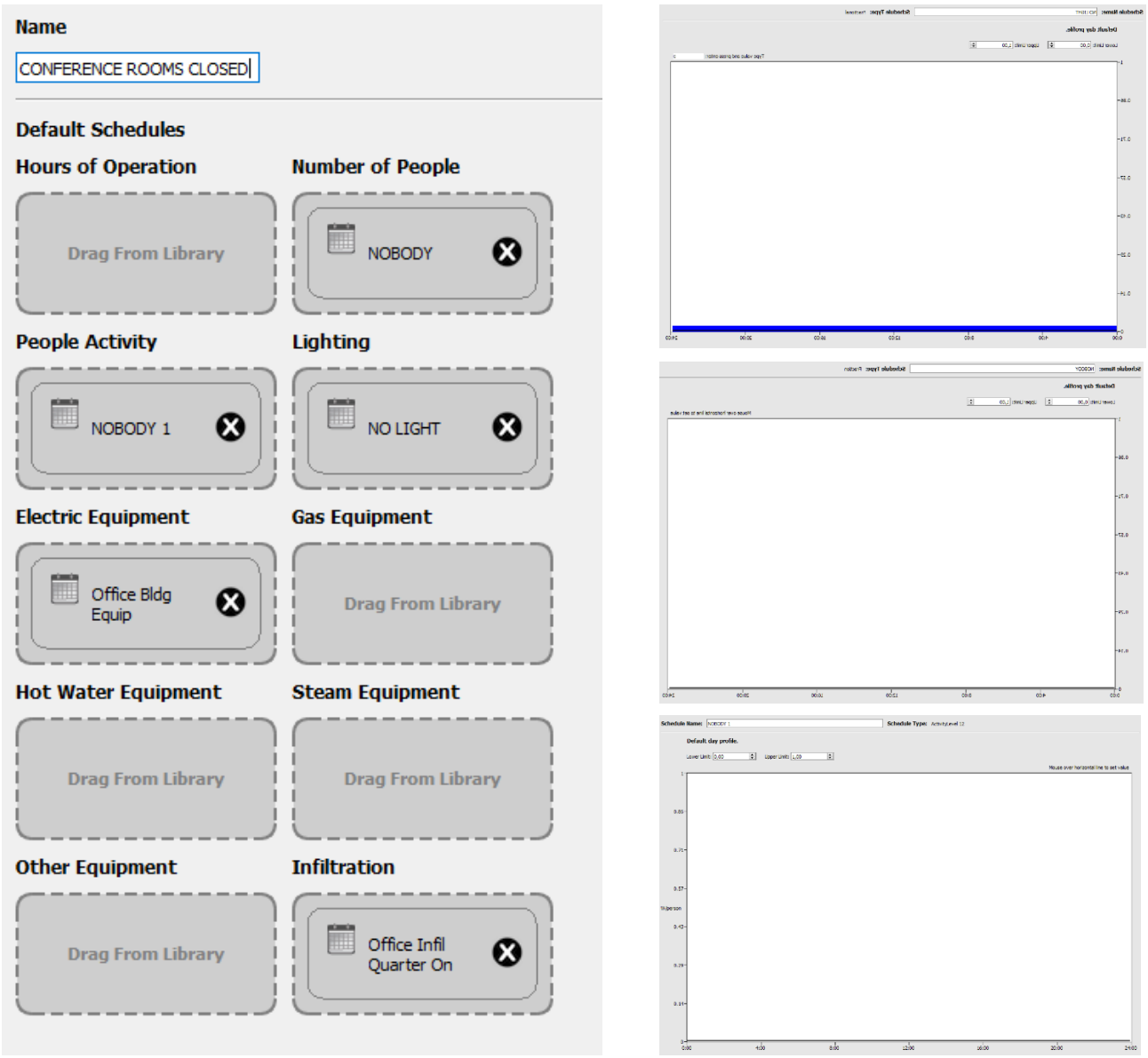
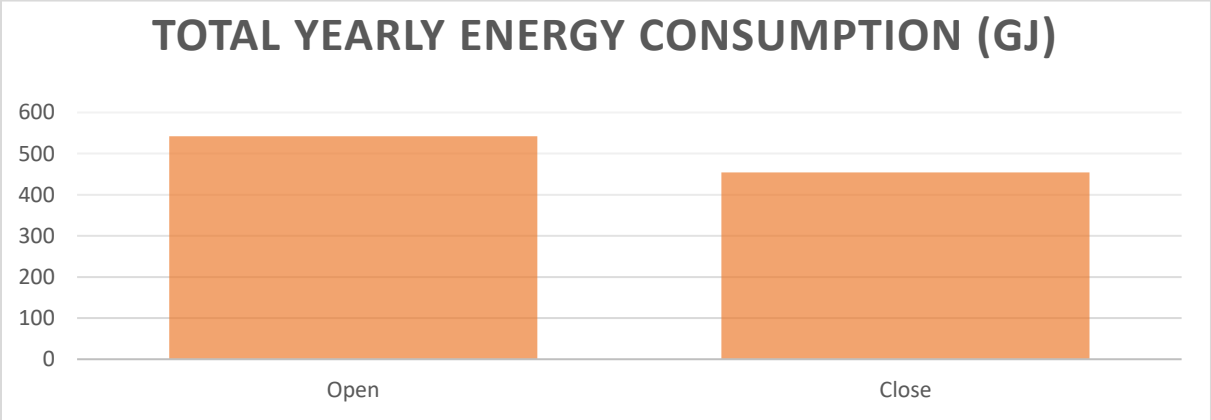
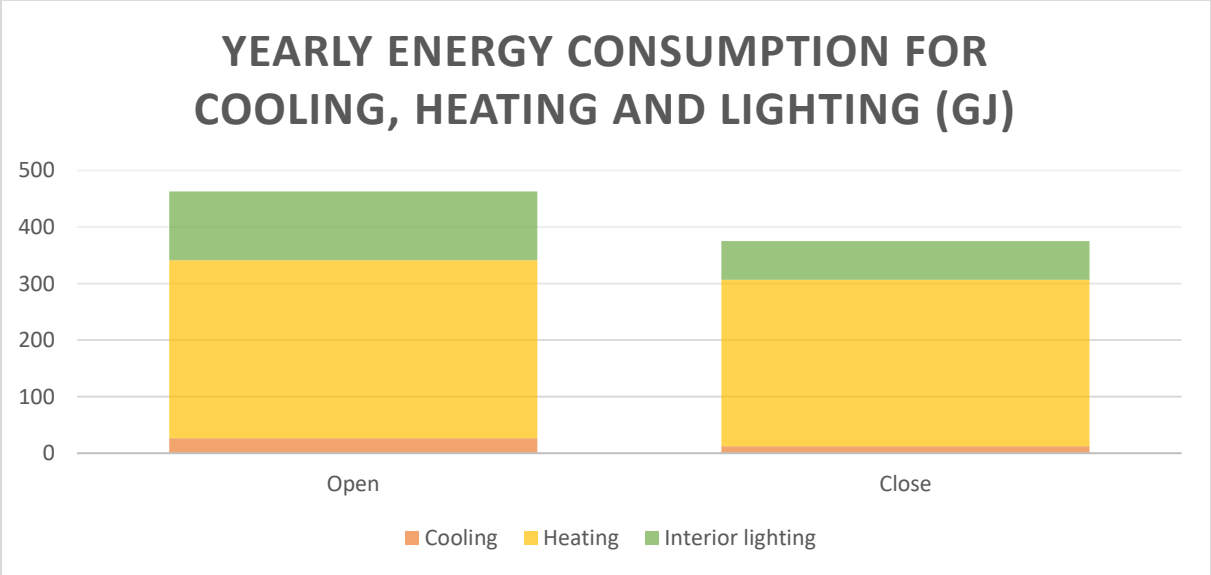


Figure 10 - Definition of the Schedule when the conference rooms are closed

Conference Room situation	Total site energy use (GJ)	Energy used for cooling (GJ)	Energy used for Heating (GJ)	Energy used for lighting (GJ)
Open	542,07	26,28	315,02	121,48
Close	454,21	12,16	294,56	68,2





Logically we see a drop of consumption when we close the conference rooms. This difference is linked to the use of lighting, but also of cooling and heating.

The total reduction of consumption is significant and shows how lighting is an important category of energy use in this building. It also shows that logically, when you have no one in the room, it's easier to cool the room in Summer.

7. Conclusion

As we saw, a lot of elements are playing an important role in energy consumption. We studied the composition of exterior walls, which can have different nature, so different terminal resistances. We also saw the role of the weather and geographical position on heating and cooling. And finally, we tried to see the impact of schedule.

By changing some characteristics, we successfully reduced the energy consumption of the building.

There are of course more elements to take in account to design an energy efficient building, but these first approach gave us a good understanding of the behavior of a building, so we can design better buildings in the future.