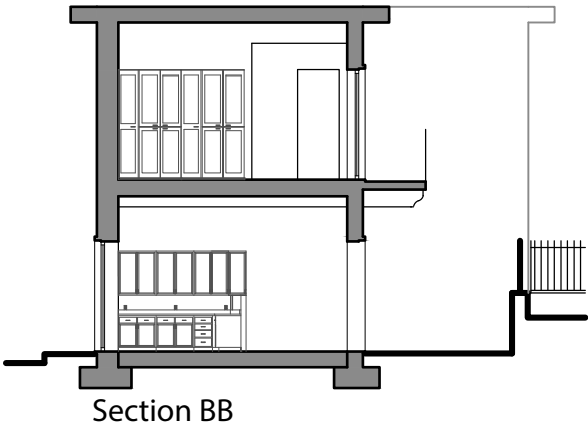
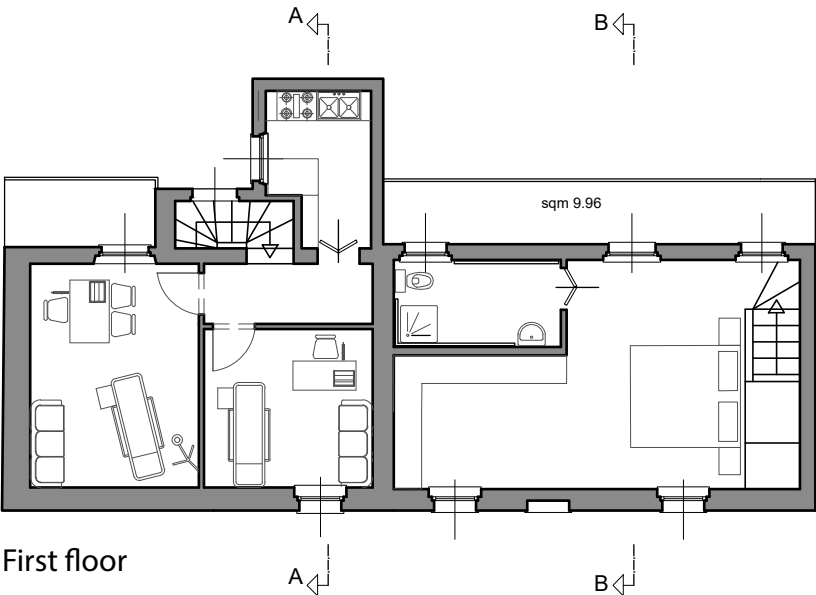
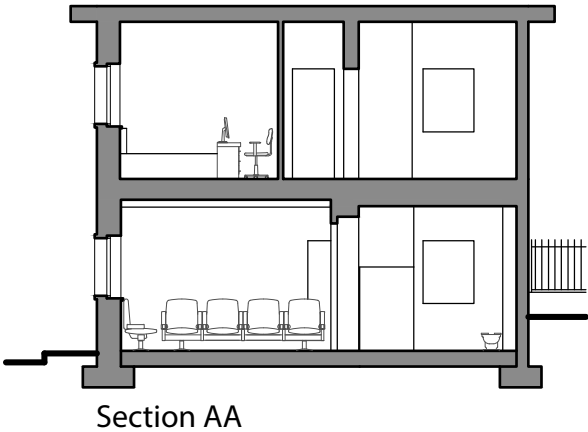
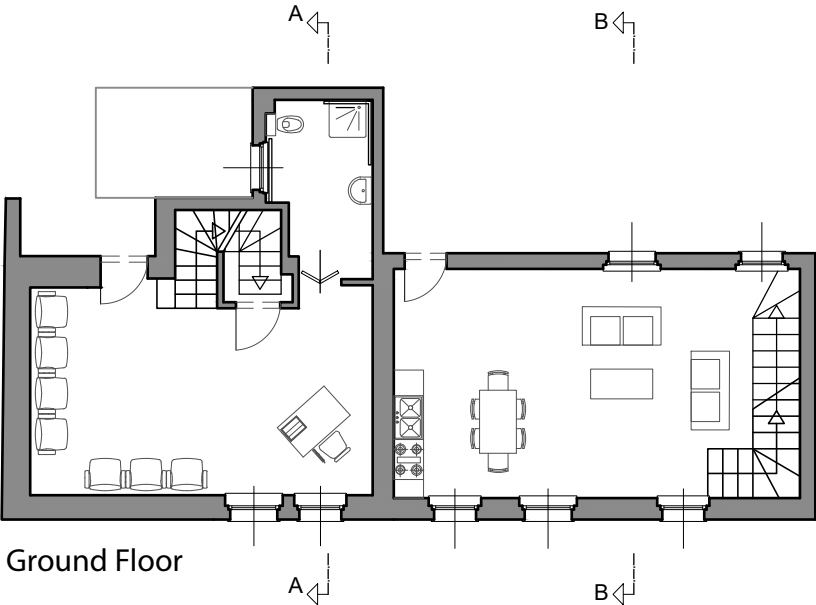


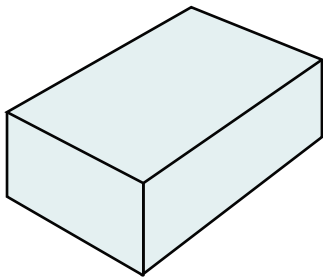
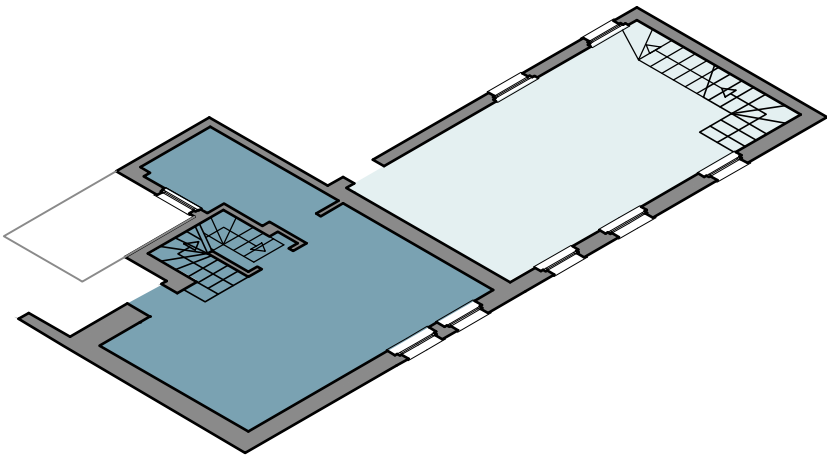
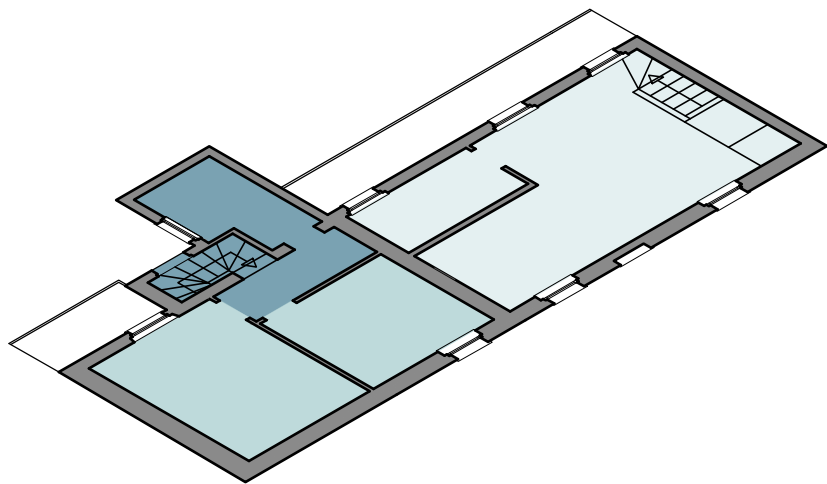
Building composed by two units

The building is composed by two different units in order to have multiple thermal zones. The one in the left hosts studios/medical offices, while in the right there is an apartment. There are in total three different thermal zones.

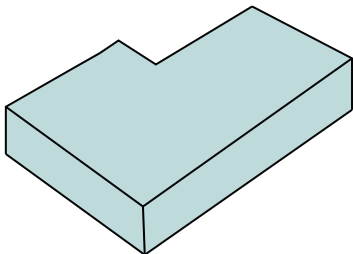


Separation in different thermal zones

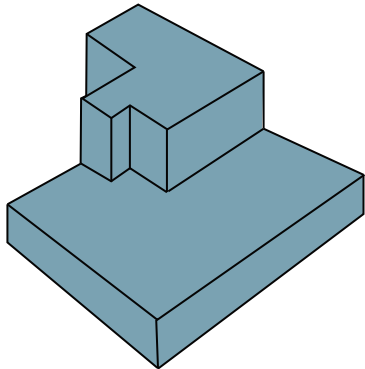
- 1_thermal zone
- 2_thermal zone
- 3_thermal zone



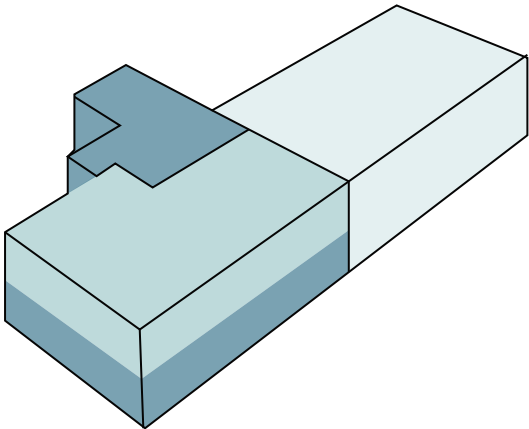
3_thermal zone



2_thermal zone



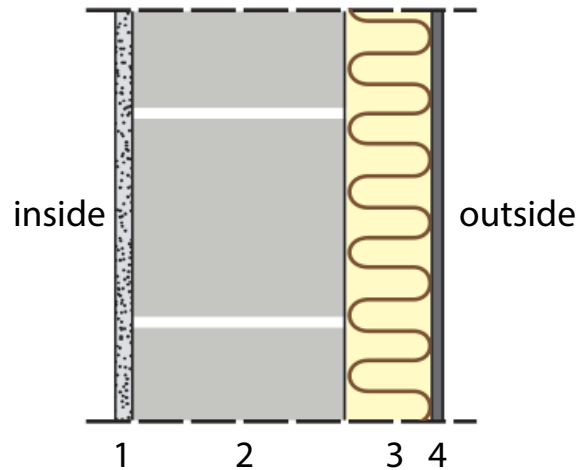
1_thermal zone



The cities used in the exercise are: Piacenza, Copenhagen and Casablanca

Types of walls:

_1 wall used in: Piacenza, Copenhagen and Casablanca in order to compare the results with different weather data

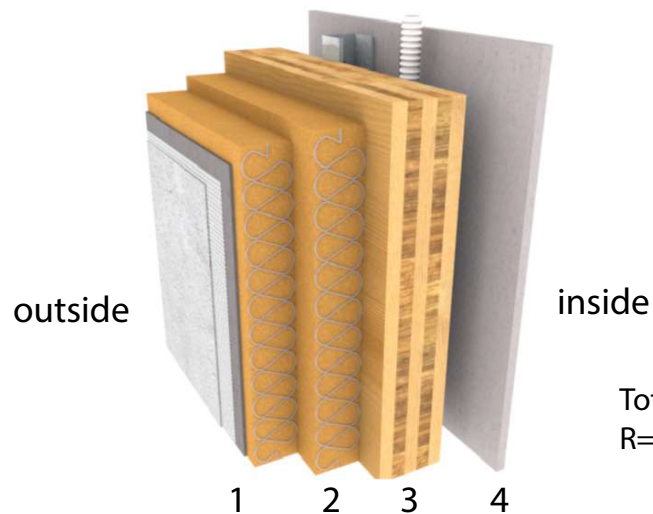


- 1 Gypsum 1.5 cm
- 2 Cement block 20
- 3 Insulation pannel 12 cm
- 4 Plaster 0.5 cm

Total thermal resistance:

$$R = d1/\lambda1 + d2/\lambda2 + d3/\lambda3 + d4/\lambda4 = 4,71 \text{ sqm K/W}$$

_2 wall used in: Piacenza

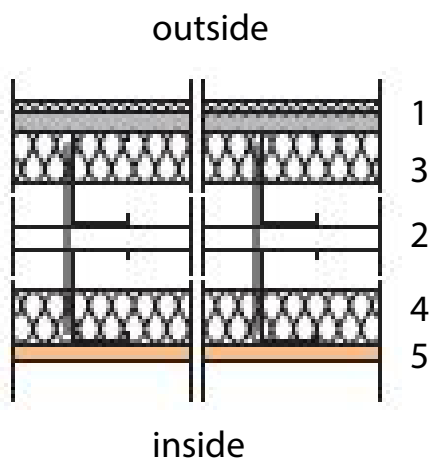


- 1 Plaster 0.5 cm
- 2 Mineral fiber insulation 18 cm
- 3 Laminated timber 34.05 cm
- 4 Gypsum 1.2 cm

Total thermal resistance:

$$R = d1/\lambda1 + d2/\lambda2 + d3/\lambda3 + d4/\lambda4 = 11,96 \text{ sqm K/W}$$

_3 wall used in: Piacenza



- 1 Plaster 0.5 cm
- 2 Stell (metal siding) 0.15 cm
- 3 Mineral fiber insulation 8 cm
- 4 Mineral fiber insulation 8 cm
- 5 Gypsum 1.5 cm

Total thermal resistance:

$$R = d1/\lambda1 + d2/\lambda2 + d3/\lambda3 + d4/\lambda4 + d5/\lambda5 = 3,94 \text{ sqm K/W}$$

Piacenza 1_case

End uses

	Electricity (GJ)	District Cooling (GJ)	District Heating (GJ)
Heating	0.00	0.00	26.13
Cooling	0.00	35.84	0.00
Interior lighting	17.16	0.00	0.00
Interior equipment	60.06	0.00	0.00
Total End Uses	77.22	35.84	26.13

Utility Use Per Total Floor Area

	Electricity Intensity (MJ/m2)	Cooling Intensity (MJ/m2)	District Heating Intensity (MJ/m2)
Lighting	117.77	0.00	0.00
HVAC	0.00	246.03	179.40
Other	412.33	0.00	0.00
Total	530.10	246.03	179.40

Piacenza 2_case

End uses

	Electricity (GJ)	District Cooling (GJ)	District Heating (GJ)
Heating	0.00	0.00	22.74
Cooling	0.00	38.03	0.00
Interior lighting	17.16	0.00	0.00
Interior equipment	60.06	0.00	0.00
Total End Uses	77.22	38.03	22.74

Utility Use Per Total Floor Area

	Electricity Intensity (MJ/m2)	Cooling Intensity (MJ/m2)	District Heating Intensity (MJ/m2)
Lighting	117.77	0.00	0.00
HVAC	0.00	261.12	156.10
Other	412.33	0.00	0.00
Total	530.10	261.12	156.10

Piacenza 3_case

End uses

	Electricity (GJ)	District Cooling (GJ)	District Heating (GJ)
Heating	0.00	0.00	29.56
Cooling	0.00	40.26	0.00
Interior lighting	17.16	0.00	0.00
Interior equipment	60.06	0.00	0.00
Total End Uses	77.22	40.26	29.56

Utility Use Per Total Floor Area

	Electricity Intensity (MJ/m2)	Cooling Intensity (MJ/m2)	District Heating Intensity (MJ/m2)
Lighting	117.77	0.00	0.00
HVAC	0.00	276.37	202.92
Other	412.33	0.00	0.00
Total	530.10	276.37	202.92

One of the chosen cities is Piacenza, an Italian city.

We wanted to use three different stratigraphies of wall in order to understand which one of them is the best one according to the climate.

The weather in Piacenza is characterized by dry summers and cool, wet winters, defined as mediterranean climate. The summer can be quite hot with high nocturnal temperatures of usually 28-33°C, but sometimes even 40°C. Thunderstorms are quite common.

From the charts we can understand that there is not a best solution: in one hand the first typology of wall is more suitable for hot seasons since the value of cooling intensity is the lowest one (246.03 MJ /m2).

On the other hand, the second type of wall which is the one with laminated timber, is proper for winter because it has the lowest value of district Heating (156.10 MJ/m2) between the other two.

The worst wall is the 3rd one because it has the worst results in both seasons.

Piacenza 1_case

End uses

	Electricity (GJ)	District Cooling (GJ)	District Heating (GJ)
Heating	0.00	0.00	26.13
Cooling	0.00	35.84	0.00
Interior lighting	17.16	0.00	0.00
Interior equipment	60.06	0.00	0.00
Total End Uses	77.22	35.84	26.13

Utility Use Per Total Floor Area

	Electricity Intensity (MJ/m2)	Cooling Intensity (MJ/m2)	District Heating Intensity (MJ/m2)
Lighting	117.77	0.00	0.00
HVAC	0.00	246.03	179.40
Other	412.33	0.00	0.00
Total	530.10	246.03	179.40

Casablanca 2_case

End uses

	Electricity (GJ)	District Cooling (GJ)	District Heating (GJ)
Heating	0.00	0.00	4.54
Cooling	0.00	56.43	0.00
Interior lighting	17.16	0.00	0.00
Interior equipment	60.06	0.00	0.00
Total End Uses	77.22	56.43	4.54

Utility Use Per Total Floor Area

	Electricity Intensity (MJ/m2)	District Cooling Intensity (MJ/m2)	District Heating Intensity (MJ/m2)
Lighting	117.77	0.00	0.00
HVAC	0.00	387.42	31.19
Other	412.33	0.00	0.00
Total	530.10	387.42	31.19

Copenhagen 3_case

End uses

	Electricity (GJ)	District Cooling (GJ)	District Heating (GJ)
Heating	0.00	0.00	40.45
Cooling	0.00	13.97	0.00
Interior lighting	17.16	0.00	0.00
Interior equipment	60.06	0.00	0.00
Total End Uses	77.22	13.97	40.45

Utility Use Per Total Floor Area

	Electricity Intensity (MJ/m2)	Cooling Intensity (MJ/m2)	District Heating Intensity (MJ/m2)
Lighting	117.77	0.00	0.00
HVAC	0.00	95.92	277.71
Other	412.33	0.00	0.00
Total	530.10	95.92	277.71

In this case the comparison is different.

We have used the same stratigraphy of the wall (the first one) in three different cities with different weathers to better understand the behaviour of the wall.

The cities have been chosen according to the different temperature that they have, in fact Casablanca is characterized by climate very mild, the average temperature goes from 13 °C (55.5 °F) in January, to 23 °C (73 °F) in August.

Copenhagen's climate is cold in winter and mild in summer, being influenced by the ocean.

From the graphs, in fact, it emerges that the energy consumed in Casablanca for cooling during the summer is quite high, since it has a hot weather. Instead, in Copenhagen the opposite situation occurs: it is required a significantly higher amount of energy for heating during Winter. These consideration refer to the in-between situation offered by the case of Piacenza. Moreover, they have been possible thanks to the application of the same kind of wall for the three different cities.