San Cristóbal de los Ángeles

INTERSET

- San Cristóbal de los Ángeles -

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OVERVIEW

« San Cristóbal de los Ángeles » takes place in Villaverde district, which is located on Madrid, near of the centre of Spain. So the climatological conditions are as severe in summer as in winter.

- ✓ The yearly average temperature is 14 ℃
- ✓ The yearly sunshine duration is 2814 hours
- ✓ The yearly average relative humidity is about 56%
- ✓ 1202 degree-days to base 20ºC on the heating period (Dec-Feb)
- ✓ 396 degree-days to base 20ºC on the cooling period (Jun-Sep)
- ✓ The total horizontal solar radiation on the heating period is 7685 W/m²
- ✓ The total horizontal solar radiation on the cooling period is 31833 W/m²

SITE

All the buildings in the settlement are integrated into a big group of similar constructions. Typically, the blocks have five storeys, concrete frame-work with wall, brick masonry. Terrain is flat with not much vegetation present; there are only some trees that contribute to the shading of the surfaces.

PRESENT PROJECT

These concrete and brick fabric buildings of habitations were built in 1950's.

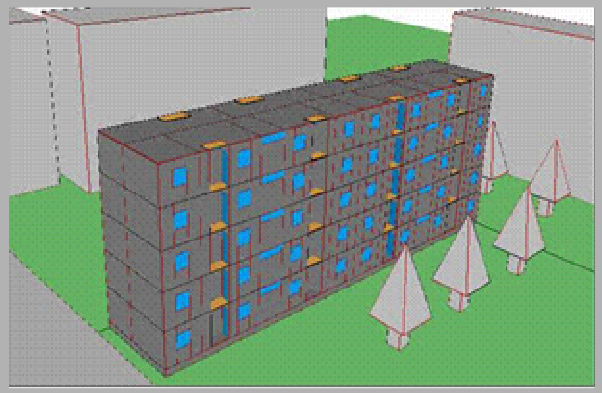
The settlement has 398000 m^2 of built area, which are organized on 160 detached blocks with 5 storeys each, have been necessary to offer flats with 68 m^2 and 3 or 4 bedrooms.

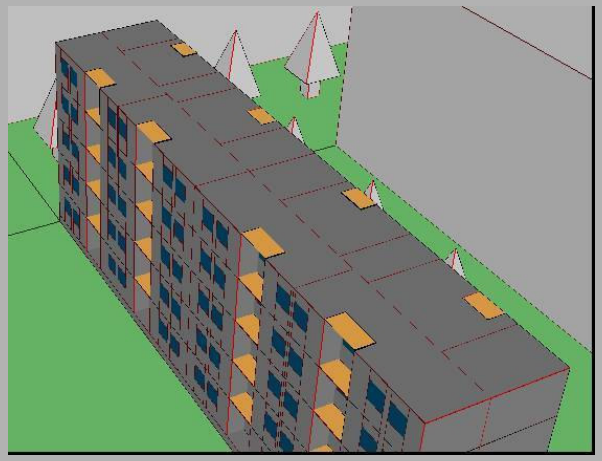
The density figures are 337 persons and 3.8 blocks per Ha.

Basically we can distinguish between buildings with its main axis oriented in the North-South direction and buildings with its main axis oriented in the East-West direction. Hereafter we will differentiate them using the next schematic draws:

INTERSET PROJECT

BUILDING TYPOLOGY

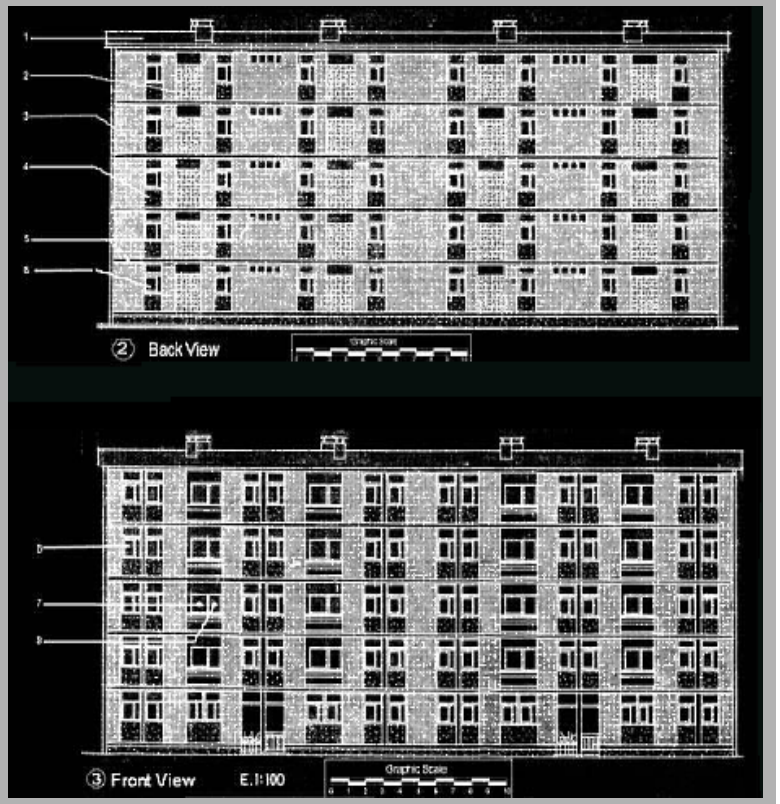




Images captured from the simulation software Developed by the Department of Termotecnia. University of Seville.

This construction is a typical rectangular block. The conditioned surface of the mean building is 1075.4 m².

Due to the proximity between the buildings, short wave radiation is more likely to be absorbed and long wave radiation is exchanged between buildings rather than lost to the sky. Finally, sheltering effects between buildings reduce the air flow.



Case Study - San Cristóbal de los Ángeles

PROJECT OBJETIVES

The refurbishment concerns the improvement of the following points:

MICROCLIMATE

Actually, the urban vegetation is negligible, the spaces between buildings are used as car parks and there are not pedestrian paths; so the green zones must be increased.

BUILDING ENVELOPE

Contribute to decrease the energy consumption, and the subsequent environmental pollution, of San Cristobal de los Angeles settlement through innovative strategies that optimize the energy demand of the building.

COMFORT

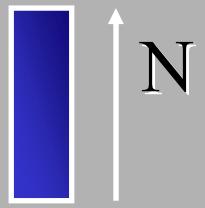
The flats of the buildings are poor insulated, discomfort is common in winter in spite of the electric heating systems installed this problem will be solved together with the first objective, however, in some zones the temperatures are too high in summer too, as a consequence some owners have begun to install autonomous “air-conditioning” units. Solar passive measures will be proposed in order to reach comfort standards without using conventional HVAC units.

The ambition of the municipality is to renovate the settlement looking for projects that combine innovative solutions with well known techniques in order to show that energetic efficiency and sustainability could be common rules in the social housing sector.

Case Study - San Cristóbal de los Ángeles

METHODOLOGY

WINTER



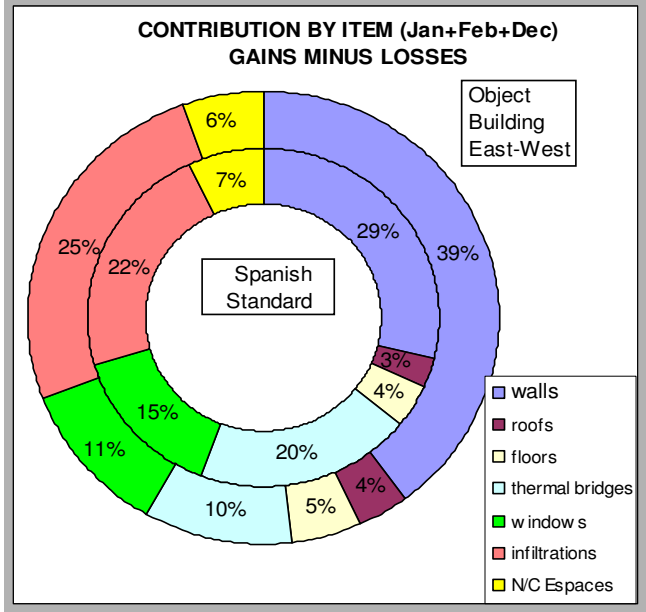
SUMMER

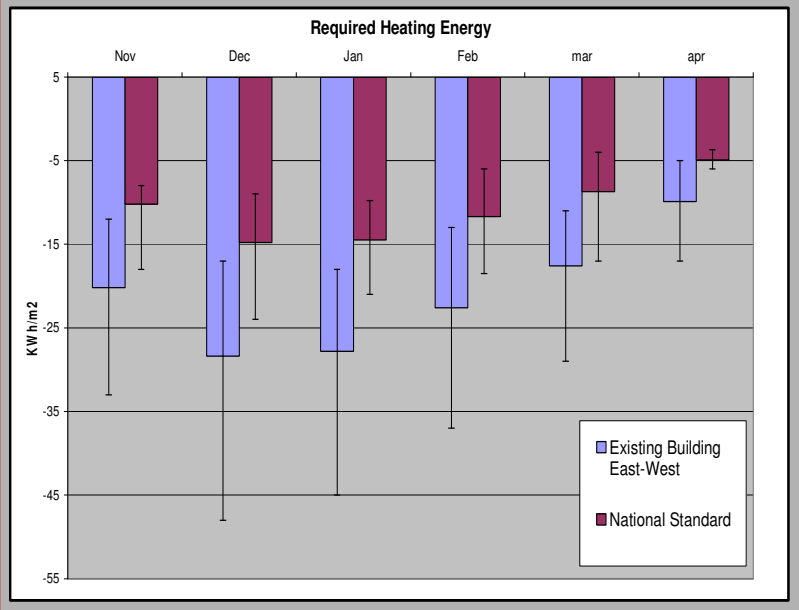
ECONOMICS

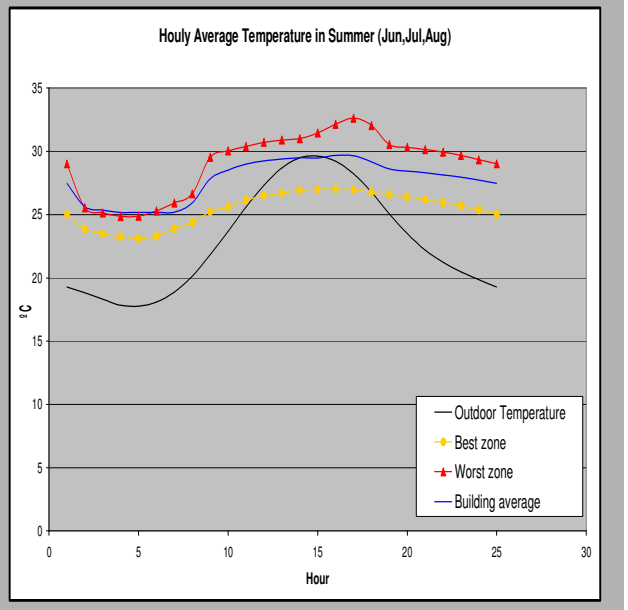
In the graph on energy requirements for heating we can see how far is the present building of fulfilling the national standard, In the heat minus losses graph it is possible to identify the items with worst thermal characteristics. In this case we are going to modify the glazings and the walls in order to decrease the energy requirements.

Some measures will have to be implemented in order to improve comfort levels.

The proposed and evaluated techniques have a cost, which can be reasonable and acceptable or not. The payback period will be evaluated in each case.







Estimations obtained by simulations for the building with its main façades to the east-west directions. In the graphic on heating requirements the lines upon the bars represents the spaces with highest and lowest energy requirements.

Case Study - San Cristóbal de los Ángeles

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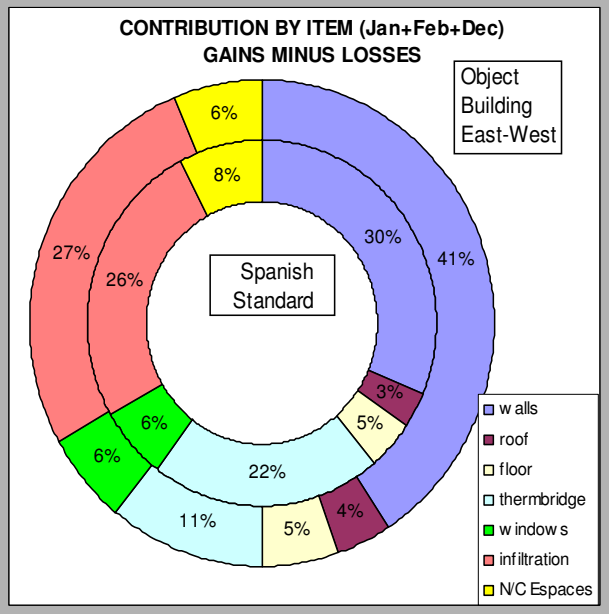
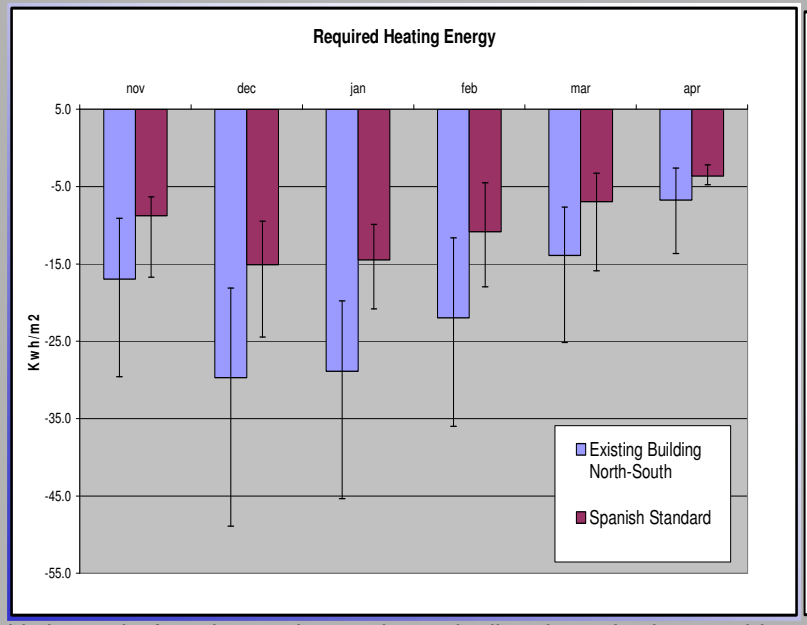
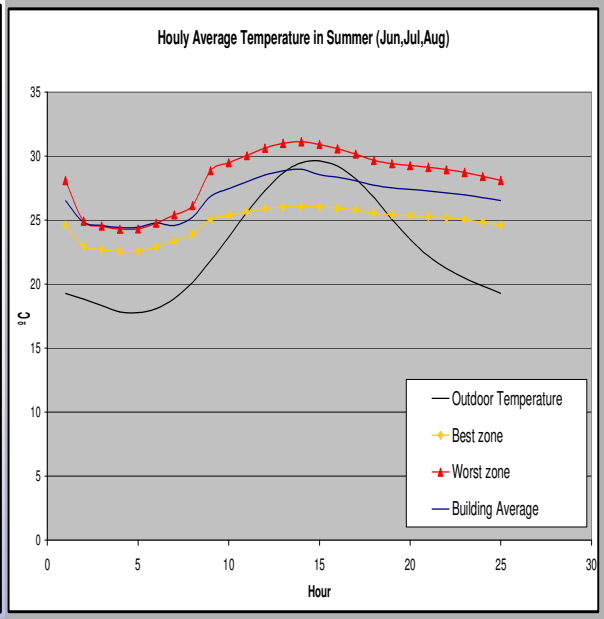






Estimations obtained by simulations for the building with its main façades to the north-south directions. In the graphic on heating requirements the lines upon the bars represents the spaces with highest and lowest energy requirements.

Case Study - San Cristóbal de los Ángeles

MICRO-CLIMATE –Scenarios Description-

SCENARIO 1: GREEN ZONES

A re-arrangement of the environment of the buildings that shape the settlement is proposed in order to extend the pedestrian spaces. This scenario will consist of adding green zones and connect them by pedestrian paths in addition to plant vegetation in the car parks.

SCENARIO 2: USE OF WATER

The evaporation of the water contained in a pond has been checked as one of the most efficient techniques to obtain a comfortable microclimate in open spaces in summer. It is proposed to place in certain parts of the settlement waterproof concrete ponds with aireation systems and plants to keep on the oxygenation of the water. The water can be collected from gutters at the level of each building. In addition this water can be used collectively for the greenery.

SCENARIO 3: ARCADES

The use of arcades could lead to a new and safe structure for pedestrian linking public spaces. The existing situation is suitable for:

- Arcades shaping public/private areas making sheltered gardens and pavements.
- Multifunctional use of arcades for example shaded car parks.
- shaping semi-private areas by water curtains.

ENVELOPE –Winter Scenarios Description-

SCENARIO 1:

IMPROVE GLAZING

SCENARIO 2:

IMPROVE GLAZING & INSULATE WALLS

Winter objective: Fulfill Spanish National Standard

Most of buildings have a poor level of insulation –only air layer- and the openings are single glazed.

The worst element in the building envelope are glazings. Trough windows 14,000KWh of the net thermal energy is lost, whereas the same element for the national standard only looses 10,000KWh. The first scenario consist of changing existing single glazing elements by double-glazing.

In order to meet the national standard it is proposed to add exterior insulation on external walls. This measure will be overlaided with the scenario 1.

ELEMENT	U existing building < W/m²K >	U National standard < W/m²K >	U proposed < W/m²K >	Obtained by means of
External Walls Wall type 1	2.0	0.66	0.60	external insulation (4 cm, Polystyrene k=0.034 W/m K)
External Walls Wall type 2	1.9	0.66	0.59	external insulation (4 cm, Polystyrene k=0.034 W/m K)
External Walls Wall type 3	2.0	0.66	0.60	external insulation (4 cm, Polystyrene k=0.034 W/m K)
Roof	1.1	0.38	0.37	external insulation (6 cm, Polystyrene k=0.034 W/m K)
Floor	1	0.49	---	No modification
Glazing	5.7	2.35	2.1	Change single glazing by double glazing

ENVELOPE –Winter Scenarios Description-

SCENARIO 3:

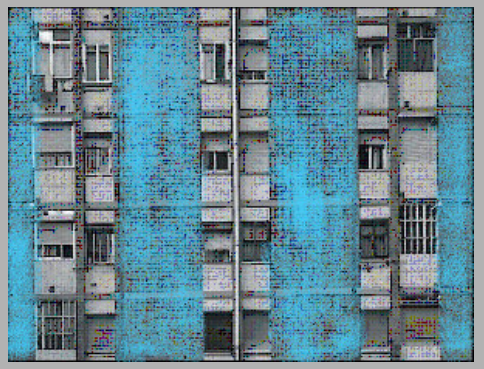
TROMBE WALL IN SOUTH FAÇADE

In the case of buildings with its axis in north-south direction the solar passive envelope element with best performance is the Trombe wall oriented to the south.

SCENARIO 4:

TRANSPARENT INSULATION IN SOUTH FAÇADE

In the case of buildings with its axis in east-west direction the solar passive envelope element with best performance is the transparent insulation.

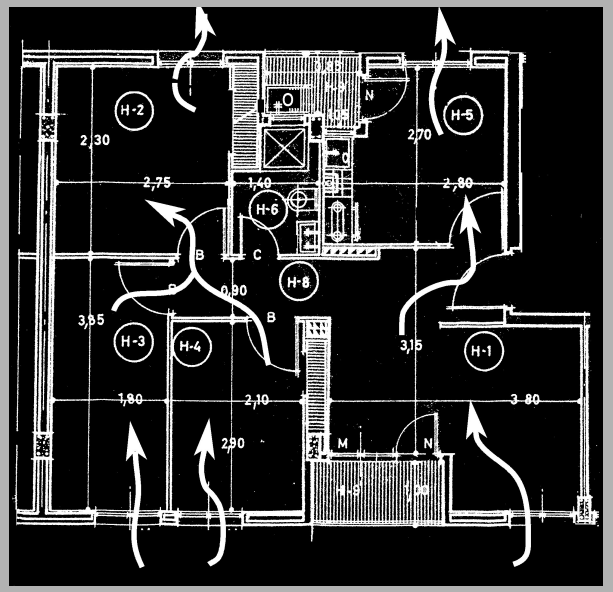


ENVELOPE –Summer Scenarios Description-

Summer: Comfort conditions with passive cooling

SCENARIO 5:

NIGHT VENTILATION



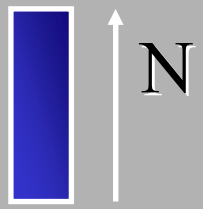
The use of night ventilation is proposed in order to take advantage of the outdoor temperatures. This measure is useful in summer when the outdoor temperature is lower than the indoor temperature, refreshing not only the air, but also walls and storeys (elements with thermal inertia) making the building less hot than outdoor during the day time thanks to the « heat storage » effect.

This measure can be implemented with or without an electronic device that controls the openings of the windows as a function of the outdoor temperatures, in the present case study this technique is going to be implemented without any kind of electronic control, thus the only requirement will be to open the windows during the night.

Case Study - San Cristóbal de los Ángeles

ENVELOPE –Winter Scenarios Results-

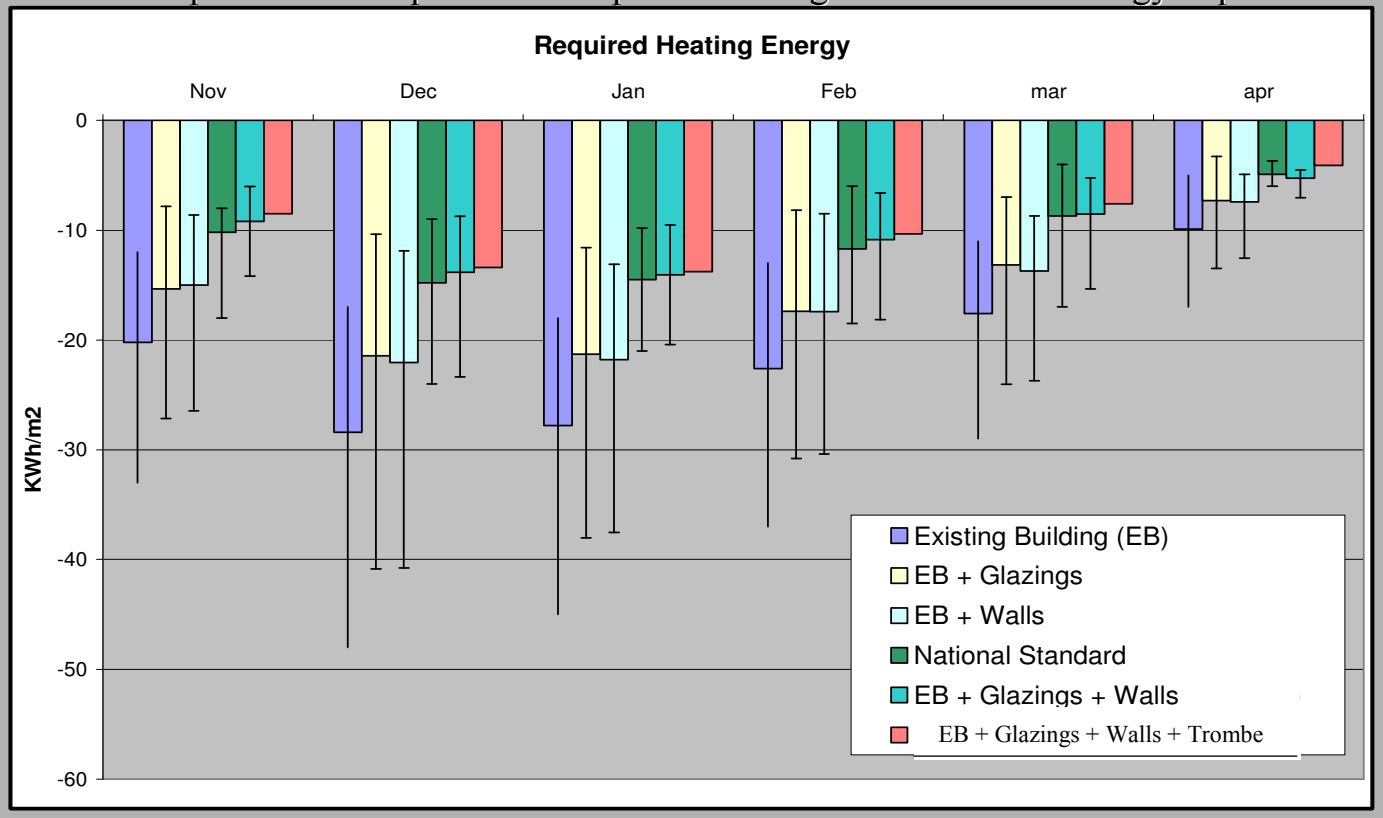
SCENARIOS 1-2-3:



Measure	Energy saving (KWh/yr)
Improve Glazings	32858
Improve Walls	31324
National Standard	66352
Imp. Glazings +Walls	64182
G + W + Trombe Wall	73980

The graph shows the energy requirements of the existing building and simultaneously the requirements for the same building in the scenario 1, 2 and 3.

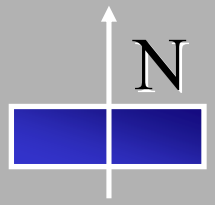
The lines upon the bars represents the spaces with highest and lowest energy requirement.



Case Study - San Cristóbal de los Ángeles

ENVELOPE –Winter Scenarios Results-

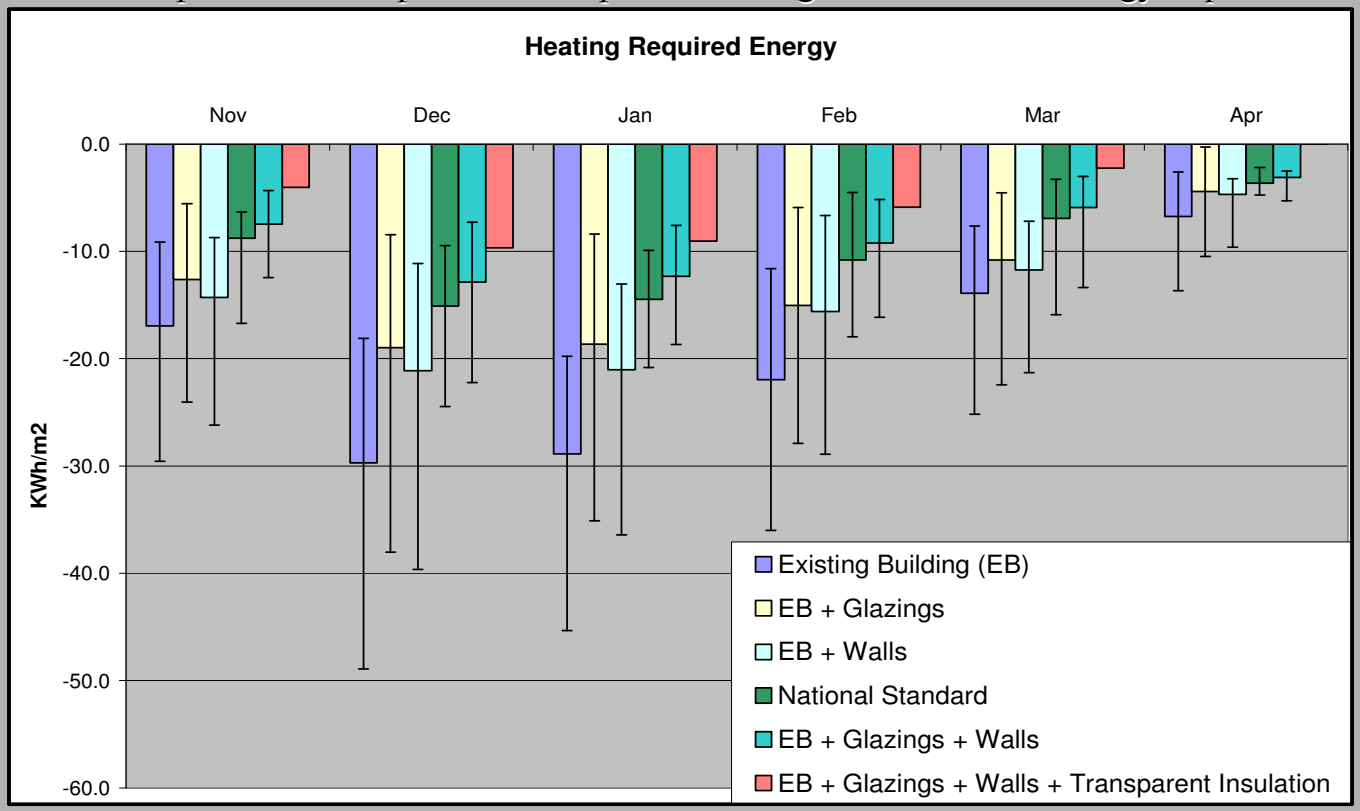
SCENARIOS 1-2-4:



Measure	Energy saving (KWh/yr)
Improve Glazings	40435
Improve Walls	31925
National Standard	64309
Imp. Glazings +Walls	72286
G + W +Transparent Ins	93822

The graph shows the energy requirements of the existing building and simultaneously the requirements for the same building in the scenario 1, 2 and 4.

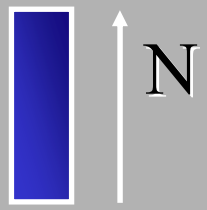
The lines upon the bars represents the spaces with highest and lowest energy requirement.

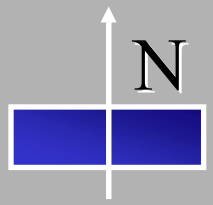


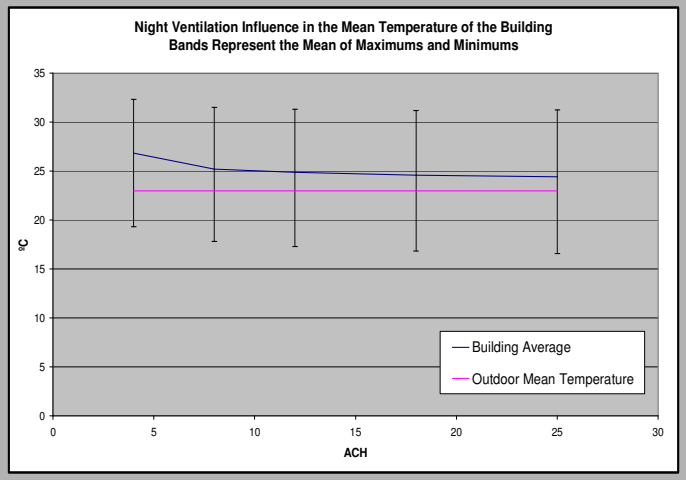
ENVELOPE –Summer Scenarios Results-

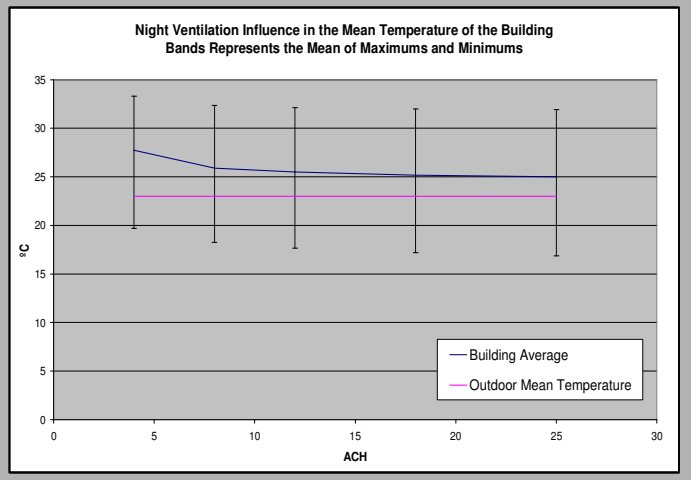
SCENARIO 5:

NIGHT VENTILATION









With 12 Air Changes per Hour it is possible to reduce the mean temperature of the building in 2ºC for both typologies of buildings. This decrease can be up to 4ºC in the worse zones.

By implementing this measure cooling requirements are avoided.

DISTRICT HEATING –Scenarios -

DISTRIC HEATING

-Scenario Description-

Actually there is a huge dispersion of individual heating installations.

In this situation, the basic scenario would be to install a district heating, improving the cold season comfort and increasing the efficiency of the heating system.

The collective system for heating could also be used for domestic hot water (DHW). Two options are feasible in this case:

- A solar system (e.g. solar panels) can be installed in each block and then use individual counters for each flat.
- Another option could consist of a small heat production unit for the entire San Cristobal de los Angeles area. The heating would be distributed to the apartments via vertical heat pipes situated in the staircases. Each apartment would be heated by a closed loop system enabling a high quality control and regulation of heat delivery. The radiator could be placed minimizing the length of heat distribution pipes. All pipes in the apartment should be placed in PVC-free tubes under the floor coverage.

ENVIRONMENTAL ASPECTS

REDUCING AIR POLLUTANT

•Avoiding air conditioning: the different envelope scenarios show that night ventilation will be sufficient in summer.

•Reducing heating energy consumption in winter and, as a consequence:

The CO_2 emissions will be reduced

INTRODUCING WASTE TREATMENT

The selective waste collection can be applied using a façade system that leads the waste to underground containers minimizing the storage in each flat. Organic waste, glass, paper and others could have their own conduction from the kitchen of each flat to buried storage containers.

COLLECTING RAIN WATER

The envisaged use of water as a consequence of implementing one or various of the microclimate scenarios will not be negligible; the green zones, the water ponds, the water curtains… will need a huge quantity of water. One proposal in this sense could consist of collecting rainwater from gutter at the level of each building. This water would be stocked in underground tank and used collectively.

In addition large reductions of water are easily obtainable through a number of quite simple measures as: water saving taps and showers, low flush toilets and reusing of grey water.

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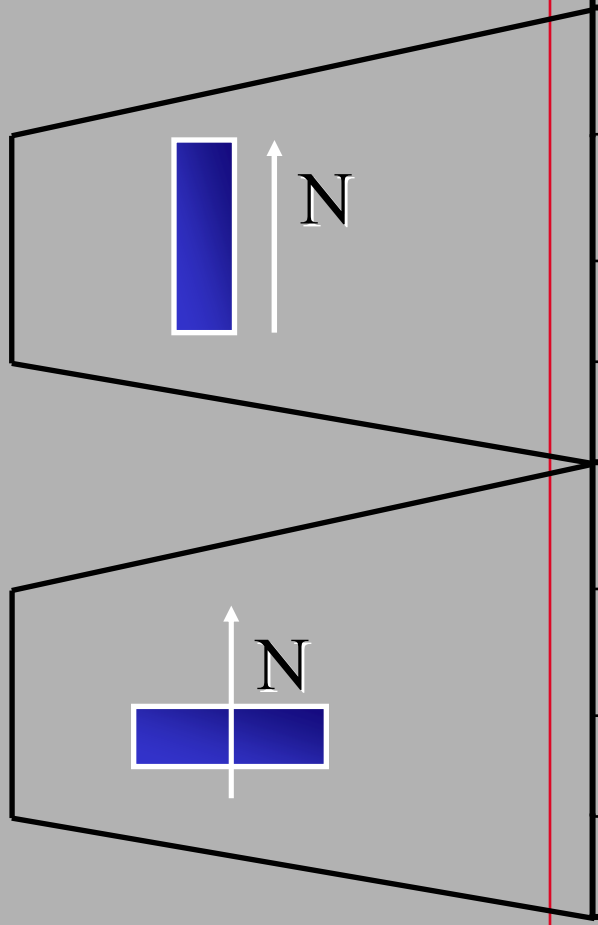
COSTS/PERFORMANCES –Scenarios-



	Costs (€)	Savings (KWh/y)	Savings (€/yr)	CO2 (t/y)	Payback (yr)
Double Glazing	8555	13982	1622	7.6	5.3
Insulate walls	9218	13329	1546	7.3	6.0
1+2	17773	27311	3168	15	5.6
3+Trombe	25958	31480	3652	17	7.1
Double Glazing	8555	17206	1996	9.4	4.3
Insulate walls	9218	13585	1576	7.4	5.8
1+2	17773	30760	3568	16	5.0
3+TI	47910	39924	4631	21	10.3

SUMMARY

The best renovation process to be applied would consist on improving glazing, and insulating walls. In addition to this measure a Trombe wall could be installed in the building with its main façades to the east-west and a Transparent Insulation for the building rotated 90º respect to this one.

Cross ventilation is an efficient measure in order to make the indoor conditions more comfortable, particularly, in this case this technique is enough to avoid cooling needs.

Increasing green zones and adding water ponds will contribute to improve the outdoor comfort of the settlement.

A small **Heat Central** is an optimum solution to supply hot water to the entire settlement.