Energy saving in residential buildings: Technologies for retrofitting

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SUMMARY - This research is part of a project related with the environmental-energetic conditions of Río Turbio city. The city is located in the south extreme part of Argentine Republic territory. This research embraced the residential area of the city with the purpose of develop techniques of retrofitting in order to improve the higrothermic comfort, as well as, optimize the energetic consume of the dwellings. There are exposed the methodology and the results of the potential capacity of saving. As a conclusion, there are exposed the data emerged from the primary consumption of energy of energy for the residential and tertiary sector, urban area and of the micro-region.

1. INTRODUCTION

The city of Río Turbio is located in the most important carboniferous basin of the country, 51°43´ south latitude and 72° west length. The climate of the region has rigorous characteristics; the most part of the year with minimum absolute temperatures surrounding -21°C and 4000 degrees days (base 18°C) of heating. In Figure 1 is shown the average temperatures of one typical year.

The city is divided into suburbs, each of them including equal typologies characteristics. The total amount of one-family dwellings is 955 and they can be classified into four predominant kinds and eleven models. From the point of view of the construction the materials used in the dwellings are:

1. Light: sandwich-sorted panels composed by two aluminium sheets containing a plate of expanded polyestirene, or dwellings built in wood. with internal insulation.

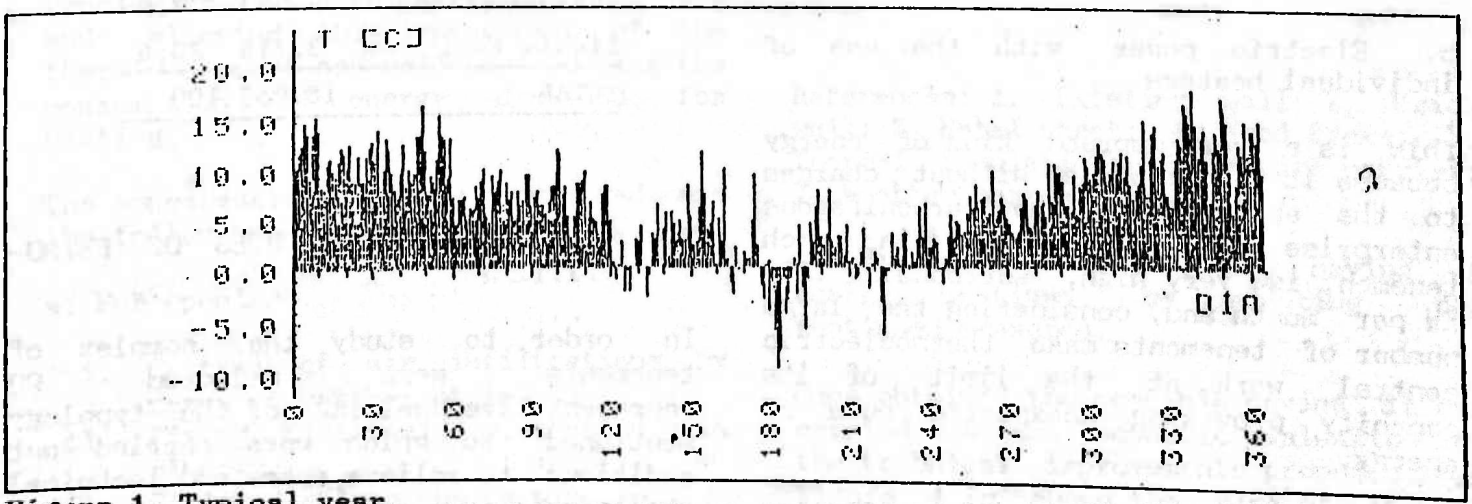

Figure 1. Typical year.

2. Traditional masonry system made of bricks or cement blocks.

3. Heavy premanufactured system in reinforced concrete.

Although, the light systems have thermal insulation, they have lack of the necessary thermal mass, therefore, great variations of temperature are produced inside of the dwellings due to the discontinuity of the heating. In premanufactured systems there are serious problems of thermical bridges in the unions among panels. The condensation inside their structure and the high consumption of electrical power with inadequate installations are causes of fire and, as a result, the total destruction of the tenement.

In cases 2 and 3 it is given just the opposite case; proper thermical mass but no insulation. The lack of adequacy to the climate conditions of habitability removed from the comfort which is obtained thanks to the high energetic consumption assigned to the heating system.

The predominant heating systems can be classified into three types depending on the sort of energy:

a. By burning of coal, either in single fire places or in cauldrons that provide hot water to the urban network of heating. These systems throw away big amounts of gas to the atmosphere producing highly contaminated air, especially considering they are being used by a large quantity of tenements.

b. Electric power with the use of individual heaters.

This is a very spread kind of energy because it is provided without charges to the employees of the carboniferous enterprise. Thee consumption in each tenement is very high, surrounding 1000 KW per month and, considering the large number of tenements make thermoelectric central work at the limit of its capacity provoking unexpected cuts of energy.

c. Consumption of bottled gas: it has been registered consumption that means repeated renews of the bottles in extreme climate conditions. Besides, it has to be noticed that the fulfilling of the bottles is carried out in Comodoro Rivadavia city 1000 Km far from Río Turbio.

In Picture 1 it is summarized the distribution in percent of each sort of energy in relation with the consumption of the residential and tertiary sector.

Picture 1.

	TEP	%
Residential	13.199	73,1
Tertiary	1.600	8,9
Transport	1.627	9
Others	1.627	9
TOTAL	18.053	100
Consumption for heating in the residential sector	11.705	88

In picture 2 it is possible to notice the contribution of residential and tertiary sector in the total amount of the urban energetic consumption.

Picture 2.

	TEP	%
Electric Energy	7.274	40,3
LPG	2.620	14,5
Coal	4.443	24,6
Liquid Fuel	3.716	20,6
TOTAL	18.053	100

2. DIAGNOSIS AND MEASURES OF RETROFITTING

In order to study the complex of tenements were selected 99 representative dwellings of the typology mentioned to which were carried out auditions to relieve space and technical characteristics as well as the energetic consumption.

With the data obtained were carried out thermical balances which allowed to know the higrothermical conditions of the tenements and the energetic consumption according to the different uses. The obtained values are shown in Pictures 3 and 4.

Picture 3.

Electric Energy Consumption	KWh/year	%
Heating	3.481	79
Domestic appliances	1.527	14
Lighting	784	7

Picture 4.

LPG Consumption	Kg/año	%
Heating	1.814	56
Hot water	770	28
Cooking	669	20

In the first evaluation is possible to notice a potential of saving surrounding 9% of the useful energy of heating by means of decreasing the internal temperature of the dwellings between 1°C and 2°C.

Technical-constructive solutions were formularized for the different typologies, easy to carry out by user and allowing the improvement of the thermic comfort as well as reducing the consumption of energy destined for heating.

The conservative measures considered are the following:

a. For openings.

i. Control of air infiltrations by means of weather strip.
ii. Fixing internal protection in windows.
iii. Fixing double glass in windows.

b. For roofs and walls.

i. Thermic insulation of the roofs with 3" of expanded polyestirene or equivalent material on the existing ceiling. Figure 2.

ii. Thermal insulation on the external face of the wall with a layer 2" of expanded polyestirene and protection against outdoors with bricks or metallic sheet. Figure 3.

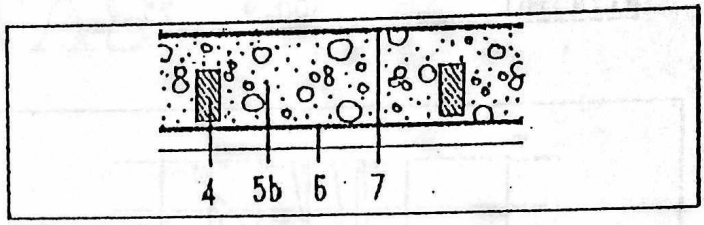

Figure 2.

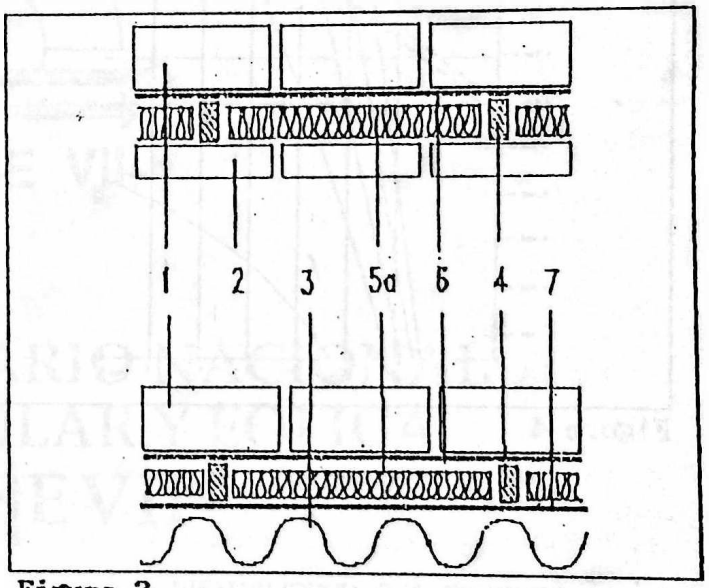

Figure 3.

References: 1. Existing wall; 2. Brick wall; 3. Metal sheet; 4. Wood frame; 5. Thermal insulation; 6. Vapour barrier; 7. Weather barrier.

In Picture 5 is shown the saving of energy obtained by adopting the mentioned measures.

Once obtained the possible saving it was carried out the economic evaluation of the technical improvements proposed. In Figure 4 is shown the time of amortization for the whole measures adopted with simultaneousness.

Picture 5.

Measures	Savings (TEP)	%
a1	210,05	6,7
a3	145,86	4,7
b1	445	14,2
b2	547,7	17,5
a1+a3	355,9	11,4
a1+a3+b1+b2	1.348,6	43
a1+a3+b1	800,9	25,6

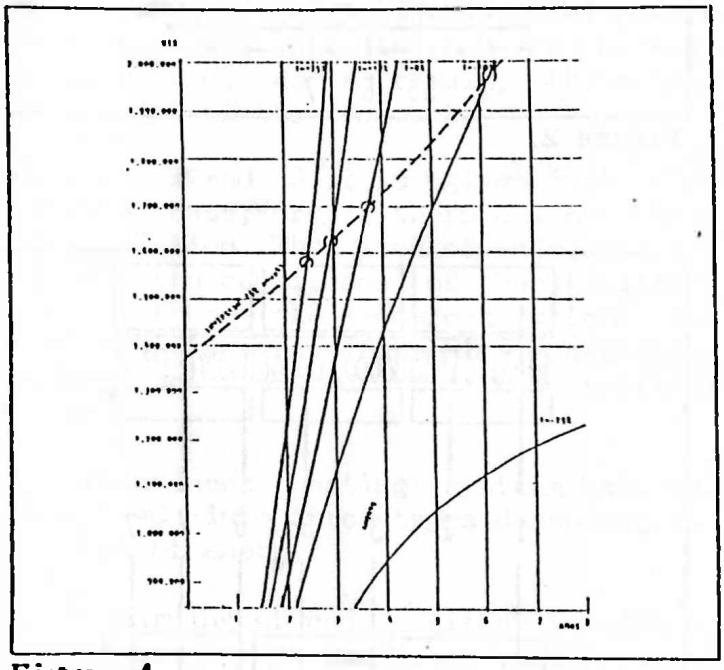

Figure 4.

3. RESULTS AND CONCLUSIONS

a. It is possible to reach an important potential capacity of saving near to 14% of the consumption of primary energy of the residential and tertiary sector decreasing from 1°C to 2°C the registered internal temperature.

b. The modification of the thermic envelope of the tenement will produce:

i. A decrease of the consumption of energy for heating up to 43% for the whole Miner Village.

ii. An improvement of the higrothermic internal conditions.

iii. A revision of the problem of obsolescence in which there are some typologies allowing its recovering.

iv. A global use of the tenement without having to use intensively rooms like kitchen and living-room.

c. By the time this research was carried out the energy was subsidized by the carboniferous enterprise. If the necessary materials were subsidized in order to produce the possible improvements, in the short time would be found:

i. Lesser consumption of energy: bottled gas, coal and electricity.

ii. Improvement of life quality of the city (the tenement and its environment) because of the reduction of the consumption of coal, the solution of the problem of storing and the environmental pollution.

iii. Better operation of the supplying system due to the decrease of the demand of coal for domiciliary uses and less charge for the thermoelectric central.

In Figure 5 are summarized the potential capacity of saving for the global primary energy of the residential and tertiary sector, urban area and micro-region.

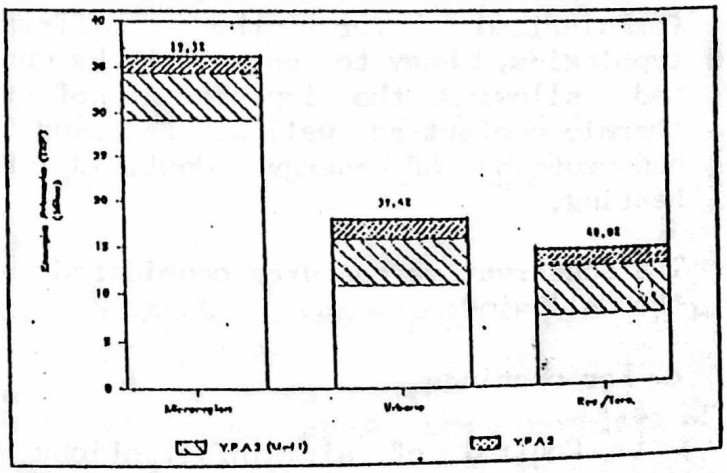

Figure 5.