Analele Universităţii din Oradea – Seria Geografie Year **XXIII**, no. **1/2013** (June), pp. **156-162**
ISSN **1221-1273**, E-ISSN **2065-3409** Article no. **231119-623**

THE INFLUENCE OF AN APARTMENT POSITIONING ON ENERGY CONSUMPTION

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Abstract: This work is part of the highly topical subject of global warming and energy conservation. The article contains parametric studies of energy consumption and CO^2 emissions for an apartment located in a block of flats, depending on its location. It was studied the energy consumption of an apartment having different cardinal orientations in the same building and of an apartment with the same position inside the building but located in different climatic zones. The case studies show the difference between the energy consumption of an apartment depending on its position, thus resulting in a few general directions for their heat insulation, so that the specific energy consumption of the apartment is below 100 kWh/m² year.

Key words: climatic zone, energy class, CO2 emission, temperatures

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INTRODUCTION

During the period 2002 - 2011, Romania registered the most drastic decrease in population of the European Union; from a number of 21 680 974 inhabitants in 2002 and down to 19 042 936 inhabitants in 2011. That is, a decline of 12% (Murgu, 2012). Taking into consideration the population evolution, we could say that the demand for new homes is low; however, the situation is slightly more complicated. In Romania, the quality of the housing stock is extremely low. Thus, the condition of the houses is bad enough, and out of 8.4 million houses, 2 million are built from clay bricks, other 0.7 million houses are built before 1944. Moreover, the average net area for a person is 15.2 square meters, while in the western countries it surpasses 25 square meters. [1]

The structure of the Romanian housing stock depending on the age is illustrated in figure 1. The real estate industry has been hit hard by the recession for over 4 years, and the INS data (National Institute of Statistics) published on the 23rd of March 2013 confirms it. Thus, the number of homes into use in the last year was of 42.566, dropping to a percent of 4.3 as compared to 2012, the market thus reaching the minimum of the last 6 years. For details, see the graph below, figure 2. [2]

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[1] *BussinessDay.ro Economie si Finante,* Real estate: how many new homes should be built annually in Romania?, (09.06.2011), *http://businessday.ro/06/2011/piata-imobiliara-cate-locuinte-noi-ar-trebui-sa-se-construiasca-anual-in-romania/*

[2] *BussinessDay.ro Economie si Finante,* Housing market: number of homes completed last year reached last 6 years minimum, (04.03.2013), *http://businessday.ro/03/2013/piata-imobiliara-numarul-locuintelor-terminate-anul-trecut-ajuns-minimul-ultimilor-6-ani/*

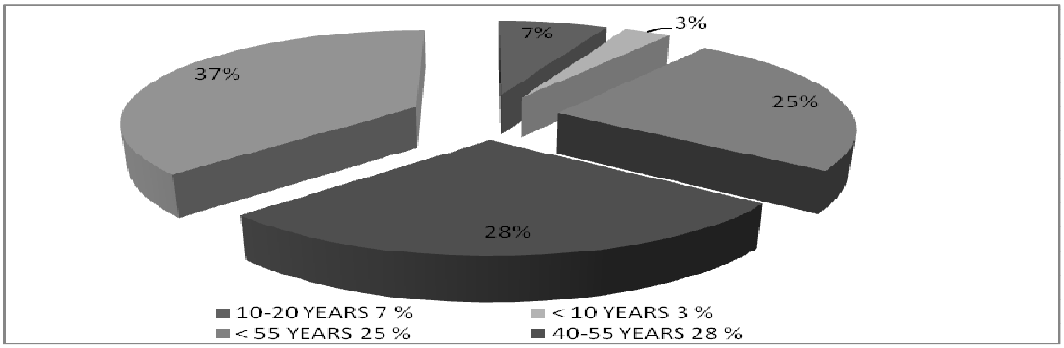

Figure 1. Status of the Romanian housing stock

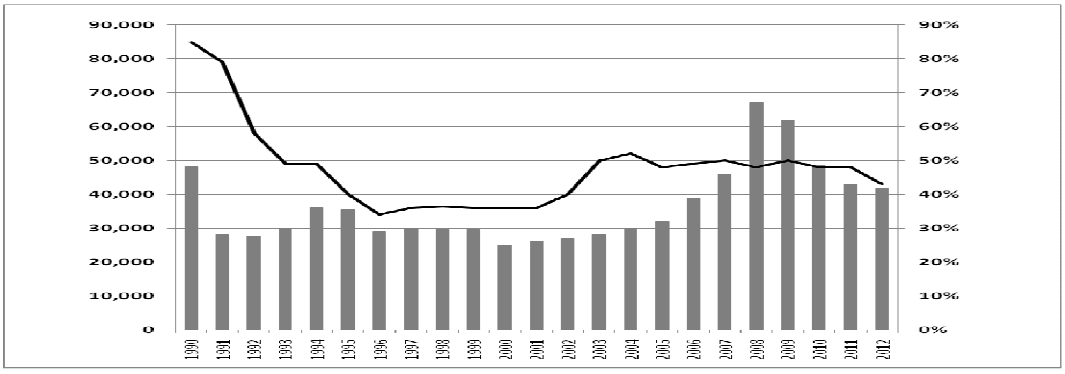

Figure 2. Number of homes into use in the last 10 years [3]

Consequently, due to demand, apartments are traded every day. In the graph below, figure 3, we can see the situation by countries with regard to the number of annual real estate transactions as a percentage of the housing stock. Click on the graph to increase. [4]

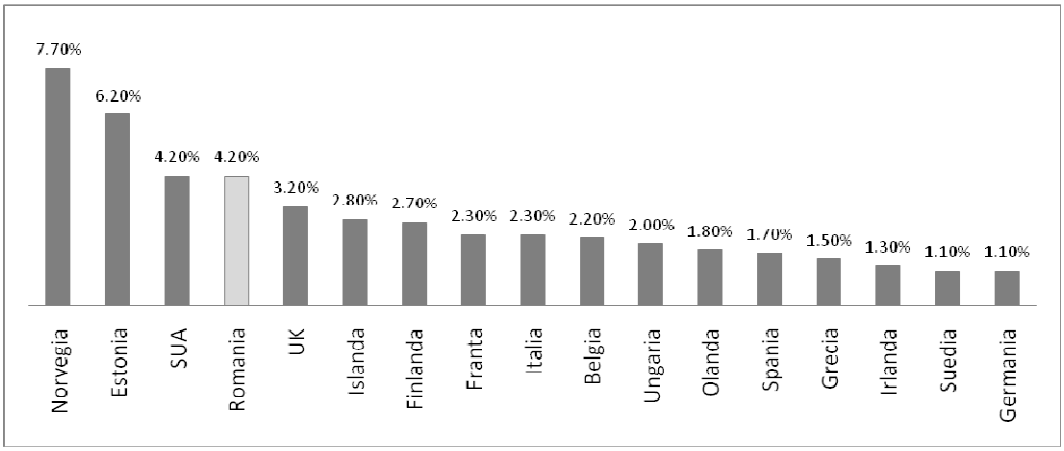

Figure 3. Number of real estate transactions, % of total housing stock [5]

[3] Idem.
[4] *„BussinessDay.ro Economie si Finante", „In Romania sold fewer homes? The data shows something else!",* (04.01.2011), *http://businessday.ro/01/2011/in-romania-se-vand-putine-locuinte-datel-arata-cu-totul-altceva/*
[5] Idem.

According to Law 372/2005 amended, regarding the energy performance of buildings, sellers have the duty to inform buyers on the energy consumption of the traded apartment. Lately, the buyers' interest for the energy consumption of an apartment has been increasingly higher. Due to the correct understanding of the power consumption concept for an apartment, the transaction prices for apartments are beginning to differentiate on the basis of energy performance. Coming to meet the interest of buyers, sellers, investors and designers, this work includes various parametric studies on energy consumption and CO2 emissions, depending on the position of the apartment. It is obvious that a south-facing apartment will have a different power consumption compared to one facing the north, east or west. The study of energy consumption of an apartment with the same orientation, but located in a different climatic zone is also interesting. At the same time, as a result of the studies carried out, some general enveloping solutions are given, depending on the location of the apartments.

MATERIAL AND METHOD

An apartment built in 1985 was taken into consideration. The living space is located in a block of flats, at an intermediate floor. The exterior surfaces (the walls) are made of autoclaved aerated concrete and they are 30 cm thick. The woodwork is made of PVC with insulating glass windows. It was considered that the flat is heated from the central heating. The apartment mapping is shown in figure 1. The flat is composed of entrance hall, two rooms, a kitchen, a balcony, and a bath.

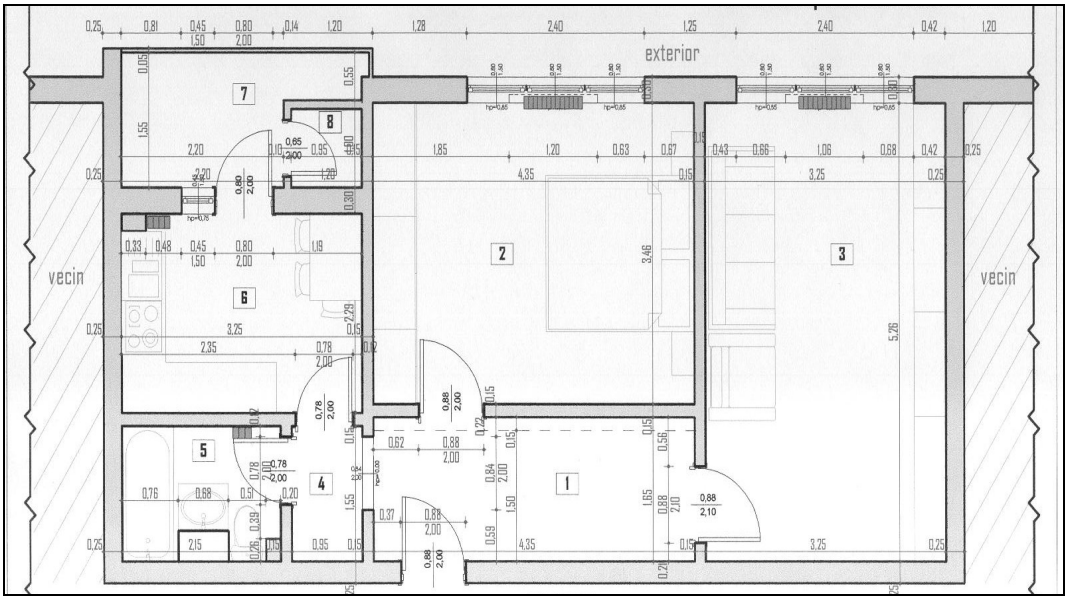

Figure 4. The mapping of the studied flat

For the purpose of calculating the energy consumption, CO2 emissions and for the classification of the studied apartment from the point of view of energetic performances, the software *"All Energy v1.0 Apartments"* was used.

Case Study 1

The study has been carried out for different locations. It is known that the territory of our country is divided into climatic zones, and the study carried out recently by INCERC (National Institute for Research and Development in Construction) from Bucharest suggests the following climatic zoning (Figure 5): zone I - Te0=-120C, zone II - Te0=-150C, zone III - Te0=-180C, zone IV - Te0=-210C, zone V - Te0=-250C (Iancau, 2013).

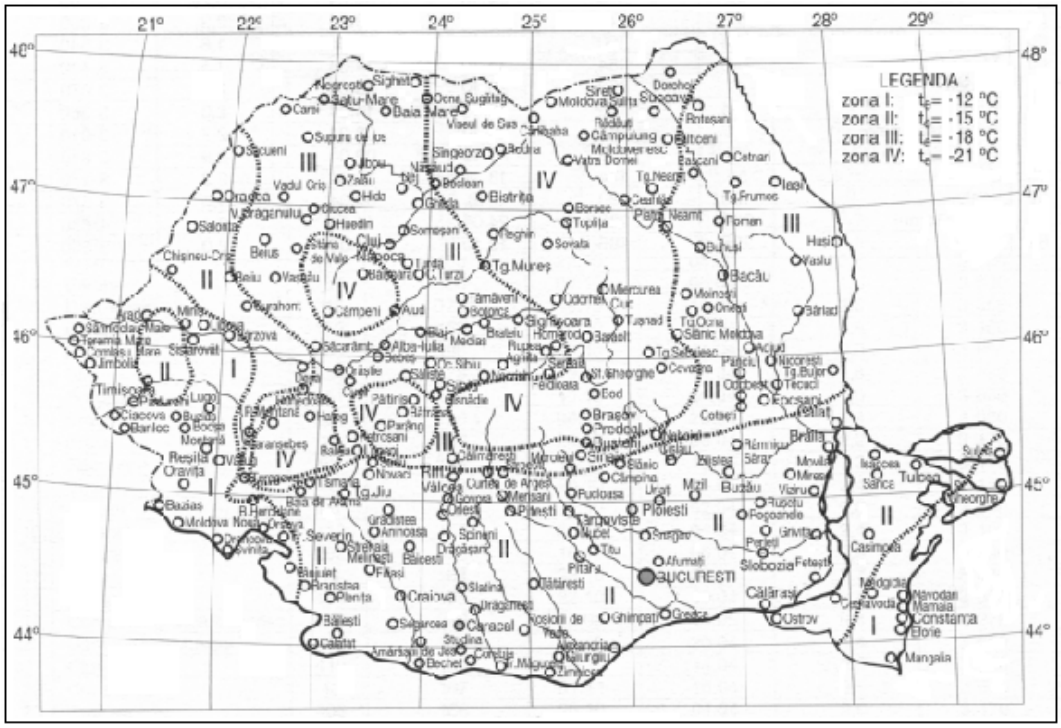

Figure 5. Climatic zoning of Romania [6]

It was considered the apartment situated in the climatic zone I - respectively the area of Constanta city, in the climatic zone II - respectively the city area Oradea, climatic zone III - respectively in Cluj city area and the climatic zone IV - respectively Suceava city area. Thermal resistances of the enveloping elements of the studied apartment are shown in table 1.

Table 1. The values for thermal resistance for envelope surface - case study

Symbol	Construction Element	Orientation	Surface (m^2)	R'min (m^2K/w)
E	Exterior walls	S	18.95	0.87
		E	3.315	0.87
F	Exterior woodwork	S	9.48	0.39
SC.	Staircase	-	28.99	0.43

Table 2. The values for thermal resistance for envelope surface

Symbol	Construction Element	Orientation - case study -				Surface (m^2)	R'min (m^2K/w)
		1	2	3	4		
E	Exterior walls	S.	W	E	N	18.95	0.87
		E	S	N	W	3.315	0.87
F	Exterior woodwork	S.	W	R	N	9.48	0.39
SC.	Staircase	-	-	-	-	28.99	0.43

[6] www.mdrt.ro/.../constructii_ancheta_publica_contr483.pdf

Case Study 2

The study was carried out for the same apartment, situated in the climatic zone II, in the city of Oradea, in the same building, but located in turn, with the exterior stained glass and opaque surfaces facing the 4 cardinal points. Thermal resistances of the envelope elements of the studied apartment are shown in table 2.

RESULTS AND DISCUSSION

After simulation with *"All Energy v1.0 apartments"* software, the following results on the energy consumption were obtained, and the classification of energetic performance for the apartment in both case studies:

Case Study 1: - results

Specific energy consumptions for apartment heating and CO2 emissions are presented in table 3. The increase in consumption of energy for apartment heating is shown as a percentage, depending on its location, considering as reference climatic zone I.

Classification in the class of energy performance for the studied apartment is shown in table 4. For energy notation is also included the energy consumption for producing hot water and at the same time consumption with lighting and home appliances.

Differences in energy consumption are obvious, as well as the energy notation in classes of energy performance. It is the ideal case of an apartment located at the intermediate floor, having all vicinities (sides, top, and below) inhabited.

Table 3. Specific energy consumption for apartment heating depending on its location

No.	Location	Climatic zone	Annual energy consumption (kWh/ m² year)	Growth of energy consumption %	CO2 equivalent emissions indicator (kgCO2/m² year)
1.	Constanta	I	63.90	0.00	15.34
2.	Oradea	II	78.65	23.08	18.88
3.	Cluj	III	90.08	40.94	21.62
4.	Suceava	IV	142.91	123.64	34.30

Table 4. Energy notation of apartment for total consumption

No.	Location	Climatic zone	Energy notation / apartment
1.	Constanta	I	B
2.	Oradea	II	B
3.	Cluj	III	C
4.	Suceava	IV	C

Case Study 2 – results

Specific energy consumption for heating and CO2 emissions are presented in table 5.

Table 5. Specific consumption for apartment heating depending on location

No.	Orientation	Annual energy consumption (kWh/ m² year)	Growth of energy consumption %	CO2 equivalent emissions indicator (kgCO2/m² year)
1.	S	63.90	0.00	15.34
2.	W	92.75	45.14	22.26
3.	E	92.75	45.14	22.26
4.	N	103.22	61.53	24.77

Table 6. Energy notation of apartment for total consumption

No.	Orientation	Energy notation / apartment
1.	S	B
2.	W	C
3.	E	C
4.	N	C

Classification in the class of energy performance for the studied apartment is shown in table 6.

Using the above mentioned software, and complying with its limits, we obtained as a result that the apartment facing towards the west has the same power consumption as the one facing east. It should be noted that an apartment facing north, located in the climatic zone II, requires a quantity of energy comparable to an apartment situated in the climatic zone III, facing south.

SOLUTIONS

In order to reduce the energy consumption of apartments located in blocks of flats in the existing habitable fund, it is necessary to envelope them and also to bring their envelopes up to current standards. This work aims to examine the differences in the enveloping, necessary for different apartment locations and orientations. The thermal rehabilitation of the studied apartment is suggested. This will be done by replacing the existing joinery with a new one that has a high thermal performance and by arranging a thermo insulating system on facade, made of various thicknesses of expanded polystyrene.

Solutions for study 1

Table 7 provides a comparative presentation of the thermal rehabilitation results for the apartment located in the four climatic zones. Exterior walls will be enveloped with expanded polystyrene, whose thickness varies according to the climatic zone. The exterior woodwork will be replaced with high performance joinery, having Rmin' = 0.77 (m^2 K/w).

Table 7. Specific energy consumption for heating the apartment rehabilitated based on location

No.	Location	Zone	Rehabilitated elements			Annual energy consumption for heating (kWh/m^2 year)	Energy notation/ apartment
			Exterior woodwork	Exterior walls			
			m^2 K/w	Insulation thickness	m^2 K/w		
1.	Constanta	I	0.77	2	1.32	38.42	B
2.	Oradea	II	0.77	4	1.78	40.10	B
3.	Cluj	III	0.77	11	3.37	40.31	B
4.	Suceava	IV	0.77	-	>	>41.00	B

It is to be noted that for the apartment having the characteristics mentioned in chapter 1, in order to save energy with heating, it is necessary to envelope with 2 cm of polystyrene in Constanta (climatic zone I), with 4 cm of polystyrene for facade in Oradea (climatic zone II) and 11 cm in Cluj (climatic zone III). Thus, these apartments will be categorized as class B of energy performance. In order to obtain comparable parameters in Suceava this kind of enveloping is not effective.

Solutions for study 2

Table 8 provides a comparative presentation of the thermal rehabilitation results for the apartment oriented in the four cardinal directions. Exterior walls will be enveloped with expanded

polystyrene, whose thickness varies according to orientation. The exterior woodwork will be replaced with high performance joinery, having Rmin' = 0.77(m² K/w).

Table 8. Specific energy consumption for heating the apartment rehabilitated based on orientation

No.	Climatic zone II Orientation	Rehabilitated elements			Annual energy consumption (kWh / m² year)	Energy notation/ apartment
		Exterior woodwork	Exterior walls			
		m² K/w	Insulation thickness	m² K/w		
1.	S	0.77	0.00	0.872	78.65	B
2.	W	0.77	1.00	1.09	75.53	B
3.	E	0.77	1.00	1.09	75.53	B
4.	N	0.77	2.00	1.32	72.39	B

It is to be noted that for the apartment having the characteristics mentioned in chapter 1, in order to obtain an equivalent energy consumption for heating with the necessary consumption for heating the south facing apartment, it is necessary to envelope with 2 cm of polystyrene insulation the apartment facing north and with 1 cm of polystyrene the apartment facing east or west. Thus, these apartments will be categorized as class B of energy performance.

CONCLUSIONS

The climatic zone in which the apartment is located has an influence of up to 123% upon energy consumption. The orientation of the apartment towards cardinal points has a significant influence of up to 62%. These differences determine the enveloping solution, the rehabilitation price and directly or indirectly the price of the apartment.

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Submitted: February 21, 2013 | Revised: April 25, 2013 | Accepted and published online May 19, 2013