ENERGY CONSUMPTION EVOLUTION IN CONSTRUCTIONS DOMAIN FROM ROMANIA

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Abstract: As in a building, it is unthinkable to conduct the main activities, in the absence of energy sources (electrical energy, thermal energy, gas, hot water, fuels, etc.), any consumption reduction-through a more efficient use of energy is reflected positively in the building budget. The less power we consume, the less money we shall pay for it. This think is valid only in the circumstances in that the energy consumption from building are metered, therefore only if we play what we consume. Because the energy is used in a building, in the shape of thermal energy for heating and household hot water preparation, electrical energy (electricity) for lighting and for electromechanical installations supply, the buildings require a certain quantity of energy, indifferent of destination. In this paper, the authors analyse especially the evolution of the energy consumption afferent to civil buildings, that of all goods, have the longest duration of use and participate with a percentage of 30...40% to the primary energy requirement.

Keywords*:* civil buildings, energy consumption, energy sources, metering, evolution.

1. INTRODUCTION

The *energy* is used in a building in the shape of thermal energy for heating and household hot water preparation, electrical energy for lighting and for electromechanical installation supply. The Romania's position in the geographical zone with temperate-continental civilization climate with excessive tints, as well as the current civilization level make about 40% from the primary energy consumed to the country level to be used in the shape of thermal energy for the heating of the public spaces and individual housing and for the consumption hot water production [1]. This percentage justifies the permanent interest given to the heating problem in the Romanian society.

On the line of durable development in constructions, performance levels record a continuous evolution. Thus, irrespective of the heating system type, the average duration of the heating period and the conventional outdoor air temperatures, it was pursued the obtaining of the comfort parameters in the residential, administrative and industrial buildings with specific primary energy consumptions as low, that lead finally to a small percentage of environmental pollution and heating costs bearable for the population.

Where thermal energy is delivered from a specialized production installation, by means of a thermal agent pumped into transport and distribution infrastructure to more consumers, we are dealing with a centralized system of supply with thermal energy (HSSC).

2. BUILDINGS CLASSIFICATION AND HOUSING FUND EVOLUTION [1]

Civil buildings, in that the man is the main user, can be divided into two big categories:

A. residential buildings, hostels, hotels:

a.1. individual buildings (single family homes, coupled, row houses);

a.2. multi-storey buildings with more apartments, buildings of type block of flats;

B. public or tertiary buildings (buildings with other destinations than dwelling houses) such as: hospitals, clinics, nurseries, buildings for educational, social and cultural buildings (theatres, cinemas, museums), public institutions (shops, commercial spaces, firms, offices, banks) and others industrial buildings.

Buildings with other destination than housing may be classified by:

b.1. mode of occupancy into buildings (with continuous occupancy or discontinuous occupancy);

b.2. class of thermal inertia (buildings with big, average or small inertia).

Irrespective of buildings destination, these must satisfy a series of quality requirements, that are basically: resistance and stability, safety in exploitation, safety to fire, hygiene, people's health, restoration and protection of environment, thermal insulation, waterproof insulation, energy savings and protection against noise.

The main constructive systems practiced for existing buildings were the following [3]:

1. Integral prefabricated buildings, with height regime preponderant of 5 levels, but also 9 levels, built between 1960-1990 (about 1.2 million buildings are approximately 37% of all apartments);
2. Buildings with mixed structure, being with frames and reinforced concrete structural walls, exterior walls BCA brick masonry or with prefabricated panels of facede, with height regim of 5 and 9 levels height of 5 and 9 levels;

3. Buildings with reinforced concrete walls, made using sliding formworks and strength structure of monolithic reinforced concrete frames, having shops on the ground floor (built in a small number);
4. Buildings with brick masonry structure, with height regime of 2 ... 4 levels;
5. Buildings with walls of wood, adobe (a mixture of straw and earth) or framework.

According to the Statistical Yearbook on January 1, 2000, our country's population was 22.455.000 inhabitants, Romania being situated on an average position in viewpoint of density (94 inhabitants/km^2). Population distribution by age groups indicates the constant process of demographic aging and, implicit, a decrease in occupancy of dwellings from 2.83 persons/dwelling in 2000 to 2.77 persons/dwelling in 201 (table 1) [1].

Table 1. Evolution of the population and of the dwelling fund

Item	Year	Population forecast [inhabitants]	Occupancy degree forecasted, [persons/housing]	Number of dwellings
1	1995	22.681.000	2,92	7.782
2	2000	22.455.000	2,83	7.923
3	2005	22.800.000	2,80	8.120
4	2010	23.200.000	2,77	8.375

Regarding the dwellings fund evolution in the country, as well as their level of endowment with equipement (table 2 and table 3), it observes a dwellings number increase.

Table 2. Dwellings d evolution

Item	Year	Number of dwellings		Habitable space	
		[pieces]	[%]	[$10^3 \cdot m^2$]	[%]
1.	Prior to 1980	6.999.000	88,3	236.566	86,9
2.	1981...1985	7.645.000	96,5	233.413	85,8
3.	1985...1990	8.006.000	101,0	146.847	90,7
4.	1991	7.659.000	96,6	258.518	95,0
5.	2000	7.923.000	100	272.039	100

Table 3. Degree of edowment with electrical and thermal installations, for the residential buildings

Item	Degree of endowment		Medium	
			Urban, [%]	Rural, [%]
1.	Dwellings equipped with central heating systems, characterised theoretically by mears of high energy efficiency		87,00	1,70
2.	Dwellings that are connected to a public network or have proper systems of consumption hot water preparation		92,00	4,80
3.	Dwellings that have:	- cold water	87,00	11,30
		- sewage	86,00	10,00
4.	Dwellings that have electrical connections for lighting and power outlets		93,00	82,40

On the one hand, this is due to the construction of dwellings for young people and families with modest incomes and the construction of dwellings from the population savings. On the other hand, this increase is due to the rehabilitation of a number of residential buildings from the existing dwellings fund, for the comfort standard improving.

In 2010, there were approximately 389 dwellings per 1000 inhabitants, their percentage depending on rooms number, as shown in Figure 1.

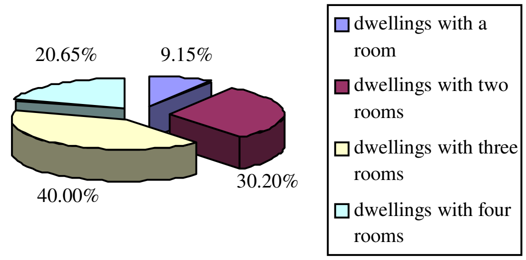

Fig. 1. Dwellings percentage depending on rooms number in 2010

It is observed that the dwellings with three rooms will be most numerous because they represent a minimum necessary for domestic development, when the purchase of a dwelling will be a problem hard to solve for a good time.

Also the energy consumption in the household sector by 2010 could be divided an classified both fuel type (table 4) and types of dwellings (Figure 2).

Table 4. Energy consumption in the household sector, by types of fuel

Item	Energy type	U.M.	In the residential sector	
			U.M.	PJ
1.	Solid fuel	$10^3 \cdot$ t	6,5	191,6
2.	Liquid fuel	$10^3 \cdot$ t	3,8	112,1
3.	Gaseous fuel	10 $\cdot m^3$	1,0	34,2
4.	Unconventional energy	PJ	0,7	0,7
	Total	-	-	**338,6**
5.	Electricity	TW·h	7,1	25,6
6.	Centralized heating	PJ	107,3	107,3

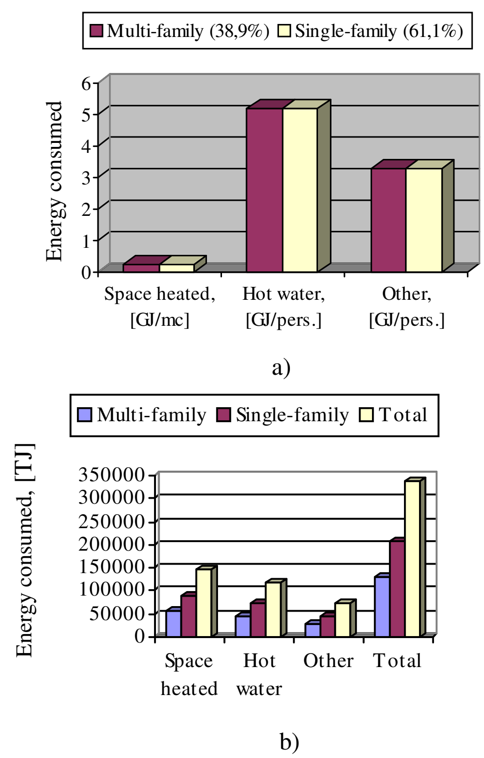

Fig. 2. Energy consumption by type of housing:
a) specific costs expressed in m^3/GJ or GJ/person;
b) the total costs, expressed in TJ

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3. ENERGY SUPPLY OF BUILDINGS

During cold season, the energy is used for thermal comfort insurance inside. This supposes the realization of a correlation between temperature and humidity. For this, it is necessary a correct heating and ventilation of the house. Otherwise, in the cold season, the dampnes (of walls) and the mildew can form on the walls of bathrooms and massive furniture bodies behind. The humidity can come from outside or onside. The air contains water as vapor. For example, at 0°C the air contains 5g water/m^3, and at 20°C the air can contain can contain 17g water/m^3. The damp air in contact with cold surfaces condenses, leading to gradual walls damping. A damp wall leads of three times more energy towards outside than a dry wall. In addition, the wall material damage appears in time.

Durring warm season, the energy is used for climate maintenance, because it appears the discomfort caused by high temperatures.
To save energy, in both cases it is necessary a correct insulation of the building envelope, both by improving thermal insulation (exterior walls, windows, roof, basement) and by maintaining of the heating and air conditioning installation in the good condition of operating. Lately, the climate maintenance installation number has increased much, and so the electrical consumption afferent to buildings.
It asks the question which is the percentage of the expenses and of the energy costs, in the invoice for the comfort level insurance for diverse buildings types and different energy supply systems (figure 3, 4 and 5) [2], [7].

Apartments (1)	
Heating (blue)	40,47 %
Household hot water (red)	35,48 %
Food preparation (yellow)	15,54 %
Lighting and labour saving devices (violet)	8,51 %
TOTAL	***100,00 %***
Row housing, coupled (2)	
Heating (blue)	41,62 %
Household hot water (red)	35,03 %
Food preparation (yellow)	15,23 %
Lighting and labour saving devices (violet)	8,12 %
TOTAL	***100,00 %***
Individual houses (3)	
Heating (blue)	53,40 %
Household hot water (red)	27,18 %
Food preparation (yellow)	11,89 %
Lighting and labour saving devices (violet)	7,53 %
TOTAL	***100,00 %***

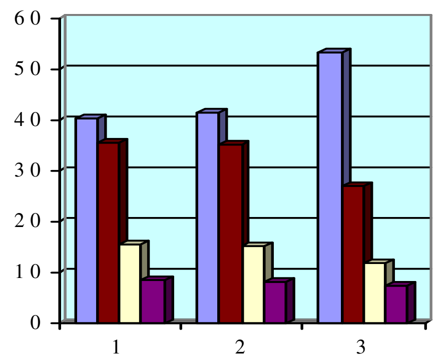

Fig. 3. The share of activities in the energy invoice for buildings supplied in the centralized system

Apartments (1)	
Heating (blue)	49,82 %
Household hot water (red)	20,58 %
Food preparation (yellow)	19,13 %
Lighting and labour saving devices (orange)	10,47 %
TOTAL	***100,00 %***
Row housing, coupled (2)	
Heating (blue)	50,77 %
Household hot water (red)	20,43 %
Food preparation (yellow)	18,58 %
Lighting and labour saving devices (orange)	10,22 %
TOTAL	***100,00 %***
Individual houses (3)	
Heating (blue)	62,32 %
Household hot water (red)	15,02 %
Food preparation (yellow)	13,88 %
Lighting and labour saving devices (orange)	8,78 %
TOTAL	***100,00 %***

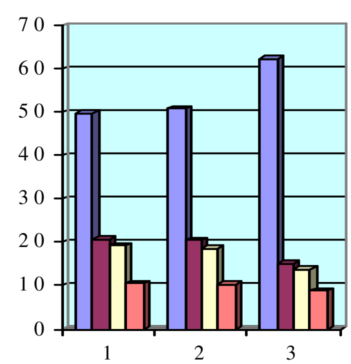

Fig. 4. The share of activities in the energy bill for buildings equipped with its own thermal power plant

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Row housing, coupled (1)	
Heating (blue)	61,19 %
Household hot water (red)	4,85 %
Food preparation (yellow)	22,39 %
Lighting and labour saving devices (orange)	11,57 %
TOTAL	***100,00 %***
Individual houses (2)	
Heating (blue)	73,09 %
Household hot water (red)	3,65 %
Food preparation (yellow)	16,28 %
Lighting and labour saving devices (orange)	6,98 %
TOTAL	***100,00 %***

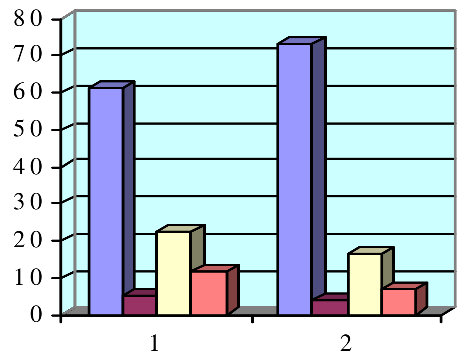

Fig. 5. The share of activities in the energy bill for buildings equipped with stoves for heating

In all cases, the main percentage of the expances for the energy services of the dwellings is owned by heating costs, irrespective of heat supply system type and of dwellings type (table 5).

Table 5. Percentage of the expances for the energy services of the dwellings

Energy consumption type	Apartament	Row housing, coupled	Individual house
Dwelling heating	45,15 %	51,18 %	62,94 %
Lighting and labour saving devices	9,49 %	9,97 %	7,74 %
TOTAL	**54,64 %**	**61,15 %**	**70,68 %**

These data are different from one geographical zone to another, from one family to another, being influenced by dwelling endowment and standards of living, implicit by family incomes.

At the national level, the average annual global consumption in Romania has decreased from 2,7 TEP/dweller in 1990, to 1,8 TEP/dweller in 2010, the world average being of 1,76 TEP/dweller. The power consumption is approximately 2000 kWh/(dweller·year), in that domestic consumption is of 340 kWh/(dweller·year) [5]. Comparative with the world level, this represents average value.

4. ENERGY IMPACT ON THE ENVIRONMENT

The correlations that exist between energy and environment are known. In all processes of exploitation, conversion, transport, distribution and utilisation of the all forms of energy, the environment is affected. The substances that result from these processes pollute chemically, visually, electrically, magnetically and sonorously the environment generally, but the living persons too (people, plants, animals). The chemical substances resulted from the fuels combustion (CO_2, CH_4, NO_x, SO_2) are the glass-house effect cause, that leads to the increase temperature environment.

For Romania, the emissions of CO_2 are about 5,2 tonnes/(dweller·year) and at the European Union's level these are of 7,3 tonnes/(dweller·year) [3].

The mode of solving this problem is provided in International Conventions, European Union and national development strategies.

A problem that was given its importance and less attention is given to it, is the problem of the forest that can counterbalance the emissions of CO_2. Both at world level and national, the forests have been cut down mercilessly and without judgment. In addition to climate influences, the forests lack produce soil erosion too. For example, in Dolj district the forests represent less than 45% as compared with the area in 1945 [7]. The forests have been cut before 1990 and after land appropriation. It was not planted and do not plant anything. In these circumstances, the process of desertification of the area south of Oltenia tends to enlarge to Craiova. Urgent measures and programs for reforestation are required, and the population must has an active rol. For this, campaigns of population informing on the effects that feel and see through the severe drought it the zone, in recent years, are necessary. The zones, the areas and the species that will plant, must be identified.

The environment problem must seen through respecting of the following principles [4]: the polluter has responsibility and he pay; the implementation of the environment politics in the main directions of activity (agriculture, industry, energy, transports, tourism, habitat and social life); the increase of the role of participation of the population, of the non-governmental organizations and associations, of local authorities to taking of decisions; the evaluation of the human activity impact on the environment; the subsidiarity principle – the actions undertake by the more efficient persons, in the prior directions and in the places with maximum effects; the development of the information, of the education, of the dialogue and of the transparency.

We will not insist on the known measures that must be followed, but we will insist on the necessity of the urgement and of the application of these measures.

The building as a medium [5]. As how it was mentioned, in the spaces of dwett but in those too in that different activities (education, health, culture, management, industry) are in progress, the realization of a microclimate (thermal, visual, olfactory and auditory comfort) is necessary for the assurance of a good productivity of the activity that is in progress. In an ailing building, a normal activity with healthy people cannot be in progress.

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The lack of heating generates low-temperatures, humidity, dampness of walls, mildew, there fore culing buildings. These produces discomfort (stress), but also diseases (rheumatism, cardiovascular ailments, ailments of the breathing apparatus), leading to the decrease of the intellectual work capacity of the pupils and of the students (in the education spaces and at home), to the decrease of the physical and psychic recovery capacity of the which stay in the ailing buildings. In addition, the diseases lead to the increase of the medicines consumption, of the hospitalization days number, of the sick leaves days number, of the number of those who are pensioned ahead of term. Last but not least, the work capacity and therefore yhe production achieved decrease. The investment made in the educational and professional preparation of the people cannot recover.

It imposes a financial analysis at the macroeconomic level, so at the national level, that to compare the expenses from accounting with the health problems, with the funds that would spend for the improvement of the system of supply with electric energy necessary for the dwellings heating.

It is therefore necessary both a quantization of the supplement ary health expenses, because of the thermal comfort lack (the buildings heating), and their comparison with those for the ailing buildings recovery.

Also, it is imposes an attentive analysis to the use of the actual decentralised systems of climatizing, to the efficiency and the costs of these systems, for a more responsible use of their own, therefore for the electrical energy consumption decrease. Projects for the complex three-generated installations use (electrical energy, thermal energy and cold) at the important buildings (hospitals, space of education, administration, banks) can make.

Also, it is imposes a more attentive analysis of the manner of calculation of the expenses for heating, taking dwelling blocks particularities into account, in the first time. Indifferent by mode of heating of the blocks, to the expenses calculation well must be taken into account the norms of heating requirement calculation, from that the supplementary surfaces of the heating devices result for the flats from the certain positions (the last floor, ground floor, corner, north). These assure the comfort for those which dwell in the rest of the flats. One thing is clearly, simply, knew and that must be taken into account as to the calculation of the repartition of thermal energy consumed for heating.

The manner of assurance of the funds for thermal rehabilitating of ailing buildings is an important problem that must be considered. It is known that a good part of families, which in blocks of flats, are poorly and do not have money to pay for the energy consumption. They unplug and in this way the temperature into buildings decrease, with implications on the health condition. So in the future will must found ways through that the money necessary to the buildings treatment to be assured from the actual funds of subsidization of the heating, for these families.

Also, concrete legislative and financing solutions will must found for the use of the regenerative energy sources, that to cover a part of the electrical and thermal energy requirement. All these will lead to a decrease of the global energy requirement and therefore to the decrease of the reccurency effort for the importation of energy.

5. FACTORS THAT INCLUDE THE IMPACT OF THE ENERGY EFFICIENCY MEASURES

Since 1989, the international organizations have tried to implement the energy efficiency projects in Romania. In spite of the important financial efforts, the energy efficiency measures have not always had the expected social impact.

There are more factors that have contributed to this, of that the most important factors were [3]: the relative decreased price of fuels; the relative decrease price of the energy; until recently, the population was not awarely of the energy saving necessity; energy saving methods are not knew; in the case of the buildings connected to the cogeneration system, a direct connection between the consumed thermal energy (for heating and in the form of householding hot water) and the costs paid for this consumptions was not existed; at the governmental level, a coherent politics of supporting of the energy efficiency measurement was not existed; the beneficiaries dispose not of funds for the energy efficiency measurement application.

An analysis of the view of development of the systems of supply with thermal energy produced centralized in Romania, must take account of the following main factors [2], [6]:

1) Factors of local-zone nature: - The present situation from point of view of the consumer supply with heat; - The technical state, the remanent lifetime and the economical performance of the system of supply with heat; - The type of the consumers from zone from point of view of the electrical energy and heat requirements structure and of the evolution of these requirements in the near, average and long duration perspective; - The social-economic situation of the consumers, under the aspect "of the financial capability" of payment of the energy view; - The present situation and the primary energy resources evolution in perspective, from point of view of the classical fuels used in the perspective, of the industrial energy waste and/or urban reusable energy waste products, of the reusable energy resources available in the zone.

2) Factors of macro-economical nature: - Policy looking to the primary energy resources usable at the level of the country and of the diverse specific geographical zones;- The property forme looking to the existent and perspective sources of supply with heat and possible with electrical energy, at the level of the objective analysed in the present and in perspective; - *The tariff policy looking to: the* fuel consumed by diverse categories of consumers, the electrical energy produced by the power plants belonging to state and the electrical energy produced by the sources of the auto-producers or of the independent producers, the heat produced from point of view of the local tariffs adoption on characteristical types of the consumers; - The legislation and the clear and undiscriminator settlements for the all energy producers (irrespective of their property form) from the energy domain, that refer to the electrical and thermal energy market existence and to the access to this – the consumers

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limit in the supplier choise, the transparance at the specific production costs establishment for the all energy producers, the undiscriminator tariffs for the same consumers types and the same conditions of consumption of the fuels and of the sold energy; - The ensemble energy policy of the country, with the emphasizement of the cogeneration domain policy materialized through: the position under the aspect of the cogeneration (keeping into account of hers advantages: the environment pollution decrease in the energy production domain and th total energy invoice decrease at the consumers), the position under the investors aspect (keeping into account of taxes, fees and creating a climate of long – term financial stability by order of 15…20 years, specific to investments in the energy domain).

6. CONCLUSIONS

In life, therefore in the life of a building too, nothing can be concepts without energy. But, the human development generates paradoxes (the life standard improvement requires the energy consumption increase, that in the context of ENERGY – ENVIRONMENT – CONSUMER threatens the human health and the global economy). In addition, the interest for the energy (oil) generates conflicts (1973, 1991, 2003). For that, it is necessary the application of some principles balanced in the energy domain: accessibility, availability (quantity, quality), acceptability.

People must do something, not wait for the disaster. An educated and informed man can have an important contribution to the energy saving. In this action of energy saving, therefore of environmental protection, all people must insolve, especially children on which we must teach them to value the energy and to respect the environment. For this, the projects of information are required for to tell us what we do to save the energy and for to have a clean environment and saving money. For energy saving, global strategies are required and they must involve the energy and the environmental and must made from to familial level, dweller association, locality, until national and international level.

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