A COMPARATIVE ANALYSIS OF THE BUILDING STOCK IN EU AND ROMANIA

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Abstract: *Buildings occupy an important role in our modern society. However, the existing buildings have a very low thermal protection, leading to high levels of energy consumption making the buildings sector among the most significant CO_2 source in Europe. Even if new buildings have high performance levels, the majority of the building stock is represented by older buildings which require renovation work. The European Union has imposed important reduction of specific energy consumption in all sectors, but energy conservation in buildings remains a key element in obtaining the sustainable development as evidence of human solidarity beyond the limits of space and time.*

In this paper the importance of the energy reductions in the building sector is outlined and both the energy policy and building stock statistics in EU and Romania are presented. Moreover, some measures and initiatives at European level are discussed, focusing on some important themes: demography, housing stock age and energy requirements.

Keywords: construction; building sector; energy consumption; building stock.
JEL Classification: A12; F64; L74.

INTRODUCTION

The worldwide economic impact of the construction sector is considerable. Its global market volume consists of almost 3 trillion US dollars and accounts for as much as 10% of world GDP, function of the accepted definition of the sector. The construction sector is the biggest industrial sector in Europe (10-11% of GDP) and in the United States (12%). In the developing countries it represents about 2-3% of GDP while in most countries it accounts for more than 50% of national capital investment. It provides almost 7% of world employment with a total workforce of about 111 million workers, 74% of which are in low-income countries (UNEP, 2003).

The global population has risen with more than 100% since 1950. Most of this increase has occurred in the developing countries. If the actual demographic trend continues, in the next two decades, around 98% of world population growth will happen in developing world. Presently, almost 75% of the people in developed countries already live in urban areas and the share of the population living in cities is expected to reach 40% before the end of this decade. This percentage was less than 20% in 1950. These demographic trends translate into an increased demand for buildings and infrastructure (UNEP, 2003). The residential sector has experienced annual growth rates around 1% but most countries have encountered a decrease in the rate of new build

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construction in the recent years, reflecting the impact of the current economic crisis on the construction sector.

Building sector accounts for 42% of final energy consumption at European Union level but it has the greatest potential in obtaining energy and emissions reductions. Energy efficiency work can provide half the emissions reductions needed by 2050 (80% compared to the level of 1990). Moreover, investments in energy efficient buildings have negative costs, which can bring between 12 and 60 Euros for residential houses and between 74 and 107 Euros in the industrial sector per ton of CO_2 not emitted into the atmosphere.

1. CLIMATE CHANGE IMPACT ON WORLD'S ENERGY POLICY

Recently, it has become increasingly clear that human society cannot continue with the current socio-economic models. The progress of human civilization was based on excessive consumption of energy and resources that has led to an increased dependence on oil, natural gas and coal. Currently almost 85-90% of total energy consumed worldwide comes from fossil fuels. Therefore, the concentration of greenhouse gases has increased continuously, and if the present rate continues, the concentration of carbon dioxide (CO_2) will exceed the accepted maximum limit of 450 ppm (parts per million). After some scenarios, CO_2 concentration will exceed 750 ppm (MacKay, 2009), global average temperatures will rise by a value between 1.8 – 4.0 °C, and in the worst case scenario by 6.4 ° C (Solomon et al., 2007).

The considered reference temperature is 2.0 °C above the level at the beginning of the industrial age. At the present day it has risen with almost 0.8 °C. Overcoming this reference temperature will lead to an increase of the climate change intensity with irreversible and potentially catastrophic risk on the planet. The exact causes are still debated, but the effects have become faster and more severe than initially expected. Among them, of a severe gravity are considered to be water shortages, melting glaciers, floods and rising sea and ocean levels.

Fighting climate change can be effective only if global actions are enforced. A first important step was taken in the Kyoto conference in 1997, when the resulted protocol was ratified by almost all countries. Five years before, at Rio de Janeiro, the *sustainable development* concept was imposed, which was initially seen as a solution against the continuing degradation of natural environment. It stated a basic principle accepted today: to satisfy the needs of today's generation without affecting the generations of tomorrow. With time, this concept has grown to include a

balance between socio-economic systems and the natural capital and to ensure equity between countries and not only between generations.

Taking into account the progress made so far, the 2.0 ° C temperature target will not be obtained earlier than 2050. Therefore, at the international meeting in Copenhagen in 2009, the leaders of EU member governments have pledged to reduce emissions by 30% by comparison to the value of 1990, if the approach was supported by other developed countries. Because of the opposition of U.S., China, Brazil, South Africa and India, the conference ended in a failure, any reference related to global temperature reduction targets and emissions of greenhouse gases by 2050 being removed from the treaty.

A few years later, amid the economic crisis, the lack of firm political decisions taken in Copenhagen and new information regarding climate change (concentrations of CO_2, CH_4 and N_2O in 2010 reached the highest level recorded so far; the United Nations recommended in its report of 23 September 2011, that the target of CO_2 emissions reductions must increase from 6 to 11 Gt by 2020, in order to achieve the target of reducing with 2 °C the average global temperature; the new scenarios put the average temperature increase to at least 3.5 ° C by 2100), delegates from 195 countries met in Durban, South Africa, from 28 November to 11 December 2012. The conference proved a greater success than in Copenhagen because several important decisions were taken to fight climate change (Tuddenham, 2012):

- Kyoto Protocol, which expired at the end of 2012, has been extended from January 1, 2013;
- Big polluters (U.S., China and India) agreed to sign the first document to be legally obliged to comply with a series of commitments;
- Differences between the measures taken so far and the need to achieve the 2 ° C are stated clearly;
- Countries are no more classified as developed and developing countries, which produced inequalities between the assumed objectives.

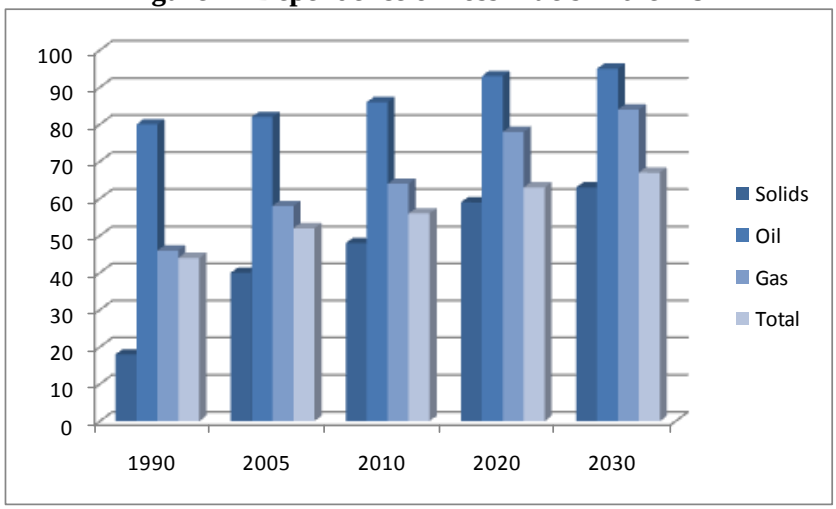
2. ENERGY POLICY AND BUILDING STOCK IN THE EUROPEAN UNION

2.1 Energy policy

Dependence on natural gas imports in EU will increase from 57 to 84% until 2030 and from 80 to 93% for oil (Figure 1). Therefore, efficient use of energy resources is above all an economic reason, even before considering the benefits of reducing greenhouse gas emissions. It is estimated

that the implementation of European directives cost of gas and oil imports will fall by 50 billion per year until 2020.

Figure 1 - Dependence on fossil fuels in the EU



Source: prepared by author based on processing data from European Commission available at http://ec.europa.eu/research/energy/eu/index_en.cfm?pg=policy-energy-and-climate-policy.

Although the treaties of Maastricht, Amsterdam and Nice have not provided a common energy policy, the European Union (EU) has developed an integrated energy and climate policy approach that pursues the following key objectives:

➢*Energy security*, in order to coordinate the demand and supply of energy in the EU according to the international context;

➢ *Competitiveness* of European economies, to ensure development and affordable energy;

➢ *Sustainability*, to combat climate changes, to promote energy efficiency and renewable energy.

European Commission estimates the investment costs necessary to achieve a low carbon based economy at 0.5% of GDP between 2013 and 2030. The prospects are encouraging, emissions of the EU 27 member states in 2006 were already 10.8% below those of 1990, although the EU economy grew during this time by approximately 1.5% per year. The economic crisis has certainly played an important role, decreasing fossil fuel consumption by 5.5% in 2009, while the share of renewable energy in the European energy mix grew to 10.3%. Moreover, the annual cost for achieving this goal has become increasingly smaller.

The 30% emissions reduction target becomes more and more feasible both technically and economically, while the European leaders are promising reductions energy and fuel consumption in all sectors by 2050. The European Commission estimates that switching to the 30% target would

generate an extra 2 million jobs to the already existing 3.4 million which provide almost 2.5% GDP in EU, representing about 40% of global market share.

2.2 Building stock

EU territory covers around 35° geographic latitudes (from the 36º parallel in Greece to 70º parallel in northern Scandinavia). Therefore climatic conditions can vary significantly from one country to another. For example, the average exterior temperature in January is -6 °C in Helsinki while in Athens is +10 º C. In temperate and cold climates, approximately 80% of total energy consumption is used for space heating, 12% for heating hot water and the remaining for consumer electronics, communications and lighting (Eicker, 2009). The large energy consumption for heating results mainly from the insufficient thermal protection of existing buildings, which account for almost 90% of the total housing stock. However, in southern regions, energy consumption for heating is, in absolute terms, at the same average value of 50 kWh/m^2/year due to low values of thermal resistance imposed on the envelope and low efficiency building services.

Lately, there has been given a considerable effort toward classifying the EU existing building stock in order to have a better assessment of the existing data. Such an investigation was performed by Nemry et al. (2010) using Eurostat data from 2005. In order to obtain comparable climatic boundary conditions, the heating degree days (HDD) of EU-25 countries were utilised as an indicator to group similar zones in the EU-25 countries (Table 1).

Table 1 - Grouping of countries according to heating degree days

Geographical zone	Countries	Population, 2003 (10^6 inhabitants)	Building stock (in 10^6 m^2)
Southern Europe	Cyprus, France, Greece, Italy, Malta, Portugal, Spain	181.1	6378
Central Europe	Austria, Belgium, Czech Republic, Denmark, Germany, Hungary, Ireland, Luxemburg, Poland, Slovakia, Slovenia, The Netherlands, United Kingdom	252.3	7909
Northern Europe	Estonia, Finland, Latvia, Lithuania, Sweden	21.3	624

Source: prepared by author based on processing data from Nemry et al. 2010, p. 978.

In 1995, among 150 million existing residential dwellings in the European countries, approx. 66% are single family homes, with a percentage of more than 80% in Germany, Ireland, Luxembourg and the UK (Gavrilas, 2006).

An important share of the building stock in EU countries is older than 50 years, while many buildings in use are hundreds of years old. More than 40% of the residential buildings have been constructed before the 1960s when restrictions on building energy consumption were almost nonexistent. UK, France, Denmark, Sweden, Czech Republic and Bulgaria have the largest share of old buildings. With a few exceptions, it can be stated that the building stock has doubled between 1961 and 1990 (BPIE, 2011).

There are two major phenomena that now influence the European Union building stock in the European Union. Due to the population decline, fewer children and younger single person households, dwellings across the EU become smaller and smaller. On one hand the population decline reduces the housing demand, but on the other hand the larger number of smaller households will balance the decline. Another important change in the past decades was the change in tenure form, generally from renting to owning.

Housing stock in Europe changes slowly in quality and numbers. Although there are thousands of dwellings being built annually, new constructions account only for a few percents of the existing housing stock. Therefore, the quality profile of the dwelling stock changes can be considered to have low impact on the energy profile in the building sector.

3. ENERGY POLICY AND BUILDING STOCK IN ROMANIA

3.1 Energy policy

Romanian energy policy has been set in line with the EU requirements. The set targets for the renewable energy consumption are ambitious. The proposed target in 2010 for the consumed electricity from renewable energy sources was of 33% (including nuclear power) with an increase to 38% in 2020. Romania has taken advantage of the opportunities related to large scale hydropower projects, but the potential for small scale hydropower projects has remained largely untapped.

Even if our country has favourable conditions for renewable energy production, so far many potential investors have been hesitant to invest in Romania due to uncertainty related to the required legislation, the high level of corruption and the bureaucratic processes. However, by far, the most promising opportunities come from wind energy. The wind energy potential is estimated to be around 23 TWh, largely located in the eastern part of the country. In the recent years there has been a lot of investment from large companies like CEZ, Energias de Portugal, RWE and Enel.

The largest percentage of energy reduction comes from the residential sector. According to present official evaluations, the majority of buildings in Romania are classified between C and D classes on the energy certificate level. There are voices that consider this evaluation to be too optimistic and that in reality most buildings could be closer to an "E"-standard (BPIE, 2012). Given the low thermal performance of the building stock older than 15 years, the energy consumption for heating is almost twice the equivalent of other European countries.

3.2 Building stock

The housing stock in Romania consists of approximately 8.2 million dwellings concentrated in some 5.1 million buildings. The majority of dwellings in the urban area (72%) are represented by blocks of flats, while in rural areas the majority (94.5%) is represented by individual dwellings. There are around 81 000 blocks of flats, making about 2% of the building stock but which account for 37% of the dwellings in Romania.

In urban areas 23.5% of the buildings can be found, which is more than half of residential units (52.54%), while in rural areas are 3 times more buildings than in urban housing. As a result of privatization of the housing stock, housing is now privately owned 97.2% of all households while the state-owned housing represents 2.6% of the building stock. Over 50% of private dwellings and over 75% of the state property are found in urban areas (BPIE, 2012).

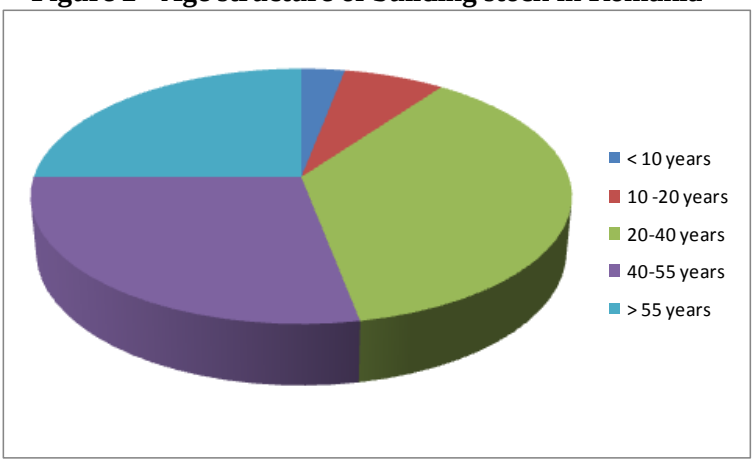
The largest share of buildings is represented by the single family residential (95% of the existing housing stock), mostly built before 1989. Most of these homes are located in buildings with an age between 15 and 55 years, characterized by an advanced degree of wear and low thermal insulation.

Percentage age of dwellings in our country in 2001 was as follows (Pavel et al., 2006):

- Under 10 years old: 3%
- 10 to 20 years old: 7%
- 20-40 years old: 37%
- 40-55 years old: 28%
- Over 55 years: 25%

The graphical representation of the current building stock in Romania is presented in Figure 2.

Figure 2 - Age structure of building stock in Romania



4. EU POLICY IN THE BUILDING SECTOR

CO_2 emissions need to be reduced with the absolute urgency. In Europe there are three main types of actions being taken: actions for climate change mitigation, adaptation measures for construction and measures on educating residents.

The CO_2 approach against the climate change consists of finding solutions that reduce the amount of carbon dioxide emitted to the atmosphere. Further developments of present technologies (fossil fuels and bio fuels, coal and carbon sequestration, nuclear fusion and fission, amongst others) reduce CO_2 emissions without significant changes in the contemporary energy scenario, with smaller financial costs.

The energy savings approach in the buildings is focused on the energy losses reduction, on managing energy gains in the cooling and heating seasons and by improving the equipments efficiency. This negative energy approach favours consumption reduction and behavioural changes, which can be translated into less emissions and smaller energy needs.

Given the limits on the extent and speed of the application of carbon-free energy sources, it is important that a significant absolute reduction in the energy demand to be achieved over the coming decades. Reductions in the energy intensity (annual energy use per unit of floor area) of new buildings by a factor of 3–4 relative can be achieved and that reductions in the energy intensity of existing buildings by factors of 2–3 can be accomplished through comprehensive renovations (Harvey, 2009).

European Parliament Directive on the energy performance of buildings (Directive 2010/31/EU), reiterates the need to reduce emissions of greenhouse gases by 20% by 2020. The residential sector is responsible for almost 40% of total energy consumption and 24-36% of total

CO_2 emissions (values vary depending on the author). Energy saving potential is high, in EU being estimated at around 20%.

As previously mentioned, reducing energy consumption is a priority assumed by the European Union. If building energy efficiency is improved by 22%, 45 million tons of CO_2 will be released into the atmosphere, which is about 14% of the target by 330 million tons. With the implementation of European Directives on the energy performance of buildings, in force since 2003, most European countries have increased the minimum thermal resistance values allowed to reduce heat loss through the building envelope.

The main directions of obtaining energy savings proposed by the EU are: construction of energy efficient buildings (passive houses with minimal energy consumption with zero energy, zero carbon emission, energy independent, and so on), the upgrade of existing buildings with energy efficient equipment (heat pumps, heat recovery systems, rainwater collection, solar panels, wind turbines, etc.) and physical and thermal rehabilitation of buildings.

Brito et al. (2012) quantified the separate share of these strategies in obtaining global potential energy savings between 2020 and 2050 (Table 2). Consumption reductions from other sectors were considered to be irrelevant for the study or absorbed by population growth.

Table 2 - Potential of energy savings in buildings and overall reduction in 2050

Strategy	Target	Energy savings	Overall reduction in 2050
Construction of energy efficient buildings	1% / year	95%	25%
Upgrade or retrofitting	2% / year	50%	23%
Rehabilitation	2% / year	25%	9%

Source: prepared by author based on processing data from Brito et al., 2012.

By the year 2050, energy targets can only be achieved through simultaneous application of all three strategies, although from the previous table the importance of constructing energy efficient building and equipping existing buildings with energy efficient equipment can be observed. Although it can seem that the impact of thermo physical rehabilitation of buildings is small, its importance cannot be neglected due to the large share of old buildings. It is estimated that in 2050, 60% of residential areas will be represented by old buildings (Eicker, 2009). Building retrofitting can provide energy saving and ensure interior comfort for the occupants.

CONCLUSIONS

Climate changes are the greatest risk facing mankind in the last millennia, threatening the natural environment, the global economy, human lifestyle, security and safety of all.

Energy from fossil fuels is becoming more and more expensive and if the current situation continues, the energy price will be economically unbearable for most of the population. Moreover, the rising energy price also increases the price of new efficient materials needed for building's retrofitting. So far the safest and most accessible form of clean energy is saved. In this way, energy conservation in new buildings and in existing thermal rehabilitation has become a widely accepted necessity.

With their potential to deliver high energy and CO_2 savings, as well as many societal benefits, energy efficient buildings have an increasingly important role in the construction of a sustainable future in Europe.

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