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## Environmental and Economic Aspects Associated to the Energy Sector

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*The energy sector is one of the most important sectors of activity, with an significant impact both on the economy and also on the environment. This paper aims to analyse and evaluate the major economic and environmental issues associated with the energy sector. Among the environmental aspects are analysed those related with the extraction, transport and storage of fossil fuels, the combustion of fossil fuels and the aspects concerning the management of wastes generated by the energy sector. The economic aspects related with the energy sector that are reviewed are the increase of energy consumption, the limited resources of fuels, the significant fluctuation with a growth tendency of the price, the dependence on imports*

**Keywords:** energy, fossil fuels, environmental protection, energy efficiency

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### Introduction

Climate change represents one of the greatest social, economic and environmental global threats. This phenomenon could affect the basic elements of life throughout the planet: access to water resources, food production, health and the environment. As a result of the global warming, hundreds of millions of people will be threatened by the devastating effects of the flood, lack of food or water.

Climate change may have a very serious impact on the economic growth and development. Actions on climate change are necessary in all countries around the world, and should not hinder the economic growth of the rich or poor countries.

Some considerations on the energy sector are necessary in the context of greenhouse gases generation and also on climate change.

Through the combustion of fossil fuels, the energy sector has a major contribution on the generation of greenhouse gases emission, mainly carbon dioxide. Reduction of the resulted pollutant emissions represents an important measure for environmental protection and also for the improvement of the human health condition - major requirements in the strategy of sustainable development of the society – being well known the association of the greenhouse effect with climate change.

Because of the limited resources of fossil fuels, at global scale, the energy production from renewable or alternative sources is increasing. In order to reduce GHG emissions, short-term trend is to promote efficiency and rational utilization of energy, while the long-term trend is the replacement of the consumption of non-renewable resources with alternative technologies based on the use of renewable sources and with low-emission of pollutants.

## **Environmental aspects associated with the energy sector**

### **The extraction, transport and storage of fossil fuels**

The activities of extraction, transport and storage of fossil fuels can produce a number of effects on the environment: pollution with crude oil/oil products, volatile organic compounds, methane, sound pollution, waste generation.

In the process of extraction of fossil fuel, are generated emissions of methane and carbon dioxide. Extraction and primary processing of solid fossil fuels, and also the processes of extraction and loading of liquid and gaseous fossil fuels, have a significant impact on the environment.

The transport of fossil fuels may constitute a significant source of environmental pollution, both as a result of emissions generated by burning fossil fuels, energy required for transport, in the case of oil and coal, and as a result of possible pollution episodes during this activity.

The storage of fossil fuels is another important element that can cause major damages to the environment. Both in the case of oil and natural

gas are a danger of explosion in the event of an accident, but also coal has spontaneous combustion risk under certain conditions.

### **Combustion of fossil fuels**

Combustion of fossil fuels is the most important source of emissions of carbon dioxide, the most common of the greenhouse gases. The concentration of CO<sub>2</sub> in the atmosphere is increasing, causing concern about the degree of solar radiation containment, which will result in increasing the average temperature of the Earth surface.

Emissions of greenhouse gases generated by the energy sector accounts for the largest share of the total GHG emissions globally. For countries not listed in annex I to the United Nations Framework Convention on climate change, future GHG emissions from the energy sector were in the last two decades to about 75 % of the total emissions generated by this group of 41 industrialized countries.

Through the combustion of fossil fuels, other greenhouse gases are also emitted into the atmosphere (nitrogen oxides, sulphur dioxide), which as a result of the reactions with water vapour in the atmosphere give rise to acid rain which have an impact on both the natural environment and also to the built environment.

### **Aspects concerning the management of wastes generated by the energy sector**

The main types of wastes arising from the activities in the energy sector are ashes, residues, oil waste, and transformers which have become waste.

Ash of thermal power station is produced through combustion, in suspension, by the fine grinded coal. Burning fuel has generated and continues to generate huge quantities of ash content, which are stored into dumps.

Electrical transformers are loaded with synthetic or mineral oils that enrich during operation in PCB, substances which belong to the category of persistent organic pollutants. These devices can cause accidental environmental pollution, also from oil leaks during the period of operation and in time by transforming into hazardous waste, which can endanger the

human health and the environment, and also block the resources of the raw material necessary to develop the new products.

Water pollution with petroleum residues is a particularly serious problem. Accidental discharges of petroleum products in water or soil can affect both the surface water, and the groundwater. The consequences of such pollution on the organoleptic properties of water, on aquatic fauna and flora are particularly harmful and sustainable.

### **Issues related to the use of renewable energy sources**

#### *The use of wind energy*

The location of wind turbines on holdings situated in areas which could attract a large number of birds or bats, such as migration routes may have a negative impact on biodiversity. For this reason, for wind farm projects, as well as for any changes made to the existing central winds, studies of the impact assessment are realised.

#### *The use of water energy*

The use of hydro-power may lead to problems in terms of environmental impact. The construction of a hydroelectric station involves the construction of an accumulation dam that may affect flora and fauna area and sometimes can cause conflicts when it is located in proximity to national parks or when the water level of the dam covers localities.

The hydro-power stations can change the landscape and can affect ecosystems, the variety and number of species and also the water quality by concentrating into salts. Also, in areas where there are hydroelectric power stations, the climatic disturbance may occur because of the excess of moisture.

#### *The use of geothermal energy*

The exploitation of geothermal water resources can result in a negative impact on the environment as a result of the unstable soil in the area, with the danger of low-intensity earthquakes. Also, "cooling" of the areas with geothermal activity, after several decades of intensive use, can limit the period of operation, although it is a renewable source.

#### *The use of solar energy*

The negative effects of the use of solar energy are related to the fact that most photovoltaic cells contain nitrogen trifluore, a pollutant that can

persist in the atmosphere around 550 years, considered among the first five greenhouse gases that will be included in a post-Kyoto agreement.

#### *The use of biomass*

The main negative effect on the environment associated with the use of biomass for power generation is related to the effect of cutting the trees, because they act like pools of absorption.

### **Aspects on the use of nuclear energy**

The operation of nuclear power stations is similar to that of thermo stations, except that the nuclear energy required to produce the steam is produced by fission nuclear reactions of isotopes.

Alongside the positive elements of the nuclear energy use, we should also highlight the negative aspects from the point of view of the environmental protection.

In addition to the serious safety problems in the usage and/or in the event of an accident, a major disadvantage associated with the use of nuclear energy is the generation of radioactive waste that can be extremely dangerous. These wastes may persist thousands of years and require proper storage in specially equipped spaces.

At the same time, the nuclear power plants may create environmental imbalances as a result of the use of large amounts of water needed for cooling systems, by radionuclide content of the emissions into the air and water, as well as through radioactive waste products.

The pollution is manifested in all stages of the energy cycle-production, and also a part of the radioactive material continues to be extremely dangerous for several years.

### **Accidents during the process of obtaining the energy**

The production, distribution and consumption of electricity can create an impact on the environment in the event of accidents, such as:

- accidental oil spills from the electric power equipment (power transformers, circuit breakers, high and low tension equipment coils) during operation or maintenance;
- accidental overflow of electrolyte caused by improper handling of the batteries from the stations;

- the appearance of eruptions, fires and accidental spills of oil and water in the cellars of the extraction of crude oil rigs and natural gas, with effects on the soil and ground and surface water;
- fire, accidental spills of oil, fissures of the tanks from the storage and treatment of crude oil stations;
- possible accidents related to fire, fissure of the facility which leads to the discharge of water to the compression and drying stations.

## **Economic issues related to the energy sector**

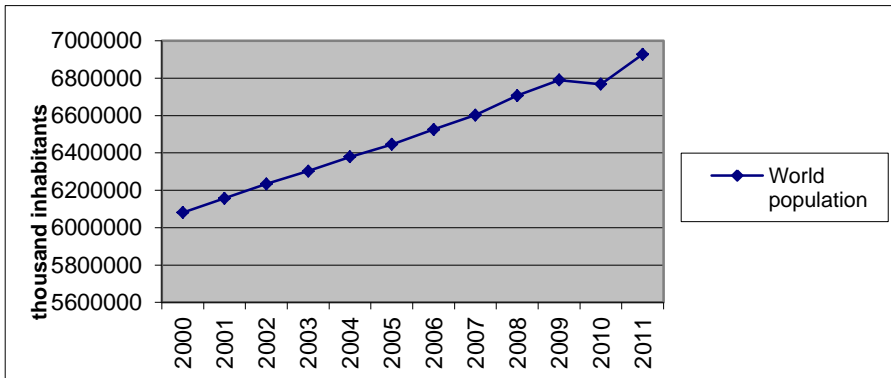
### **Global energy consumption increase**

Population growth and improved quality of life due to technological progress and economic development have caused a continuous increase in energy needs. This trend has resulted in increased energy consumption globally, affecting the generation of greenhouse gases and therefore the impact on the environment and the economic sector.

Directing the development towards technologies that generate a lower level of the greenhouse gases emissions is the premise to reaching a more efficient economy.

### ***Demographic evolution***

In the period 1960-2010, Earth's Population has doubled, reaching 7 billion inhabitants at the end of 2011, with an increasing tendency. During this period, the population growth can be attributed to the demographic growth from Asia, Africa, and the Latin America. Asia is the most populated continent (more than 60 % in 2010) with 4.16 billion inhabitants, followed by Africa with 1 billion inhabitants, meaning 14.8 % of the population of the Globe.



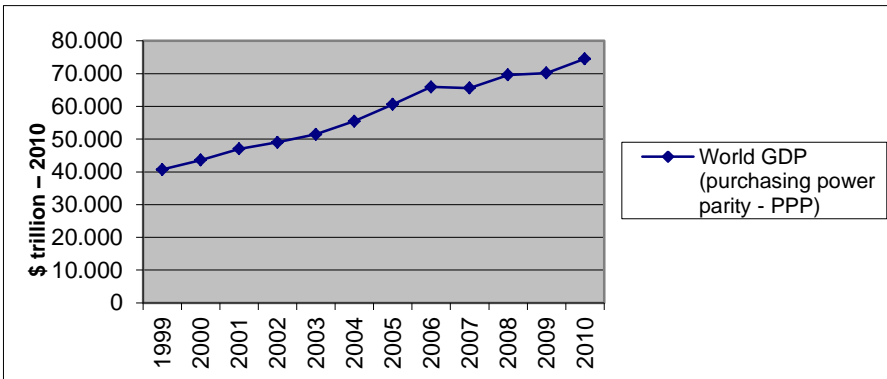
**Figure 1:** World population, 2011 (thousand inhabitants)  
*Source: CIA World Fact book*

In 2010, the European Union (EU-27) accounted for 7.3 % of the total population of the Planet, with a density of 116.7 inhabitants/km<sup>2</sup>, higher than in the United States, but lower than the values recorded in Indonesia, China, Japan, India or in South Korea.

### ***Evolution of the gross domestic product at the global level***

The gross domestic product (GDP) is a global indicator of the economic growth. GDP represents the value of all final goods and services produced in a country in a given year. To ensure comparability of data between countries, the indicator used is the GDP calculated at the purchasing power parity (PPP), which represents the amount of the sum of all goods and services produced in a country or group of countries, valued at the prices from the United States. This way of expression is used to bring to a common denominator of living conditions and utilization of resources in many countries, thus ensuring the data comparability.

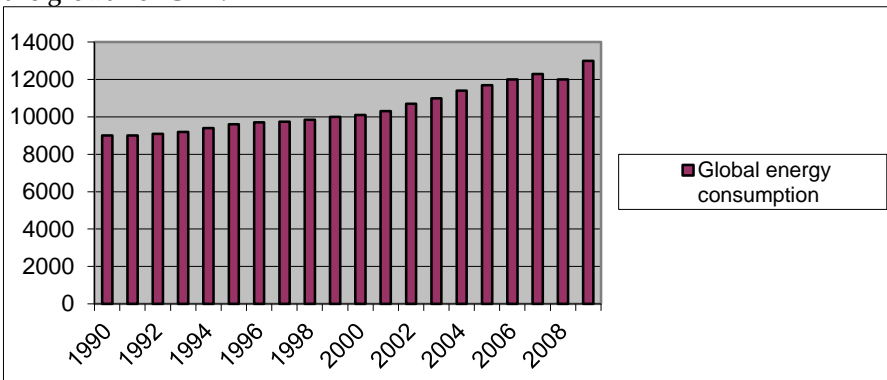
Figure 2 presents the worldwide evolution of the GDP calculated on the base of the purchasing power parity that corresponds to the dollar in 2010.



**Figure 2:** The evolution of the World GDP (purchasing power parity -PPP) (\$ trillion) - 2010

Source: CIA World Fact book

Consequently the consumption of energy at the global level has followed an uptrend registering an increase of about 30 % in the period 1990-2010, as a result of the population growth, technological progress and the growth of GDP.



**Figure 3:** Global energy consumption, 2010

Source: <http://yearbook.enerdata.net>

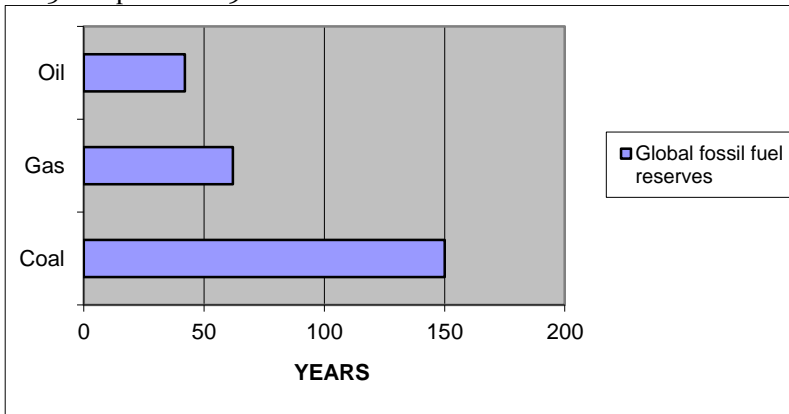
**Limited resources of fuels and the significant fluctuation with a growth tendency of the price**

Due to increasing global energy consumption, the problem that arises is fossil fuel reserves getting lower and increasing prices trend.



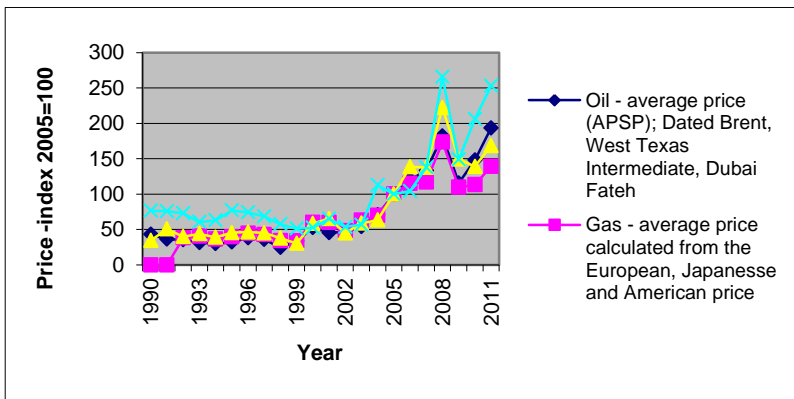
The known oil reserves can sustain the current level of consumption only until 2040, gas reserves until 2070, while the world reserves of black coal a period of over 200 years, even with an increase in the level of exploitation. Forecasts indicate an economic growth, which will involve an increased consumption of energy resources.

It is estimated that approximately a quarter of the primary energy resource needs, at the global level, will be covered by coal. In the same time with the increase of the energy consumption will also grow the coal consumption. The consolidated data of the World Energy Council (WEC) shows an increase of almost 50 % of the extraction of coal in the world in 2005 compared to 1980.



**Figure 4:** The availability of the global fossil fuel reserves

Source: World Business Council for Sustainable Development (WBCSD). Energy data, 2008



**Figure 5:** Fossil fuels average prices evolution

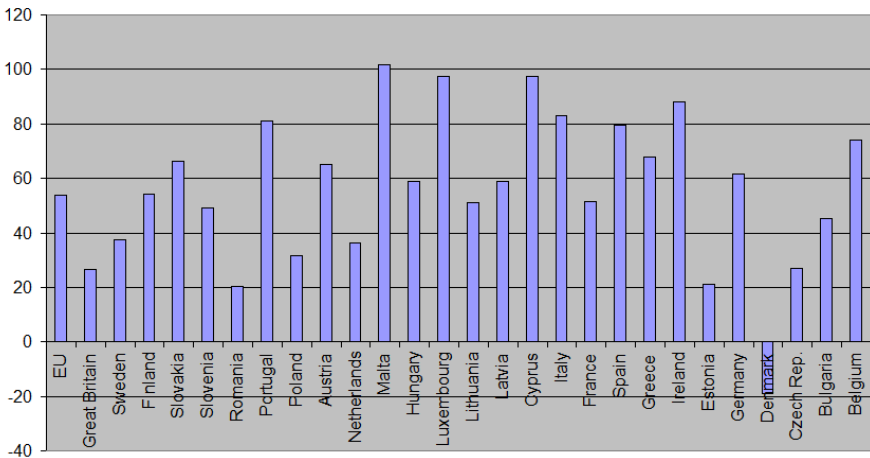
Source: International Monetary Fund, World Economic Outlook Database, 2011

Therefore, the decrease in resources of fossil fuels, which leads to an increase in the prices of the energy generated by those resources, may have significant effects on the economic development globally.

**Energy security – dependence on imports, vulnerability to changes in the global economy**

The dependence on energy imports makes a state vulnerable to everything that signifies changes in the world economy.

Consequently, for the period till 2020, the European Union policy in the field of energy, primary focus on a few fundamental objectives, for which the EU has proposed separate packages of legislative and regulation reform. Among these objectives is also the security in the energy supply, which aims the reduction of EU vulnerability on energy imports, on interruptions in supply, on possible energy crises, and on insecurity in the future power supply.



**Figure 6:** European economies dependence on energy imports  
*Source: European Commission*

Romania and Estonia are among EU countries with the lowest degree of dependency on energy imports, lower only than Denmark. From 2007 till 2009, Romania has reduced the degree of dependence from 31.5 % to 20.3 %, according to an EC report, EU average being almost 54 %. These annual imports are estimated at EUR 350 billion or approximately 700 euro/year for each EU citizen, on actual prices.

## **Energy efficiency**

According to the Business Dictionary, energy efficiency represents the percentage of the amount of energy consumed by a piece of equipment or a car, for a useful activity, and which is not lost under the form of heat.

Energy efficiency is a concept that includes methods and means by which the energy consumption may be reduced, as a result of a techno-economic analysis.

Low energy efficiency generates a higher consumption and also higher costs.

Directive No. 2006/32/EC on energy efficiency to end-users, stipulates that EU Member States undertake to reduce the final energy consumption by at least 9 % in a period of nine years (2007-2016) compared with the average consumption from the last five years for which data are available (2001-2005).

Also, the package "Energy-Climate Change" sets a series of targets for the EU for 2020, known as objectives "20-20-20", and a reduction of 20 % of primary energy consumption, that has to be achieved through the improving of the energy efficiency, compared to the level of the consumption that would have been reached in the absence of these measures.

## **Expenditures on environmental protection**

Pollution and environmental protection are considered to be essential issues for humanity. Transformations that are taking place globally in terms of environmental quality require finding some solutions to ensure the maintenance of the ecological balance of the planet, in terms of sustainable development. The improvement of the quality of the environment in terms of sustainable growth can be achieved through the promotion of economic instruments in environmental management, as well as by integrating environmental policies into sectorial policies.

The expenditures on environmental protection represent the amount of capital expenditures and the expenditures on current activities for activities of environmental protection.

Environmental protection is an activity, in which the main goal is to collect, treat, reduce, prevent or eliminate the pollutants and the pollution

or any other type of environmental degradation resulting from the anthropogenic activity. Thus, activities and expenditures of environmental protection can be classified into two distinct categories, depending on the nature and type of work - "pollution mitigation" and "pollution prevention".

The pollution mitigation involves mainly the use of methods, techniques or equipment of the type "end-of-pipe".

"Pollution prevention", is defined as the totality of methods, practices, technologies, processes or equipment designed to prevent or reduce the pollution created at the source, thereby reducing the environmental impact associated with the emission of contaminant and/or other pollution-generating activities.

Pollution prevention can be an integrant part of the production process.

Pollution prevention may involve various types of activities, for example:

- modification of equipment or technologies;
- application of new, improved, technologies;
- reforming or redesigning products;
- use of renewable raw materials;

The expenditures on environmental protection may relate to activities that generate products or results in the form of savings, or are financed through subsidies or through capital allocation.

In table no. 1 are presented the total expenditures allocated by the industrialized nations of the world in the period 1990 to 2004 for pollution prevention and control. The values represent the percentage of GDP allocated for this purpose.

**Table 1:** Total expenditures for the prevention and control of pollution, 1990-2004

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Canada	-	-	-	-	-	-	-	-	-	-	1	-	1.2	-	-
Mexico	-	-	-	-	-	-	-	-	-	-	0.7	-	-	-	-
USA	1.4	1.5	1.5	1.5	1.5	-	-	-	-	-	-	-	-	-	-
Japan	-	-	1.2	-	1.4	1.3	1.4	1.3	1.4	1.4	-	-	-	-	-
Korea	-	-	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.6	1.8	1.8	-
Australia	-	0.6	0.6	0.9	0.8	0.8	0.9	0.5	-	-	-	0.4	-	-	-
New Zealand	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-
Austria	2.1	2.2	-	-	1.8	2	1.8	2.6	2.7	2.4	1.9	2	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Belgium	-	-	-	-	-	-	0.9	0.9	-	-	-	-	1.1	-	-
Czech Rep.	-	1	1.2	1.9	1.8	2.2	2.2	2.3	1.8	1.4	0.9	0.8	0.6	-	-
Denmark	-	-	-	-	-	-	-	-	1.9	-	-	-	-	-	-
Finland	-	-	-	-	1	1.1	1.2	1.1	1	0.9	1	-	-	-	-
France	-	1	-	-	-	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	-	-
Greece	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-
Hungary	-	-	0.6	0.5	0.8	0.5	0.6	1	1.4	-	-	1.5	1.5	-	-
Ireland	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-
Italy	-	-	-	-	-	-	-	1.9	-	-	-	1.4	-	-	-
Netherlands	1.6	1.7	1.8	-	-	1.8	-	2.2	2	2	2.1	2.1	-	2.1	-
Norway	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	2.6	2.3	1.9	1.8	1.4	1.5	1.5
Portugal	-	-	-	-	-	-	0.9	0.9	0.8	0.7	0.8	0.7	0.6	0.6	0.6
Slovakia	-	-	-	-	-	-	-	-	-	2	0.8	1	1.2	0.8	-
Spain	-	-	-	0.8	-	-	-	-	-	0.8	-	-	-	-	-
Sweden	-	1.1	-	0.8	-	-	-	-	-	0.8	-	-	-	-	-
Turkey	-	-	-	-	-	-	-	1.1	-	-	-	-	-	-	-
United Kingdom	0.7	-	-	-	-	-	-	0.9	-	0.7	0.9	0.6	0.5	0.6	-

### Health expenditures as a result of the pollution generated by the energy sector

Combustion processes that take place in the energy sector are the main source of airborne particulate and gaseous pollutants.

The actions of atmospheric contaminants on the organism are materialized in effects that are acute and chronic, which can be measured by changes in the frequency of appearance of certain ailments (morbidity) which may be associated with pollution.

The statistics reveal an increase in the population exposed to morbidity, by the increasing frequency of respiratory tract maladies, by the allergies and diseases associated with accumulation of toxic contaminants in the body.

In these circumstances there is a need to increase health costs to fund the treatment of these patients, whose conditions are generally chronic, or encounter frequent acute episodes. The increasing greenhouse

gases emissions that generate increasing air pollution, causes far more than 370 000 premature deaths annually at the European Union level.

## Conclusions

In the context of the economic crisis that we face, identifying and resolving the problems of the energy sector represents a global challenge. In order to address these problems as much as possible, it is necessary to use sustained measures related to the growth of the energy efficiency, investments in renewable energy sources, investments in carbon capture and storage, but also the use of financial or fiscal instruments.

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## References

- [1]. European Parliament, (2003), Directive EC/2003/87 *in order to improve and extend the Community system for trading the greenhouse gases emission certificates, modified and completed*
- [2]. European Parliament, (2009), Decision EC/406/2009 *on the effort of Member States to reduce greenhouse gas emissions*
- [3]. European Parliament, (2009), Directive EC/28/2009 *on the promotion of the use of energy from renewable sources*
- [4]. Government of Romania (2011), *Romania's energy strategy for the period 2007 – 2020 updated for the period 2011-2020*
- [5]. International Energy Agency IEA (2007), *Energy Prices & Taxes 2007*
- [6]. International Monetary Fund, (2011), *World Economic Outlook Database*

- 
- [7]. Leca A, Muşatescu A., Paraschiv D.M., Voicu-Dorobanţu R., Marinoiu A. (2009), *The impact of the implementation of the energy-climate package on the Romanian economy*
- [8]. Stern, N. (2006). "Stern Review on *The Economics of Climate Change* (pre-publication edition). *Executive Summary*". Available at: <http://www.webcitation.org/5nCeyEYJr>
- [9]. United Nations, Department of Economic and Social Affairs, (2010), *World Population Prospects, 2010 revision*. Available at: [http://epp.eurostat.ec.europa.eu/statistics\\_explained/index.php/European\\_population\\_compared\\_with\\_world\\_population](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/European_population_compared_with_world_population)