

ENVIRONMENTAL CONCERNS RELATED WITH COGENERATION HEAT AND POWER PLANTS IN ROMANIA

Magdalena Matei*, Lucian Matei**, Cornel Salisteanu* , Iulian Udriou*, Claudiu Radu*** and Gheorghe Mitroi****

* University Valahia Targoviste, 18-20, Unirii Street, Targoviste, Romania, tel +40 216 24 30 24, +40 748 88 22 11, e-mail: magdalenamatei@yahoo.com

** University of Bucharest, 1, Balcescu B-lvd, Bucharest, Romania

***Romanian Agency for Mineral Resources, Bucharest, Romania

**** Romanian Policy, Targoviste, Romania

ABSTRACT

Pollutant emission corresponding to district heating plants represents one of the main air pollution sources in many localities. Therefore, important investments are needed in this sector so that the negative impact on environment and human health is reduced. 79 from the total of 80 Large Combustion Plants (LCP) which belong to 26 public local authorities are old and they are not in compliance with the requirements of Directive 2001/80/EC.

Priority 3 of Sectoral Operational Programme "Environment" (SOP ENV) „Improvement of municipal heating systems in selected priority areas” supports the refurbishment of the LCP operating within the municipal heating systems with the aim to reduce gas emissions at the level of the plant, as well as to improve the energy efficiency at the level of plant and distribution network.

A big challenge for municipal heating plants is the transposition of Directive 2003/87/EC concerning European Union Emission Trading Scheme for greenhouse gases emissions, respectively the National Allocation Plan for CO₂ emission. This, entered into force from 1st January 2007, creates, both, opportunities and obligations for the co-generation heat and power plant operators. More of them have already been involved in Join Implementation projects, using the amount of money obtained by selling their emission reduction for investments.

KEY WORDS

combustion plants, pollutants emission, emission trading.

Abbreviation

BAT - best available technique ;

CHP - cogeneration heat and power;

DH - district heating;

DHS - district heating system;

EU - European Union;

EU ETS –European Union Emission Trading Scheme;

GD - Governmental Decision;

GHG - greenhouse gases;

JI – Join Implementation;

LCP- large combustion plants

MAI - Minister of Administration and Interiors

MET - Ministry of Economy and Trade

MEWM-Minister of Environment & Water Management;

NAP - National Allocation Plans;

NER - new entrants reserve;

PM - particulate matters;

SOP ENV- Sectoral Operational Program "Environment"

1. Introduction

From 1 January 2007 Romania became member state of EU. During 2003-2006 period Romania transposed the EU legislation within all sectors, including energy and environment, in order to comply with the EU regulation.

In many urban agglomerations, LCP, particularly the municipal heating plants, are the main pollution sources due to old technologies and long-term under-investments, thus are highly polluting the environment and represent a threat to the population health.

The Directive 2001/80/EC was transposed into Romanian legislation by the GD 541/2003 concerning the limitation of SO₂, NO_x and PM emissions from LCP, modified and concluded by GD 322/2005. The paper presents state of the art of this Directive implementation in Romania, with special accent on its effect on DHS.

The legal framework for the implementation of the EU-ETS in Romania was set up by the GD 780/2006 which transposes both, Directive 2003/87/EC and Directive 2004/101/EC. In 2006 MEWM prepared the NAP, establishing the total number of allowances and their allocation for each plant for one year period beginning with 1 January 2007, and for five years period beginning with 1 January 2008. The NAP was submitted to the European Commission and becomes operational after its approval by the Romanian Government following the final decision of the European Commission. The paper presents the principles used for NAP development and the influence of the implementation of EU-ETS on thermal power plants. The relationship between the allowances and the current/anticipated emission evolution, as well as CO₂ price on the market will influence the future decisions of all heat production company.

2. Current Situation in DH in Romania

In Romania the most CHP plants were built some 40-50 years ago. In the 60s began the development of the DHS for municipalities. The most facilities were brought from

the former communist countries. The standard power was 50 MW_e. After 1989, the industrial output decreased considerably, steam was no more delivered to the industrial sector, and thus the capacity of the CHP plants could no more be used on the whole; for this reason, the CHP plants run inefficiently.

A big problem was the decision to maintain over 4-5 years the cross subsidies; the industrial sector paid big charges to the power stations, in order to cover the incapacity of the population to pay the heating charges. For this reason many industrial consumers were lost. Since 2002 the power stations are functioning „on their own feet”, but still cannot be efficient because of the high production prices [1].

A recent survey of USAID – IRG[2] shows that now approximately 23% of all households in Romania are connected to DHS. Recent trends analysis of DHS during the period 2000-2006 shown:

- Continued closing of DH companies and heat generating plants: from 258 in 2000 to 118 in 2006;
- Continued customer disconnections from DH: from 320,000 apartments in 2000 to 185,000 apartments in 2006;
- Increasing residential tariffs for heat and hot water services[2].

To maintain the social supportability of heat price represent a challenge target of the central and local governments[3].

The estimation of necessary amount of funding for DH rehabilitation in Romania (September 2004) is 6.98 billion Euro in 14 years, which means an average of 450 million Euro/year. The most important obstacles for the rehabilitation of the DHS are the uncovered financial needs and the low absorption rate of the funds[4].

Energy efficiency measures will concentrate on the rehabilitation of distribution systems, in line with Romanian Government policy. This policy for the restructuring of systems for thermal energy production and distribution is set out in the programme “Urban heating 2006 – 2009, quality and efficiency”. The objectives of this national programme are that centralized system for thermal energy production and distribution to meet a thermal efficiency of at least 80%, by eliminating the losses from networks for hot water and heating supply and by introduction of metering.

According to the national strategy for thermal energy supply, 52% of the urban population will benefit from centralised urban heating services and will be further connected to centralized systems in the medium and long term.

For increasing the absorption rate of the funds, the planning and implementing responsibility was transferred to the local authorities, by maintaining only the coordination role for the central authorities (and not the leadership role).

3. The Implementation of the Directive 2001/80/EC in Romania

In many urban agglomerations, LCP, particularly the municipal heating plants are the main pollution sources due to old technologies and long-term under-investments, thus are highly polluting the environment. In October 2004, with the support of PHARE 2001, MEWM elaborated the National Strategy for Atmosphere Protection.

Through the Law No 271/2003, Romania ratified the Convention on long distance crossborder atmosphere pollution and the three protocols of Convention on reduction of acidification, eutrophication and the level of troposphere ozone layer. Romania committed itself to comply in 2010, with the level of emissions thresholds laid down in Gothenburg Protocol, as resulted from the Table 1[5]. In this respect, concrete implementation measures have been taken into consideration (assumed by each economic operator), such as emissions reduction programmes for SO₂, NO_x, from LCP, and from other activities (refinery, petro-chemistry, etc.)[5].

Table 1. Romanian commitments in accordance with Gothenburg Protocol

Pollutant (thousand tons)	1990	2002	2004	Emissions ceilings for 2010, Protocol	Percentage of the emission reduction for 2010 (comparing to 1990)
SO ₂	1,311	781	960	918	-30%
NO _x	546	357	326	437	-20%

Table 2. The pollutants emission [kt] during 1980-2003 and targets till 2017

Year	SO ₂	NO _x	PM
1980	561	135	189.8
1993	691.9	134.5	128.6
1996	630.5	115.8	86.9
1997	677.7	111.3	71.9
1998	502.5	77.1	68.2
1999	519.8	93.3	56.4
2000	558.9	105.7	53.9
2001	604.1	117.4	48.5
2002	496.7	103.5	35.7
2003	518.1	113.2	30.6
2008	530	125	33,8
2010	336	114	23,2
2013	148	112	15,5
2016		80	
2017		74	

Pollutant emissions from LCP have a significant negative impact on human health and environment and represent the most important part of total emissions of SO₂ and NO_x in urban areas, emphasizing the phenomena of acidification and tropospheric ozone formation.

After 1989, the industrial output decreased considerably, the electricity and steam demand going down. During the period when were built the most power plants and CHP

plants, the flue gas dispersion by high stacks was considered as an efficient and sufficient way to protect the environment and the population health. By the initial project of power plants, the LCP were equipped only with electrostatic precipitators for reduce PM content from flue gas[6]. The improving of the electrostatic precipitators performances after 1993 generated the continuous decreasing of PM emission from 128.6 kt in 1993 to 30.6 kt in 2003. Table 2 shows the evolution of pollutants emission during the period 1980-2003 and the targets till 2017[5].

In Romania, a total of 174 LCPs was inventoried - power plants, CHP plants and thermal plants with a rated thermal power equal or greater than 50 MW, which use mainly fossil fuels. These LCP are classified according to the owner or their national co-ordinator, in three large groups, as shown in the table 3.[5]

Table 3. LCP status

Type of LCP	Total	Owner or national co-ordinator		
		MET	MAI	Others
Total LCP number	174	72	80	22
Old plants (type I)	163	64	79	20

The 80 LCP under the co-ordination of MAI (state owned), which belong to 26 public local authorities, are the only providers of thermal energy (heat and hot water) for the population in areas in which they are located; some of them are CHP plants. Out of the total number of LCP, 7 LCP are in compliance with the requirements of Directive 2001/80/EC, 157 are non-compliant, and 10 LCP are closed. As a result of the analysis of the 174 LCP, Romania obtained transition period on type of pollutants discharged into atmosphere (SO₂, NO_x and PM) between 1-6 years for 77 LCP (2008-2013) and for NO_x, between 1-2 years for 6 LCP (2016-2017)[6].

Table 4 presents the compliance of Romanian LCP to the 2001/80/CE Directive's requests, expressed as thermal installed capacity, as well their evolution during 2003-2015 period[5].

Table 4. The compliance of Romanian LCP to the 2001/80/CE Directive's requests , expressed as thermal installed capacity

LCP	Installed thermal capacity 2004 (MWt)	Installed thermal capacity 2007 (MWt)	Installed thermal capacity 2015 (MWt)
MET Coordinator	33 005	31 423	26 293
MAI Coordinator	17 686	17007.6	16 443.8
Others	5 373	5.257	5 087
Total	56 064	53.68.6	47 823,8
			Out of which
complying	1 341	9 053.7	47 823.8
uncomplying	54 723	44 633.9	0

The cost of LCP Directive implementation in the period 2007-2013 is estimated at about €2.1bn Euro.

Priority 3 of SOP ENV „Improvement of municipal heating systems in selected priority areas” supports the refurbishment of the LCP operating within the municipal heating systems with the aim to reduce gas emissions at level of the plant, as well as to improve the energy efficiency at the level of plant and distribution network. This priority axis will be supported by the Cohesion Fund. SOP ENV mechanism is shown in fig.1 [5].

Actions under SOP ENV envisage reduction of the negative impact on the environment and human health in those urban agglomerations that suffer most from pollution by old urban heating systems.

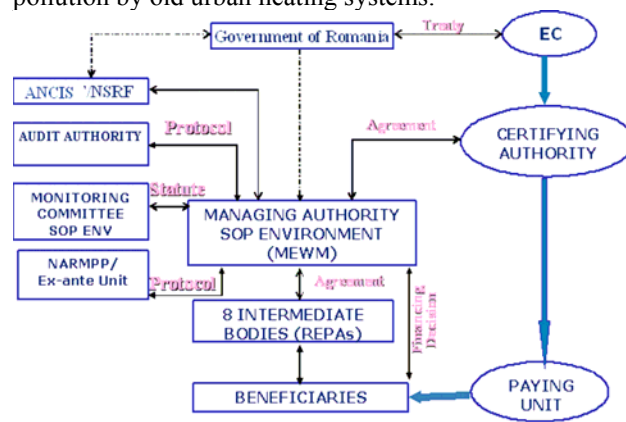


Fig.1 - SOP ENV mechanism

Interventions will be based on a medium/long term regional heating strategy. The main aim is to promote the rational use of the non-renewable energy sources and, where possible, those of renewable or less polluting sources of energy for urban heating plants. Particular attention will be given to the LCP upgrading, aiming to significant reduction of SO₂, NO_x and PM emissions, and thus contributing to the implementation of air-related Directives for which Romania has transition periods.

An integrated approach will be taken to the implementation of projects in this Priority Axis, considering both demand-management and energy-efficiency measures and direct improvement of the environmental performance of urban heating boilers. The first element – demand-management and energy efficiency – also results in direct environmental improvement because it leads to reduction in pollution via a lower need for heat generation.

The main measures for achieving these proposed objectives and targets include the BAT implementation specific to LCP for the purposes of desulphurization (DeSO_x), reduction of nitrogen oxides (DeNO_x), and reducing PM emissions from flue gases and undertaking the required monitoring of the relevant pollutants. The co-generation alternative and the use of renewable energy sources, less polluting, will also be supported where the feasibility studies will indicate this solution.

Finally, in line with an integrated approach to environmental protection, projects under this priority axis may also include investment to improve the management

of solid and liquid waste from urban heating plants in relation with the investment in reducing air pollution (notably the rehabilitation of slag and ash dumps).

The selection of projects under this SOP ENV priority axis is based on a national strategy that prioritises interventions against pre-defined set of criteria, where reduction of the negative environmental impact, air pollution in particular, prevails. The beneficiaries of this priority axis will be the local authorities of the selected municipalities or, as the case may be, their wholly owned urban-heating operating companies[5]. Most of the municipalities that are potential beneficiaries under this priority axis already manage large investments, internationally co-financed, in relation with municipal public works. The assessment of the capacity of the beneficiaries to implement the SOP ENV operations will be based on an institutional analysis. Besides the SOP ENV interventions, additional financing sources for urban heating systems will be attracted from external loans or private-public-partnership.

The operations to be developed under this key area of intervention will finance the following indicative activities developed within the frame of eight DHS refurbishment:

- Rehabilitation of boilers and turbines (for co-generation of electricity);
- Introduction of BAT for SO₂, NO_x and PM emissions reduction ;
- Introduction of improved metering;
- Rehabilitation of non-compliant slag and ash landfills;
- Rehabilitation of heat distribution networks;
- Technical assistance for project preparation, management, supervision and publicity, including public awareness campaigns.

It is expected to obtain a reduction of emissions from 80,000 tons SO₂ to 15,000 tons and from 7,000 tons NO_x to 4,000 tons[5].

4. Greenhouse Gas Emissions in Romania

According to 2004 Romania's National Inventory Report for anthropogenic emissions of direct GHG and indirect GHG, the total quantity of emissions (excluding net CO₂ from LULUCF8) is 154.627 mil. tones CO₂ equivalent and the estimate of net emissions after taking into account the removals from the land use change and forestry sector is 119.958 mil. tones CO₂ equivalent. This represents more than 50% below the obligation under the Kyoto Protocol. The restructuring of Romanian economy after 1990 generated a dramatically decreasing of the power demand, which means a reduction of the CO₂ emitted by the fossil fuelled power plants. Fig. 2 shows the total GHG emissions in Romania during the period 1989-2003 compared to the target under the Kyoto Protocol. [5] The GHG emissions trend reflects the main trend in the economic development of the country. After year 1999 as a result of the revitalization of the economy, the emissions have been increasing.

In the total GHG emissions of year 2004, CO₂ emissions accounts for 75.25%. CH₄ emissions accounts for 17.42%

and N₂O for 7% of total GHG emissions. Fluorinated gases contributed with about 0.3% to total GHG emissions.

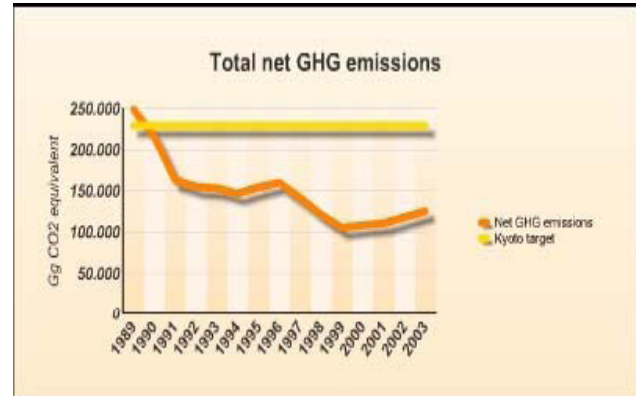


Fig.2 - The total GHG emissions in Romania during the period 1989-2003 compared to the target under the Kyoto Protocol.

5. The Directive 2003/87/CE Transposition in Romania

The EU – ETS is a Community - wide scheme established by Directive 2003/87/EC for trading allowances covering emissions of GHG from installations set out in Annex I of the Directive. The first phase of the scheme started on January 1st 2005 and will end on 31st of December 2007. The second phase will run from 2008 to 2012, corresponding to the first commitment period under the Kyoto Protocol.

The EU ETS is not a mechanism under the Kyoto Protocol, but an instrument under EU climate change policy. The EU ETS is intended to assist the EU member states in achieving their Kyoto Protocol's emission reduction targets in a cost-effective way. It has established an entity-based cap-and-trade system for GHG emissions, starting in the first phase with the CO₂ emitting industrial installations, with a rated thermal input exceeding 20 MW.

The main points of EU ETS are:

- Allocates via NAP – emissions quotas for each installation that generates significant quantities of CO₂ (cement, glass and ceramics, energy, paper, steel);
- Penalties of 100 EUR/t of CO₂ for exceeding the quotas;
- First period 2005-2007 – penalties of 40 EUR/t of CO₂ over the allocated quantity;
- Emission reductions can be done internally in the installation or via emissions trading.

The provisions of the Directive became compulsory after Romania's accession to the EU. The legal framework for the implementation of the EU ETS in Romania was set up by the GD 780/2006 on Establishing the Greenhouse Gas Emission Trading Scheme, which transpose both Directive 2003/87/EC and Directive 2004/101/EC[7]. In 2006 Romania developed the NAP, which was submitted to the European Commission. The NAP states the total amount of allowances that the Romanian Government intends to issue during the both phases (2007 and 2008 –

2012), and how it intends to distribute these allowances among the installations subject to the scheme.

The NAP becomes operational after its approval by the Romanian Government, following the final decision of the European Commission.

According with the NAP, the national cap is 84,200,000 allowances allocated for the year 2007 and 487,770,000 allowances allocated for the period 2008–2012 (97,554,000 per year)[5].

The total amount of allowances to be allocated was determined through top-down projections. The method used was a combination of the historical approach and forecast approach. The base year for CO₂ emissions projections was the year 2003. Allocation to installations was done in two steps: first, allowances allocated to the sectors, and subsequently to installations within the sectors. The sectors distinguished are: energy, refineries, production and processing of ferrous metals, cement, lime, glass, ceramics, pulp and paper.

Allocation at sector level was done considering the top-down projected emissions, which are based on historic emissions, projected growth of production and projected reduction of carbon intensity. The historical reference period was 2001– 2004. The relevant emissions of an installation were the average emissions of the two years with the highest emissions within the historic reference period [5].

Allocation of allowances at the installation level was done on the basis of the share of relevant emissions in the total relevant emissions in that sector. For installations which have no historical data for the reference period (including those which began operating in 2005) the relevant emissions was determined using the formula:

Relevant emissions = Average specific emission of the sub sector x forecasted production of the installation for 2007 x 95%. Allowances were set aside for Early Action bonus for installations which reported early voluntary emission reductions. For 2007, the Early Action Reserve comprises 5,203,971 allowances, representing 6.18% and for the 2008-2012 period, 26,019,855 (5,203,971 annually), representing 5.33% of the total amount of allowances to be allocated. The Early Action Reserve was subtracted from the overall national cap. In order to avoid double counting, a JI reserve for indirect reductions was set aside for the period 2008-2012 for the JI projects. The JI reserve comprises 5,592,500 allowances (1,118,500 annually), representing 1.15% of the total amount of allowances allocated [5].

A CHP bonus was granted to CHP installations with overall efficiency higher than 65%. For 2007 cogeneration reserve includes 912,938, representing 1.08% from the total amount of allowances; for the 2008 – 2012 period, the reserve includes 4,564,690 allowances (912,938 annually), representing 0.94% from the total amount of allowances.

Allocation for new entrants shall be done for free from a set aside named NER. For 2007, the NER comprises of 1,567,929 allowances, representing 1.86% and for the 2008 – 2012 NER comprise of 39,428,365, representing

8.08% from the total amount of allowances allocated. CHP new entrants shall receive 99% of the amount of allowances, calculated based on the emissions of the installation (in order to balance the fact that older CHP plants receive a CHP bonus and promote the CHP technology), where as all other installations shall receive 95%. Allowances from the NER not used within the 2007 period shall be cancelled. Allowances from the NER not used within the second period, at the end of third quarter of 2012 shall be auctioned.

One installation is to be considered finally closed when for at least one year its production is zero, its CO₂ emissions are zero and the installation will not be opened anymore.

Allowances are issued by 28th of February of each year during the period. For year 2007 the issuance of allowances shall be done in 10 days after the NAP approval by the Romanian Government, after EC approval.

Banking from the first to the second period of the EU ETS is not allowed.

Indirect JI known projects connected with centralized heating systems for the period 2008-2012 which are included in the NAP, and their total number of the allowances are: Sawdust 2000” (Intorsura Buzaului, Gheorghieni, Huedin, Vlahita, Vatra Dornei) (264,995), Geothermal energy use for DHS in Oradea-zone 2 and Beius (119,270), Development of municipal utilities - Heating system of Fagaras (170,223), Biomass use for energy production in Neamt County (2,321,517), Energy consumption management and improvement of DHS in Resita city (110,512), Rehabilitation of CHP Timisoara Sud (127,920), Improving efficiency for steam boilers in Holboca CHP II Iasi (98,500), DH network improvement in Timisoara city (19,680), DHS efficiency improvement for Drobeta Turnu -Severin CHP (130,447), Installation of a steam turbine TKL 22 type at CHP Giurgiu (304,675), DHS rehabilitation in Iasi city (2,325,650), Rehabilitation and modernization of the DHS in Braila city - heat transport system (912,985), New CHP facility in CET Găvana - Pitesti city (382,360) Rehabilitation of unit 7 (330 MW) in Isalnita Power Plant (2,479,610) Cogeneration in Targoviste city (412,018), Rehabilitation and modernization of Zalau CHP (1,281,919) Rehabilitation of Timisoara Centre CHP (429,295), Modernisation of CHP Bacau (new GT 14 MW) (459,775), Cogeneration CTZ Cluj-Napoca (169,800), New cogeneration equipment in Toplita DHS (577,320). There is to remark the big numbers of the projects connected with CHP plants, respectively DHS, taking into account that the total number of certificates allocated to known JI projects is 18,071,670.

6. The Impact of EU ETS on Energy Services

The future decisions of the heat production companies should be influenced by the relationship between the allowances and the current/anticipated emission

evolution, as well as by the CO₂ price on the market. As consequence, a company which could sell more electricity and heat that was anticipated has to take into account the number of its allowances within the NAP in order to decide if the best solution is to produce more electricity and heat, but it is necessary to buy allowances, or it is better to produce less, in order to comply with the NAP. In a opposite situation, an other company which could sell less electricity and heat that was anticipated could compensate this loss by selling allowances. Anyway, all the companies has to pay the administrative costs for data collection, emission monitoring, checking and reporting. On the other hand, all of them will have as benefits an improving of their image and reputation due their careful for environment.



Fig.3 – The evolution of allowances prices in the EU-ETS

There is an increasing of the commercial risk associated with the incertitude of future price of the allowances. Fig 3 presents the evolution of the price of allowances for use in the EU ETS during the period January 2005-November 2006 and it has to remark the high volatility of the prices. The allowances price will be affected by the following factors: the allowances demand on the market, the natural gas price related to coal price, the electricity and heat demand, the climate condition: cool or not so cool winter, economic development or recession. It is expected an increasing of CO₂ price during post Kyoto period.

7. Conclusion

The Directive 2001/ 80/EC was transposed into Romanian legislation by the GD 541/2003 concerning the limitation of SO₂, NO_x and PM emissions from LCP, modified and concluded by GD 322/2005. Romania requested and was granted transition periods for the implementation of the Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from LCP, in order to introduce BAT to comply with a maximum permissible level of emissions for SO₂, NO_x and PM. The technological measures for compliance was included in

the emission reduction programs of each operators. Priority 3 of SOP ENV „Improvement of municipal heating systems in selected priority areas” supports the refurbishment of the LCP operating within the municipal heating systems with the aim to reduce gas emissions at the level of the plant, as well as to improve the energy efficiency at the level of plant and distribution network.

The legal framework for the implementation of the EU ETS in Romania was set up by the GD 780/2006, which transposes Directive 2003/87/EC and Directive 2004/101/EC. In 2006 Romania developed the NAP, which was submitted to the European Commission. The NAP states the total amount of allowances that the Romanian Government intends to issue during 2007 and 2008 – 2012, and how it intends to distribute these allowances among the installations subject to the scheme. The future decisions of the heat production companies should be influenced by the relationship between the allowances and the current/anticipated emission evolution, as well as by the CO₂ price on the market.

References

- [1] M. Matei., L. Matei, D. Enescu , E.Varjoghie, F. Radu, District Heating Versus Local Heating – Social Supportability, *Proc. FOREN 2004*, Neptun, Romania, 2004, CD-ROM, s4-25.
- [2] M. J. G Cain. - A Survey of 12 Romanian Cities - Consumer Attitudes Toward District Heating in Romania, *Proc. Workshop on „Impact of liberalization of local heat markets on the heat supply to household consumers”*, Brasov, Romania, 2007, CD-ROM.
- [3] M. Matei, L. Matei, M. Marinescu, R. Grigoras, S. Ene and O. Nedelcu, District heating – How to become a sustainable alternative in Romania’s present conditions?, *Proc. The Sixth World Energy System Conference*, Torino, Italy, 2006, CD-ROM, B4.5, p. 539, ISBN10: 88-87380-51-1, ISBN13: 978-88-87380-51-4.
- [4] Caian S., The Strategy for Energy Efficiency in Romania, *Proc. Workshop „Integrated Approach to EU funded Projects for Rehabilitation and Air Emission Reduction of District Heating Systems in Romania”*, Predeal, Romania, 2006, CD-ROM.
- [5] <http://www.mmediu.ro>
- [6] M. Matei, L. Matei, M. Marinescu, R. Grigoras, V. Dogaru, D. Enescu , The implementation of Council Directive 2001/80/EC in Romania, *Proc. The Sixth World Energy System Conference*, Torino, Italy, 2006, CD-ROM, B8.2, p. 681, ISBN10: 88-87380-51-1, ISBN13: 978-88-87380-51-4.
- [7] M. Matei, L. Matei, M. Marinescu, R. Grigoras, C. Salisteanu and I. Udrouiu, State-of-the-art of the Directive 2003/87/CE transposition in Romania, *Proc. The Sixth World Energy System Conference*, Torino, Italy, 2006, CD-ROM, B5.5, p. 578, ISBN10: 88-87380-51-1, ISBN13: 978-88-87380-51-4.