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ECO-BIO-ECONOMIC DEVELOPMENT AND EMISSIONS REDUCTIONS BY CHANGING TECHNOLOGY

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Abstract

The main objective of this article is the establishment of an innovative training system about social, environmental and economical aspects of the climate change and air pollution, based on the analysis of the eco-bio-economy development implemented in order to move to circular ecological growth with a focus on monitoring and emission reduction to ensure sustainable development. The analysis focuses on setting targets for a developed and organized training courses as engineering and eco-bio-economiy education program module in order to raise awareness and channel knowledge to specialists about: climate change forecasting analysis models, mitigating specific greenhouse gas emissions, adapting public policies to climate change. Scaling up renewable energy to 36% of the global energy mix by 2030 would provide about half of the emissions reductions needed to hold warming to 2°C. Over the period under review (2005-2016), among ten Central and Eastern European Countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, Slovakia), Poland is the undisputed renewable growth leader, accounting for almost 83 million tonnes of oil equivalent from primary production of biomass, hydropower, geothermal energy, wind and solar energy.

Keywords: Eco-Bio-Economy, Sustainable Development, air pollutants, greenhouse gas emissions, renewable energies, Central and Eastern European Countries.

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1. Introduction

Primary target group of the training course is audiences professional in climate field, economic, social, environmental level in order to implement projects and measures that continuously improve the lives of current and future generations, by developing at the level of central and local communities the ability to manage and effectively use natural resources, to stimulate innovation in the social and environmental fields, thus ensuring sustainable agriculture, food security, prosperity, environmental protection, biodiversity, and economic and social cohesion. American scientist Lester Brown, one of the pioneers of the concept of sustainable environmental development, launched the eco-economic theory in 2001 that highlights the importance of ecology and environmental protection in the sustainable development of mankind (Brown, 2001). Environmental policy procedures should be a sound basis for sustainable development for the benefit of all human beings and the environment (Ostrom, 2007). It has been demonstrated that we can survive a month without food, between 3 and 8 days without water, between 3 and 10 minutes (differentiated from person to person) without air, these being the physical requirements of our physical body that sustain physical life. God could have created humanity in a million different ways, but people's lives depend mainly on breathing, drinking water and eating food. As Steffen and Kirch conclude in their studies, it is necessary to effectively integrate the three pillars of sustainable development into the economic, social and environmental dimensions (Steffen, Sanderson, & Jager, 2004; Kirch, 2005).

1.1. Interactions between the three pillars of sustainable development: economy, environment and society

Ecological economy differs from conventional economy and conventional ecology in terms of the high horizon of its perception of climate change and the importance it attaches to the interaction between the environment and the economy (figure 01).

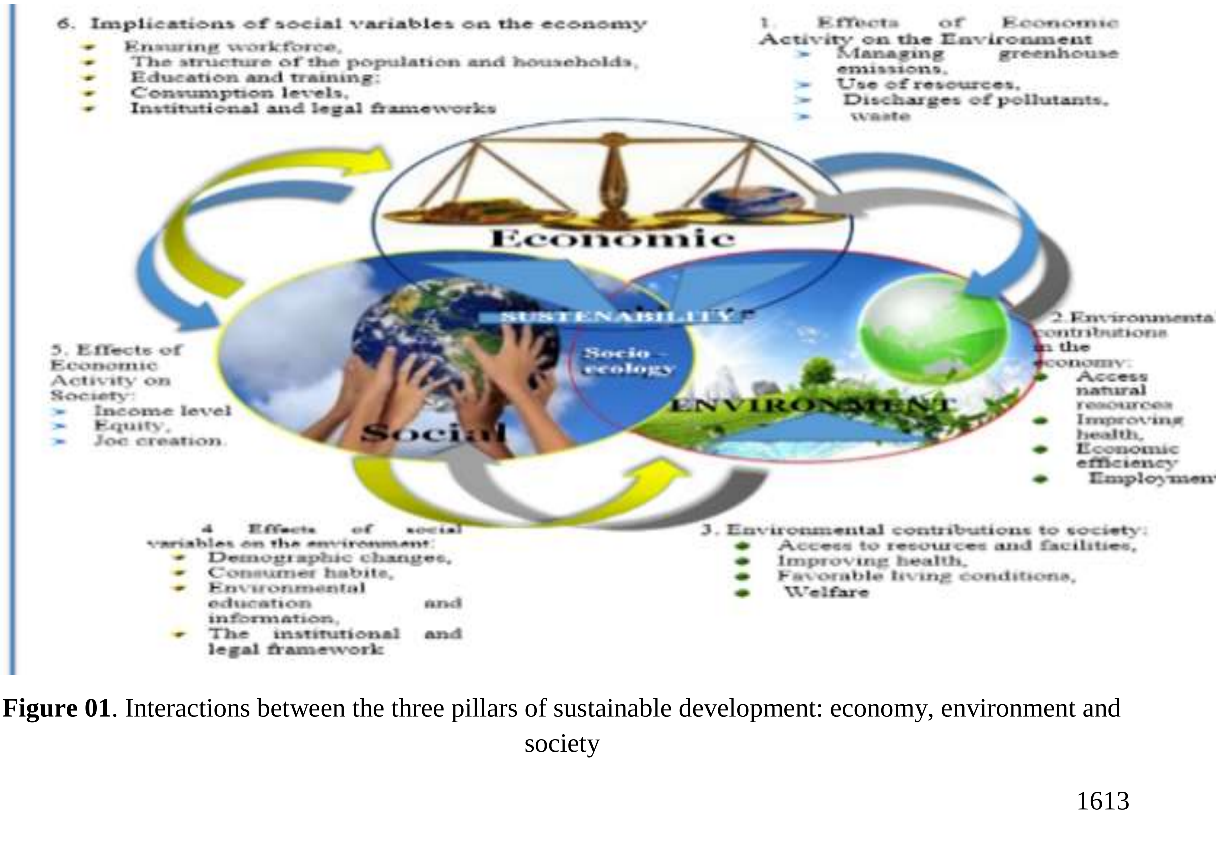

Figure 01. Interactions between the three pillars of sustainable development: economy, environment and society

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The transition to eco-bio-economy is expected to solve the following issues:

- Dependency of limited fossil resources;
- Increases in energy consumption, especially in the transport sector;
- Climate change and global warming;
- Contamination of the environment with unnatural and non-degradable materials;

Sustainable development seen from the perspective of environmental protection should focus on reducing air pollution by limiting greenhouse gas emissions, prudent management of water and land resources, effective waste management policies, protecting biodiversity (Constanza, Daly, & Bartholomew, 2006).

However, to prevent the deterioration of the environment and to improve living standards, it is necessary to restructure the tax system by reducing income taxes and increasing environmental taxes for destructive activities, so that taxes reflect ecological truth.

1.2. Environmental policies at EU level and Central and Eastern Europe Countries.

The Energy Union supports the shift towards a resource-efficient, low-carbon economy to achieve sustainable growth through their legal frameworks and related initiatives. The European Union, which is a signatory to the United Nations Convention on Climate Change (UNFCCC), reports annually the status of greenhouse gases (GHG) eliminated in the atmosphere by its Member States (Paris Agreement, 2015)

With the ratification of the Kyoto Protocol in 2002, the European Union (EU) is the main region that has made strong efforts to mitigate climate change among developed economies, setting a 20% greenhouse gas reduction target in 2020 compared to 1990. EU 28 GHG emissions were reduced by 17.88% in 2016 compared to 2007.

After EU integration (in May 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, Slovakia and January 2007: Romania and Bulgaria), the main objective of the countries in Central and Eastern Europe (10 CEEC) was to raise living standards by aligning policies with EU requirements. Therefore, they have implemented profound and coherent political reforms in order to ensure better interaction and coordination between EU Member States and reduce the gap between them and Western European countries.

The EU emission reduction obligation is shared between Member and industry through the EU Emissions Trading Systems (EU ETS). EU Sustainable Development Goals (SDG) indicator set it is used to monitor progress towards SDG 7 on affordable and clean energy, SDG 12 on ensuring sustainable consumption and production patterns and SDG 13 on climate action. Furthermore, the European Council has agreed on three key targets for the year 2030: at least 40 % cuts in greenhouse gas emissions (from 1990 levels), at least 27 % share for renewable energy and at least 27 % improvement in energy efficiency (European Union, The EU Emissions trading system, 2013).

2. Problem Statement

Air pollution seriously damages human health and the environment. Emissions of gases can lead to major environmental problems and can cause acidification, eutrophication or photochemical fog and smoke. Data on emissions of air pollutants (ammonia (NH_3), non-methane volatile organic compounds (NMVOC),

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nitrogen oxides (NOx) and sulphur oxide (SOx)) annually reported by Member States to the European Commission under Directive 2016/2284 of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants (European Environment Agency, 2016)

The pollutant with the greatest reduction in emissions across the 10 CEEC has been SOx. Emissions of SOx in 2016 stood at 1.09 million tonnes compared to 2,24 million tonnes in 2008 . The majority of SOx emissions were reduced in the energy production and distribution sector (Electricity, gas, steam and air conditioning supply, 185.386 tonnes less). In *Romania,* emissions of SOx in 2015 stood at *147.219,27* tonnes compared to *520.743,47* tonnes in 2008.. Over the last 27 years, EU-wide emissions of NOx more than halved from 18.1 to 7.6 million tonnes. In the 10 CEEC, the largest reduction of NOx took place in Poland, by roughly 15,33 %. Road transport is the main contributing sector to total NOx emissions. Emissions of NH3 almost entirely derive from agriculture. Main reductions were achieved through better waste management. Nowadays, ammonia is likely to be the most important acidifying gas emitted in Europe. Compared to other pollutants, reductions in NH3 emissions were moderate. In 10 CEEC, over the past 9 years the emissions of NH3 decreased from 749.877,19 to 669.353,74 tonnes. Between 2008 and 2016, CEEC-10-wide emissions of NMVOC have been reduced by roughly 15% from 1.028 million tonnes to 875.081,15 tonnes. The charts below show the evolution of the main greenhouse gases in ten countries from Central and Eastern Europe (figure 02, figure 03, figure 04, figure 05). This analysis has shown that Poland is the most polluting country in the 10 post-communist EU countries.

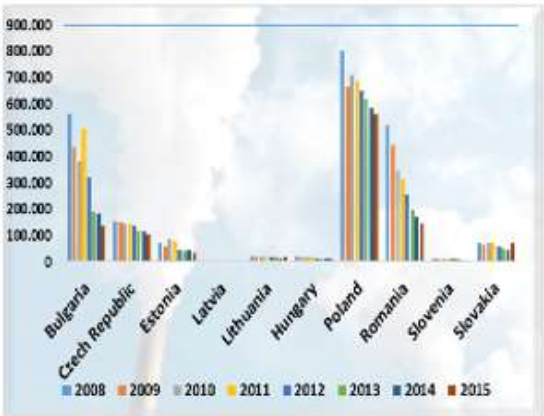

Figure 02 Sulphur oxides (SO_2 equivalent), 10 CEEC

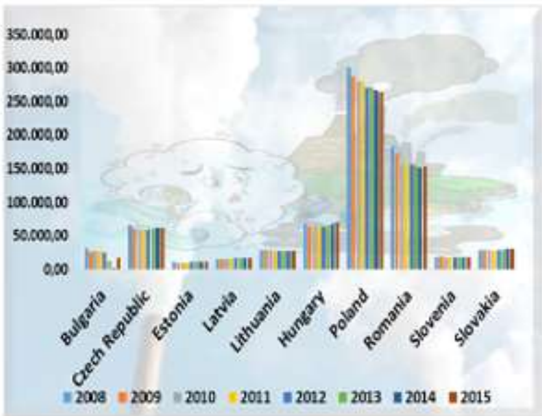

Figure 03 Ammonia (NH_3), 10 CEEC

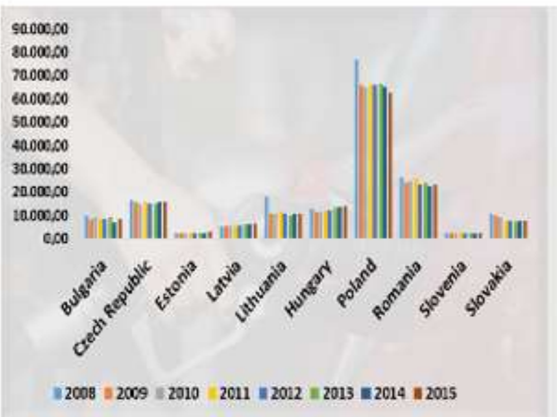

Figure 04 Nitrous oxide (NOx), 10 CEEC

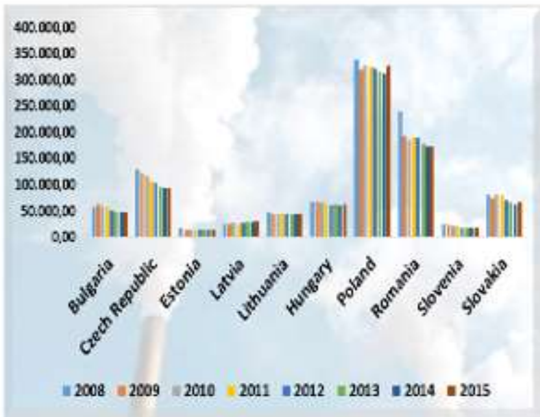

Figure 05 Non-methane volatile organic compounds (NMVOC)

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Also, Romania and Poland are leading countries in the release of considerable amounts of emissions into the atmosphere. Between 2015 and 2008, the most notable achievements in reducing carbon dioxide in the air occurred in the Romania, where the total quantities have been reduced by 27% from 93039627 tonnes to 67935589 tonnes.

3. Research Questions

How did different countries from Central and Eastern Europe implement renewable energy and what impact did it have on GHG reductions?

A substantial reduction in CO_2 emissions could be achieved by changing existing energy generation technology with renewable energy technologies. The Energy Union strategy highlights renewable energies as part of the required efforts for the decarbonisation of the energy system. EU Cohesion Policy (2014-2020) invests EUR 29 billion in sustainable energy, including energy efficiency, renewable energy, smart energy infrastructure and low-carbon research and innovation

Renewable energy technologies are recognized as having the potential to serve as an effective tool for managing natural resources and to encourage a change in positive environmental behaviour. Primary production of biomass, hydropower, geothermal energy, wind and solar energy are included in renewable energies.

Over the period under review (2005-2016), among ten Central and Eastern European Countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, Slovakia), Poland is the undisputed renewable growth leader, accounting for almost 83 million tonnes of oil equivalent from primary production of biomass, hydropower, geothermal energy, wind and solar energy. Perhaps surprisingly, Romania is the second-largest growth market for renewables with 64 million tonnes of oil equivalent from primary production of biomass, hydropower, geothermal energy, wind and solar energy. However, uncertainties around proposed tax reforms and energy policies could hinder renewable growth in Romania (figure 06).

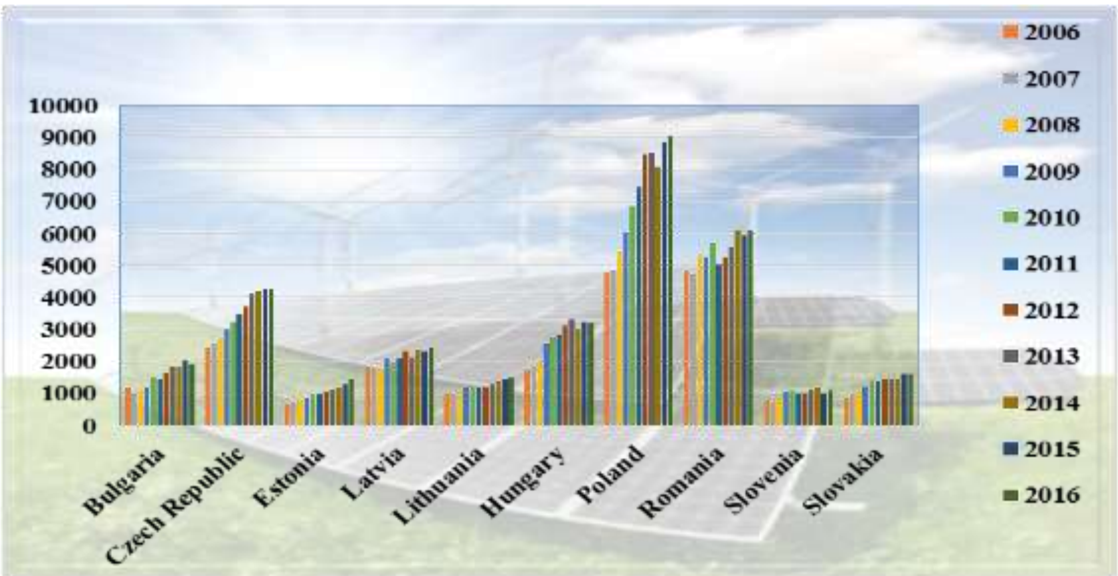

Figure 06. Primary production of renewable energy by type, 1 000 tonnes of oil equivalent

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Poland is the most polluting country of the 10 post-communist EU countries, releasing the most significant quantities of greenhouse gases in the atmosphere, as shown in the graph above. For this reason, we have chosen to evaluate the dependency between renewable energy and emissions of ammonia, sodium oxides, sulfur oxides, non-methane volatile organic compounds, which are expressed in CO_2 equivalent.

4. Purpose of the Study

Air pollution processes frequently involve the analysis of the simultaneous influence of several variables (in our case emissions of ammonia, sodium oxides, sulphur oxides, non-methane volatile organic compounds, which are expressed in CO_2 equivalent), apparently independent of one variable considered to be (dependent) on their action (renewable energies).

The linear modelling of this multiple correlation is the simplest solution adopted in a preliminary study phase. It is formally expressed through the equation y= $\boldsymbol{\alpha_0}$+$\boldsymbol{\alpha_1 x_1}$+$\boldsymbol{\alpha_2 x_2}$+…$\boldsymbol{\alpha_n x_n}$+$\boldsymbol{e_i}$:

where:

tax- independent variable;

$\boldsymbol{x_1}$ ….$\boldsymbol{x_n}$- factorial variables;

$\boldsymbol{\alpha_0}$ … $\boldsymbol{\alpha_n}$.- model parameters;

5. Research Methods

A multiple regression model was used in order to study the dependence of renewable energies by the four air pollution emissions (ammonia (NH3), non-methane volatile organic compounds (NMVOC), nitrogen oxides (NOx), and sulphur oxide (SOx)), in Poland. Thus, following the estimation of the Minitab (figure 07) parameters for emissions of ammonia, nitrogen oxides, sulphur oxides and non-methane volatile organic compounds, it was obtained a model that captures the dependence of the regenerative energy of ammonia (NH3), nitrogen oxides (NOx) sulphur oxides (SOx) having the following equation:

Renewable energy = -6309.94 +0.026528 * NH3 +0.005375* NOx – 0.0032*Sox,

for which it has been obtained Coefficient of determination R^2=0,947249.

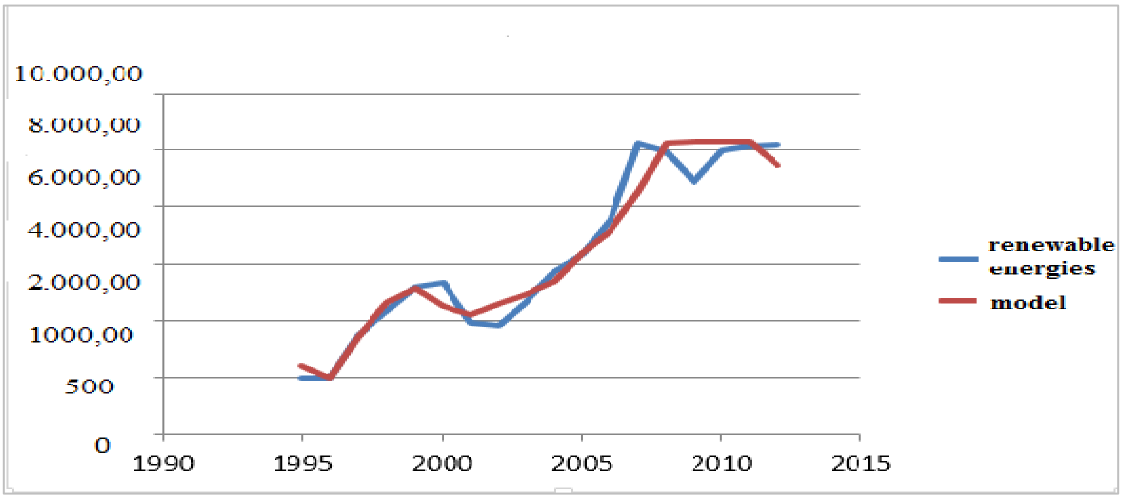

Figure 07. The evolution of renewable energy in the period 1990-2015 compared to the trend of renewable energy obtained according to our model, in Poland, Multiple Regression Model, Eviews7

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Given that the Coefficient of determination is close to 1, the correlation is strong, so the endogenous variable (renewable energies) is strongly influenced by exogenous (gas emissions). It also shows what percentage of renewable energy can be attributed to significant factors (NH3, NOX, SOX,). In our case, about 94.72% of the increase in the amount of renewable energy is due to the variation in gas emissions (expressed in tonnes of CO2 equivalent)

6. Findings

The calculation of the parameters is done by the least squares method and the resulting equations are solved. It was checked the significance of the parameters and models as a whole and the models are statistically correct. Also, the residues were checked and they are normal, independent and homoscedastic.

T-test significance values for the coefficients and p-values are given below. Since p-values are smaller than 0.05, the coefficients are significant (table 01).

Table 01. Statistical values of the „t" test and corresponding „p" values, Poland

Coefficients	t Stat	P-value
-6309,94	-4,45776	0,000541
0,026528	4,76197	0,000304
0,005375	4,642569	0,00038
– 0,0032	-12,014	9,.21E-09

To validate the model as a whole, it was used the ANOVA and Fisher (F) test to determine how much of the variance of the dependent variable is explained by the estimated equation. If this coefficient is close to 1, then the correlation is significant, so the endogenous variable is strongly influenced by the exogenous ones. The results of the F test confirm that the model is significant overall because its value is 83.7998 and the p-value is $3{,}492 * 10^{-9} < 0{,}01$.

F = 83,7998, p-val = 3.492E-09

For the homoscedasticity analysis of the residues we used a series of tests: " F" test that shows a normal distribution because the statistical test is 0.26 and the value of "p" is 0.077 and Levene test, whose statistic has a value of 1.68, corresponding to a p value of 0.213.

7. Conclusion

The transition to eco-bio-economy is expected *to solve the following issues*: dependency of limited fossil resources by increasing production of our global energy needs from alternative energy sources: solar energy, wind power and moving; increases in energy consumption, especially made through transition to an affordable, reliable, and sustainable energy system; climate change and global warming made through a substantial reduction in CO_2 emissions achieved by changing existing energy generation technology with renewable energy technologies. Those who will take a course in eco-bio-economy development and renewable energy can be prepared to face this looming crisis. A study of renewable energy may reinforce existing mathematical and analytical reasoning abilities. These classes often emphasize an interdisciplinary

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approach that improves the understanding of economy, social and environmental sciences. Students may develop an appreciation for the business aspect of the energy industry.

Greenhouse gas emissions reductions have been the result of a combination of policy measures. National emissions reduction policies have led to the following important results in the period between 2011-2016 compared to 2010. The following main findings are widely based on the European Union emission inventory report 1990–2016 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP). The pollutant with the greatest reduction in emissions across the 10 CEEC has been SOx. Emissions of SOx in 2016 stood at 1.09 million tonnes compared to 2,24 million tonnes in 2008 . The majority of SOx emissions were reduced in the energy production and distribution sector (Electricity, gas, steam and air conditioning supply, 185.386 tonnes less). In Romania, emissions of SOx in 2015 stood at 147.219,27 tonnes compared to 520.743,47 tonnes in 2008. Over the last 27 years, EU-wide emissions of NOx more than halved from 18.1 to 7.6 million tonnes. In the 10 CEEC, the largest reduction of NOx took place in Poland, by roughly 15,33 %.

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