Emissions trends of greenhouse gas from the metallurgical and mining industry in Ukraine

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Abstract
The paper considers the status and trends of greenhouse gas (GHG) emissions from Metallurgical and Mining Industry in Ukraine to fulfill target of the United Nations' Framework Convention on Climate Change (UNFCCC) and to mitigate climate change (CC). The paper collected current status in Ukraine to dynamics of GHG emissions from metallurgical and mining industry based on data of National GHG inventories.
Key words: GREENHOUSE GAS, EMISSIONS, METALLURGICAL AND MINING INDUSTRY

Climate change (CC) is caused by increase of greenhouse gases (GHG) in the atmosphere. These gases reach the atmosphere as a result of activities of our everyday life: the use of energy from fossil fuels (coal, oil and gas), in industrial processes, when flying or driving, or when using electric equipment at home.

The UNFCCC entered into force on 21 March 1994. Today, it has near-universal membership. The 195 countries that have ratified the Convention are called Parties to the Convention. Preventing "dangerous" human interference with the climate system is the ultimate aim of the UNFCCC.

The ultimate objective of the Convention is to stabilize GHG concentrations at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system. It states that such level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner. Industrialized nations agree under the Convention to support CC activities in developing countries by providing financial support for action on CC above and beyond any financial assistance they already provide to these countries [1].

Intergovernmental Panel on Climate Change (IPCC) draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers and organized the development of internationally accepted methods for conducting National GHG emission inventories (National Inventory Report, NIR) [2].

Ukraine signed the UNFCCC in 1992. The Verkhovna Rada (Parliament) Of Ukraine ratified the Convention on October 29, 1996 and Ukraine became a Party to the UNFCCC on August 11, 1997. On March 15, 1999 Ukraine signed the Kyoto Protocol to the UNFCCC. Ukraine according emission targets for industrialized country (EIT), targeted stabilization of GHG emissions at the 1990 levels [3].

Ukraine has submitted annual GHG inventory for 1990–2013 (NIR and CRF tables) [4] prepared in accordance with IPCC 2006 [5] and GPG 2000 [6].

IPCC 2006 use methodological approach is to combine information on the extent to which a human activity takes place (called activity data or AD) with coefficients which quantify the emissions or removals per unit activity. These are called emission factors (EF).

The following greenhouse gases are covered in the IPCC 2006:

GHG: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6); nitrogen trifluoride (NF_3); trifluoromethyl sulphur pentafluoride (SF_5CF_3); halogenated ethers;

other gases (precursors): nitrogen oxides (NO_x), ammonia (NH_3), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO) and sulphur dioxide (SO_2) [5].

Uncertainty estimates are an essential element of a complete NIR of GHG emissions and removals. They should be derived for both the national level and the trend estimate, as well as for the component parts such as EF, AD and other estimation parameters for each category. IPCC 2006 therefore develops a structured approach to estimating inventory uncertainty. Emissions/removals estimates are based on: (1) conceptualization; (2) models; and (3) input data and assumptions (e.g., EF and AD). Each of these three can be a source of uncertainty [5–11].

IPCC tier represents a level of methodological complexity. Usually three tiers are provided. Tier 1 (T1) is the basic method, Tier 2 (T2) intermediate and Tier 3 (T3) most demanding in terms of complexity and data requirements. Tier 1 methods for all categories are designed to use readily available national or international statistics in combination with the provided default EF and additional parameters that are provided, and therefore should be feasible for all countries. Tiers 2 and 3 are sometimes referred to as higher tier methods and are generally considered to be more accurate (using country-specific (CS) methods and/or EF) [5, 7–11].

Based on data NIR of Ukraine 2013, the total GHG emissions in 2013 was 385.93 Mt CO_2-equivalent (without CO_2 emissions from Land-Use Change and Forestry, LULUCF).

The emission trend of the Ukraine is typical for EIT countries. According to the latest Ukrainian data available to the UNFCCC (2013), the decline in GHG emissions continue reaching a minus 57.7 % level in comparison with 1990. Uncertainty trends, taking into account of LULUCF – 2.45 %; excluding of LULUCF – 0.79 % [4].

Trends in CO_2 emissions in 2008–2013 to the effects of the global financial and economic crisis, which largely determines the commercial production of basic export-oriented industries (metallurgical, chemical, machine building), which in turn impact on providing industries – electricity, mining (extraction of ore and coal) [4].

GHG emissions and removals in Ukraine from Metal Industry in 2013 are shown in Figure 1.

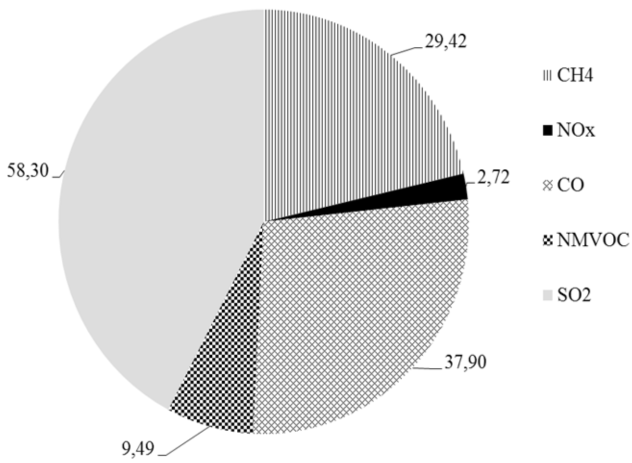

Figure 1. GHG emissions and removals from Metal Industry of Ukraine in 2013

CH_4 emissions are second after CO_2 share in total GHG emissions. The main sources of CH_4 emissions are the Energy sector – 65.3% (including LULUCF) in 1990. In 2013, the proportion changed slightly: Energy – 66.3%. The largest CH_4 emissions in the Energy sector come from Coal mines.

Emissions trend GHG equivalent (eq) emissions from Metal Industry in Ukraine during 1990–2013 are showed in Figure 2. Emissions trend CO_2 and CH_4 from Metal Industry in Ukraine during 1990–2013 are showed in Figure 3 and Figure 4 accordingly.

The largest GHG emissions in Ukraine occur in the Energy sector. In 2013, the share of this sector amounted to 77.8 % of the total GHG emissions with LULUCF.

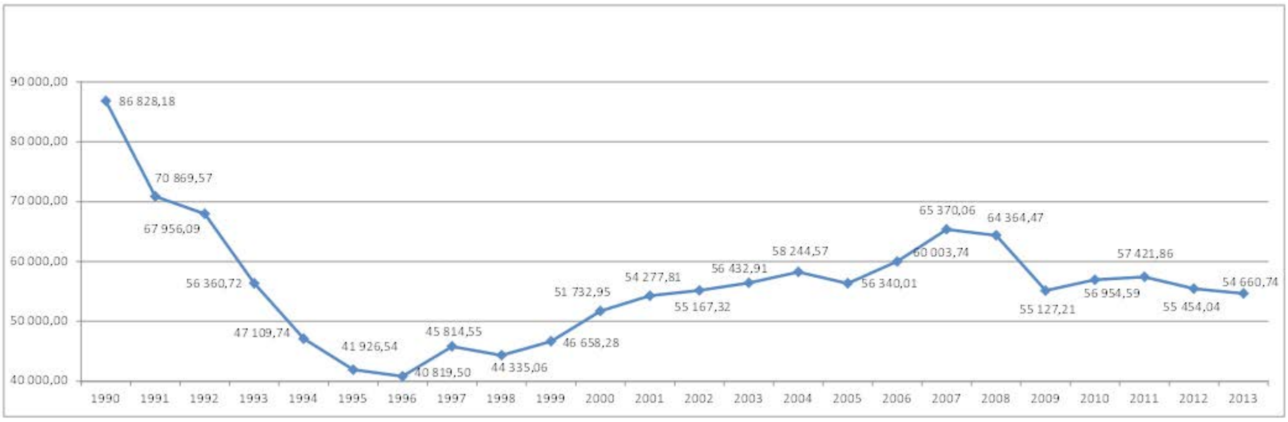

Figure 2. Emissions trend GHG eq emissions from Metal Industry of Ukraine during 1990–2013

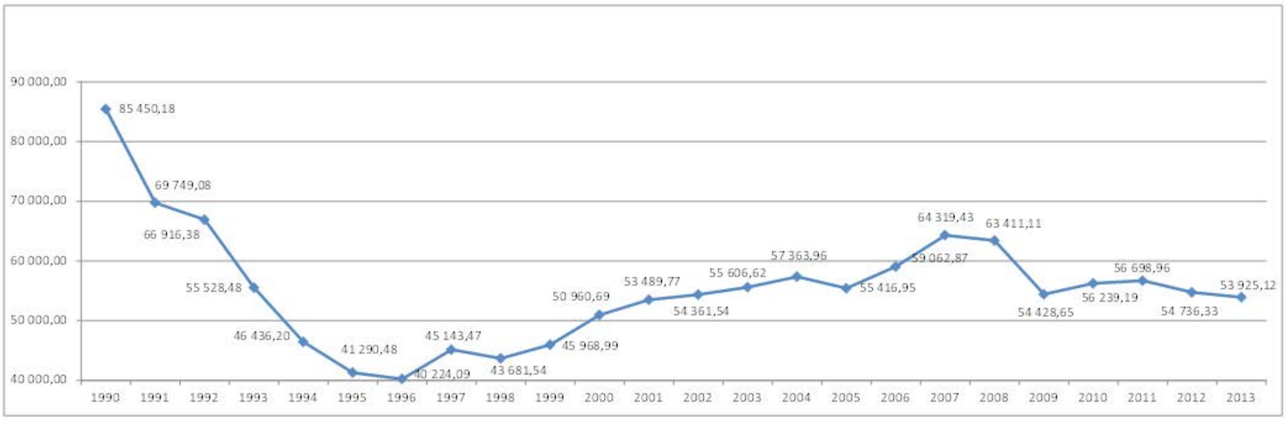

Figure 3. Emissions trend CO_2 from Metal Industry of Ukraine during 1990–2013

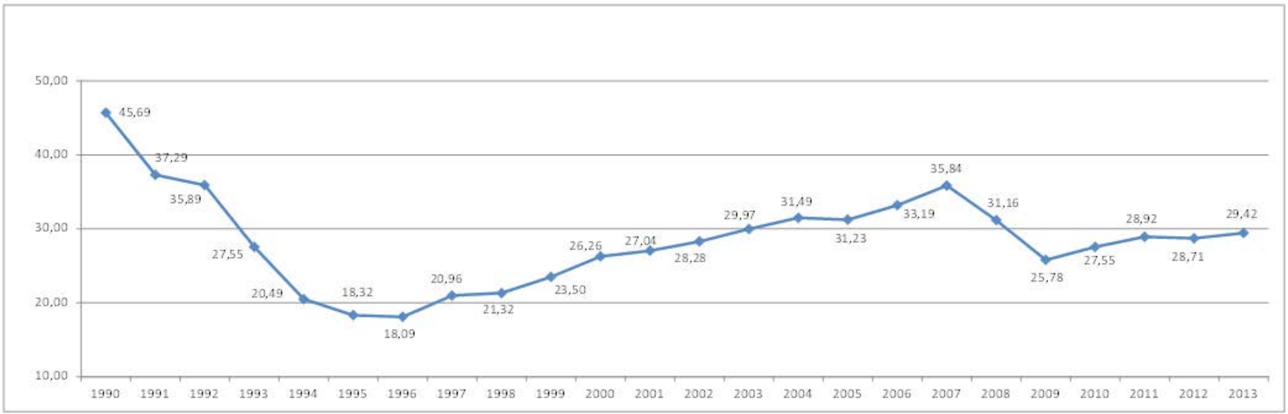

Figure 4. Emissions trend CH_4 from Metal Industry of Ukraine during 1990–2013

About 82 % of emissions in this sector accounts for emissions in category "Fuel Combustion" and 18 % – in the category of emissions "Emissions associated with leaks". In 2013, total emissions in the Energy sector decreased by 61.3 % compared to 1990.

Next in importance (20.6 % of total GHG emissions in 2013) is the sector "Industrial Processes and Product Use" (includes the manufacture of iron and steel, non-ferrous metallurgy). Emissions from iron and steel production as the key categories and are the largest source of GHG emissions in the sector is 77.3 % [4].

The greatest emissions occur during the production of pig iron, which is produced by reduction of iron ore in blast furnaces. Carbon contained in the coke is used as fuel and as a reductant. Specialty for the evaluation of the Energy sector, Metallurgical and Mining Industry in Ukraine NIR shown in Table 1.

As Table 1 shows GHG emissions from the Metallurgical and Mining Industry in Ukraine is made with a combination of Tier 1 (T1) and Tier 3 (T3). Estimation of CO_2 emissions from Metallurgical coke production are showed in Figure 5

Table 1. Specialty for the evaluation of the Energy sector, Metallurgical and Mining Industry in Ukraine NIR

Sectors and Categories	Estima-tion method	Used EF	Including LULUCF			Without LULUCF		
			The share in total emissions,%		Uncer-tainty in 2013, %	The share in total emissions,%		Uncer-tainty in 2013, %
			1990	2013		1990	2013	
Energy			**82.10** **77,93** **1,87**	**77.93**	**1.87**	**76.54**	**70.16**	**1.69**
Fuel Combustion Activities – Energy Industries	IPCC-2006, T1, T2	IPCC-2006						
Industrial Processes and Product Use			**13.84**	**20.52**	**0.81**	**12.90**	**18.48**	**0.73**
Metal Industry – Iron and Steel Production	CS, T3, T1	CS						
Metal Industry – Ferroalloys Production	CS, T3, T1	CS						

The Tier 1 method assumes that all coke made onsite at iron and steel production facilities is used onsite. The Tier 1 method is to multiply default EF by tones of coke produced. Therefore, the Tier 1 is appropriate only if production is not a key category. The Tier 1 methodology for CH_4 is based on EF and national production statistics.

The Tier 2 method is appropriate if national statistics on process inputs and outputs from integrated and nonintegrated coke production processes are available. The Tier 2 method is not applicable to estimating CH_4 emissions.

Unlike the Tier 2 method, the Tier 3 method uses plant specific data because plants can differ substantially in their technology and process conditions. If actual measured CO_2/CH_4 emissions data are available from onsite and offsite coke production plants, these data can be aggregated and used directly to account for national emissions from metallurgical coke production using the Tier 3 method.

Total national emissions will equal the sum of emissions reported from each facility. If facility-specific CO_2 emissions data are not available, CO_2 emissions can be calculated from plant-specific activity data applying the Tier 2 method. Total national emissions will equal the sum of emissions reported from each facility.

Ukraine is among the top ten countries in terms of Steel production [12]. In 2013, the country produced 32.8 million tons of Steel, which is 1.5 % more than the previous 2012. At the same industry observed the following trends that directly affect the level of GHG emissions:

increasing the share of steel produced by the basic oxygen process and the electric steel, with a corresponding decrease in the proportion of open-hearth steel production process;

increasing the share of steel, which is bottled at the continuous casting machines.

The above trends are characterized by a decrease in energy intensity of production, and as a result, help to reduce specific emissions of GHG.

Non-ferrous metallurgy in Ukraine, in contrast to the black, occupies a large share both in terms of emissions and in terms of fuel consumption. However, the industry is characterized by greater power consumption. The main share in the production of non-ferrous metals occupies zinc and lead. Aluminums production in Ukraine ended in May 2010.

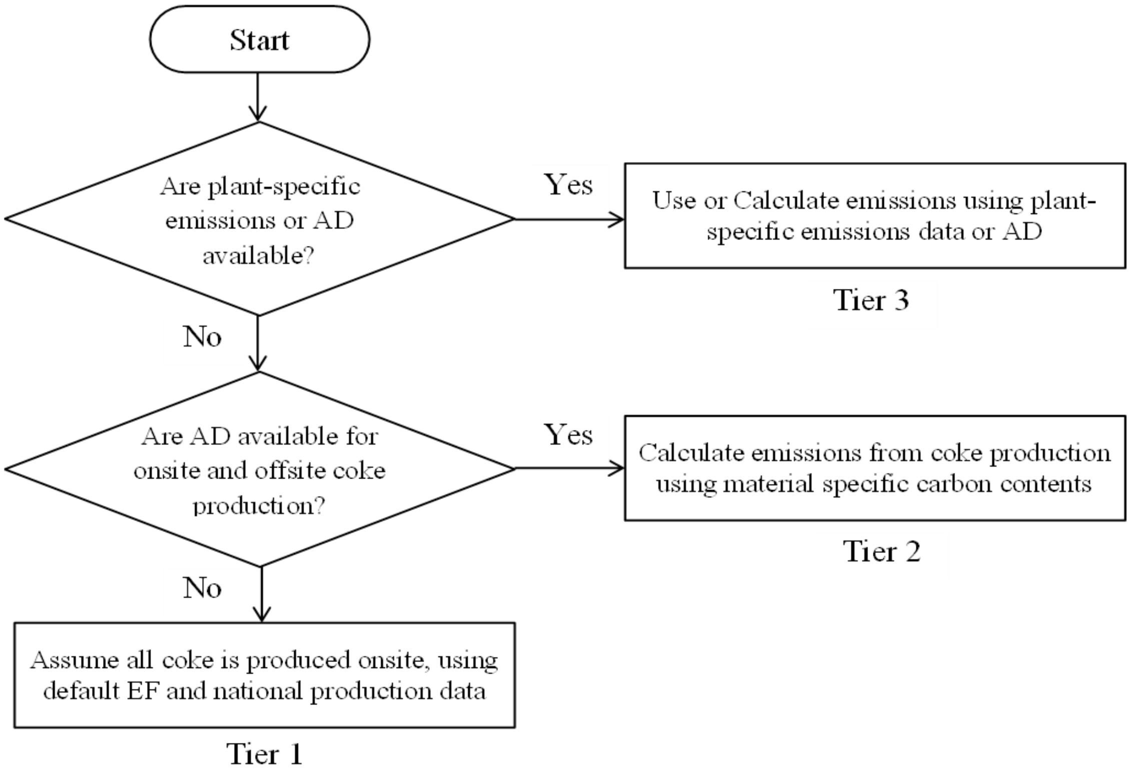

Figure 5. Estimation of CO_2 emissions from Metallurgical coke production

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Among all categories of the greatest amount of CO_2 emissions is observed in the production of iron and steel. CH_4 emissions in the industrial sector are connected mainly with the production of pig iron and coke [4].

Thus, one of the main ways to increase competitiveness of domestic steel products and reduction of anthropogenic impact on the environment is to increase energy efficiency.

Solving the problem of efficient use of energy resources in international agreements is possible under the following conditions:

strictly compliance with established commitments to GHG emissions reductions;

restructuring of the energy balance of mining and smelting complex;

reduce the use of fossil fuels;

changing natural energy resources secondary exhaust energy (such as blast furnace and coke oven gas).

Consideration of environmental impact during the planning and selection of production technology, product assortment, structures of fuel and energy enterprises to stimulate technological innovation and the development of energy efficient technologies.

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