B-3: Greenhouse gas emissions

1) General description

1.1) Brief definition

This indicator is a measure of anthropogenic emissions of greenhouse gases (GHGs) included in Annex A to the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC): carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). Values for these gases are presented in total and with regard to sources and sinks through land use, land use change and forestry (LULUCF), by economic sector[1] , per capita and per unit of GDP (in constant prices in the national currency and in international dollars[2] in PPP).

1.2) Units of measurement

Emissions of different GHGs are presented in tons of CO_2 equivalent (CO_2-eq), in total and by economic sectors as defined by the International Standard Industrial Classification of All Economic Activities (ISIC Rev. 4). For cross-country comparisons, the indicator may be presented in thousand tons per square km of the country's territory, in tons per capita and in tons per GDP unit (expressed in constant prices in the national currency and in international dollars in PPP).

1.3) Context

Relation to other indicators from the Guidelines - This indicator relates to indicators „B-1: Air temperature" and "B-2: Atmospheric precipitation".

2) Relevance for environmental policy

2.1) Purpose

The indicator provides a measure of the existing and future anthropogenic impact on the earth's climate due to emissions of GHGs into the atmosphere. It shows the extent to which

[1] As defined by the International Standard Industrial Classification of All Economic Activities (ISIC Rev. 4).
[2] The International dollar a is monetary unit which is used by the World Bank for the calculation of the GDP in PPP.

countries have achieved their specified goals for emissions and the response to country policies for achieving the emissions target.

2.2) Issue

Increasing GHG concentrations can affect the earth's climate, and have potential consequences for ecosystems, human settlements, agriculture and other socio-economic activities. The contribution of each of the GHG to global warming depends on its ability to absorb Earth's radiant heat flux and its lifetime in the air. Three GHGs – CO_2, CH_4 and N_2O – account for around 98% of the environmental pressure that leads to climate change. At the same time, PCFs, HFCs and SF_6 have more considerable time of existence in the atmosphere in comparison with carbon dioxide, methane and nitrous oxide. In order to aggregate the emissions of different GHGs, these are presented in CO_2 equivalent, based on the concept of its global warming potential (GWP). The GWP is the estimated potential of a greenhouse gas to contribute to global warming in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide (whose GWP is standardized to 1). For example, the GWP of CH_4 is 21, while that of N_2O is 310, and that of sulphur hexafluoride is 22800, which means that the impact of 1 kilogram of CH_4 on global warming is 21 times higher than that of 1 kilogram of CO_2, while that of 1 kilogram of N_2O is 310 times higher than that of 1 kilogram of CO2, and the impact of 1 kilogram of sulphur hexafluoride is 22800 times higher than that of 1 kilogram CO_2. A GWP is calculated over a specific time interval, commonly 20, 100 or 500 years. Here the GWP for an interval of 100 years shall be used.

Emissions of CO_2 and other GHGs are still increasing in many countries, despite some progress in decoupling CO_2 and other GHG emissions from economic growth. The main challenges are to limit emissions of CO_2 and other GHGs and to stabilize the concentration of GHG in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Based on the measures of GHG emissions it is possible to outline current trends in emissions in relation to the country targets. Determining the difference between target and GHG emissions ("distance to target" measurement) helps in comparing progress made in countries of South-Eastern and Eastern Europe, Caucasus and Central Asia with countries covered by the networks of the European Environment Agency (EEA). Furthermore with the collected data it is possible to compute projections on future trends in anthropogenic GHG emissions. This implies achieving GHG emissions targets set by international agreements or national strategies and strengthening efforts to implement related national and international strategies and to further decouple GHG emissions from economic growth. A country's future GHG emissions will largely depend on development trends in the economy, on technologies, on social transformations, as well as on the absorbing ability of carbon sinks (first of all, by forests) of GHGs on its territory.

A country development scenario with a special focus on economic priority sectors that are the major sources of emissions is a specific way to analyse consequences based on various assumptions about future trends and GHG reduction strategies. Activities in the Land Use, Land-Use Change and Forestry (LULUCF) sector can provide a relatively cost-effective way of offsetting emissions, either by increasing the removals of greenhouse gases from the atmosphere (e.g. by planting trees or managing forests), or by reducing emissions (e.g. by curbing deforestation).

2.3) International agreements and targets

a) Global level

The UNFCCC binds its Parties to reduce their emissions, to ensure collection of the relevant information, and to develop strategies for adaptation to climate change and for cooperation in research and in developing new technologies. The UNFCCC requires all Parties to carry out emission inventories. In addition, the Annex I countries[3] must regularly submit "national communications" to the Conference of the Parties. The communications should describe the work done by a particular Party to implement the Convention, including projection of GHG emissions for the next 10–20 years. The Kyoto Protocol to the UNFCCC stipulates that Annex I Parties (mainly industrialized countries) shall individually or jointly reduce their aggregate emissions of a "basket" of six GHGs to 5% below 1990 levels by the average during 2008–2012. To achieve this group target, each Party had to accomplish its own specific task in the area of emissions reduction. The Russian Federation and Ukraine, for instance, had to stabilize their emissions at 1990 levels, whereas the EU-15 countries had to reduce their levels by 8 %.

Under Article 3.3 of the Kyoto Protocol, Parties decided that greenhouse gas removals and emissions through certain LULUCF activities — namely, afforestation and reforestation since 1990 — are accounted for in meeting the Kyoto Protocol's emission targets. Conversely, emissions from deforestation activities will be subtracted from the amount of emissions that an Annex I Party may emit over its commitment period. The World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002 made commitments to an urgently needed and substantial increase in the use of renewable (non-carbon) energy sources as well as the setting up of programmes leading to more sustainable consumption and production patterns, including a reduction in energy use.

b) Subregional level

The Environment Strategy of countries of South-Eastern and Eastern Europe, Caucasus and Central Asia foresees, in particular, energy efficiency measures in environmental policies as well as in programmes for mitigating climate change and for achieving the Kyoto Protocol targets. The European Union takes the lead in climate change related issues including the reduction of GHG emissions and has established a specialized General Directorate "Climate Action" within the European Commission. The 2nd European Climate Change Programme has been launched in 2005 followed in 2011 by the Roadmap for moving to a competitive low carbon economy in 2050.

[3] Belarus, Russian Federation and Ukraine are Annex-I countries; the other countries of South-Eastern and Eastern Europe, Caucasus and Central Asia belong to non-Annex I countries.

3) Methodology and guidelines

3.1) Data collection and calculations

In order to be aggregated, non-CO_2 gases are weighed by their respective global warming potential and presented in CO_2-equivalent units.
The estimation of the total amount of flux of the GHGs into the atmosphere should be provided as aggregated emission in tons of CO_2-equivalent. To incorporate greenhouse gas emissions and removals through LULUCF activities in the countries' performance, the net value for LULUCF (which can be positive or negative) should be provided, and added to the aggregated emissions in the production table. The estimate of a country's GHG emissions can be based on statistical data of state administration bodies regarding activities which affect the GHG concentration in the atmosphere (sources and sinks of GHGs). For instance, annual data on GHG emissions from fuel combustion activities can be estimated based on the annual consumption of fossil fuels. Annual data on methane production in agriculture in relation to gastric fermentation can be evaluated based on the number of animals and the species involved. Emission factors connect emissions with statistics on anthropogenic activities. Following is a simplified description of the estimation technique:

GHG emissions = (data on anthropogenic activities) x emission factors.

Activity data describe the annual, national magnitude of an activity (e.g. tonnes of coal mined nationally in a given year) and the Emission factor is the mass of GHG emitted per unit of activity (e.g. Gg CH_4 per tonne of coal mined). Both internationally adopted emission factors developed by the Intergovernmental Panel on Climate Change (IPCC) and national emission factors can be applied. Data on GHG absorption by anthropogenic sinks can be calculated through annual deposition of carbon from the atmosphere. The GHG emissions values should be estimated for each year.

3.2) Internationally agreed methodologies and standards

Parties to the UNFCCC have adopted reporting guidelines, including a set of tables for the Common Reporting Format (CRF), which is in line with the IPCC Guidelines for National Greenhouse Gas Inventories. Signatories to the Kyoto Protocol adopted Guidelines for national systems for estimation of anthropogenic GHG emissions by sources and removals by carbon sinks. ISO has developed ISO 14064 standards for the quantification, reporting and verification of GHG emissions. A large number of international models for projecting both short-term and long-term trends in the evolution of GHG emissions in various sectors of the economy are available. IPCC has published three types of scenarios: "without measures", "with measures" and "with additional measures". National-level emissions scenarios are developed based on state programmes for socio-economic development, with

special focus on the priority sectors of the economy that are the major sources of emissions and sinks.

4) Data sources and reporting

In all countries of South-Eastern and Eastern Europe, Caucasus and Central Asia, national statistical and/or environmental agencies collect data on GHG emissions into the atmospheric air from stationary sources using a standardised reporting form. Emissions from mobile sources are calculated on the basis of quantity of consumed fuel and composition of vehicle fleet. All countries of South-Eastern and Eastern Europe, Caucasus and Central Asia are Parties to the UNFCCC and submit to the Secretariat national GHG inventories of anthropogenic emissions by sources and removals by sinks of GHGs not controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer. As a part of their UNFCCC commitments, Annex 1 Parties are required to submit a national communication on a regular basis (every four to five years); other Parties have no obligation regarding regularity.[4] All countries of South-Eastern and Eastern Europe, Caucasus and Central Asia are Parties to the Kyoto Protocol and have established national coordination centres which collect the data for the calculation of emissions and sinks of GHGs, and take care of GHGs emission projections scenarios.

5) References at the international level

- United Nations Framework Convention on Climate Change (1992): http://www.unfccc.int;
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (1997);
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories: http://www.ipcc-nggip.iges.or.jp/;
- Good practice guidance and uncertainty management in national GHG inventories (IPCC, 2000): http://www.ipcc-nggip.iges.or.jp/public/gp/english/;
- Good practice guidance for land-use, land-use change and forestry (IPCC, 2003): http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html ;
- The GHG Indicator: UNEP Guidelines for Measuring GHG Emissions for Businesses and Non-commercial Organizations (UNEP, 2000);
- UNFCCC guidelines on reporting and review (document FCCC/CP/2002/8);
- Annual European Union greenhouse gas inventory 1990–2010 and inventory report 2012 (EEA Technical Report No. 3/2012);

[4] At present, at least one national communication is available for each country of South-Eastern and Eastern Europe, Caucasus and Central Asia.

- Council Decision 2002/358/EC of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the UNFCCC and the joint fulfilment of commitments thereunder;
- Decision No. 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and implementing the Kyoto Protocol;
- IPCC: http://www.ipcc.ch ;
- European Commission, General Directorate Climate Action: http://ec.europa.eu/clima/news/index_en.htm ;
- UNSD: http://unstats.un.org/unsd/environment/ ;
- EEA: http://themes.eea.europa.eu/IMS/CSI .