



Data Sources and Methods for the Greenhouse Gas Emissions Indicators

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Environment Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 819-997-2800
Toll Free: 1-800-668-6767 (in Canada only)
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca

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1. Introduction

The Greenhouse Gas Emissions indicators (ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=FBF8455E-1) are part of the Canadian Environmental Sustainability Indicators (CESI) program (ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=47F48106-1), which provides data and information to track Canada's performance on key environmental sustainability issues. This indicator is also used to measure progress towards the goals and targets of the Federal Sustainable Development Strategy (ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1).

2. Description and rationale of the Greenhouse Gas Emissions indicators

2.1 Description

The Greenhouse Gas (GHG) Emissions indicators report trends in anthropogenic (human-made) GHG emissions at the national level (total emissions, emissions per person and emissions per unit of gross domestic product [GDP]),¹ at the provincial/territorial and at the economic sector level for seven GHGs: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), sulphur hexafluoride (SF₆), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and nitrogen trifluoride (NF₃).

Emissions from natural, unmanaged sources (material decay, plant and animal respiration, volcanic and thermal venting, etc.), and absorption of emissions by natural sinks (forests, oceans), are not captured by these indicators.

2.2 Rationale

The GHG emissions indicators are used to track the progress of Canada's efforts to lower emissions and reach environmental performance objectives. Use of the GHG indicators in conjunction with economic performance indicators such as the GDP supports national-level decision making on sustainable development.

As an Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC) (unfccc.int/2860.php), Canada is required to prepare and submit a national inventory of anthropogenic sources and sinks of GHGs on an annual basis.

Since direct measurement of emissions from all sources is not possible, the UNFCCC requires that countries develop, update, publish and maintain national inventories using internationally approved and comparable emissions and removals estimation methods for the seven GHGs. Canada's inventory is developed in accordance with the recently revised UNFCCC Annex I Inventory Reporting Guidelines (unfccc.int/documentation/documents/advanced_search/items/6911.php?preref=600003988) which require the use of the 2006 methodological guidance developed by the Intergovernmental Panel on Climate Change (IPCC) (www.ipcc-nggip.iges.or.jp/public/2006gl/). The IPCC guidelines are approved and developed through an international process that involves testing of methods through preliminary inventory development, country studies, technical and regional workshops, and national and international experts consultations.

2.3 Recent changes to the indicator

The National Inventory Report 1990–2013: Greenhouse Gas Sources and Sinks in Canada (ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1) is required to follow new UNFCCC reporting guidelines. These new guidelines include the adoption of revised methodologies in

¹ GHG intensity per unit of GDP is calculated using the real inflation-adjusted GDP in 2007 dollars.

accordance with IPCC guidelines, and the use of revised global warming potentials (GWPs). The impact of the revised GWPs amounts to approximately a 2.3% increase in total emissions throughout the time series. Other changes include those implemented for the continuous improvement of Canada's inventory and changes that address recommendations made by the expert review team (ERT) during the annual review of previous inventories.

3. Data

3.1 Data source

The Greenhouse Gas Emissions indicators are based on GHG emissions data taken from Environment Canada's National Inventory Report 1990–2013: Greenhouse Gas Sources and Sinks in Canada (ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1). Data used to develop the emission and removal estimates presented in the National Inventory Report (NIR) are drawn from published and unpublished sources from various government departments, industry sources and scientific papers. The methods used to prepare the emission and removal estimates are consistent with internationally accepted Intergovernmental Panel on Climate Change (IPCC) reference documents. Figures 1-2 and 1-3 of the NIR illustrate the inventory preparation process and show the main partners involved in preparing the annual inventory. A comprehensive list detailing all data sources (disaggregated by sector and sub-sector) can be found in chapters 3 through 7 of the NIR.

3.2 Spatial coverage

GHG emission estimates are provided at the national and provincial/territorial levels.

3.3 Temporal coverage

GHG emission and removal estimates are compiled annually and reported for the period 1990 to 2013. Complete details of the temporal coverage for each data source used for the indicators can be found in chapters 1 (section 1.2.2) and 3 through 7 of the NIR.

3.4 Data completeness

Although the GHG emissions indicators are comprehensive, some emission sources have not been included in the indicators because they are not reported in the NIR. Owing to their relatively small contributions to the total emissions, these excluded sources do not significantly affect the overall completeness of the inventory. A detailed explanation of the excluded emission sources can be found in Annex 5 of the NIR. In addition, emissions and removals from the land-use, land use change and forestry sector are excluded from national totals and subsequently not reported as part of the GHG emission indicators.

3.5 Data timeliness

The data included in the indicators cover the period from 1990 through the end of 2013. Preparation of the GHG emissions inventory takes almost 16 months from the end of the last reporting year because of the time needed to collect, validate, calculate and interpret the data.

Between November and January, emission estimates are prepared by Environment Canada's Pollutant Inventories and Reporting Division with input from numerous experts and scientists across Canada. From January through March, the NIR text and accompanying emission data tables are developed. This material is reviewed by external experts and Environment Canada officials, and finally submitted electronically to the United Nations Framework Convention on Climate Change (UNFCCC), typically by mid-April.

4. Methods

In general, greenhouse gas (GHG) emissions are estimated by multiplying activity data by emission factors.

$$\text{Emissions} = \text{activity data} \times \text{emission factor}$$

Activity data refer to the quantitative amount of human activity resulting in emissions during a given time period. The annual activity data for fuel combustion sources, for example, are the total amounts of fuel burned.

Emission factors are based on samples of measurement data, and are representative rates of emissions for a given activity level under a given set of operating conditions. They are the estimated average emission rate of a given pollutant for a given source, relative to units of activity.

Guidelines produced by the Intergovernmental Panel on Climate Change (IPCC) for countries reporting to the United Nations Framework Convention on Climate Change (UNFCCC) (unfccc.int/2860.php) provide various methods for calculating a GHG emission from a given human activity. The methods for estimating emissions are divided into "tiers," each encompassing different levels of activity and technological detail. The same general structure is used for all tiers, while the level of detail at which the calculations are carried out can vary. Annex 3 of the National Inventory Report (NIR) describe the methods used to estimate Canada's GHG emissions, and illustrate that the selection of IPCC method type is highly dependent on the importance of each category and the availability of data.

The GHG emissions are reported in carbon dioxide equivalents (CO₂ eq), determined by multiplying the amount of emissions of a particular gas by the global warming potential (GWP) of that gas. GHGs differ in their ability to absorb heat in the atmosphere due to their differing chemical properties and atmospheric lifetimes. For example, over a period of 100 years, methane's (CH₄) potential to trap heat in the atmosphere is 25 times greater than carbon dioxide's potential, and thus it is considered to have a GWP of 25. The IPCC publishes the GWPs and atmospheric lifetimes for each GHG which can be found in Table 1-1 of the NIR.

The GHG emissions by economic sector indicator represent a different classification than the activity sector emissions prescribed by the IPCC methodology and UNFCCC Reporting Guidelines. Instead of reporting on Canada's emissions by activity, GHG emissions have been allocated to the economic sector in which they are generated (e.g., transportation emissions directly supporting an industrial activity, like off-road trucks in mining activities, have been allocated to the economic sector in which they are generated rather than to the transportation "activity" sector). A comprehensive detailing of the emissions reported by economic sector can be found in chapter 2 of the NIR.

The application of quality assurance and quality control (QA/QC) procedures is an essential requirement of the GHG inventory development and submission process. QA/QC procedures ensure and improve transparency, consistency, comparability, completeness and confidence in the national emissions for the purpose of meeting Canada's reporting commitments under the UNFCCC. Chapter 1 (section 1.3) of the NIR provides a complete description of the QA/QC procedures.

5. Caveats and limitations

Annex 2 of the National Inventory Report (NIR) presents the uncertainty assessment for Canada's greenhouse gas (GHG) emissions. Further details on uncertainty related to specific sectors can be found in the uncertainty sections of chapters 3 through 7 of the NIR.

The sum of emissions from all provinces and territories does not equate to the national total, because emissions from some minor sources are estimated only at the national level. In particular, GHG emission estimates from consumption of perfluorocarbons (PFCs) and nitrogen trifluoride (NF₃), as well as emissions of sulphur hexafluoride (SF₆) from semi-conductor

manufacturing, are only available at the national level. Nevertheless, the trends in emissions from provinces and territories are considered representative of the actual emission trends in these jurisdictions.

As part of the continuous improvement process, recalculations are performed annually on Canada's previously reported GHG emission estimates, to reflect updates to source data and estimation methodology. Chapter 8 (section 8.1) of the NIR provides a summary of the recalculations that occurred due to methodological changes and/or refinements since the previous submission, with a brief description, justification and summary of individual impacts on previously reported emission estimates.

6. References and further reading

6.1 References

Environment Canada (2015) National Inventory Report, 1990–2013: Greenhouse Gas Sources and Sinks in Canada. Available from: ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1.

6.2 Further reading

Intergovernmental Panel on Climate Change (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Available from: www.ipcc-nggip.iges.or.jp/public/2006gl/.

www.ec.gc.ca

Additional information can be obtained at:

Environment Canada

Inquiry Centre

10 Wellington Street, 23rd Floor

Gatineau, QC K1A 0H3

Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800

Fax: 819-994-1412

TTY: 819-994-0736

Email: enviroinfo@ec.gc.ca