

Carbon Footprint Assessment and Reduction Workbook Guidance

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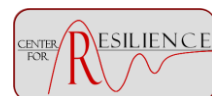


Table of Contents

Introduction.....	1
History of Project.....	1
Software Analysis.....	1
Tool Architecture.....	2
Navigation.....	3
Data Characterization and Entry.....	3
Emissions Summary.....	3
Annual Reports.....	3
Reduction Analysis.....	4
Emission Intensity.....	4
Emission Factor Data.....	4
Documentation.....	4
Units Conversion.....	4
Help.....	4
Data Collection.....	5
Emission Factors.....	5
Tutorial.....	5

Introduction

The Carbon Footprint Assessment and Reduction (C-FAR) workbook provides cities, municipalities and local governments with a simple Microsoft Excel application to enter and organize emissions data, track changes over time, and establish feasible reductions goals. With basic knowledge of Excel and the resources described within this document, it is possible to use the tool to conduct a baseline emissions inventory with less cost and effort than other available alternatives. For cities that sign the U.S. Mayors' Climate Protection Agreement, this tool is an important resource to help initiate the first steps of the agreement: (a) Conduct a baseline inventory of greenhouse gas (GHG) emissions, and (b) Set a GHG reduction target.

This document describes the background of the tool development, outlines the tool's features and capabilities, and provides a guide for general use of the tool. Recommended references are listed in the footnotes at the bottom of each page.

History of Project

On February 22, 2007, Mayor Michael B. Coleman signed the U.S. Mayors' Climate Projection agreement¹. As part of this agreement, Susan Ashbrook, the city's Environmental Steward², was charged with the task of conducting a baseline emission inventory, setting a GHG reduction target, and developing a climate action plan to achieve that target. Based upon an analysis of available inventory software options, described in detail below, it was determined that a transparent, flexible and easy to use inventory tool for municipalities was not available in the public domain.

Accordingly, a decision was made to develop a nonproprietary Microsoft Excel tool for the City of Columbus with technical assistance from the Center for Resilience³ at The Ohio State University. The intent of this project was to utilize the tool to conduct an emissions inventory for the City of Columbus, and then to share the tool with regional partners to encourage further emissions reductions. The availability of this public domain municipal emissions inventory tool has fostered partnerships with the Mid-Ohio Regional Planning Commission (MORPC), several climate conscious cities within Central Ohio, and Ameresco, an energy services company. Ameresco has joined MORPC's Center for Energy and the Environment and will offer its services free of charge to cities interested in conducting a baseline emissions inventory.

Software Analysis

A survey of the available resources for conducting a municipal GHG emissions inventory was conducted to select the most desirable technical approach for the City of Columbus to achieve its goals of completing a baseline GHG inventory and having a methodology and tool that could easily be shared with regional partners.

¹ <http://www.usmayors.org/climateprotection/agreement.htm>

² City of Columbus Get Green Initiative www.getgreencolumbus.org

³ Center for Resilience www.resilience.osu.edu

Several software options exist for municipalities to track their GHG emissions. The International Council for Local Environmental Initiatives (ICLEI)⁴ offers the only software customized specifically for municipal governments, available for a fee based on city population. The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD)⁵ have developed various public domain tools to track GHG emissions for businesses and universities. There are several other GHG emissions inventory tools or calculators designed for various scales. The Intergovernmental Panel on Climate Change (IPCC)⁶ manages a national GHG emissions inventory and publishes the Microsoft Excel tool utilized for the inventory. The most common tools are personal carbon calculators that estimate the GHG emissions from personal behavior.

Based on the availability of published emission factors^{7,8} and lack of publicly available tools developed for municipalities, the City of Columbus elected to develop, C-FAR, a Microsoft Excel based spreadsheet to track its emissions. This made it possible to have a more transparent and flexible tool, and to offer the tool to other local municipalities to track their GHG emissions with no fees for software development or usage. The tool also offers a reduction target analysis feature, which helps users to understand the impact of potential mitigation projects proposed in the City's climate action plan. The project benefited from a number of general references that are publicly available for developing emission inventory tools.^{9,10}

Tool Architecture

The municipal emissions inventory tool is intended to support each step in developing a GHG emissions inventory. The primary steps of conducting an emissions inventory and the corresponding tool worksheets are as follows:

1. Defining the inventory scope
 - Help Worksheet
2. Collecting and organizing data
 - Data Characterization and Annual Data Entry Worksheets
3. Reporting emissions results
 - Emissions Summary Worksheet
 - Annual Reports Worksheet
 - Municipal Intensity Factors Worksheet
4. Developing a Climate Action Plan
 - Reduction Analysis Worksheet
5. Setting a reduction target
 - Reduction Analysis Worksheet

⁴ <http://www.iclei.org/index.php?id=771>

⁵ The Greenhouse Gas Protocol Initiative www.ghgprotocol.org

⁶ <http://www.ipcc-nggip.iges.or.jp/EFDB/main.php>

⁷ EIA Technical Guidelines: Voluntary Reporting of Greenhouse Gases. January 2007

⁸ Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation 1998-2000. Energy Information Administration, U.S. Department of Energy, April 2002

⁹ Natural Capital Solutions. Climate Protection Manual for Cities: Chapter 3. www.climatemanual.org


¹⁰ World Resources Institute. Designing a Customized GHG Calculation Tool. www.ghgprotocol.org

The tool is composed of a series of worksheets within a Microsoft Excel .xls document. Navigation through the tool can be performed easily with the Navigation worksheet and corresponding linked buttons throughout the tool, or with the worksheet tabs at the bottom of the tool. Originally developed in Microsoft Excel 2003, this tool is cross compatible with versions '97 through '07. No detectable errors have occurred in the range of versions. (If any errors are discovered, please report them to kieran.sikdar@gmail.com.)

The following are brief descriptions of the important worksheets to orient the user to each component of the tool. A detailed tutorial for general use of the tool can be found below in the Tutorial section.

Navigation

This is the main worksheet that provides a visual representation of the steps necessary to complete an emissions inventory. It contains buttons linked to all the main pages within the tool.

Users can click the  button found on every worksheet to return to the main navigation worksheet. In addition, buttons linked to other locations in the tool are provided on many of the worksheets.

Data Characterization and Entry

The most important part of doing a GHG emission inventory is data collection. Only with high quality, consistent, and accurate data will the outputs from this tool be meaningful. Data categories to organize and describe each data entry, as well as general information to describe the municipality of interest, are entered in the Data Characterization worksheet. The data entry worksheets, accessed by clicking the year of desired entry in the Annual Data Entry Worksheets Navigation Bar, allow users to enter annual consumption data that are translated into equivalent carbon dioxide emissions by the tool. A typical entry might be the annual number of kilowatt hours of electricity consumed by a building, or gallons of diesel consumed by a vehicle fleet. Outputs from the data entry are summarized in the grey tables at the top right of each annual data entry worksheet in tabular form.

Emissions Summary

GHG emissions data from each year in which data are available are presented on this worksheet. A linear emissions trend line is derived from existing data and projected into the future and past. A table is included to enter regional emissions data, in order to understand the relative emissions contribution of the city conducting the inventory.

Annual Reports

Annual GHG emissions data are summarized in graphical and tabular form. Each pie chart corresponds to the table on the right of each chart. These graphs and tables are intended to be included in emissions reporting documents and presentations as necessary. Tables and graphs can simply be inserted into Microsoft Word documents using the copy and paste features or by inserting an Excel table or graph from the Insert menu. Graphs and tables can also be printed directly from the Excel file.

Reduction Analysis

Users can analyze the impact of GHG emissions mitigation and reduction projects and set a realistic emissions reduction target in the Reduction Analysis worksheet. Users can enter and modify project-specific reduction scenarios, which influence overall GHG reduction targets. A simple resources savings calculator is also provided to show the direct material savings. However, this table does not include a full economic analysis of mitigation project implementation. The World Resources Institute publishes a general guidance document for emissions mitigation projects.¹¹

Emission Intensity

Users can enter annual data related to the size of the municipality of interest to understand how size and growth impacts specific sources of GHG emissions. Intensity factors, i.e., measures of efficiency, are utilized to account for growth and for setting reduction targets. A common intensity factor for national inventories is emissions per GDP. Users interested in applying intensity factors should review the guidance offered by WRI.¹²

Emission Factor Data

Factors utilized to calculate equivalent carbon dioxide emissions for each category are listed in the Emissions Factor Data worksheet. These data are drawn from the U.S. Environmental Protection Agency as well as the Energy Information Administration. Summaries of commonly used emission factors and sources are available in the **Help** worksheet.

Documentation

Specific descriptions, references, sources and websites for each individual emission factor are listed on this worksheet. Additional emission factor information and documentation is provided in the **Help** worksheet.

Units Conversion

Common unit conversions are provided for data that are not expressed in the required emission factor units. This table may be helpful in converting data and emission factors to the appropriate units for the emissions inventory.

Help

The Help worksheet provides general guidance for conducting an emissions inventory. It is also a supplement to Microsoft Excel's Help reference and provides specific topics that may be helpful terms to search. All important Excel features utilized within the tool are listed and possible remedies are included for problems related to each feature. General guidance is also provided for emission factor references and emissions scoping.

¹¹ The GHG Protocol for Project Accounting. www.ghgprotocol.org

¹² World Resources Institute. Target Intensity: An Analysis of Greenhouse Gas Intensity Targets www.ghgprotocol.org

Data Collection

Direct measurement of CO₂ emissions is rarely possible. Thus, emissions are based on estimates of emissions from economic consumption data. Data collection is generally the most time-consuming element of an emissions inventory. It is also the most important part of the inventory process with regard to quality of results and accuracy. This document is not intended to provide data collection guidance, as other publicly available references are sufficient^{13,14}.

Emission Factors

Emission factor data are compiled from the U.S. Environmental Protection Agency (USEPA¹⁵) and the Energy Information Administration (EIA^{16,17}). Emission factors are utilized to convert economic consumption data into equivalent carbon dioxide emissions. The resulting emissions are only as accurate as the economic data and emission factors. The US EPA, WRI, IPCC and the EIA have done extensive research to understand, validate and improve the accuracy of current GHG emission factors utilized in this inventory.

Default values for the City of Columbus emissions inventory were selected on the basis of regional electricity generation and the resource consumption of the City. Default emission factors may be relevant for a city other than Columbus, depending on the types of fuels used for regional electricity generation and the types of resources consumed by the city. The USEPA and EIA references mentioned above provide guidance for selecting new emissions factors if the default values do not apply.

Tutorial

The following provides a brief demonstration of the features of the Carbon Footprint Assessment and Reduction workbook for a first time user.

1. First, open the Excel file C-FAR_vX.xls.
2. Introduction and Help
 - a. It is highly recommended that new users read all the information contained in the Introduction and Help worksheets as well as the information in this user guide to familiarize themselves with the intended functionality of the tool as well as the general Excel features utilized in the tool development.
 - b. Next, click the blue Navigation button.
3. Navigation
 - a. The Navigation worksheet serves as the central link to all other worksheets in the tool. It also provides a visual framework of the flow of data entry and analysis that generally proceeds when conducting an emissions inventory. Once users are familiar with navigation and the use of the tool, data entry can begin.

¹³ Dautremont-Smith, Julian. Guidelines for College-Level Greenhouse Gas Emissions Inventories. www.lclark.edu/~seed/ghginventoryguide.pdf

¹⁴ World Resources Institute. A Corporate Accounting and Reporting Standard. www.ghgprotocol.org

¹⁵ INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2005 (April 2007), USEPA #430-R-07-002

¹⁶ EIA Technical Guidelines: Voluntary Reporting of Greenhouse Gases. January 2007

¹⁷ Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation 1998-2000. Energy Information Administration, U.S. Department of Energy, April 2002

- b. Click the Data Characterization button.
4. Data Characterization & Data Entry
 - a. Users must enter information regarding the city and personnel performing the inventory. All light turquoise cells are used for this purpose throughout the tool. They are inputs into the tool as depicted by the legend on the Help page. Select a baseline year in order to highlight the relevant navigation links throughout the tool. Applicable years will be outlined with a green background and turquoise text.
 - b. The information from the Data Categorization table is used throughout the tool as a reference for how to organize and group data. The entries in the Category column will correspond to the emission factors used in the tool. Thus, great care must be taken with the units of each entry in this column to make sure emission factor units match with the units of available data. The data can also be organized by two additional categories. It may be necessary to enter a “Miscellaneous” or “Other” categories for two additional columns of data categorization to ensure that each data entry can be properly categorized. Any changes to data categorization, emission factor names or units must be done in the Data Categorization table. After data categorization is complete, click the desired year of initial data entry on the Data Entry navigation sidebar.
 - c. The categories entered in the Data Categorization table can be seen on the data entry sheets. Utilize the Annual Data Entry Worksheet navigation to begin data entry. Data are entered in rows from left to right. Drop down menus in each row will contain a list of the categories previously entered by the user in the Data Categorization table. These drop-down menus appear for the first two hundred entries. If necessary, data entry capacity can be expanded by copying the last blank row and pasting it over the necessary range of cells for the amount of data entries desired. The gray emission summation tables will need to have the calculation ranges updated as well.
 - d. If a category does not apply to a particular data entry, select the “Other” or “Miscellaneous” category described above. This allows for all data to be tracked accurately within the tool.
 - i. Once the “Category” is defined in the first column, the Units column for the entry is automatically populated. Select categories from the drop down menus in the first three columns.
 - ii. Activity Data can now be entered. Make sure that the data units match what is listed in the Units column. Typical Activity Data or resource consumption would be kilowatt hours of electricity or gallons of gasoline.
 1. MT eCO₂ are automatically calculated from the Category and Activity Data entered.
 - iii. Additional information can be included in the notes column.
 - iv. Repeat step 4.d.i and 4.d.ii until all annual data for the initial year have been entered.
 1. Once all categories have been entered, manual entry may be preferred. Manual entry is facilitated by Microsoft Excel’s automatic word completion feature by only requiring the user to enter the category’s complete set of unique characters. For example, if “Electricity” is the only category that starts with an

“E”, only “E” will have to be typed, but categories that share common words or beginnings will require the first unique character to be type. For example, if several categories have “Public” as the first part of the category, “Public U” would have to be typed for Public Utilities.

- e. Click the next year for desired data entry on the Data Entry navigation bar on the left of the worksheet. Repeat step 4.d.i and 4.d.ii for all additional years.
 - f. Click the blue Navigation button.
 - g. Click the Emissions Summary button.
5. Emissions Summary
- a. All the data entered on the individual data entry sheets will appear as total annual emissions on the Annual Emissions Summary graph. This graph also includes a linear trend line that is calculated from the data entered and projected into the future and past.
 - b. Activity Data can be entered for another city or regional area for comparison. Data for each city or region must be from the same year for accurate comparison.
 - c. A year is then selected to compare emissions for the city that is using the inventory tool to the regional emissions data entered in step 5b. The comparison results appear graphically in the pie chart to the right.
 - d. Click the Navigation button.
 - e. Click Annual Emission Reports
6. Annual Emission Reports
- a. Click on the desired year of data to view it in the Annual Report navigation bar. A summary of the data entered for that year is presented in tabular and graphical form. Chart labels may need to be modified or relocated. The position of labels is done automatically by Excel and some labels may overlap. These charts were designed for reporting purposes. The tables also show annual changes in emissions for each category from the previous year.
 - b. Click in the Annual Report navigation bar to view other years in a similar way.
 - c. If desired, select the charts and/or tables individually to place in a reporting document. Use the copy and paste function to place the charts/tables in the Word document.
 - i. The insert Excel Table or Excel Graph feature is another method to import the Annual Reporting charts and tables.
 - d. Graphs and tables can be printed directly from the Excel file. Be sure to note that every third page is blank.
 - e. Click the Navigation button.
 - f. Click Emission Reduction Analysis
7. Emission Reduction Analysis
- a. Enter data for expected mitigation projects. This process is similar to the data entry process. The category of emissions that is being reduced as well as the year the project impact will begin should be selected.
 - b. Prices can be modified in the Project Resource Savings table to reflect actual unit resource prices necessary. This table must be modified manually if categories are changed in the first column of the Data Categorization table.
 - c. The Graph Inputs table can be modified to analyze potential reduction targets.

8. Municipal Intensity Factors
 - a. Users can enter annual data related to the size of the municipality of interest on the Emission Intensity tab to understand how size and growth impacts the per unit quantity of specific sources of emissions.
 - b. If categories in the Data Categorization table of the Input Home worksheet are modified from the default City of Columbus values, this worksheet must be updated manually before it is used. Intensity factors are not commonly used for municipal emissions inventories and can often be confusing.
9. Emission Factor Data
 - a. Users can modify historical, current or future emission factor data for each emission category and year. Changes to emission factors in this worksheet are reflected throughout the tool. Users can click on the emission factor category column title to view the documentation for the data.
10. Emission Factor Documentation
 - a. Default sources, references and websites for each emission factor are listed here.
11. Unit Conversions
 - a. This worksheet can be used as a reference to convert raw data into appropriate units to match emission factor data.